THE UNIVERSITY OF ZAMBIA SCHOOL OF NATURAL SCIENCES

2008 SECOND SEMESTER

1. BS212- PLANT AND ANIMAL PHYSIOLOGY
2. BS319- BIOSTATISTICS
3. BS322-ECOLOGY
4. BS322-ECOLOGY
5. BS332- ANIMAL PHYSIOLOGY
6. BS332-ANIMAL PHYSIOLOGY
7. BS342-MYCOLOGY
8. BS349-MICROBIOLOGY
9. BS352- PARASITOLOGY
10. BS362-GENETICS
11. BS412-APPLIED ENTOMOLOGY
12. BS432-ADVANCED PARASITOLOGY
13. BS435-MEDICAL MICROBIOLOGY
14. BS442-ADVANCED MOLECULAR BIOLOGY
15. BS445-ECOPHYSIOLOGY OF PLANTS
16. BS455-WILDLIFE ECOLOGY
17. BS482-FOOD MICROBIOLOGY
18. BS925-BIOLOGY OF TERRESTRIAL VERTEBRATES
19. C102-INTRODUCTORY CHEMISTRY II
20. C205-ANALYTICAL AND INORGANIC CHEMISTRY
21. C225-ANALYTICAL CHEMISTRY I
22. C265-BASIC PHYSICAL CHEMISTRY
23. C312-BIOCHEMISTRY II

24. C321-ANALYTICAL CHEMISTRY II
25. C322-ANALYTICAL CHEMISTRY III
26. 342-INORGANIC CHEMISTRY III
27. C352-ORGANIC CHEMISTRY IV
28. C362-COLLOIDS AND ELECTROCHEMISTRY
29. C412-ADVANCED BIOCHEMISTRY II
30. C422-APPLIED ANALYTICAL CHEMISTRY
31. C452-ADVANCED ORGANIC CHEMISTRY II
32. C492-ORGANIC INDUSTRIAL CHEMISTRY
33. CST2032-FUNDAMENTALS OF COMPUTER ARCHITECTURE
34. CST2041-INTRODUCTION TO OPERATING SYSTEM
35. CST2042-INTRODUCTION TO DATABASES AND FILE SYSTEMS
36. CST2042-INTRODUCTION TO DATABASES AND FILE SYSTEMS
37. CST3011-ALGORITHMS AND DATA STRUCTURES
38. CST4021-NUMERICAL ANALYSIS
39. CST4131-ADVANCED OBJECT ORIENTED PROGRAMMING WITH JAVA
40. CST4252-ELECTRONICS FOR COMPUTING IV
41. GEO112-INTRODUCTION TO HUMAN GEOGRAPHY II
42. GEO175-INTRODUCTION TO MAPPING TECHNIQUES IN GEOGRAPHY
43. GEO212-GEOGRAPHY OF ZAMBIA
44. GEO272-QUANTITATIVE TECHNIQUES IN GEOGRAPHY II
45. GG322-STRATIGRAPHY AND REMOTE SENSING
46. GEO482-ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT II
47. GEO492-NATURAL RESOURCES ECONOMICS
48. GEO495-ENVIRONMENTAL HAZARDSAND DISASTERS

49. GEO922-GEODRAPHY OF REGIONAL PLANNING AND DEVELOPMENT
50. GEO932-URBAN GEOGRAPHY
51. GEO952-GEOGRAPHICAL HYDROLOGY
52. GEO962-BIOGEOGRAPHY
53. GEO971-AIRPHOTOGRAPHY
54. GEO972-SATELITE REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS
55. GEO995-ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT I
56. M111-MATHMATICAL METHODS I
57. M162-INTRODUCTION TO MATHMATICS, PROBABILITY AND STATISTICS II
58. M212-MATHMATICAL METHODS IV
59. M292-INTRODUCTION TO PROBABILITY
60. M422-MODULE AND FIELD THEORY
61. M32-REAL ANALYSIS VI
62. M912-MATHMATICAL METHODS VI
63. M962-TIME SERIES ANALYSIS
64. P198-INTRODUCTORY PHYSICS
65. P332-STATISTICAL PHYSICS
66. P342-DIGITAL ELECTRONICS
67. P412-NUCLEAR PHYSICS
68. P442-DIGITAL ELECTRONICS II
69. P485-PHYSICS OF RENEWEABLE ENERGY RESOURCES AND ENVIRONMENT

THEUNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 212: PLANT AND ANIMAL PHYSIOLOGY, PRACTICAL PAPER

TIME: TWO HOURS

INSTRUCTIONS: ANSWER **ALL** QUESTIONS

Use separate answer books for each section

SECTION A: Plant Physiology

1. The rate of water flow (Jv) in plant tissues is determined by the driving force and the resistance to water movement.

   (a) Express water flow rate (Jv) in terms of the driving force and hydraulic conductivity (Lp) and in terms of the driving force, tissue resistance (r) and cross section area (A) through which the water flows.

   (b) The hydraulic conductivity (Lp) of a 400 mm long maize root system was found to be 1×10^{-7} m s^{-1} MPa^{-1} and the root surface area (Ar) was 7.5×10^{-3} m^2, calculate the hydraulic root resistance (Rr).

SECTION B: Animal Physiology

2. (a) List the cellular and non-cellular compartments of blood.

   (c) Define and calculate a haematocrit in a practical situation.

   (d) List the factors which cause a decreased haematocrit

3. (a) Differentiate between serum and plasma.

   (a) State the functions of plasma proteins.

4. (a) Draw a labeled diagram of chick embryo at about 72 to 75 hours of incubation.

(b) Describe in detail the structure of a chicken egg and explain the functions of the various parts.

5. (a) Explain how nitrogenous waste products of dietary protein metabolism are removed from the body in different animal groups.

(b) How are these animal groups classified on the basis of nitrogenous waste products?

(c) Briefly describe the habitats associated with the animal groups mentioned above.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 212: PLANT AND ANIMAL PHYSIOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS, WITH AT LEAST TWO QUESTIONS FROM EACH SECTION. USE SEPARATE ANSWER BOOKS FOR EACH SECTION.

SECTION A: Plant Physiology

1. Summarise the physiological roles of gibberellins in plant growth and development.
2. Draw a scheme of CO_2 fixation in C-3 photosynthesis, clearly indicating carboxylation, reduction and regeneration phases of the cycle and the enzymes catalyzing each step.
3. Describe briefly the cohesion-tension theory of water movement in the xylem and summarize the main issues in the controversy surrounding its validity.
4. Draw a table showing the mineral elements required for normal growth and development of plants, distinguishing between macronutrients and micronutrients. Give one function of each listed element.

SECTION B: Animal Physiology

5. Describe the feeding strategies of the various animal groups.
6. Describe the composition and function of pancreatic juice, and explain how the composition is regulated.
7. Explain how sharks and freshwater fish deal with the physiological problems associated with osmotic and ionic regulation.

TURN OVER

8. Summarise each of the following:

(a) Synaptic transmission and the roles of neurotransmitters in synaptic transmission
(b) Cell membrane potential
(c) Euryhaline versus stenohaline
(d) Gonadogenesis

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 319: BIOSTATISTICS
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS

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1. Data for a completely randomized design with 3 treatments and 4 replications per treatment are shown below. The data represent protein percentages in maize at 2, 4 and 9 weeks after December 1 in Lusaka province for the 2008-2009 crop-growing season.

Replications	Weeks after December 1, 2008 (= Treatments)		
	2 Weeks	4 Weeks	9 Weeks
1	33	15	11
2	25	21	9
3	21	14	7
4	29	18	13

Test the Null Hypothesis (H_o) that there are no significant differences in the protein content of maize for the three treatments (i.e. periods in weeks).

2. The following data describe the state of grief of 66 mothers who have suffered a neonatal death (death of a baby within one month of birth). The table relates this to the amount of support given to them by hospitals and relatives:

Grief State	Type of Support		
	Good	Adequate	Poor
I	17	9	8
II	6	5	1
III	3	5	4
IV	1	2	5

TURN OVER

Test the Null Hypothesis (H_o) that there is no association between the state of grief in the mothers and the support they receive from hospitals and relatives.

3. The results of a Randomized Block Design (RBD) experiment are presented below in which for some unknown reasons, two cells, a and b are blank (i.e. with no results).

TREATMENTS	BLOCKS (Replicates)		
	1	2	3
1	11	13	16
2	18	20	b
3	a	29	30
4	29	30	31

a. Estimate the values of the missing data in cells a and b.
b. Conduct an ANOVA of the complete data.

4. The height in metres of third year male students (n=15) were measured against their age and the following were the results:

Height (m)	Age (years)
1.58	28
1.60	34
1.62	24
1.64	23
1.66	33
1.68	29
1.70	30
1.72	26
1.74	24
1.76	27
1.78	31
1.80	22
1.82	21
1.84	32
1.86	25

(a) Derive the linear regression equation
(b) Determine the variability of the deviations of y from the regression line.
(c) What would be the height of a 36 year old male student?

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5. Two samples of the Kafue weed, with 6 plants each, were collected from two locations of the Kafue River between Mazabuka and Kafue gorge dam. The lengths of the root systems of the plants (cm) were as follows:

SAMPLE 1	SAMPLE 2
97	88
104	101
17	87
101	67
31	65
98	43

a. Examine the significance of the difference between the mean root lengths, assuming that the population variances of the samples are equal.
b. Test the equality of variances of the two root system samples.

6. The number of elephants was counted in relation to proximity to human settlements (kilometres) in 6 different National Parks. The following were the results:

National Park	Number of Elephants	Distance of nearest settlement (km)
Kafue	28	8.0
Blue Lagoon	16	5.5
South Luangwa	14	4.5
Kasanka	20	3.5
Lochinvar	20	5.0
Mosi-oa-tunya	27	3.3

(a) Find the covariance between the number of elephants and proximity to human settlements.
(b) Determine whether there is correlation between the number of elephants and proximity to human settlements.
(c) Test the Null Hypothesis (H_o) that $\rho=0$.

7. (a) Explain how a normal distribution curve looks like and why is it important.
(b) State two parameters that fix or characterize the binomial distribution.
(c) Explain when a t-distribution must be used instead of a normal distribution.
(d) State the relationship of χ^2 to $N(0, 1)$.
(e) Five coins are tossed at once. Let, **r**, represent the number of heads in the toss. Thus, **r**, can have values 0,1,2,3,4 5. Determine the distribution of **P(r)** in the toss of the five coins.

8. The following measurements of length (in mm) of the antennae of 10 males and 10 females of the 6th developmental stage of the Armoured ground cricket, *Acanthoplus speiseri* Brancsik, collected in bushes, west of Kaunda Square Stage I, in Lusaka, were recorded by a researcher at the Department of Biological Sciences:

Specimen Number	1	2	3	4	5	6	7	8	9	10
Sex										
Male	76.1	67.0	61.0	62.5	53.0	52.0	66.4	60.0	59.0	73.6
Female	77.6	57.4	66.0	65.0	65.6	69.3	66.0	58.0	65.0	63.0

(a) Calculate the 95% confidence limit of the mean antennal length of each sex.

(b) Test the Null Hypothesis (H_o) that the two sexes have antennae of the same length.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 – 2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 322: ECOLOGY
THEORY PAPER

TIME: THREE HOURS
INSTRUCTIONS: ANSWER QUESTION **1** AND ANY OTHER **FOUR** QUESTIONS.
ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

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1. An ecologist carried out a census of grasshoppers on a 50m x 50 m grassland plot using the capture-recapture method. In the first random sample, 49 grasshoppers were caught, 45 were marked and released into the population. In the second random sample, 45 grasshoppers were captured out of which 10 were recaptures. Estimate the grasshopper population size and explain the assumptions associated with this method.

2. Explain the structure of energy pyramids in ecosystems using the laws of thermodynamics.

3. Discuss the intermediate disturbance hypothesis.

4. Describe how community patterns are estimated and their relevance in community dynamics.

5. Summarise the following:
   (a) the fate of energy and matter in the grazing food chain
   (b) open and cybernetic ecosystems

6. Compare and contrast each of the following pairs in relation to succession:
   (a) pioneer and late seral plants
   (b) facilitation and inhibition

7. Describe the characteristics of the savanna biome.

8. Describe the different types of ecological efficiencies and their relevance to food chains.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER [redacted] EXAMINATIONS – FEBRUARY/MARCH 2008

BS322

ECOLOGY

(PRACTICAL PAPER)

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER ALL FIVE QUESTIONS AND USE ILLUSTRATIONS WHEREVER POSSIBLE.

Question 1. A researcher monitored the development of a grassland community in a 1 x 1 m quadrat that was tilled in November 1996 by recording grass species on the quadrat for nine years and obtained the results shown in the Table below.

Number of grass species recorded annually in a tilled quadrat from 1997 to 2005.

Year	1	2	3	4	5	6	7	8	9
Species	0	3	3	2	4	6	6	9	8

Using a species-time relationship, discuss the development of this grassland community and its significance to the concept of succession.

Question 2. What ecological gradients or structural components do photographs G, H, I and J represent and give reasons for your answers.

Question 3. What Raunkiaer's life forms do photographs K, L, M and N represent and give reasons for your answers.

Question 4. What types of species interactions are represented by photographs X, Y, Z and AA and give reasons for your answers.

Question 5. Photograph S represents a trophic structure at a savanna habitat near Lusaka. Describe and illustrate the trophic structure.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 – 2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 322: ECOLOGY
PRACTICAL PAPER

TIME: THREE HOURS
INSTRUCTIONS: ANSWER **ALL** FOUR QUESTIONS. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

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1. The following data represent the percentage catch of prey and predatory fish in the Zambian portion of Lake Tanganyika from 1975 to 1980.

	1975	1976	1977	1978	1979	1980
Prey fish	79	60	31	56	60	19
Predatory fish	6	27	57	26	30	57

   Analyse the data and describe the results using the Lotka – Voltera model.

2. Gross primary productivity (GPP) in Lochinvar National Park on the Kafue Flats is estimated at 16 tonnes/km^2/year and the large herbivore productivity is 0.4 tonnes/km^2/year. If 20% of the GPP is used by plants in metabolism, and the consumption and assimilation efficiencies of large herbivores are 30% and 25% respectively, calculate:
   (a) net primary productivity (NPP)
   (b) amount in kg of plant biomass consumed by herbivores
   (c) amount in kg of plant biomass assimilated by herbivores
   (d) the production efficiency of large herbivores

3. The following are the life form spectra in biomes A and B as indicated in Figures 1 and 2 respectively. Compare and contrast the life forms in the two biomes.

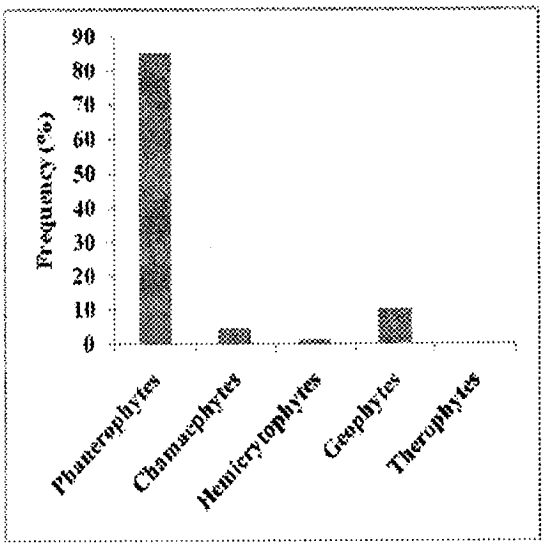

Figure 1

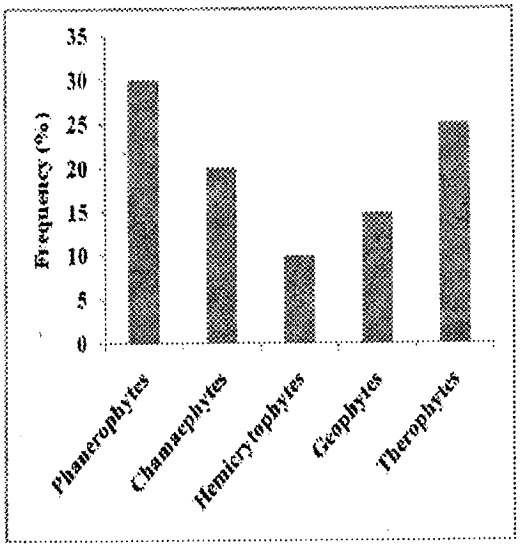

Figure 2

4. The data below were collected in two 50m x 100m quadrats established on Great East Road Campus. Determine the importance value of the tree species.

Species	Frequency	Density	Basal area (m^2)
Delonix regia	2	29	44.37
Ficus elastica	1	53	113.95
Ficus religiosa	1	43	309.33
Gmelina arborea	2	59	237.77
Spathodea campanulata	1	6	10.44

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 332: ANIMAL PHYSIOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS WITH AT LEAST TWO QUESTIONS FROM EACH SECTION. USE SEPARATE ANSWER BOOKS FOR EACH SECTION. USE ILLUSTRATIONS WHERE NECESSARY

SECTION A

1. (a) Describe the structure of the nephron.
   (b) Discuss the three major processes used by the vertebrate kidney to produce the final composition of urine.

2. Summarize the following:
   (a) Hering-Breuer reflex
   (b) Capillary membrane fluid exchange
   (c) Renal clearance
   (d) Normal electrocardiogram (ECG).

3. Discuss the cardiovascular responses during exercise.

4. Discuss the processes involved in the acclimation of mammals to environmental hypoxia.

SECTION B

5. Discuss the physiological mechanisms that enable animals to survive in environments whose parameters markedly differ from those of their own internal environments.

6. Discuss the signal transduction cascade triggered during the visual response.

TURN OVER

7. (a) Compare and contrast the biochemical mechanisms of steroid and non-steroid hormones.
   (b) Discuss the roles, functions and regulation of the hormones of the hypophysis.

8. Compare and contrast hearing in humans and echolocation in *Myotis lucifugus*, the brown bat.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER DEFERRED EXAMINATIONS – MARCH 2008

ANIMAL PHYSIOLOGY (THEORY)
BS 332

TIME: THREE HOURS
INSTRUCTIONS: ANSWER ANY **FIVE** QUESTIONS
ALL QUESTIONS CARRY EQUAL MARKS

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1. a.) What is a nephron?
   b.) List and discuss the processes used by the mammalian kidney to achieve the final composition of urine.

2. List and discuss the factors that regulate energy intake.

3. a.) What is hypoxia?
   b.) Explain the processes involved in the acclimation of mammals to reduced availability of oxygen.

4. Describe the different types of muscle fibre proteins and discuss their functions.

5. State important anterior pituitary gonadotropins. Explain their functions in the reproductive cycle of a female mammal.

6. Give some examples of symbiotic micro-organisms in the alimentary canal of the herbivore and explain how they benefit their host.

7. a.) What is a receptor?
   b.) Classify different types of receptors.
   c.) Explain their properties.

8. Write short notes on the following:
   a.) Bile
   b.) Basal ganglia
   c.) Pancreatic enzymes
   d.) Leptin

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER EXAMINATIONS – FEBRUARY 2008

BS 332

ANIMAL PHYSIOLOGY (THEORY)

TIME: THREE HOURS
INSTRUCTIONS: ANSWER ANY FIVE QUESTIONS. ALL QUESTION CARRY EQUAL MARKS

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1. (a) What is osmoregulation?
   (b) Describe in detail the physiological adaptations involved in osmoregulation in different animal groups.

2. Cyclic adenosine monophasphate (cAMP) is not the only second messenger system used by different hormones. Two other important ones are (1) the calcium – calmodulin second messenger system, and (2) the phopholipid second messenger system (diacylglycerol, inositol triphosphate, and phosphatidylinositol triphosphate).

   Explain in detail the:

   a) cAMP second messenger mechanism, and either
   b) calcium-calmodulin second messenger system, or
   c) phopholipid second messenger system,

3. a) What are receptors
   b) Classify them
   c) Explain their properties

4. a) What is puberty?
   b) Discuss the gonadotropic hormones and their effects on ovaries.

5. Write short notes on:

   a) Glucostatic theory of hunger.
   b) Fever.
   c) Capillary membrane fluid volume exchange.
   d) Synaptic transmission.

6. Discuss the compensatory measures that occur in response to a fall in core body temperature as a result of cold exposure and in response to the rise in core body temperature as a result of heat exposure.

7. Describe the sliding – filament mechanism of skeletal muscle contraction. How do cross-bridge power strokes bring about shortening of the muscle fibre.

8. Describe the cardiovascular changes during exercise.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 342: MYCOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. ANSWERS TO QUESTIONS 1-5 AND 6-8 SHOULD BE MADE IN SEPARATE ANSWER BOOKS. ALL QUESTIONS CARRY EQUAL MARKS.

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1. (a) Distinguish between plasmogamy and karyogamy.
   (b) Describe the sexual life cycle of a named Zygomycotina.
   (c) Explain how this fungus is adapted to survive unfavourable conditions.

2. Describe the formation of septa in fungi and explain their significance in the success of fungi.

3. Discuss the phenomenon of differentiation as an adaptive feature in *Beauveria bassiana* (Bals.) Vuill. an insect pathogen.

4. Describe the different kinds of methods used to assess growth in fungi and explain the advantages and disadvantages of each one of them.

5. (a) Describe catabolite repression with respect to carbon nutrition.
   (b) Explain how a mixture of carbohydrates in the environment are utilised by fungi as a source of nutrients.

6. (a) Compare and contrast fungal predation and parasitism.
   (b) Describe the mechanisms by which fungi capture their prey.

7. Explain food contamination and spoilage by fungi and discuss the associated health problems in humans.

8. Describe dermatophytes and their role in human health.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SECOND SEMESTER UNIVERSITY EXAMINATIONS
FEBRUARY 2008

BS 342: MYCOLOGY
PRACTICAL PAPER

ANSWER ALL QUESTIONS:
ALL QUESTIONS CARRY EQUAL MARKS

TIME: THREE HOURS

1. (i) Give the proportions of potatoes, dextrose and water required for the preparation of potato dextrose agar medium.
   (ii) At what stage of medium preparation is autoclaving required. State the temperature and pressure required for this purpose.
   (iii) How do you determine the minimum amounts of agar medium to be poured in a Petri dish?

2. Compare and contrast the extent of growth and colony texture of specimens P, Q and R. Give metabolic reasons for the differences observed.

3. Examine microscopic preparations labelled S, T, U and V. Make a drawing of each specimen to illustrate their reproductive features. Compare and contrast their reproductive features.

4. The following are hypothetical results of an experiment using one fungus species.

   Table of the total number of conidia produced (x 10^8) per centimetre cubed of soil per month.

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Sterilised soil	8	15	25	50	80	90	88	91	89	85
Unsterilised soil	10	20	30	55	60	55	56	70	60	66

   (i) Plot graphs of the results on the graph paper provided.
   (ii) What type of growth is demonstrated by the fungus growing in sterilised soil between November and March.?
   (iii) Give reasons for the fungus growth shown in sterilised soil between April and July.
   (iv) Explain the difference in growth of the fungus between April and July in sterilised and unsterilised soil.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2006-2007 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

Theory Paper

BS 349: MICROBIOLOGY

TIME: THREE HOURS

INSTRUCTIONS:

Answer Section A (Compulsory). Answer Two questions each from Section B & C. A total of FIVE questions should be answered.

Answer each section in a SEPARATE answer book.

SECTION A

Question 1. Write brief notes on any **FOUR** of the following:

i. Microbial ecology as a science
ii. History of Microbial ecology
iii. Nutrition of soil bacteria
iv. Significance of actinomyces
v. Ecology of soil fungi
vi. Microbial communities and ecosystems

SECTION B

Question 2 a. How does Carl Woese divide organisms into domains in his universal phylogenetic tree? List at least three major Characteristics that differentiate the domains.

2 b. Briefly discuss natural, phenetic and phylogenetic classification systems.

Question 3 a. What is meant by Biochemical Pathways of energy production?

3 b. Chemoheterotrophic organisms produce energy by several pathways. Discuss the generation of energy in glycolysis, respiration and fermentation.

Question 4 a. What data is required to calculate the generation time of a bacterial culture in the exponential phase of growth?

4 b. Calculate the generation time time of a bacterial culture when its population increases from 10^6 to 10^{12} cells in 10 hrs?

Question 5.a. Classify microorganisms according to

(i) their preference for temperature and
(ii) their oxygen requirement.

5 b. Explain how oxygen becomes toxic to some microorganisms when they grow in its presence. How do organisms that tolerate oxygen differ from those that are poisoned by it?

SECTION C

Question 6. What is glycocalyx? Describe the structure and function of glycocalyx in bacteria and explain how its presence can be microscopically revealed.

Question 7. Discuss bacterial cell wall appendages with reference to types, structure and function.

Question 8. What are the characteristics of viruses? Why are viruses considered so important? Describe virus structure and their genome types.

Question 9. Write short notes on any **FOUR** of the following:

i. Baculovirus
ii. Botulism
iii. Prosthecae
iv. Transformation
v. Nucleiod
vi. Enveloped viruses

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 352 : PARASITOLOGY
THEORY

TIME : THREE HOURS

INSTRUCTIONS : ANSWER ANY **FIVE** QUESTIONS AND USE ILLUSTTRATIONS WHEREVER POSSIBLE. ANSWER EACH QUESTION ON A SEPARATE ANSWER SHEET

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1. Describe in detail the life-cycle of Giardia intestinalis. Relate this to the pathology it causes in its definitive host and the resultant clinical symptoms.

2. Describe the life-cycle of Trypanosoma (brucei) rhodesience. Suggest the control measures of the disease caused by this parasite

3. a. Describe the structure of sporulated Eimeria tenella oocyst.
   b. State the mode of locomotion of the following parasites:
      I. Balantidium
      II. Trichomonas vaginalis
      III. Plasmodium falciparum
      IV. Toxoplasma gondii
      V. Entamoeba histolytica
   c. Distinguish between salivaria and stercoraria

4. Discuss the development and life-cycle of an acanthocephalan

5. Describe in detail the part of life-cycle of plasmodium in mosquito. Suggest some important central measures

6. a. Describe the life cycle of a parasite in which Retro-infection transmission is involved.
   b. Discuss the process that makes *Stongyloides stercoralis* infection life-threatening in immunocompromised hosts.

7. Write short notes on each of the following:

   a. Development of elephantiasis in *Wuchereria bancrofti* infections.
   b. Development of Cysticercosis in human hosts

c. Granulomous formation in humans infected with schistosomes.

8. Describe:

a. The host, parasite and environmental features important in the transmission of human schistosomes.
b. Pathogenesis in *Onchocerca vulvulus* infections
c. Pathogenesis in hookworm and *Ascaris lumbricoides infections*

The University of Zambia

School of Natural Sciences

Second Semester University Examinations

February, 2008

BS 352
PARASITOLOGY
PRACTICAL PAPER

Time: Three (3) Hours

Instructions:

1. Answer **ALL** questions
2. For each specimen provided, labelled specimen I (SI) to specimen II (S II) and provide the following information:

a. Species name
b. Developmental stage
c. Sex (where applicable)
d. Vector species (where applicable)
e. Intermediate host species (where applicable)
f. Definitive host
g. The role it plays in transmission
h. Type of life-cycle for each species.

END OF EXAMINATION

LIB

THE UNIVERSITY OF ZAMBIA
SECOND SEMESTER EXAMINATIONS

FEBRUARY 2008

BS 362 GENETICS (I)

THEORY PAPER

TIME : Three (3) Hours

INSTRUCTIONS : Answer Two (2) Questions from Section A and Three (questions from Section B. All questions carry equal (20) marks. Inclusion relevant diagrams, illustrations, labels, drawings and tabulated information w enhance your answer. Answers to Sections A and B must be written in separa answer booklets. A scientific calculator may be used.

SECTION A. Answer any two questions.

Question 1

(a) Define the following terms:

(i) Mutation
(ii) Genetic recombination
(iii) Plasmids
(iv) Transposons
(v) Prototrophic and auxotrophic nutrition

(b) Use diagrams to illustrate the experimental design by Lederberg and Tatum involving genetic recombination between bacterial cells

(c) Distinguish among the following: F^+ cell/ Hfr cell/ F^- cell

Question 2

(a) Describe the remarkable properties of the bacterial fertility factor F.

(b) Define conjugation and use diagrams to illustrate the possible outcome of F^+ / F^- mating.

LIB

THE UNIVERSITY OF ZAMBIA
SECOND SEMESTER EXAMINATIONS

FEBRUARY 2008

BS 362 GENETICS (I)

THEORY PAPER

TIME : Three (3) Hours

INSTRUCTIONS : Answer Two (2) Questions from Section A and Three (3) questions from Section B. All questions carry equal (20) marks. Inclusion of relevant diagrams, illustrations, labels, drawings and tabulated information will enhance your answer. Answers to Sections A and B must be written in separate answer booklets. A scientific calculator may be used.

SECTION A. Answer any two questions.

Question 1

(a) Define the following terms:

(i) Mutation
(ii) Genetic recombination
(iii) Plasmids
(iv) Transposons
(v) Prototrophic and auxotrophic nutrition

(b) Use diagrams to illustrate the experimental design by Lederberg and Tatum involving genetic recombination between bacterial cells

(c) Distinguish among the following: F^+ cell/ Hfr cell/ F^- cell

Question 2

(a) Describe the remarkable properties of the bacterial fertility factor F.

(b) Define conjugation and use diagrams to illustrate the possible outcome of F^+ / F^- mating.

Question 2 continued

(c) Match each item in column A with the appropriate one in column B

#	Column A	#	Column B
A	Frameshift mutagen	1	A mutagen that is incorporated into DNA in place of a normal base
B	Nucleoside analogue	2	A mutagen that causes the formation of highly reactive ions
C	Base-pair mutagen	3	A mutagen that causes the formation of pyrimidine dimers
D	Ionization radiation	4	A mutagen that alters adenine so that it base pairs with cytosine
E	Non-ionization radiation	5	A mutagen that causes insertions

Question 3

(a) What are the components of R plasmids?

(b) Draw a diagrammatic representation of an R plasmid isolated from *E. coli* as seen by electron microscopy.

(c) Define transduction and explain the mechanism of generalised transduction. Draw a diagram to illustrate your answer.

SECTION B. Answer any three questions.

Question 4

(a) Explain the relationships among the following concepts: linkage, recombination frequency, chiasma frequency and genetic maps.

(b) In an experiment, markers were transferred from five Hfr bacterial strains to F^- strains in the following order:

Hfr strain	Order of entry
1	BKARM
2	DLQEOC
3	OEQLDN
4	MCOEQLDN
5	RAKBN

(i) Draw a circular map showing the sequence of these markers on the chromosome
(ii) For each strain, indicate on the map the site of insertion of the fertility factor
(iii) Briefly explain the experimental design employed for this kind of gene mapping

Question 5

(a) Distinguish between:
(i) Homologous and homeologous chromosomes.
(ii) Hyperploids and hypoploids.
(iii) Polysomics and polyploids.
(iv) Double trisomics and tetrasomics.

(b) Explain the common types of aneuploids.

(c) Outline the origin of amphidiploidy in *Brassica* species and the origin of allohexaploidy in bread wheat (*Triticum aestivum*).

Question 6

(a) The hardy-Weinberg law was discovered by two scientists working independently in the early 20th Century.
(i) State the assumptions made in the Hardy-Weinberg Law
(ii) Briefly explain the consequences of the failures of the assumptions
(iii) Briefly outline the applications of the Hardy-Weinberg Law

(b) The genetic locus that leads to haemophilia, a blood disorder, is on the human X chromosome. The frequency of haemophilia, caused by a recessive allele (h) at this locus, is 2.8% in the males from a sample population.
(i) Estimate the frequency of female carriers in the population
(ii) Estimate the frequency of haemophiliac females

Question 7

Two pure lines of a crop plant were crossed to produce F_1 hybrids. The total variance of one polygenetic trait of the F_1 hybrids was estimated to be 8.76. For the F_2 plants, the total variance of the trait was 40.96 while the variance due to dominance effects was 10.4.

(a) Estimate the broad sense heritability of this trait
(b) Estimate the narrow sense heritability of this trait
(c) Predict the genetic variance of the F_4 generation of this plant
(d) Suggest why it is important to estimate the heritability of a polygenic trait

Question 8.

(a) Give a brief account of genetic diseases
(b) Briefly explain the modern techniques which are employed in the diagnosis of genetic diseases
(c) Explain the significance of genetic counselling

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

SECOND SEMESTER UNIVERSITY EXAMINATIONS

FEBRUARY 2008 EXAMINATIONS

BS 412 APPLIED ENTOMOLOGY

PRACTICAL PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER ALL QUESTIONS.

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1. You are provided with an Identification Key to the genera based on the soldier caste.
   i. Identify and draw specimens **A** and **B** indicating the distinguishing diagnostic features.
   ii. Briefly outline collecting and preservation methods of these specimens.
   iii. What is the pest status of specimen **A** and **B**?

2. On the benches are specimens **C, D, E, F** and **G** believed to be of agricultural importance. For each specimen;
   i. Draw and label the diagnostic characteristic features
   ii. Identify the drawn specimen
   iii. State the pest status of each specimen

3. On the benches are specimens **H** and **I** believed to be of medical importance. For each specimen;
   i. Draw and label the diagnostic characteristic features
   ii. Identify the drawn specimen
   iii. Write brief notes about the biology and life cycle of each specimen.

4. On the bench you are provided with specimen **J.**
   i. Draw and label the diagnostic features of this specimen.
   ii. Identify the drawn specimen
   iii. What type of mouth parts does this specimen possess?

5. On the bench you are provided with specimen **K**.
   i. Name this specimen
   ii. What kind of nozzles can appropriately be used
   iii. In what situations can this specimen be appropriately used?

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 412: APPLIED ENTOMOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **TWO** QUESTIONS FROM EACH SECTION WITH THE **FIFTH** QUESTION FROM EITHER SECTION. USE SEPARATE BOOKLETS FOR EACH SECTION.

SECTION A

1. Discuss malaria vector control in Zambia.

2. Beneficial insects and their products can be used to improve rural livelihoods in Zambia. Argue for or against this statement.

3. (a) Explain the concept of Integrated Pest Management (IPM).
   (b) Discuss the prospects and constraints of introducing IPM programmes among small-scale farmers in Zambia.

4. A cotton field has been attacked by insect pests in Kanakantampa farming block area.
   (a) State the potential major pests you would expect to find in this field.
   (b) Describe the control measures you would recommend to the farmer.

SECTION B

5. Discuss the concept of economic injury level and its relevance to Integrated Pest Management (IPM).

6. In developing economic thresholds in pest management, several approaches are devised. Discuss the major classes in which these approaches can be grouped.

7. Describe in detail how pest intensity and the types of pest damage would influence crop yield loss.

8. (a) Describe the life cycle of the silkworm (*Bombyx mori* L.).
   (b) Explain in detail how silk is produced by *B. mori*.

END OF EXAMINATION

The University of Zambia
SCHOOL OF NATURAL SCIENCES

Second Semester University Examinations

February 2008

BS 432

Advanced Parasitology II

Theory Paper

Time: Three (3) Hours

Instructions: Answer Five (5) questions only. Only One (1) question from Section A, two (2) from section B and two (2) questions from Section C. Answers from each section should be in a separate answer book.

All questions carry equal marks. Illustrations (diagrams, graphs and tables) may enhance the quality of your answers.

Section A

Q1. A. What is the basic function of cellular respiration? Why is cellular respiration so critical to cells?

B. Discuss the major pathways of carbohydrates degradation and their end products in *Trypanosoma brucei*.

Q2. A. Distinguish between Lysosomes and Peroxisomes.
Explain the functions of each structure.

B. Discuss the major pathways of energy metabolism in *Trichomonas vaginalis*.

Section B

Q3. A. Draw the tegument of the Cercaria of *Schistosoma* mansoni and label its structure. Give the function of its surface coat.

B. Discuss the generalized pathways of carbohydrates in the adult stage of *Ascaris Lumbricoides*.

Q4. A. Draw a labeled diagram to show the organs of a molluscan body.

B. An outbreak of intestinal *Shistosomiasis* has broken out among Primary Schools children in a highly endemic area. You have been offered the following drugs for treatment.

a. Sodium antimony tartrate
b. Melarsoprol
c. Praziquantel
d. Metrifonate

(i) Which drug should be most effective against the parasite being tested.
(ii) Which drug would you recommend for large-scale treatment? Explain why?
(iii) State, to which group of drugs, does each drug belong
(iv) State the mode of action of your chosen drug
(v) Write the chemical structure of your recommended drug.

Q5. A. Write short notes on the following *Schistosome* stages:

(i) egg
(ii) miracidium
(iii) sporocyst

B. Onchocerciasis is a filarial infection which causes blindness and debilitating skin lesions.

(i) Give the scientific names of both the parasite that causes the above mentioned disease and its Vector.
(ii) List the names of three (3) drugs that could be used for the treatment of Onchocerciasis.
(iii) What is the drug of choice that is suitable for large-scale onchocerciasis.
(iv) State the impact of the recommended drug on the eye and skin lesions.

Q7. A. (i) What is the infective stage of the *Eimeria tenella* parasite?

(ii) Draw a labeled diagram to show the ultra-structure of its infective stage.

(iii) Discuss the process of hatching and activation of the infective stage of *Eimeria tenella* parasite in the host.

B. State the major problems in developing successful anti-parasitic drugs.

Q8. A. Draw diagrams to show the development of *Taenia solium* stages in the life-cycle.

B. (i) Explain the mode of action of Metronidazole on *Entamoeba histolytica*.

(ii) Write the chemical structure of metronidazole and state its side effects.

(iii) Write a balanced bio-chemical equation for the conversion of Pyruvate to Lactate and name the enzyme that is involved in the chemical reaction.

END OF EXAMINATION

Section C

Q6. A. Draw and describe the structural and biological functions of the external surface of Cestodes.

B. Fill the following table:

No.	Drug	Synthetic or natural product	Made from	Half-life	Principal Use
1.	Artmisinin				
2.	Mefloquine				
3.	Chloroquine				
4.	Ivermectin				

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATION

BS 432: ADVANCED PARASITOLOGY II
THEORY

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. USE ILLUSTRATIONS WHEREVER POSSIBLE. ANSWER EACH QUESTION ON A SEPARATE ANSWER BOOKS.

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1. (a) Discuss the structure and function of a parasitic cell membrane.
   (b) Explain the mode of action of quinoline drugs that are used in the treatment of malaria.

2. (a) Discuss the carbohydrate and energy metabolism of the African Trypanosome, *Trypanosoma brucei*.

   (b) State one available drug for the treatment of early stage of human sleeping sickness and another drug for late stage cases. Explain the mode of action of each drug.

3. (a) Describe the ultra structure and functions of the following:
   (i) Flagella
   (ii) Glycosome
   (iii) Hydrogenosome

   (b) Discuss the carbohydrate and energy metabolism of the malaria parasite, *Plasmodium.*

4. (a) Discuss the carbohydrate and energy metabolism in Helminthes.

   (b) Describe the Variant Surface Glycoprotein of *Trypanosomes* (V. S. G).

TURN OVER

5. (a) Describe the function of the following structures:
   (i) Pellicle
   (ii) Contractile Vacuole
   (iii) Cytopharynx

   (b) Explain why further development of *Fasciola hepatica* metacercaria only takes place in the gut of the final host and neither within the tissues of its intermediate host nor attached to vegetation.

   (c) Name the drug of choice for *Fasciola* infection. Draw its chemical structure.

6. (a) Draw and describe the tegumentary structure and functions of the cestodes

   (b) Differences in Folate metabolism in man and protozoa have led to the development of anti-malaria drugs. Discuss the mechanism of action, therapeutic uses and adverse effects of these drugs. Support your answer by drawing the tree diagram of folate inhibitors.

7. (a) Discuss the migratory patterns of parasites that have invaded the host's body. Support your answer by drawing the process of migration.

   (b) List three (3) different drugs available for the treatment of gastro-intestinal nematode infestation of humans. State the mode of action and the side effect of each drug.

8. (a) Discuss the functional changes in the tegument (the parasitic surface) during transformation of the Schistosome from Cercaria to Schistosomulum and eventually to adult worm.

   (b) Discuss the major problems in developing successful anti-parasitic drugs. Explain the new approach that is being investigated for discovery and development of new anti-parasitic drugs.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 435: MEDICAL MICROBIOLOGY
PRACTICAL PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **ALL** QUESTIONS

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1. Examine specimens **A** and **B.**
   (a) Identify and describe the test that has been used on these specimens
   (b) Interpret the results of the test
   (c) Compare the sensitivity of the organsms in the test

2. Describe the growth characteristics of the organism growing in specimen **C.**

3. Two organisms are growing on MacConkey agar, specimen **D.**
   (a) Describe the growth characteristics
   (b) Explain why MacConkey agar is used
   (c) Explain the function of the components of this medium
   (d) Carry out microscopic examination of isolated colonies to determine the morphology of the organisms.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 435: MEDICAL MICROBIOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS

---

1 (a) Discuss the mechanisms by which antibacterial agents act to destroy bacteria.
(b) Explain why antiviral and antifungal drugs have limited spectrum of activity.

2. Explain the role played by the following bacterial structures and products in the pathogenesis of infectious diseases:
(a) fimbriae
(b) capsule
(c) plasmids
(d) verotoxin
(e) leucocidin

3. Describe the diarrhoeal syndromes caused by:
(a) Enterotoxigenic *Escherichia coli*
(b) *Shigella dysenteriae*
(c) *Clostridium perfringens*
(d) *Vibrio cholerae*

4. Discuss the procedures carried out by a clinical microbiology laboratory for the purpose of identifying pathogenic organisms and other agents of disease from clinical specimens.

5. Describe the attributes required for an organism to be pathogenic and how virulence is expressed.

6. Discuss the infection caused by varicella-zoster virus.

7. Distinguish tinea capitis and cryptococcosis with regard to their aetiology, pathogenesis, diagnosis, treatment and control

TURN OVER

8. Summarise any four of the following;
   (a) opportunistic pathogen
   (b) infectious disease
   (c) cytopathic effects
   (d) virulence determinants
   (e) therapeutic index
   (f) pathogenicity islands

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 442: ADVANCED MOLECULAR BIOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. **QUESTION 1 IS COMPULSORY.** ANSWER AT LEAST TWO QUESTIONS FROM SECTION A AND B. USE SEPARATE ANSWER BOOKS FOR EACH SECTION.

SECTION A

1. Imagine you isolated a plasmid from bacteria and digested the DNA with several restriction endonucleases, you analysed it on 0.9% agarose gel and got the picture in Figure 1. Draw the restriction map of the plasmid.

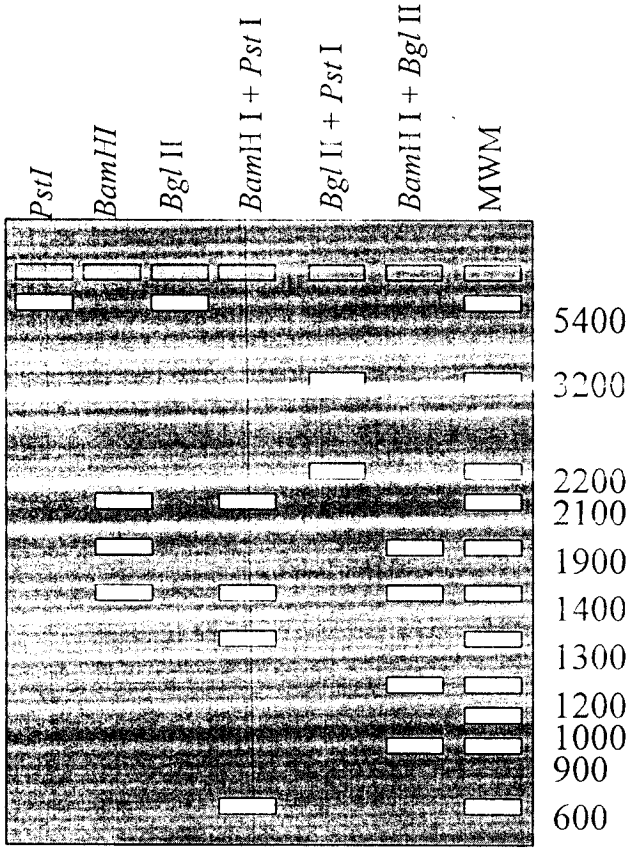


Figure 1. Agarose gel electrophoresis diagram for question 1. MWM = molecular weight marker. DNA fragment sizes in kilobase pairs are on the right hand side.

TURN OVER

2. Discuss why *Agrobacterium tumefaciens* has been described as a natural genetic engineer and design a generic experiment using *Agrobacterium tumefaciens* to over-express a gene in a model plant.

3. If you were given a mixture of ten tobacco (*Nicotiana tabacum*) seedlings containing a number of them believed to be expressing a foreign gene under an inducible promoter, discuss an approach that you would take to distinguish the transgenic from non-transgenic lines.

4. Explain the following and their applications in recombinant DNA technology:
   (a) Antisense Technology
   (b) Gene therapy
   (c) Phage Display technology
   (d) Glyphosate

SECTION B

5. Discuss any FOUR (4) DNA-based markers and how they are detected indicating the role polymorphisms play in the identification of species.

6. Discuss the methods used in the sequencing of the human genome and the benefits to research that have been gained in the publishing of the human genome as well as that of other organisms.

7. Giving specific examples, evaluate the expression of recombinant proteins in eukaryotes highlighting the significance of eukaryotic protein expression systems.

8. (a) Evaluate ONE methodological adaptation made to conventional PCR outlining the usefulness of this method.

   (b) Given the following sequence, design primers that would enable you to amplify cDNA from animal tissue highlighting the necessary steps that you would take to ensure that the primer sequences are correct. Illustrate where the designed primers will begin amplifying in RT-PCR.

```
  1  agactcagct *cctggtgaag ctcccagcca tcagccatga* gggtcttgta tctcctcttc
 61  tcgttcctct  tcatattcct gatgcctctt ccaggtgttt ttggtggtat *aggcgatcct
121 gttacctgcc ttaagagtgg* agccatatgt catccagtct tttgccctag aaggtataaa
181 caaattggca cctgtggtct *ccctggaaca aaatgctgca aaaagccatg* aggaggccaa
241 gaagctgctg tggctgatgc ggattcagaa agggctccct catcagagac  *gtgcgacatg
301 taaaccaaat* taaactatgg tgtccaaaga tacgca
```

Note: * sequence* marks the start and end of exons. The sequence has 4 exons.

END OF EXAMINATION

L/B

THE UNIVERSITY OF ZAMBIA
SECOND SEMESTER EXAMINATIONS

FEBRUARY 2008

BS 442 ADVANCED MOLEULAR BIOLOGY II

THEORY PAPER

TIME : Three (3) Hours

INSTRUCTIONS : Answer two (2) questions from Section A and three (3) questions from Section B. All questions carry equal (20) marks. Inclusion of relevant diagrams, illustrations, labels, drawings and tabulated information will enhance your answer. Answers to Sections A and B must be written in separate answer booklets.

SECTION A. Answer any two questions.

Question 1

(a) The following are names of some restriction enzymes commonly used in DNA cloning: *Bam* III, *Sal* I , *Taq* I, *Pst* I, *Hae* III and *Eco*RI. For each of the enzymes:

(i) Give the name of the organism from which it is derived
(ii) The sequence targeted by the enzyme

(b) Explain the relationship between restriction and modification in recombinant DNA technology.

Question 2

(a) Briefly describe the Sanger dideoxy method of DNA sequencing
(b) Suppose that you determine the DNA sequence of 3'- CGGTCCCGT -5' by the Sanger dideoxy method, sketch the gel pattern that would reveal the sequence of this oligonucleotide.
(c) Sketch the gel pattern that would reveal the DNA sequence in (b) above when the determination is done by the Maxam-Gilbert method.
(d) Outline the steps of the modern automated DNA sequencing method.

Question 3

Write short notes on each of the following ~~cloning vectors~~:
(a) Phasmids
(b) YACs
(c) Insertional inactivation
(d) Polycloning sites
(e) α-complementation in the *Lac* operon

SECTION B. Answer any three questions.

Question 4

What is Biosafety?
Highlight the concerns that have been raised in the use of DNA technology and explain the regulation(s) in place to overcome these concerns.

Question 5

(a) What is the importance of gene cloning in mammals?
(b) Outline the strategies involved in gene transfer in animal cells.
(c) Using a named example, describe how transgenic animals have been used to make recombinant proteins.

Question 6

Biotechnologists have used DNA techniques to develop transgenic maize using *Bt* toxins.
(a) Explain the basis of this technology.
(b) What strategies have been used to achieve this?
(c) What has been done to counteract the development of resistance to the toxins?

Question 7

In understanding the function of a given protein, you decided to carry out an *in vitro* manipulation of the DNA sequence of the protein in question. Fully describe how you would achieve this and outline all the necessary techniques available for use. What benefit does this have in Research?

Question 8

It is the nature of nature for organisms to employ means and ways to survive within their environments. Fully describe how Biotechnology has made use of these means and ways.

END OF EXAMINATION

THE UNIVERISTY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 445: ECOPHYSIOLOGY OF PLANTS
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS, WITH AT LEAST TWO QUESTIONS FROM EACH SECTION. USE ILLUSTRATIONS WHEREVER POSSIBLE. USE SEPARATE ANSWER BOOKS FOR EACH SECTION.

SECTION A

1. Discuss how light, water and temperature, affect Crassulacean Acid Metabolism (CAM).
2. Describe how photosynthesis in C-3 and C-4 subtypes is affected by environmental conditions such as light, CO_2, water availability and nutrient supply.
3. Discuss how light as an environmental factor affects the growth and development of plants, other than through the roles in photosynthesis.
4. Compare and contrast photosynthetic rates and duration of assimilation in terrestrial and aquatic plants and how they affect plant productivity.

SECTION B

5. Describe phenology and methods used to conduct phenological studies.
6. Contrast acute and chronic damage to plants caused by pollutants.
7. Discuss the usefulness of bioindicators in environmental management.
8. Discuss climate factors that affect growth in *Acacia polyacantha* in Zambia.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER EXAMINATIONS – FEBRUARY/MARCH 2008

BS445

ECOPHYSIOLOGY OF PLANTS

(PAPER)

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER FIVE QUESTIONS CONSISTING OF AT LEAST TWO QUESTIONS FROM EACH SECTION AND USE ILLUSTRATIONS WHEREVER POSSIBLE. USE SEPARATE ANSWER BOOKS FOR EACH SECTION.

SECTION A

Question 1. Discuss the ecophysiology of crassulacean acid metabolism with reference to carbon dioxide, water, light and temperature.

Question 2. Describe how C_3 and C_4 subtypes of photosynthesis are affected by environmental conditions, such as carbon dioxide concentration, water supply and nitrogen availability.

Question 3. Discuss the role of phytochrome in morphogenesis.

Question 4. How does light, other than in photosynthesis, affect plant growth and development?

SECTION B

Question 5. Discuss phenological plasticity in Zambian plants.

Question 6. Discuss the likely responses of savanna trees and grasses to climate warming in Zambia.

Question 7. Describe how plants respond to stress.

Question 8. Discuss the classification and usefulness of pollution indicators.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SECOND SEMESTER UNIVERSITY EXAMINATIONS

FEBRUARY 2008

BS 455
WILDLIFE ECOLOGY

PAPER TWO (PRACTICAL)

TIME: THREE HOURS

INSTRUCTIONS: ANSWER ALL QUESTIONS. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

---

1. Study the specimens provided and answer the following questions.

Specimen A:

(i) Class

(ii) Order

(iii) Family

(iv) Species

Specimen B:

(i) Describe appropriate census methods

(ii) Sexual dimorphism

(iii) Habitat preference

(iv) Describe Food habits

Specimen C:

(i) Give Species Name

(ii) Describe Breeding habits

(iii) Describe Distribution in Zambia

(iv) Describe capturing methods

Specimen D:

(i) Order

(ii) Describe Breeding habits

(iii) Dental formula

(iv) Conservation status

Specimen E:

(i) Scientific Name

(ii) Field impression

(iii) Distribution in Zambia

(iv) Habitat preference

2. Biologists monitoring populations of Impala (*Aeopyceros melampus*) on Chete island in lake Kariba, Sinazongwe between 1958 and 1985 gave figures as given in the table below. The island is approximately 5km^2 and is generally covered by a thicket of *Combretum* sp. Mean annual rainfall is 900mm. The island is a protected area and is regularly patrolled by game scouts. However, artisanal fishermen in the lake are allowed to land fish in certain parts of the island. For nearly 12 years the island was exposed to liberation war between 1968 and 1980, and part of the island was defoliated with herbicides. Impalas are polygamous and only a male breeds with a herd of females. Non breeding males form a bachelor herd. Using the information and data provided, explain the population trends, and discuss factors which could be most significant to this population on the island.

Table: Impala population at Chete island, lake Kariba, based on transect ground counts.

Year of Census	Total Population	Juveniles	Males	Females
1958	75	8	20	47
1968	136	6	54	76
1972	150	10	40	100
1975	308	40	58	210
1980	263	65	60	138
1985	232	72	65	95

3. Zambezi - Samaki Farms Ltd is considering establishing a Game Ranch in the Choma District along the Munyeki stream. Initial investigations show that the range is suitable for Impala, Zebra, Wildebeest, Kudu and Buffalo. The range is relatively flat, well watered and nearly all the range is within 3.5km from water. Based on the information from the Ministry of Agriculture, Food and Fisheries (MAFF) in Choma, the soils are generally excellent for the game ranch. Also results from your preliminary estimates indicate that the production of key forage species averages about 200kg/ha of dry matter per year. The proposed Sanctuary is 10,000 ha in size. Assuming that allowable use is 25% and daily dry matter intake is 2% of the animal body weight (a) how many 230 kg Sable antelopes can you stock as your base herd in the area and (b) State the main advantages and disadvantages of using mechanical animal capture method, and discuss difficulties associated with the translocation and restocking operations in wildlife management.

4. You are required to use the map provided to answer this question. Study the map carefully. It is assumed that you have just completed an ecological study of the area, and from this study answer the following questions:

(i) Which habitats are important for the following species and why?

(a) Sitatunga *(Tragelaphus spekei)*
(b) Zebra *(Equus burchelli)*
(c) Tsessebe *(Damaliscus lunatus)*
(d) Porcupine *(Hystrix africaeaustralis)*

(ii) Describe the process which you might recommend in establishing this area as a wildlife sanctuary or a Protected Area within the community.

INFORMATION FOR QUESTION TWO (4)

THE MAP AND THE DESCRIPTION OF THE AREA:

Vegetation types:

A: Termitaria grassland

B: Munga woodland

C: Chipya woodland

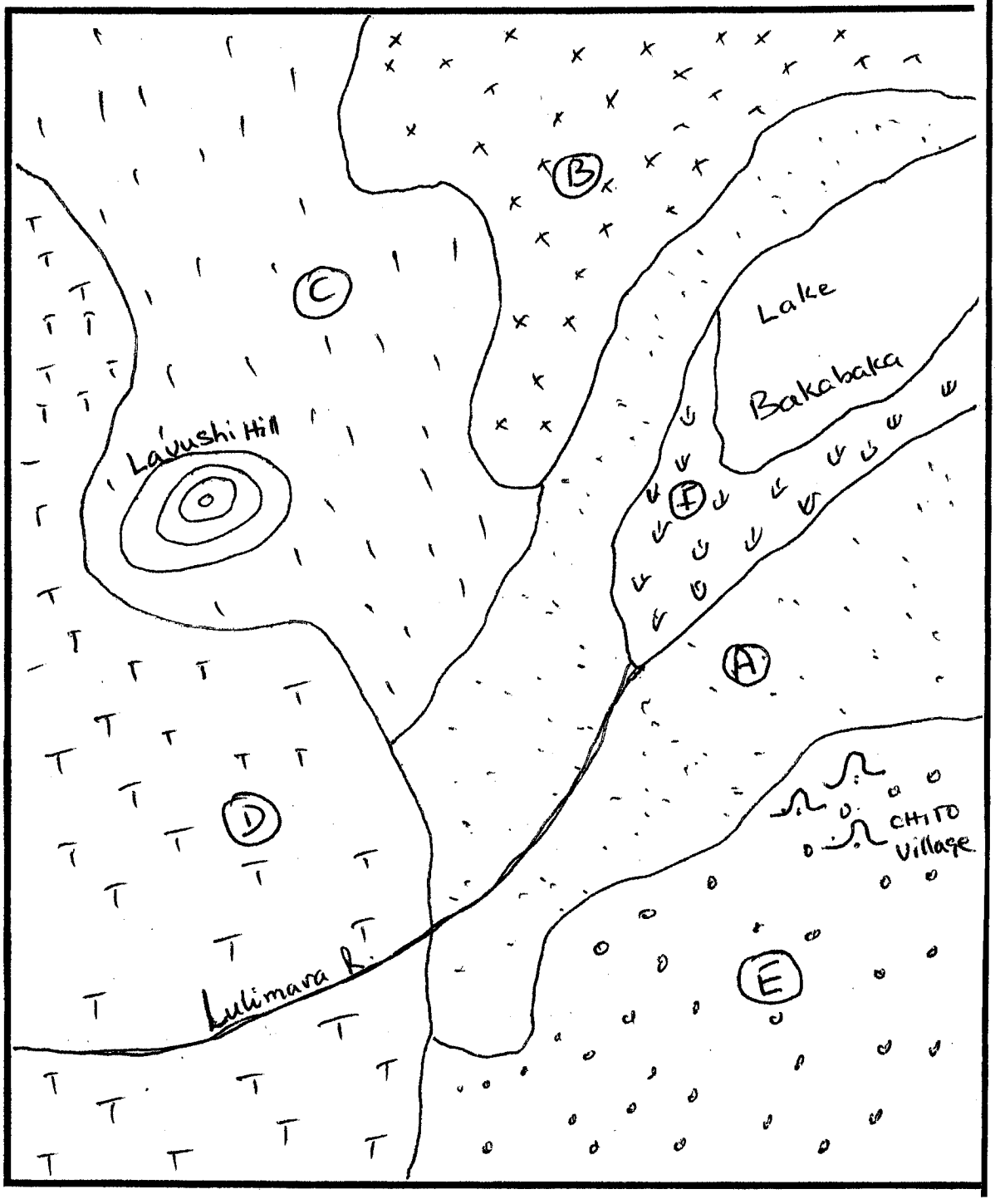
D: Miombo woodland

E: Hyparrhenia grassland

F: Swamp

The area is located in the western part of Mpika District in Chief Chiundaponde, Northern Province of Zambia. Average annual rainfall is approximately 1300 mm. Lake Bakabaka is a fresh water lake, and has fish. The river is perennial with riparian vegetation mainly *Diospyros sp* and *Zyzygium sp.* The Hot spring is salty. There is only one village of about seven household (or about 40 people). Its main activity is fishing. Farming is done at a low scale in vegetation type E. Hunting is important. The area is being considered for protection because of its importance to biodiversity. You have been asked to carry out an ecological study of the area. And from your study information, answer question three (4).

FIG. 1. for question 4



THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

BS 455: WILDLIFE ECOLOGY (Theory Paper)

TIME: THREE (3) HOURS
INSTRUCTIONS: ANSWER FIVE (5) QUESTIONS. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

1. Discuss the management application of the following terms as used in wildlife ecology: **(i)** Kidney/ Fat Ratio Index **(ii)** King Census method

2. Give a brief history of the Protected Area System in Zambia from the colonial era to the present, and give reasons why populations of most wildlife species are declining.

3. Provide brief definitions of the following terms as used in wildlife studies:

   a) Fecundity
   b) Dispersal mechanism
   c) *M 99*
   d) Animal Unit

4. Describe the main characteristics of a wildlife habitat and relate these to the significance of the *Mopane woodland* habitat in the conservation of wildlife species in Zambia.

5. Describe the process of determining the $1 - e^{-H}$ in the exploitation of wildlife populations, and discuss the assumptions and limitations of this model

6. Describe the procedure for establishing a Protected Area, and discuss limitations and difficulties in the management protected areas in Zambia.

7. The energy available to, and utilized by, an animal can serve many different functions. Suppose a herd of Impala (*Aepyceros melampus)* consists of a juvenile, adult female and a male in a game sanctuary within a Mopane woodland habitat, how would their energy demand be partitioned over the course of the year? Detail the patterns of energy flow from the environment to these animals, showing those resulting in either positive or negative energy balance.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 455: WILDLIFE ECOLOGY
THEORY PAPER

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER QUESTION **ONE (1)** AND ANY OTHER **FOUR (4)** QUESTIONS. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

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1. a) Zambezi - Samaki Farms Ltd is considering establishing a Game Ranch in the Choma District along the Munyeki stream. Initial investigations show that the range is suitable for Impala, Zebra, Wildebeest, Kudu and Buffalo. The range is relatively flat, well watered and nearly all the range is within 3.5km from water. Based on the information from the Ministry of Agriculture and Cooperatives in Choma, the soils are generally excellent for the game ranch. Also results from your preliminary estimates indicate that the production of key forage species averages about 200kg/ha of dry matter per year. The proposed Sanctuary is 10,000 ha in size. Assuming that allowable use is 25% and daily dry matter intake is 2% of the animal body weight, how many 230 kg Sable antelopes can you stock as your base herd in the area

   b) Describe the procedure for establishing a Game Ranch in Zambia.

   c) Discuss difficulties associated with the translocation and restocking operations in wildlife management.

2. Describe the process for determining the $1 - e^{-H}$ in the exploitation of wildlife populations, and discuss the assumptions and limitations associated with this model.

3. Explain the concept of carrying capacity in wildlife species populations as applied to a single population model, and discuss the assumptions and limitations associated with this model.

4. a) Describe features which would indicate that a wildlife species population was being overexploited

   b) Discuss the significance of the Community Based Natural Resources Management (CBNRM) in the governance of wildlife resources.

TURN OVER

5. Discuss the significance of (**r**) in a wildlife population and the assumptions and limitations associated with it.

6.
   a) Describe the main characteristics of a wildlife habitat and relate these to the ecology the Water Buck (*Kobus defassa*)

   b) Discuss the implications of island biogeographic theory in selecting an area for establishing a wildlife reserve in Zambia

7.
   a) Discuss features that would indicate that a wildlife habitat was being over utilised in an arid environment

   b) Describe a rehabilitation plan for a wildlife habitat of the following species:
      (i) Sitatunga (*Tragelaphus spekei*)
      (ii) Bush Buck (*Tragelaphus scriptus*)

8. Discuss in detail the management application of the following terms as used in wildlife ecology:

   (i) Kidney / Fat Ratio Index
   (ii) King Census method
   (iii) Invasive species
   (iv) *Struthio camelus*

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 455: WILDLIFE ECOLOGY
PRACTICAL PAPER

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER **ALL** QUESTIONS. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

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1. Each species listed below is an indicator for each habitat type. Complete the table by assigning each species (by marking with an X) to its one appropriate habitat type.

	SPECIES	Wetland habitat	Miombo woodland	Munga habitat	Mopane habitat	Combretum thicket
	Plant species					
1	*Acacia polyacantha*					
2	*Combretum imberbe*					
3	*Cyperus papyrus*					
4	*Diospyros senensis*					
5	*Echinochloa pyramidalis*					
6	*Julbernardia paniculata*					
7	*Oryza barthi*					
8	*Piliostigma thonningi*					
9	*Typha latifolia*					
10	*Vossia cuspidata*					
	Animal Species	Wetland habitat	Open grasslands	Hilly and rocky	Mopane woodland	Combretum thicket
1	*Aepyceros melampus*					
2	*Connochaetes taurinus*					
3	*Damaliscus lunatus*					
4	*Diceros bicornis*					
5	*Equus burcheli*					
6	*Kobus leche*					
7	*Oreotragus oreotragus*					
8	*Tragelaphus scriptus*					
9	*Tragelaphus spekei*					
10	*Wattled Crane*					

3. Biologists monitoring populations of Impala (*Aepyceros melampus*) on Chete Island in Lake Kariba, Sinazongwe between 1958 and 1985 gave figures as given in the table below. The island is approximately 5km^2 and is generally covered by a thicket of *Combretum* sp. Mean annual rainfall is 900mm. The island is a protected area and is regularly patrolled by Game Scouts. However, artisanal fishermen in the lake are allowed to land fish in certain parts of the island. For nearly 12 years the island was exposed to liberation war between 1968 and 1980, and part of the island was defoliated with herbicides. Impalas are polygamous and only a male breeds with a herd of females. Non breeding males form a bachelor herd. Using the information and data provided, explain the population trends, and discuss factors which could be most significant to this population on the island.

Table: Impala population at Chete island, lake Kariba, based on transect ground counts.

Year of Census	Total Population	Juveniles	Males	Females
1968	136	6	54	76
1972	150	10	40	100
1975	308	40	58	210
1980	263	65	60	138
1985	232	72	65	95

4. You are required to use the map (**Figure 1**) provided to answer this question. Study the map carefully, and then answer the following questions:
   a) Describe in detail each habitat type as indicated by the vegetation types.
   b) List and rank habitats according to the preference of the following species:

      i. Impala *(Aepyceros melampus)*
      ii. Water Buck (*Kobus defassa*)
      iii. African Buffalo (*Syncerus caffer)*
      iv. Kudu *(Tragelaphus strepsiceros)*

END OF EXAMINATION

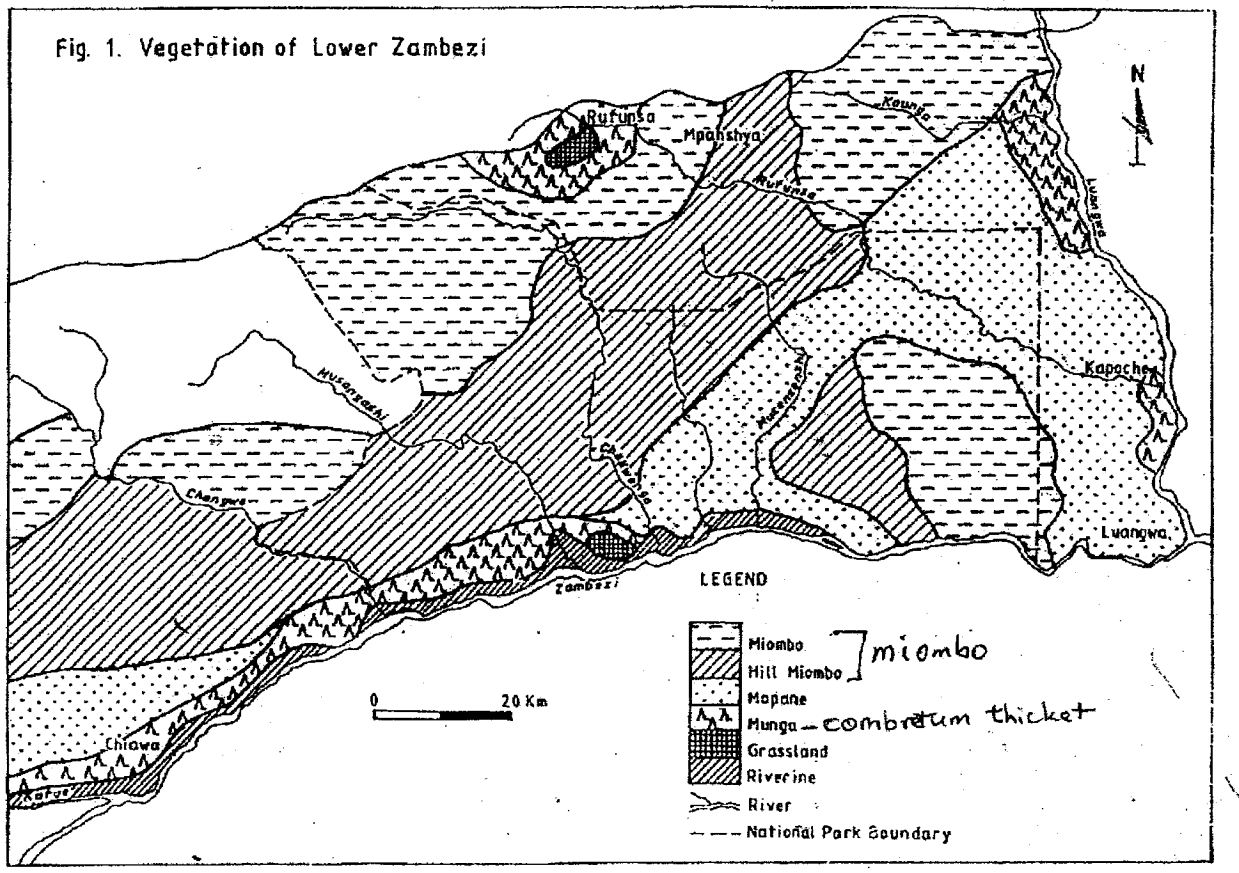

Figure 1: Lower Zambezi National Park

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008-2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 482: FOOD MICROBIOLOGY
PRACTICAL PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **ALL** QUESTIONS.

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1. Illustrate the conventional cultural protocol for isolation and identification of *Staphylococcus aureus* in a food product.

2. Examine specimen **A** provided.
   (a) Describe the growth medium used to culture the microorganism
   (b) Conduct microscopic and biochemical tests on the microorganism
   (c) Identify the microorganism

3. The bacterium growing on specimen **B** was isolated from a food sample and and from a faecal specimen obtained from a patient who complained of stomach cramps and diarrhoea six hours after consuming a food. Based on the growth characteristics,
   (a) Identify the microorganism
   (b) Explain the significance of the presence of this organism in the food sample

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END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SECOND SEMESTER UNIVERSITY EXAMINATIONS

February, 2008

BS 925
TERRESTRIAL VERTEBRATE BIOLOGY

PAPER TWO (PRACTICAL)

ID#

TIME: THREE HOURS

INSTRUCTIONS: ANSWER ALL QUESTIONS. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

EXAMINATION ANSWER BOOK
For Question Ones 1 to 54

CANDIDATE'S COMPUTER EXAMINATION

NUMBER.....

1. Full-time or Part –time.....

2. Qualifications for which registered.....

3. Course number.....

4. Date of Examination.....

ID #

QUESTION S 1- 54

Complete each statement by answering the question for each specimen examined from **1 to 54,** and use the answer sheet provided.

SPECIMEN 1:

a) Class _____

b) Family _____

SPECIMEN 2:

a) Species _____

b) Reproductive habits

SPECIMEN 3:

a) Species _____

b) Habitat :

SPECIMEN 4:

a) Genus _____

b) Species _____

ID #

SPECIMEN 5:

a) Order _____

b) Family _____

SPECIMEN 6:

a) Class _____

b) Species _____

SPECIMEN 7:

Dental formula _____

_____

SPECIMEN 8:

a) Class _____

b) Feeding habits: _____

SPECIMEN 9: Respiratory mechanism:

ID #

SPECIMEN 10:

Dental characteristics:

SPECIMEN 11:

a) Suborder _____

b) Species _____

SPECIMEN 12:

a) Class _____

b) Genus _____

SPECIMEN 13:

Draw and label specimen **M**

ID #

SPECIMEN 14:

a. Species_____

b. Conservation status in Zambia:_____

SPECIMEN 15:

a) Species _____

b) Economic importance

_____

SPECIMEN 16:

a) Species 1_____

b) Species 2 _____

SPECIMEN 17:

a) Class _____

b) Order _____

SPECIMEN 18: Field Impression:

ID #

SPECIMEN 19:

a) Order _____

b) Family _____

SPECIMEN 20;

a) Family _____

b) Species _____

SPECIMEN 21; Give the main differences between specimen (i) and specimen (ii)

SPECIMEN 22; Give the main characteristics that distinguish specimen (a) from Specimen (b)

ID #

SPECIMEN 23; Give the main characteristics that distinguish specimen (a) from specimen (b)

SPECIMEN 24; Give the main differences between specimen (i) and specimen (ii)

SPECIMEN 25; Scientific Name

ID #

SPECIMEN 26: Draw and label the dorsal region of the specimen

SPECIMEN 27: Scientific Name

SPECIMEN 28: Reproductive habits

ID #

SPECIMEN 32: Economic and Social importance

SPECIMEN 33: Feeding habits

SPECIMEN 34: Draw and label ventral view

SPECIMEN 35: Rproductive habits

ID #

SPECIMEN 29: Give functions of structure marked

SPECIMEN 30: a) Order----------

b) Scientific Name----------

SPECIMEN 31: Label the marked areas

ID #

SPECIMEN 36: Draw and label

SPECIMEN 37;

(a)Family

(b)Order

ID #

SPECIMEN 38: Breeding habits

SPECIMEN 39: Feeding habits

SPECIMEN 40: Sexual dimorphism

ID #

SPECIMEN 41: Methods of collection

SPECIMEN 42: potential enemies

SPECIMEN 43: Habitat

SPECIMEN 44: Describe digestive system

ID #

SPECIMEN 45: Distribution in Zambia

SPECIMEN 46: Number of occipital condyle

SPECIMEN 47: Dental formula

ID #

SPECIMEN 48: Respiratory system

SPECIMEN 49: Describe Uro-Genital system

ID #

SPECIMEN 50: Construct a simple key for identifying this specimen

SPECIMEN 51: Scientific Name

SPECIMEN 52: Reproductive habits

ID #

SPECIMEN 53: Breeding habits

SPECIMEN 54: Draw and label the ventral structure of this specimen

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 – 2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 925: BIOLOGY OF TERRESTRIAL VERTEBRATES
THEORY PAPER

TIME: THREE HOURS
INSTRUCTIONS: ANSWER QUESTION **1** AND ANY **FOUR** QUESTIONS.
ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

---

1. Study Figure 1 below and answer the questions that follow.

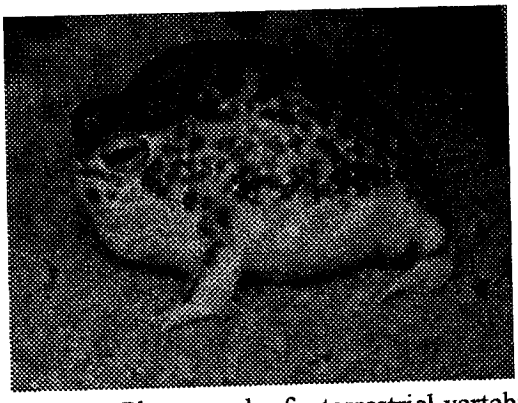


Figure 1: Photograph of a terrestrial vertebrate

   (a) name the class and family to which the animal in Figure 1 belongs
   (b) describe the characteristics of the class to which the animal belongs

2. Explain how ancestral terrestrial vertebrates dealt with the following during their transition from water to land :
   (a) abundant supply of oxygen on land compared to water
   (b) limited supply of water on land
   (c) lack of thermal stability on land compared to the aquatic environment
   (d) reproduction on land

3. Discuss the characteristics of different mammals that have enabled them to adapt successfully to a range of environments from the polar to desert environments?

4. Compare and contrast each of the following pairs as used in taxonomy
   (a) homologous and analogous structures
   (b) classification and identification

TURN OVER

(c) phenetics and cladistics
(d) analytic and synthetic characters

5. Summarise the following as used in the study of terrestrial vertebrates:
   (a) neoteny
   (b) amplexus
   (c) urostyle
   (d) autotomy

6. Describe the characteristics that Sub-orders Amphisbaenia and Serpentes share in common and discuss how the two groups can be differentiated in the field.

7. Discuss the taxonomic differences of Prototheria, Metatheria and Eutheria.

8. Discuss characteristics of Class Aves which have enabled its members acquire the ability to fly.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

C102: INTRODUCTORY CHEMISTRY II

TIME: THREE HOURS

INSTRUCTIONS TO CANDIDATES

1. Indicate your student **ID number (ONLY)** and **TG** number on ALL your answer booklets.

2. This examination paper consists of two **(2)** sections **A** and **B.**

3. Section **A** has ten **(10)** short answer questions [Total marks = **40**]

4. Section **B** has five **(5)** long answer questions [Total marks = **60**]
   Questions carry equal marks

5. **ANSWER ALL QUESTIONS IN SECTION A; AND ANSWER B1 AND ANY OTHER THREE QUESTIONS IN SECTION B.**

6. **ANSWER SECTION A QUESTIONS IN ONE BOOKLET**

7. **ANSWER SECTION B QUESTIONS EACH IN A SEPARATE BOOKLET**

YOU ARE REMINDED OF THE NEED TO ORGANIZE AND PRESENT YOUR WORK CLEARLY AND LOGICALY

USEFUL DATA

Gas constant R

8.3145 J mol^{-1} K^{-1}
0.083145 L bar mol^{-1} K^{-1}
0.08206 L atm mol^{-1} K^{-1}
62.364 L torr mol^{-1} K^{-1}
62.364 L mmHg mol^{-1} K^{-1}

Pressure

1 atm = 1.01325×10^5 Pa
= 1.01325×10^5 N m^{-2}
= 760 torr
= 760 mmHg
= 1.01325 bar

1 bar = 1.00000×10^5 Pa
= 1.00000×10^5 N m^{-2}

Acceleration due to gravity
g = 9.80665 m s^{-2}

Density of water

ρ = 1.00 g cm^{-3} = 1.00×10^3 kg m^{-3}

SECTION A **ANSWER ALL QUESTIONS**

Question A1

The initial rate of the reaction between compounds **X** and **Y** was measured in a series of experiments at a fixed temperature. The following rate equation was deduced.

$$\text{rate} = k[\mathbf{X}]^2[\mathbf{Y}]^0$$

Experiment	Initial [**X**] mol dm^{-3}	Initial [Y] mol dm^{-3}	Initial rate /mol $dm^{-3}s^{-1}$
1	1.20×10^{-3}	3.3×10^{-3}	2.68×10^{-3}
2	1.20×10^{-3}	6.60×10^{-3}	A
3	2.40×10^{-3}	6.60×10^{-3}	B
4	C	9.90×10^{-3}	8.04×10^{-3}

What is the value of A, B, and C in the Table above?

Question A2

A buffer solution contains 0.250 mol of propanoic acid and 0.190 mol of sodium propanoate in 1000 cm^3 of solution. Calculate the pH of the buffer solution. K_a, for propanoic acid is 1.35×10^{-5}.

Question A3

A sample of 0.0020 moles of F_2 was sealed into a 2.0 L reaction vessel and heated to 1000 K to study the dissociation into F atoms:

$$F_2(g) \rightleftharpoons 2\,F(g)$$

At this temperature, $K_c = 1.2 \times 10^{-4}$. What are concentrations of F_2 and F at equilibrium? What is the percent dissociation of F_2?

Question A4

Intermolecular forces are responsible for holding of molecules together and can explain the physical properties of substances.

(a) List any three intermolecular forces.

(b) Why are London dispersion forces found in all substances?

Question A5

From each of the following groups of substances, choose one that show the given physical property and give a reason for your answer.

Property	**Group**
(a) Highest boiling point	$CH_3N(CH_3)CH_3$, $CH_3CH_2CH_2NH_2$, CH_3NHCH_3
(b) Largest vapour pressure	SiO_2, NH_3, PH_3
(c) Lowest boiling point	NaF, PF_3, PCl_5
(d) Lowest vapour pressure	NaCl, H_2O, CH_3OH

Question A6

Calculate the concentration of CO_2 gas dissolved in a coca-cola soft drink if the manufacturer uses 2.4 atm to carbonate it. The Henry's constant for CO_2 gas at 25 °C is 3.36×10^{-2} mol L^{-1} atm^{-1}.

Question A7

Estimate the osmotic pressure (in atmospheres) of a 10.0 g L^{-1} solution of a non-electrolytic macromolecules, of molar mass of 1.00×10^4 g mol^{-1} at 25 °C.

Question A8

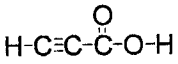
The following names are incorrect. Give the correct IUPAC name for each compound.

(a) 4-Ethyl-5,5-dimethylpentane

(c) 4-Methyl-3-hexene

Question A9

Describe the type of bonds present in the following molecule.



Question A10

Indicate the kind of hybridization you would expect for the carbon atoms labeled **1**, **2** and **3** and state geometric configuration about each atom in the following molecules.

(a) **1 2 3**
CH_2=CHCHO

(b) **1 2 3**
H-C≡C-CO_2H

SECTION B **ANSWER B1, AND ANY THREE QUESTIONS EACH IN A SEPARATE BOOKLET**

Question B1

In Experiment VII – "Estimation of ammonia in an ammonium salt" a C102 student dissolved 1.355 g of unknown ammonium salt to prepare 250 cm^3 of the solution. She measured 25.00 cm^3 of this solution in a conical flask and added to 5.00 cm^3 of formaldehyde and 3 drops of phenolphthalein indicator to measured ammonium salt solution. The chemical reaction is:

$$6HCHO(aq) + 4NH_4^+(aq) \rightarrow C_6H_{12}N_4(aq) + 4H^+(aq) + 6H_2O(l)$$

After two minutes she titrated the above mixture with 0.100 M NaOH solution until a permanent light pink colour appeared.

(i) Write the chemical equation taking place during the titration.

(ii) If she used 25.35 cm^3 of NaOH solution calculate the mass % of ammonium ion in the salt.

(iii) Name the glassware used for measuring 25 cm^3 of ammonium salt solution.

Question B2

(a) Plot concentration and time graph using data in the Table.

Time (s)	0	100	200	300	400	500	600	700	800
[X] mol L^{-1}	1.000	0.749	0.561	0.420	0.315	0.236	0.177	0.132	0.099

(b) Use the graph to calculate the half-life of the reaction.

(c) What is the order of reaction? Give reasons.

(d) How long will it take for concentration of the reactant X to fall to 40% of the original concentration.

Question B3

A chemical **C** is made by reacting chemical **A** with chemical **B** in a reversible reaction. **A**, **B** and **C** are all gases under the reaction conditions. C102 students wanted to know the optimum conditions to use in the manufacture of **C**. They carried out a series of reactions under different conditions of temperature and pressure. The percentage conversion of **A** at equilibrium is shown in Table

Pressure (MPa)	Temperature (° C)	% conversion
10	350	8
	450	12
	550	16
20	350	11
	450	20
	550	29
40	350	18
	450	
	550	49

(a) Give **two** features of a reversible reaction, when a dynamic equilibrium has been set up.

(b) Suggest the percentage of **A** that is converted at 450 °C and 40MPa.

(c) (i) Use the data in Table above to state the effect of increasing pressure on the percentage of **A** converted.

(ii) What can be deduced, from this change, about the total number of moles of reactants **A** and **B** compared with the number of moles of product **C** in the equation for the reaction? Explain how you reached your conclusion.

(d) Use the data in Table above to deduce whether the reaction between **A** and **B** is exothermic or endothermic. Explain how you reached your conclusion.

(e) It was found necessary to use a catalyst in the production of **C**.

(i) What is meant by a *catalyst*?

(ii) How does the catalyst affect the position of equilibrium?

(f) Conditions were used that should have given a conversion of **A** of 39% at a pressure of 40 MPa. In the manufacture, using these conditions, it was found that only 20% conversion was achieved. Suggest why the conversion was much less than theory suggested.

Question B4

An enzyme (E) is activated by the binding of adenosine 50-monophosphate (AMP) according to the reaction

$$E + AMP \rightleftharpoons E\text{-}AMP$$

The equilibrium constant for this association was determined at two temperatures:

$T_1 = 22.00\ °C$ $K_1 = 1.83 \times 10^3$

$T_2 = 38.00\ °C$ $K_2 = 5.78 \times 10^3$

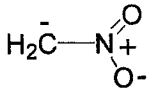
(a) Use the van't Hoff equation to calculate ΔH_{rxn} for the above reaction, assuming that ΔH_{rxn} remains constant over the small temperature range examined.

(b) Calculate ΔS_{rxn} using the van't Hoff equation at $T_1 = 22.00\ °C$ and $K_1 = 1.83 \times 10^3$.

Question B5

(a) Draw all possible structures of constitutional isomers represented by the molecular formula $C_4H_{10}O$ and classify them according to their functional groups.

(b) Nitromethylene anion, structure shown below, is an important synthetic intermediate in organic synthesis.



Nitromethylene anion

(i) Draw all possible resonance structures for the nitromethylene anion.

(ii) State which resonance structure contributes most to the hybrid.

END OF FINAL EXAMINATION

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
																1 **H** 1.01 Hydrogen	2 **He** 4.00 Helium
1 **H** 1.01 Hydrogen												5 **B** 10.81 Boron	6 **C** 12.01 Carbon	7 **N** 14.01 Nitrogen	8 **O** 16.00 Oxygen	9 **F** 19.00 Fluorine	10 **Ne** 20.18 Neon
3 **Li** 6.94 Lithium	4 **Be** 9.01 Beryllium											13 **Al** 26.98 Aluminium	14 **Si** 28.09 Silicon	15 **P** 30.99 Phosphorus	16 **S** 32.07 Sulphur	17 **Cl** 35.45 Chlorine	18 **Ar** 39.95 Argon
11 **Na** 23.00 Sodium	12 **Mg** 24.31 magnesium																
19 **K** 39.10 Potassium	20 **Ca** 40.08 Calcium	21 **Sc** 44.96 Scandium	22 **Ti** 47.88 Titanium	23 **V** 50.94 Vanadium	24 **Cr** 52.00 Chromium	25 **Mn** 54.94 Manganese	26 **Fe** 55.85 Iron	27 **Co** 58.93 Cobalt	28 **Ni** 58.69 Nickel	29 **Cu** 63.65 Copper	30 **Zn** 65.39 Zinc	31 **Ga** 69.72 Gallium	32 **Ge** 71.61 Germanium	33 **As** 74.92 Arsenic	34 **Se** 78.96 Selenium	35 **Br** 79.90 Bromine	36 **Kr** 83.80 Krypton
37 **Rb** 85.47 Rubidium	38 **Sr** 87.62 Strontium	39 **Y** 88.91 Yttrium	40 **Zr** 91.22 Zirconium	41 **Nb** 92.91 Niobium	42 **Mo** 95.94 Molybdenum	43 **Tc** 97.91 Technetium	44 **Ru** 101.07 Ruthenium	45 **Rh** 102.91 Rhodium	46 **Pd** 106.42 Palladium	47 **Ag** 107.87 Silver	48 **Cd** 112.41 Cadmium	49 **In** 114.82 Inidum	50 **Sn** 118.71 Tin	51 **Sb** 121.76 Antimony	52 **Te** 127.60 Telluriu m	53 **I** 126.90 Iodine	54 **Xe** 131.29 Xenon
55 **Cs** 132.91 Caesium	56 **Ba** 137.33 Barium	57 – 71	72 **Hf** 178.49 Hafnium	73 **Ta** 180.95 Tantalum	74 **W** 183.84 Tungsten	75 **Re** 186.21 Rhenium	76 **Os** 190.23 Osmium	77 **Ir** 192.22 Iridium	78 **Pt** 195.08 Platinum	79 **Au** 196.97 Gold	80 **Hg** 200.59 Mercury	81 **Tl** 204.38 Thallium	82 **Pb** 207.2 Lead	83 **Bi** 208.98 Bismuth	84 **Po** 208.98 Polonium	85 **At** 209.99 Astatine	86 **Rn** 222.02 Radon
87 **Fr** (223.02) Francium	88 **Ra** 226.03 Radium	89 - 103	104 **Unq** 261.11	105 **Unp** 262.11	106 **Unh** 263.12	107 **Uns** 262.12	108 **Uno** 265.00	109 **Une** 265									

KEY

Atomic number
X
Atomic mass

Name of the element X

57 **La** 138.91 Lanthanum	58 **Ce** 140.12 Cerium	59 **Pr** 140.91 Praseodymium	60 **Nd** 144.24 Neodymium	61 **Pm** 144.91 Promethium	62 **Sm** 150.36 Samarium	63 **Eu** 151.97 Europium	64 **Gd** 157.25 Gadoliniu m	65 **Tb** 158.93 Terbium	66 **Dy** 162.50 Dysprosium	67 **Ho** 164.93 Holmium	68 **Er** 167.26 Erbium	69 **Tm** 168.93 Thulium	70 **Yb** 173.04 Ytterbium	71 **Lu** 174.97 Lutetium
89 **Ac** 227.03 Actinium	90 **Th** 232.04 Thorium	91 **Pa** 231.04 Protactinium	92 **U** 238.03 Uranium	93 **Np** 237.05 Neptunium	94 **Pu** 244.0 Plutonium	95 **Am** 243.06 Americium	96 **Cm** 247.07 Curium	97 **Bk** 247.07 Berkelium	98 **Cf** 251.08 Californium	99 **Es** 252.08 Einstienium	100 **Fm** 257.10 Fermium	101 **Md** 260 Mendelevium	102 **No** 259.10 Nobelium	103 **Lr** 262.11 Lawrenciu m

Department of Chemistry-UNZA

The University of Zambia

School of Natural Sciences

Department of Chemistry

2008 Academic Year Final Examinations

First Semester

C 205: Analytical and Inorganic Chemistry

December 2008.

Time: 3 Hours.

Instructions:

[This Paper Contains Six (06) Questions; each Carrying 15 Marks].

Answer Both Questions In Section A; And, any Two (02) from Section B.

Section A.

Question 1.

a). A photon of wavelength 4000 Å strikes a metal surface, the work function of the metal being 2.13 eV. Calculate (i) the energy of the photon in eV (ii) the kinetic energy of the emitted photon electron and (iii) the velocity of photoelectron. Given that mass of electron = 9.109×10^{-31} kg, h = 1.626×10^{-34} J, C = 3×10^{8} m/s, 1eV = 1.602×10^{-10} J

b). State the hybridization involved and make sketches of (i) lone pair electron orbital of PH_3 and (ii) lone pair orbitals of ClF_3 (iii) IF_5

c). Briefly discuss expected variations of 1st Ionization energies across the elements of period 3.

Question 2.

a). Describe the changes that occur in a complex's properties when weak field ligands are replaced by strong field ligands.

b). The magnetic moment of complex $[Mn(NCS)_6]^{4-}$ is 6.06 μB. What is its electronic configuration? Calculate the magnetic moment and CFSE of the complex in terms of their Dq parameters. Given 10 Dq from $[FeF_6]^{4-}$ is 25,000 cm^{-1}, evaluate its CFSE in cm^{-1}

c). What is Borazine? How does it react with hydrochloric acid? Show the structure of the product formed. Give a balanced equation showing the hydrolysis of Borazine.

Section B.

Question 1.

a). i). What is a standard solution?

ii). What is meant by the equivalence point of a titration? How much 0.1 N Na OH would you have added to 30 mL of 0.1N HCl, at the equivalence point?

b). The precision of a method is being established; and the following data are obtained: 22.23; 22.18; 22.25; 22.09 and 22.17%. Is 22.09 a valid measurement at the 95% confidence level? Using the data above, estimate the range within which the true value falls at 99%CL

c). Write balanced equations, and decide which of the following may be regarded as redox reactions:

i). $BaCl_2 + H_2SO_4 \Rightarrow BaSO_4 + HCl$

ii). $Ag + Cl_2 \Rightarrow AgCl$

iii). $I^- + NO_3^- + H^+ \Rightarrow I_2 + NO_2$

iv). $PbO_{s)} + CO_{(g)} \Rightarrow Pb_{(s)} + CO_{2(g)}$

Question 2.

a). In dilute aqueous solution, sulphuric acid can be regarded as totally dissociated to H_3O^+ and HSO_4^-. The hydrogensulphate ion, HSO_4^-, is itself a weak acid with a dissociation constant of 1.20×10^{-2}. Calculate the concentration of H_3O^+, HSO_4^-, SO_4^{2-} and OH^- in a solution prepared by dissolving 1.00 mole H_2SO_4 in enough water to make 1.00 litre of solution.

b). Phosphorus was determined in urine by phosphomolybdate method, and the results were as follows:

Standard solution (ppm)	:	1.0	2.0	3.0	4.0	5.0
Absorbance	:	0.205	0.410	0.615	0.820	1.025

From the data obtained, determine the regression line and calculate the phosphorus concentration in the urine sample if the absorbance was 0.550.

c). A solution contains 2.50×10^{-4} M $Cu(NO_3)_2$. What is this copper nitrate concentration in ppm; and, what is the concentration of NO_3^- in this solution given that $Cu(NO_3)_2$ is a strong electrolyte.

Question 3.

a). Orthoarsenic acid, H_3AsO_4, is a triprotic acid with $pK_{a1} = 2.22$, $pK_{a2} = 6.98$ and $pK_{a3} = 11.53$. By writing appropriate equations, indicate i). What is meant by the term 'triprotic', and ii). What is the value of K_a for H_3AsO_4?

b). A sample was analysed several times using two different methods. The following two sets of results for % ethanol content were obtained:

Method I (%ethanol): 13.5; 13.3; 12.9; 13.0;

Method II (%ethanol): 12.7; 12.6; 13.3; 13.3

Does Method I give the same results as Method II at 95% confidence level?

c). A 0.1M solution of a weak monoprotic acid (HA) is found to be 5% ionized. Calculate the ionisation constant (Ka), and pH of the solution.

Question 4.

a). What is a buffer solution?

i). Calculate the pH of a buffer prepared by adding 10 ml of 0.20 M acetic acid (for acetic acid, $K_a = 1.75 \times 10^{-5}$) to 40 ml of 0.50 M sodium acetate.

ii). What is the pH and degree of hydrolysis of a 0.10 M solution of sodium acetate, $NaC_2H_3O_2$? For acetic acid, $K_a = 1.75 \times 10^{-5}$.

b). Calcium in blood is determined by two methods (AAS and Colorimetry). Determine, using the 'Pooled t-test', whether there is significant difference in the precision of the AAS method and the newly tried colorimetric method; at 95% CL. The data is:

AAS (mg/dL):	10.9; 10.1; 10.6; 11.2; 9.6; 10.0
Colorimetry (mg/dL):	9.2; 10.5; 9.7; 11.5; 11.6; 9.3; 10.1; 11.2

c). Calculate the mass of $KMnO_4$ that needs to be dissolved in 250 cm^3 of water to produce a solution of 0.500 N.

.....END OF EXAMINATION.....

The University of Zambia
School of Natural Sciences
Department of Chemistry
2008 Academic Year Final Examinations
Second Semester.

C 225: Analytical Chemistry 1

Time: 3 Hours.

Instructions:

[This Paper Contains Six (06) Questions. Answer Question No.1 and Any Three (03) Others. Each Question carries 15 marks.]

Question 1.

a. Riboflavin (Vitamin B_2) is determined in cereal samples by measuring fluorescence intensity in a 5% acetic acid solution. From analytical data given below, use the method of least squares to:

Standards concentration (ppm): 0.000; 0.100; 0.200; 0.400; 0.800

Fluorescence intensities (I): 0.000; 5.8; 12.2; 22.3; 43.3

i). obtain the equation for the best-fit line for the calibration curve

ii). calculate the concentration of riboflavin in a sample for I was found to be 15.4

b. Absorbance readings of a blank were made in a spectrophotometric method as follows: 0.002; 0.000; 0.006; 0.008; 0.003 and 0.000.

A standard solution of 1ppm analyte solution gives an absorbance reading of 0.069. What is the detection limit?

Question 2.

a. Describe 3 causes of inclusion of impurities during precipitation.

b. The first and second acidity constants of H_2S are 10^{-7} and 10^{-15} respectively. Calculate:

i). The acidity constant (K_a) for the reaction $H_2S + 2H_2O \rightarrow 2H_3O^+ + S^{2-}$

ii). $[S^{2-}]$ of a 0.1 M H_2S solution at pH 2.

c. A C 229 student determined the molarity of an acid by titrimetry, and obtained the following results 0.1067; 0.1071; 0.1066 and 0.1050. Can we discard 0.1050 as due to accidental error at 95% CL?

Question 3.

a. i). What do you understand by the terms Von Weirman ratio; masking agent; and, gravimetric factor?

ii). What mass of solute is needed to prepare 1 L of 0.8 N potassium dichromate

b. What is a buffer solution? Calculate the pH of a solution that is 0.050 M in formic acid, [HCOOH], and 0.10 M in sodium formate (Formic acid, $K_a = 1.76 \times 10^{-4}$).

c. Distinguish between the following pairs of terms:

i). Qualitative and quantitative analysis ii). Complete and partial analysis

iii). Sample and analyte iv). Major and minor constituents of a sample

Question 4.

a. i). What mass of solute is present in 500 cm^3 of 6.0 M HCl? $Ca(OH)_2$

ii). How much of the solution in 4a (i). will neutralise 750 cm^3 of 5.0 N ~~H_2SO_4~~?

b. A solution contains 2.50 x 10^{-4} M $Cu(NO_3)_2$. What is:

i. the solution's concentration in ppm

ii. the concentration of NO_3^- in this solution given that $Cu(NO_3)_2$ is a strong electrolyte

c. What is the solubility of PbI_2 in g/L if solubility product is 7.1 x10^{-9}?

Question 5.

a. Calculate the ratio of free ions to $Ag(CN)^-$ complex in a NaCN solution in which $[CN^-]$ = 0.01 M ($K_f = 1.0 \times 10^{-21}$).

b. Oxalic acid is a diprotic acid with $K_{a1} = 1.13 \times 10^{-3}$ and $K_{a2} = 3.9 \times 10^{-6}$. Determine the following:

i). the meaning of 'diprotic'

ii). equilibrium constant expression for the loss of one proton

iii). equilibrium constant expression for the loss of two protons

iv). equilibrium fractional concentration of A^{2-} ion in a 0.05 M solution at pH 1.

c. Calculate K_a for (NH_4^+), and the pH of a solution containing 2.34g NH_4Cl in 250 cm^3 given that at 25^0 C (K_b for $NH_3 = 1.75 \times 10^{-5}$).

Question 6.

a. A company trading in chemicals discovered that it had 1.300 kg of expired alkali in stock (0.500 kg of NaOH and 0.800 kg of KOH) to dispose of. To ensure safe disposal, they decided to neutralize an aqueous solution of the alkalis (dissolved in 5.0L of water) with 0.1 M H_2SO_4 acid.

i). Calculate the normality of the alkaline solution.

ii). What volume of 0.01 M H_2SO_4 would be required to neutralize the mixture?

b. The ionisation constant (K_a) for benzoic acid ($HC_6H_5O_2$) is 6.6 x 10^{-5}. Calculate the pH and degree of ionisation of a 0.2M solution of the acid.

c. What fraction of total Fe (III) concentration is present as Fe^{3+} in a solution that was initially 0.10 M Fe^{3+} and 1.0 M SCN^- (for $Fe(SCN)^+_2$, $K_f = 2.3 \times 10^3$)?

.....END OF XAMINATION.....

UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF CHEMISTRY
SEMESTER II, 2008
BASIC PHYSICAL CHEMISTRY C265

Duration: Three (3) Hour

Instructions:

This question paper is divided in two sections: **A (40)** & **B (60)**.
Answer **all questions** in section **A**.
Answer **4 questions in** Section **B**.
Answer Section **A** and **B** in **separate answer booklets**.
Answer **each question** in **Section B** in a separate booklet.

You are reminded to answer questions in a clear and logical manner.

Useful Information and Constants:

R= 8.314 $Jmol^{-1}$ K^{-1}, Molar volume of gas at STP = 22.4 dm^3 mol^{-1}, STP = 273 K and 1 bar (10132 Pa), A= 0.509 $kg^{1/2}mol^{-1/2}$ at 298.15 K, $\frac{2.303RT}{F} = 0.05916V$, F = 96485 C mol^{-1}

SECTION A: ANSWER ALL QUESTIONS

Question A1

At 100 °C and 16 kPa, the mass density of sulphur vapour is 0.6388 kg m^{-3}. What is the molecular formula of phosphorous under these conditions?

Question A2

A sample of argon, mass 6.56 g, occupies 18.5 L at 305 K. Calculate the work done when the gas expands isothermally against a constant external pressure of 7.7 kPa until its volume has increased by 2.5 L.

Question A3

A sample of a perfect gas initially occupies 11.0 L at 270 K and 1.2 atm is compressed isothermally. To what volume must the gas be compressed to reduce its entropy by 3.0 J K^{-1}?

Question A4

The enthalpy of combustion for H_2, C (graphite) and CH_4 are – 285.8, – 393.5, and – 890.4 kJ mol^{-1} respectively. Calculate the standard enthalpy of formation ΔH_f for CH_4.

Question A5

(a) A fixed mass of marble is reacted with dilute hydrochloric acid at constant temperature. Explain why the rate of reaction is increased if the lumps are reduced in size.

(a) State the difference between homogeneous and heterogeneous catalysis.

Question A6

At 2000 K, 1 mole of water is 2 % dissociated at 1 bar according to the reaction

$$H_2O(g) \rightleftharpoons H_2(g)+\frac{1}{2}O_2(g)$$

What is its K_P?

Question A7

Carbonic acid, HCOOOH, is a weak acid, with $K_a = 4.5\times10^{-7}$, and dissociate as

$$HCOOOH(aq) \rightleftharpoons H^+(aq)+HCOOO^-(aq)$$

Use the Debye-Hückel limiting law to calculate the pH of 0.01 m HCOOOH when its degree of dissociation is 6.71 %.

Question A8

The limiting molar conductance at infinity dilution of CH_3CH_2COONa, NaCl, and HCl are 0.00854367, 0.012645 and 0.042616 $\Omega^{-1}m^2mol^{-1}$ respectively. What is the limiting molar conductance at infinity dilution of CH_3CH_2COOH?

SECTION B: ANSWER ANY FOUR (4) EACH QUESTION IN A SEPARATE BOOKLET

Question B1

(a) (i) Dalton's law of partial pressures states that the total pressure of a mixture of gases is the sum of the partial pressures of the components of the mixture. Which assumption of the kinetic molecular theory justifies this law? Explain in brief.

(ii) 200 mL of oxygen is collected over water at 25 °C and 1 atm. If the oxygen obtained is dried at constant temperature of 25 °C and 1 atm, what volume will it occupy?

(iii) What volume will be occupied by the water removed from the oxygen if maintained at 25 °C and 1 atm? (The equilibrium vapour pressure of water at 25 °C is 0.04 atm)

(b) 0.167 g of ethanol, C_2H_5OH, was injected into a gas syringe and the syringe placed in a boiling water bath for several minutes. The atmospheric pressure was 101300 Pa and the temperature of the bath was 100 °C.

(i) Calculate the volume, in cm^3, of ethanol vapour that would have been produced under these conditions (use $R = 8.314\ J\ K^{-1}\ mol^{-1}$.)

(ii) Explain why the gas syringe of 100 cm^3 capacity was found to be unsuitable.

Question B2

The feasibility of a chemical reaction depends on the standard free energy change, ΔG°, which is related to the standard enthalpy and entropy changes by $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$. Use this information this information, where relevant, in answering the questions below.

(a) Ice melts at atmospheric pressure only if temperature rises above 0 °C.

(i) State the signs of the enthalpy and entropy changes during melting.

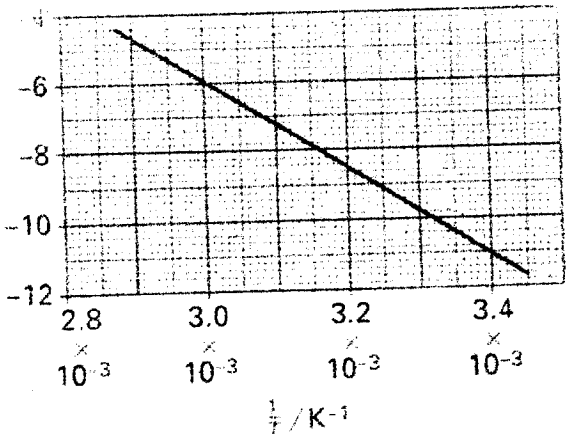
(ii) Explain why ice does not melt at temperatures below 0 °C.

(b) When sodium hydrogen carbonate is added to dilute hydrochloric acid, the temperature drops. Despite this, the reaction is spontaneous. Explain how this can be achieved.

(c) Give the signs of enthalpy, entropy and free energy change for combustion of propane. In ***each*** case give a reason for your answer.

Question B3

(a) A C265 a student obtained the following graph using data obtained from a kinetics experiment. The decomposition of a gas was studied at different temperatures (T) and the value, k, obtained at each temperature. Values were calculated for $1/T$ and for $\ln k$. A plot of $\ln k$ against $1/T$ is shown below.



(i) What do the symbols k and A in the Arrhenius equation represent?
(ii) Determine the gradient for the graph and hence deduce the value of the activation energy, E_a.

(b) In separate reactions between sulphur dioxide and oxygen, an increase in concentration of SO_2 from 0.180 mol dm^{-3} to 0.540 mol dm^{-3} was found to increase the initial rate by a factor of 9.

(i) What is meant by order of reaction?
(ii) Explain why the rate of the reaction above increased by an increase in the concentration of SO_2.
(iii) Deduce, using the information above the order of reaction with respect with to SO_2.

Question B4

Methanol is produced at 500 K from the reaction:

$$CO(g)+2H_2(g) \rightleftharpoons CH_3OH(g)$$

If CO gas and H_2 gas in the above reaction comes from reaction:

$$C_{graphite}(s)+H_2O(g)\rightarrow CO(g)+H_2(g)$$

the initial moles of CO and H_2 in methanol production are one mole each. At 500 K

$\Delta G_f^\circ(CH_3OH(g))=-134.27\,x10^3\ Jmol^{-1}$, $\Delta G_f^\circ(CO(g))=-155.414\,x10^3\ Jmol^{-1}$ and $\Delta G_f^\circ(H_2(g))=0.00\,Jmol^{-1}$.

(a) Calculate ΔG_r°
(b) Determine the equilibrium constant, K_P using information in (a).
(c) What pressure is required to convert 25 % CO to CH_3OH?

Question B5

The electromotive force (EMF) of the cell

$$Pt|H_2(1bar)|HCl(0.01m)|AgCl(s)|Ag$$

at various temperatures is

T(in K)	273.15	288.15	298.15	308.15
E (in V)	0.45780	0.46207	0.46419	0.46565

The E°_{cell} and $\partial E / \partial T$ are 0.2223 V and +1.902 x10^{-4} V/K respectively at 298.15 K.

(a) Write the cell reaction.
(b) Calculate the EMF of the cell at 298.15 K using the mean activity coefficient calculated from the Debye-Hückel limiting law.
(c) Use the measured EMF of the cell at 298.15 K in the table above to calculate ΔH of the cell reaction.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATIONS

C312: BIOCHEMISTRY II

TIME: THREE HOURS

INSTRUCTIONS:

1. **THERE ARE SIX (6) QUESTIONS IN THIS EXAMINATION PAPER**
2. **ANSWER ANY FIVE (5) QUESTIONS ONLY**
3. **ALL QUESTIONS CARRY EQUAL MARKS**
4. **MAKE SURE YOU HAVE 2 PRINTED PAGES OF THIS EXAMINATION PAPER**

- **Question 1** The fixation of ammonia (or ammonium) as carbomyl phosphate is an initial process in the series of reaction steps leading, via arginine, to the final metabolic product of human and mammalian nitrogen metabolism, urea.

  Write down the chemical reactions and enzymes to show how this series of reaction steps leads to urea synthesis in humans and some domestic animals.

[20 marks]

- **Question 2** The aromatic amino acids are derived from four and two carbon atoms provided by erythrose 4-phosphate and phosphoenolpyruvate, respectively.

  a) **Describe** and **show** the various steps of the biosynthetic pathway involving erythrose 4-phosphate and phosphoenolpyruvate as the starting materials and leading to the formation of amino acid tyrosine (provide names and structures of biomolecules and the names of the enzymes involved).

  b) **Discuss** the fact that the first step in this multibranched biosynthetic pathway involving erythrose 4-phosphate and phosphoenolpyruvate

leading to the formation of tyrosine is subject to multiple feedback inhibition and control by the three amino acids.

[20 marks]

- **Question 3** Using the Lynen Cycle, **show** how you would break down stearic acid. **How** many cycles does it take it take to completely break down stearic acid?

[20 marks]

- **Question 4** **Describe** the biosynthesis of cholesterol. **What** factors regulate it and what factors influence cholesterol content in man?

[20 marks]

- **Question 5** **Give** a detailed account of the mechanism of prokaryotic protein synthesis on the ribosomes.

[20 marks]

- **Question 6** **Write** an essay on the functions of all enzymes involved in the replication of DNA and transcription (including post transcriptional processing) in both eukaryotic and prokaryotic cells. Show equations/structures where possible.

[20 marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
2008 ACADEMIC YEAR FIRST SEMESTER
FINAL EXAMINATIONS

C321 ANALYTICAL CHEMISTRY 11
TIME: 3 HOURS
INSTRUCTIONS

1. Answer any **FOUR** of the questions in this paper.
2. All questions carry equal marks (15 Marks)
3. Show all your working and reasoning clearly

QUESTIONS :

1. (a) Transferrin is the iron-transport protein found in blood. It has a molecular weight of 81 000 and carries two Fe^{3+} ions. Desferrioxamine B is a potent iron chelator used to treat patients with iron overload. It has a molecular weight of about 650 and can bind one Fe^{3+}. Desferrioxamine can take iron from many sites within the body and is excreted (with its iron) through the kidneys. The molar absorptivities of these compounds (saturated with iron) at two wavelengths are given below. Both compounds are colourless (no visible absorption) in the absence of iron.

	ε [M^{-1} cm^{-1}]	
λ (nm)	Transferrin	Desferrioxamine
428	3540	2730
470	4170	2290

A solution of transferring exhibits an absorbance of 0.463 at 470 nm in a 1.000 cm cell. Calculate the concentration of transferring in milligrams per millilitre and the concentration of iron in micrograms per millilitre.

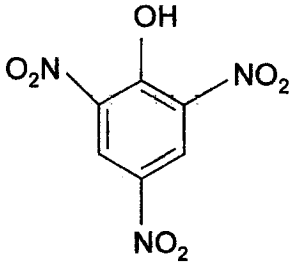
(b) Complex formation by 3-aminopyridine and picric acid in chloroform solution gives a yellow product with an absorbance maximum at 400 nm. Neither starting material absorbs significantly at this wavelength. Stock solutions containing 1.00×10^{-4} M of each compound were mixed as follows and the absorbances of the mixtures were recorded

Picric acid (mL)	3-Aminopyridine	Absorbance at 400 nm
2.70	0.30	0.106
2.40	0.60	0.214
2.10	0.90	0.311
1.80	1.20	0.402
1.50	1.50	0.442
1.20	1.80	0.404

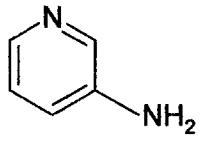
0.90	2.10	0.318
0.60	2.40	0.222
0.30	2.70	0.110

Prepare a graph of absorbance versus mole fraction of 3-aminopyridine and find the stoichiometry of the complex.

Picric acid



3-aminopyridine



(c) With the aid of ketches, describe the operation of charge coupled devices (CCD) in absorption spectrometry.

(d) Draw a block diagram of a typical absorption spectrophotometer. Give two types of monochromators that are used in these instruments and describe their purpose.

(e) What is chemiluminescence? Give an example of a reaction that chelumineses.

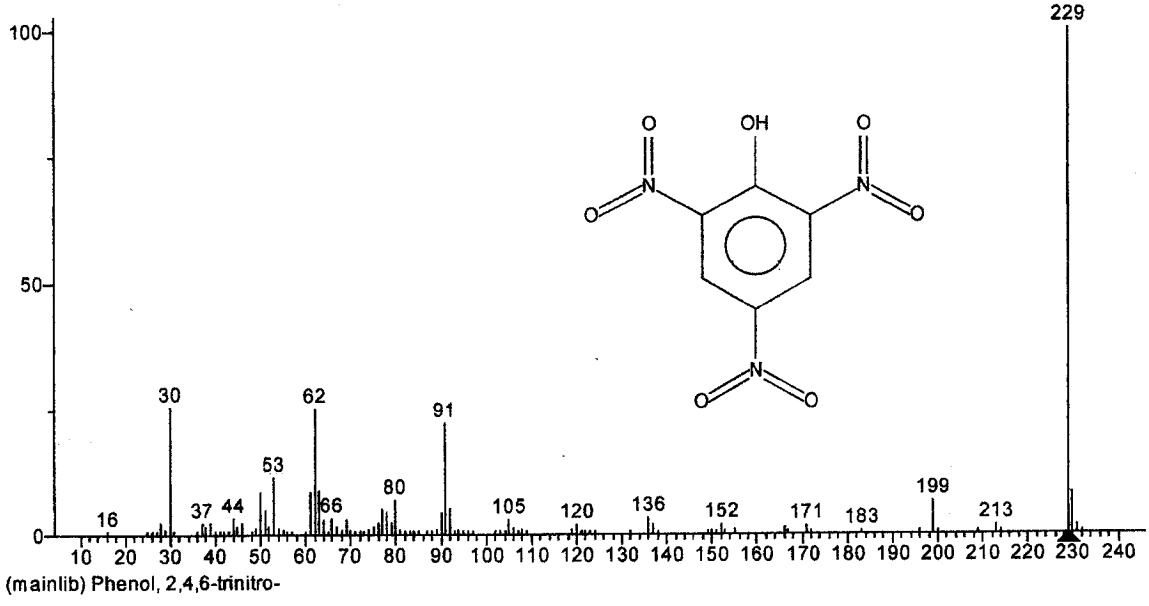
(15 Marks)

2. (a) Use a sketch to outline what happens when a molecule absorbs light energy (no description necessary).

(b) There is an emission process that occurs within $10^{-9} - 10^{-6}$ seconds usually referred to as an allowed transition, which one is it? Sketch and label completely the instrumentation used to carry out measurements for this process.

(c) With the aid of sketches, describe the operation of a quadrupole mass spectrometer found in the Department of Chemistry. Include, ionisation techniques, mass analysis and detection.

(d) Below is a mass spectrum of picric acid (MM= 229) obtained by Electron Ionization (EI). Assign plausible fragment structures for m/z ratio peaks at 229, 199, 183 and 91. It would have been expected that the molecular ion in this case should have fragmented extensively but did not why?



Mass Spectrum of Picric acid **(15 Marks)**

3(a) Why are echelle gratings better than echellette gratings as used in emission determinations.

(b) Explain the 2 types of nuclear relaxation and their implication in NMR.

(c) Describe the terms: Magnetic anisotropy, Coupling constant and Diamagnetic shielding.

(d) An analyst notes that a 1ppm solution of Na gives a flame emission signal of 110, while the same solution containing also 20ppm K gives a reading of 125. It was determined that a 20ppm solution of K showed no blank reading. Explain the results.

(e) The drug tolbutane)MW = 270) has molar absorptivity of 703 at 260nm. One tablet is dissolved in water and diluted to a volume of 2L. If the solution exhibits an absorbance in the UV region equal to 0.687 in a 1 cell, how many grams of the drug are in a tablet? **(15 Marks)**

4 (a) What do you understand by the terms: phosphorescence, isosbetic point and Doppler broadening.

(b) Describe the premix chamber burner and total consumption burner and compare them with respect to efficiency and sensitivity.
(c) Give a description of the components of an AA spectrometer you can use in elemental analysis of alkali metals found in serum, include the types of elements that can be done by this technique and why the technique is preferred.
(d) Over what concentration range in mg/L could analyses be done for Fe(II) chelate which possesses a molar absorptivity of 12000 if it is desired to confine the transmittance readings within the range 0.200 to 0.650. Assume an optical length of 1.00cm. (Fe = 55.4).
(e). Describe radiation sources and detectors for the UV, Visible and IR regions of the spectrum. **(15 Marks)**

5 (a) IR is a very useful technique in analysis. How does the IR instrument work and give two examples of substances that can be done by this instrument.
(b) Describe and compare different causes of deviations from Beer's law.
(c) What do you understand by the terms: Raleigh scattering, Raman effect fingerprint area in IR?
(d) 0.131g of pure caffeine is dissolved in 1L, exactly 10ml of the solution is diluted to 100ml and the solution gave an absorbance of 0.854 in a 1cm cell. What is the concentration of the solution? An unknown aqueous solution of caffeine gave an absorbance of 1.022 in a 2cm cell at 272nm. What is the concentration of the solution (MW caffeine = 194.2).
(e) In an experiment to determine Na, two approaches were used, that is, using direct intensity method and internal standard method, which method should be better and why? **(15 Marks)**

END OF EXAMINATION QUESTIONS

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

C322 ANALYTICAL CHEMISTRY 111

TIME: 3 HOURS

INSTRUCTIONS:

1. **ANSWER ANY FOUR of the questions in this paper.**
2. **All questions carry equal marks (15 Marks)**
3. **Show all your working and reasoning clearly**

QUESTION 1

(a) What is an electroactive species? Give three (03) examples of electroactive species used in analytical chemistry, complete with appropriate equilibrium equations of each.

(b) Describe the operation principles of: differential refractometer, fluorometric and uv detectors.

(c) For the chromatogram shown in fig.1, determine the resolution between peaks B and C and also determine value for α for the same peaks.

(d) Methods of isotope dating rely on conversions of $^{40}_{19}K$ to $^{40}_{18}Ar$ and $^{87}_{37}Rb$ to $^{87}_{38}Sr$. (i) What are the nuclear equations for the conversions? (ii) Write out change in full, $^{27}_{13}Al(\alpha, p)\ ^{30}_{14}Si$.

(e) What do you understand by the terms: transducer, Geiger-Muller counter and Compton scattering?

(15 Marks)

QUESTION 2

(a) The relative times for several compounds measured from sample injection are: air, 45 secs, propane, 1.5 min; pentane, 2.35 min; acetone, 2.45 min, xylene, 15 min. What are the relative times of the compounds using pentane as a standard? Calculate resolution between acetone and pentane if their base widths are 2 and 3 mins respectively.

(b) In the TLC analysis of amino acids, ninhydrin was used to visualise the separated spots. What is the formed product and what other technique could be used in the analysis of amino acids?

(c) In potentiometry, discuss the uses and applications of Nernst equation and ion selective electrodes..

(d) Using specific chemical reactions and equations, discuss two (02) similarities and two (02) differences between electrolytic and voltaic cells.
(e) Equivalence conductance of a 0.0125N HOAC solution done at 25^0C was found to be 14.4. Calculate both degree of dissociation and the ionization constant of HOAC. (Limiting equivalence conductance of HOAC is estimated to be 390.7 cm^2/eq-ohm).
(15 marks)

QUESTION 3

(a) Describe 3 ways in which chemical species are transported in solution when using electrochemical methods.
(b) Discuss the main differences between x-ray emission and x-ray diffraction techniques and also include the uses of these techniques in analysis.
(c) A conductance cell was filled with KCl solution with specific conductance of 0.01288 mho/cm. The measured resistance at 25^0C was 48.3 ohms. (i) What is the cell factor K? When the same cell was filled with 0.100N $CdCl_2$, a resistance of 123.7 ohms was found, (ii) what is the equivalent conductance of $CdCl_2$ solution?
(d) How many grams of copper will be deposited on a cathode if a constant current of 0.5 A is passed for 5 minutes?
(e) What do you understand by the terms: NAA, DIDA and elastic scattering?

(15 Marks)

QUESTION 4

(a) Describe the 3 methods of extraction of samples using fractional process of solvent extraction.
(b) What are amperometric titrations and describe 2 classifications of such titrations.
(c) Octane and iso-octane give retention times of 800 and 815 seconds on a column known to have 8100 theoretical plates. (i) What resolution will be found if a sample containing these compounds is run on this column?, (ii) assuming the retention times remain unchanged, how many theoretical plates are needed to achieve baseline resolution of R = 1.5?.
(d) What is the potential of a half-cell obtained by mixing 30.0ml of 1.0×10^{-1}M Fe^{2+} and 60 ml of 1.0×10^{-3}M Fe^{3+} ($E^0_{Fe2+/Fe3+} = +\ 0.77V$).
(e) Compound A has molecular weight (MW) of 98.4 and heat of fusion of 1.63 Kcal/mol. Compound B has MW of 64.3 and melts at similar temperature as compound A. 500mg of each sample yields DTA peak areas of 60 and 45 cm^2 for A and B respectively. What is the heat of fusion for B?

(15 Marks)

QUESTION 5

(a) Discuss the differences between oscillometry and conductometry as applied to analysis..

(b) Calculate the cell voltage, and give the polarity of the right electrode of the cell: Pt|Ti^{3+} (1.0×10^{-1}), TiO^{2+} (1.0×10^{-3}), H^{+} (1.0×10^{-1})||V^{2+} ~~(1.0×10^{-1} M)~~|Pt. ($E^{0}_{V2+/V3+} = -0.26V$; $E^{0}_{TiO2+/TiO3+} = +0.10V$).

(c) Describe the differences in the following terms used in polarography: kinetic currents; catalytic currents and absorption currents.

(d) Component Y is eluted in 15 minutes. Component Z needs 25 minutes and non-retarded substance X needs 2 minutes. (i) What is relative retention Z with respect to Y? (ii) What is the capacity factor for Y on this column? (iii) What fraction of total time does Y spend in the mobile phase?

(e) Describe what determines the rate of travel of an average molecule in a chromatographic system?

(15 Marks)

$V^{2+}(1.0 \times 10^{-2} M)$; $V^{3+}(1.0 \times 10^{-1} M)$|Pt

END OF EXAMINATION QUESTIONS

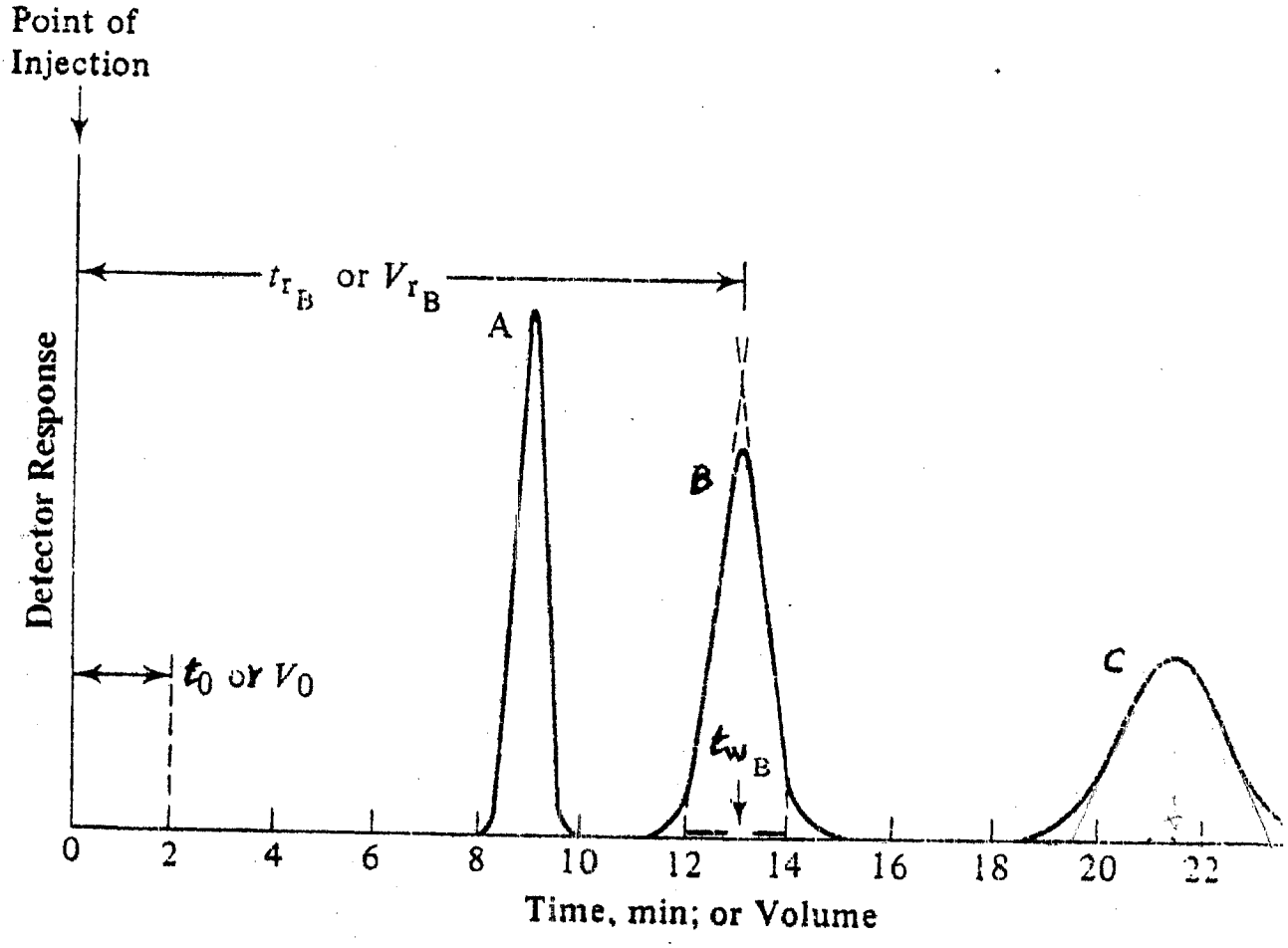


FIGURE 1 *Chromatogram of the three-component mixture.*

t_0 = time for solvent to traverse the column, t_{r_B} = retention time of substance B, t_{w_B} = peak basewidth of substance B, h = peak height. Units can also be given in terms of volume rather than time: V_0, V_{r_B}, V_{w_B}, and so forth.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

C342: INORGANIC CHEMISTRY III

TIME: THREE HOURS

INSTRUCTIONS: ANSWER ANY FOUR QUESTIONS

Question 1.

(a). Discuss the salient features of inner sphere mechanism for electron transfer reaction.

(b) The intermediate $[Fe(SCN)(OH_2)_5]^{2+}$ can be detected in the reaction of $[Co(NCS)(NH_3)_5]^{2+}$ with $Fe^{2+}(aq)$ to give $Fe^{3+}(aq)$ and $Co^{2+}(aq)$. What does this observation suggest about the mechanism.

(c) During the phosphane exchange reaction of $[CoBr_2(PPh_3)_2]$ there involves a large negative value of ΔS. What could be the probable mechanism involved. Justify your answer.

Question 2.

(a) Propose a suitable structure for the actinium complex $K_3[UO_2F_5]$ and support using necessary arguments.

(b) Lanthanides have similar chemical properties, then which property is used in the separation of Lanthanides. How is it done?

(c) Give a balanced equation for the reaction of any of the lanthanide metals with aqueous acid (H^+). Justify your answer with redox potential and oxidation states.

Question 3.

(a) What is the principle behind atom bomb? How does it differ from Hydrogen bomb?

(b) What is meant by critical mass in relation with nuclear reactor? Why does it vary?

(c) Draw a diagram to illustrate how binding energy per nucleon varies with mass number. Comment on the shape of the curve.

Question 4.

(a) In the tetrahedral series $\nu_{(CO)}$ decreases and $\nu_{(MC)}$ increases in going from $Ni(CO)_4$ to $[Co(CO)_4]^-$ to $[Fe(CO)4]^{2-}$. Explain why?

(b) Complete the reaction

$$2C_3H_5MgBr + NiCl_2 \xrightarrow{\text{ether}}$$

Draw the structures of $Fe(\eta^1\text{-}C_3H_5)(CO)_2(\eta^5\text{-cp})$ and $Co(\eta^3\text{-}C_3H_5)(CO)_3$.

(c) Give the equation for a workable reaction that will convert $Fe(\eta^5\text{-}C_5H_5)_2$ into $Fe(\eta^5\text{-}C_5H_5)(\eta^5\text{-}C_5H_4COCH_3)$.

Question 5.

(a) Using the 18 electron rule as a guide, indicate the probable number of carbonyl ligands in (1) $W(\eta^5\text{-}C_6H_6)(CO)_n$ (2) $Rh(\eta^5\text{-}C_5H_5)(CO)_n$ and (3) $Ru_3(CO)_n$

(b) Predict the products of these reactions.

$[PtCl_4]^{2-} + 2I^- \rightarrow$

$[PtI_4]^{2-} + 2Cl^- \rightarrow$

(c) It is possible to prepare different isomers of Pt(II) complexes with four different ligands. Predict the products expected if 1mole of $[PtCl_4]^{2-}$ is reacted successively with the following reagents.[the product of reaction (i) is used in reaction (ii)].

(i)2 moles of NH_3. (ii) 2 moles of py.(iii) 2 moles of Cl^- . (iv) 1mole of NO_2^-.

Question 6.

(a) Describe, what requirements must meet any solvent.

(b) Write down the physical and chemical properties of liquid sulphuric acid, sulphur dioxide and ammonia.

(c) Write down the reactions production of non-aqueous solvents: H_2SO_4, SO_2, and NH_3.

(d) Describe the production of sulfites of sodium and barium using the liquid sulphur dioxide. Write down the reactions between liquid SO_2 and H_2S at room temperature and at –70

END OF EXAMINATION

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
				KEY													
				Atomic number **X** Atomic mass Name of the element X													
1 **H** 1.01 Hydrogen																1 **H** 1.01 Hydrogen	2 **He** 4.00 Helium
3 **Li** 6.94 Lithium	4 **Be** 9.01 Beryllium											5 **B** 10.81 Boron	6 **C** 12.01 Carbon	7 **N** 14.01 Nitrogen	8 **O** 16.00 Oxygen	9 **F** 19.00 Fluorine	10 **Ne** 20.18 Neon
11 **Na** 23.00 Sodium	12 **Mg** 24.31 magnesium											13 **Al** 27.99 Aluminium	14 **Si** 28.09 Silicon	15 **P** 30.99 Phosphorus	16 **S** 32.07 Sulphur	17 **Cl** 35.45 Chlorine	18 **Ar** 39.95 Argon
19 **K** 39.10 Potassium	20 **Ca** 40.08 Calcium	21 **Sc** 44.96 Scandium	22 **Ti** 47.88 Titanium	23 **V** 50.94 Vanadium	24 **Cr** 52.00 Chromium	25 **Mn** 54.94 Manganese	26 **Fe** 55.85 Iron	27 **Co** 58.93 Cobalt	28 **Ni** 58.69 Nickel	29 **Cu** 63.65 Copper	30 **Zn** 65.39 Zinc	31 **Ga** 69.72 Gallium	32 **Ge** 71.61 Germanium	33 **As** 74.92 Arsenic	34 **Se** 78.96 selenium	35 **Br** 79.90 Bromine	36 **Kr** 83.80 Krypton
37 **Rb** 85.47 Rubidium	38 **Sr** 87.62 Strontium	39 **Y** 88.91 Yttrium	40 **Zr** 91.22 Zirconium	41 **Nb** 92.91 Niobium	42 **Mo** 95.94 Molybdenum	43 **Tc** 97.91 Technetium	44 **Ru** 101.07 Ruthenium	45 **Rh** 102.91 Rhodium	46 **Pd** 106.42 Palladium	47 **Ag** 107.87 Silver	48 **Cd** 112.41 Cadmium	49 **In** 114.82 Inidum	50 **Sn** 118.71 Tin	51 **Sb** 121.76 Antimony	52 **Te** 127.60 tellurium	53 **I** 126.90 Iodine	54 **Xe** 131.29 Xenon
55 **Cs** 132.91 Caesium	56 **Ba** 137.33 Barium	57 – 71	72 **Hf** 178.49 Hafnium	73 **Ta** 180.95 Tantalum	74 **W** 183.84 Tungsten	75 **Re** 186.21 Rhenium	76 **Os** 190.23 Osmium	77 **Ir** 192.22 Iridium	78 **Pt** 195.08 Platinum	79 **Au** 196.97 Gold	80 **Hg** 200.59 Mercury	81 **Tl** 204.38 Thallium	82 **Pb** 207.2 Lead	83 **Bi** 208.98 Bismuth	84 **Po** 208.98 Polonium	85 **At** 209.99 Astatine	86 **Rn** 222.02 Radon
87 **Fr** (223.02) Francium	88 **Ra** 226.03 Radium	89 - 103	104 **Unq** 261.11	105 **Unp** 262.11	106 **unh** 263.12	107 **uns** 262.12	108 **Uno** 265.00	109 **Une** 265									

57 **La** 138.91 Lanthanum	58 **Ce** 140.12 Cerium	59 **Pr** 140.91 Praseodymium	60 **Nd** 144.24 Neodymium	61 **Pm** 144.91 Promethium	62 **Sm** 150.36 Samarium	63 **Eu** 151.97 Europium	64 **Gd** 157.25 Gadolinium	65 **Tb** 158.93 Terbium	66 **Dy** 162.50 Dysprosium	67 **Ho** 164.93 Holmium	68 **Er** 167.26 Erbium	69 **Tm** 168.93 Thulium	70 **Yb** 173.04 Ytterbium	71 **Lu** 174.97 Lutetium
89 **Ac** 227.03 Actinium	90 **Th** 232.04 Thorium	91 **Pa** 231.04 Protactinium	92 **U** 238.03 Uranium	93 **Np** 237.05 Neptunium	94 **Pu** 244.0 Plutonium	95 **Am** 243.06 Americium	96 **Cm** 247.07 Curium	97 **Bk** 247.07 Berkelium	98 **Cf** 251.08 Californium	99 **Es** 252.08 Einstienium	100 **Fm** 257.10 Fermium	101 **Md** 260 Mendelevium	102 **No** 259.10 Nobelium	103 **Lr** 262.11 Lawrencium

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

C352: ORGANIC CHEMISTRY IV

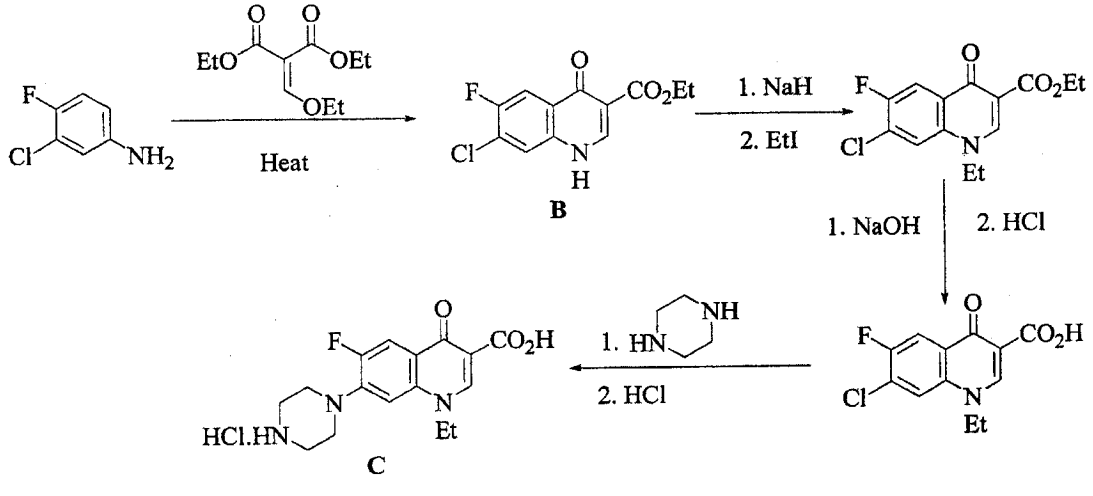
TIME: THREE HOURS

INSTRUCTIONS:

1. Answer any FOUR questions.
2. Present your answers in a logical manner.
3. Mark allocation for questions is shown, (x)

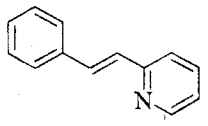
QUESTION ONE

(a) The synthesis of a broad spectrum antibiotic **C** is shown below. The stages are the Gould Jacobson quinoline synthesis to give **B** and the displacement reaction to afford **C**. What are the mechanisms of these reactions?



[12]

(b) (i) Provide a synthesis of stilbazole, structure shown below, from 2-methylpyridine.

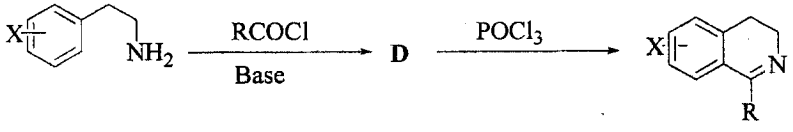


Stilbazole

(ii) Account for the fact that alkyl groups at C-2 and C-4 positions of quinoline can be easily deprotonated by strong bases.

[10]

(c) Dihydroisoquinoline **E**, shown in the scheme below, is an intermediate in the Bischler-Napieralski synthesis of isoquinolines. Give the structure of the product **D** and provide a mechanism for the formation of the dihydroisoquinoline **E** from **D**.

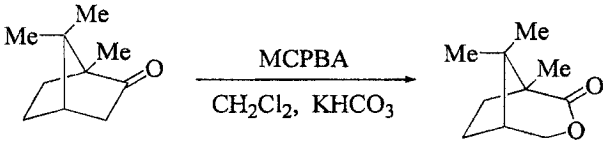


E: Dihydroisoquinoline

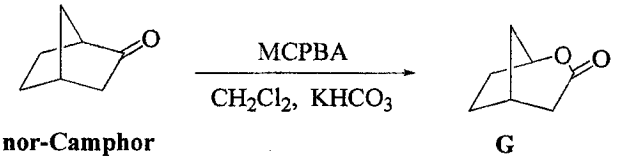
[8]

QUESTION TWO

(a) Baeyer-Villiger oxidation of Camphor gave an unexpected product **F** in 30 % yield; where as norcamphor gives the expected product **G** as shown below. Provide a mechanistic explanation for these experimental results.



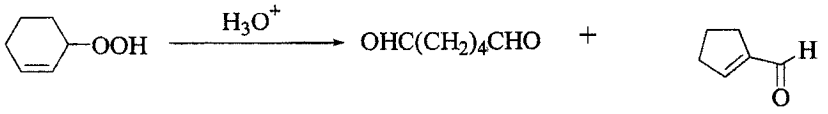
Camphor **F**

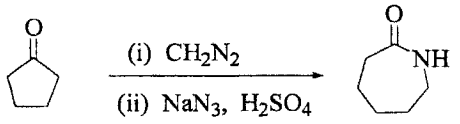


nor-Camphor **G**

[10]

(b) Sugget plausible reaction mechanisms to account for the observed products of the following reactions.

(i) 

(ii) 

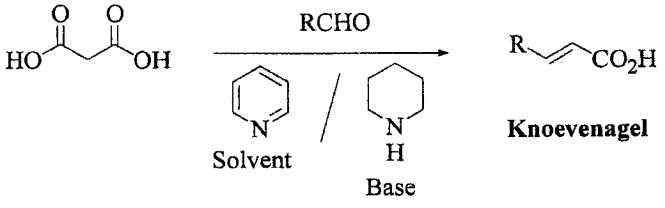
[20]

QUESTION THREE

(a) (i) With the aid of an example, state two ways in which a carbanion can be generated.

[8]

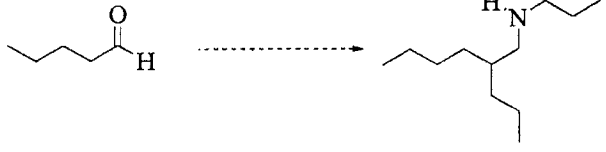
(b) Propose a mechanism to account for the reaction shown below.



[10]

(c) Suggest synthetic sequences for the following transformations:

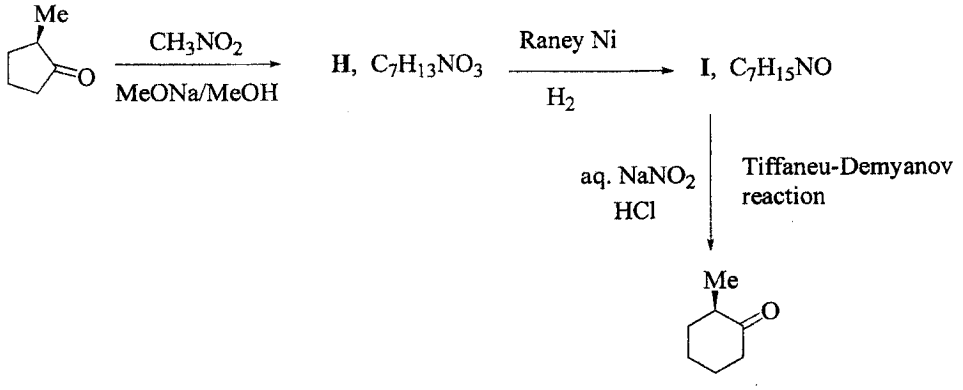
(i) 

(II) 

[12]

QUESTION FOUR

(a) A general method for homologation of cyclic ketones is shown below. The last step of this reaction sequence is known as Tiffaneu-Demyanov reaction, a variant of Pinacol rearrangement.

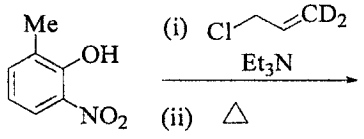


(i) Identify the intermediates **H** and **I**.
(ii) Suggest the most likely mechanism for the Tiffaneu-Demyanov reaction shown above.
(iii) Give the structure of one other possible product that can be expected to be formed in the last step of the above reaction sequence.

[12]

(b) Predict the major organic products and give mechanisms of the following reactions.

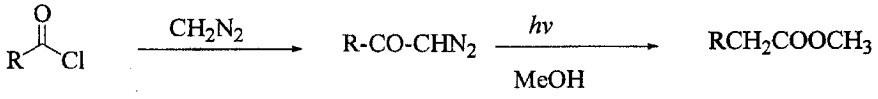
(i)



(ii)

[10]

(c) A general method for extending carbon chains of carboxylic acids is shown below.

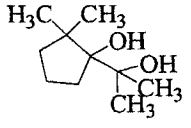


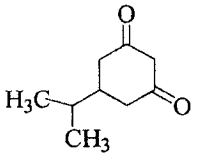
Give the mechanisms of the above reactions.

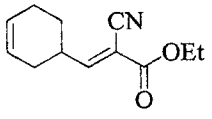
[8]

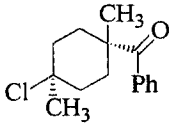
QUESTION FIVE

Suggest the most probable synthesis for **any three (3)** of the following compounds.

(i) 

(ii) 

(iii) 

(iv) 

30 marks

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF CHEMISTRY

SEMESTER II: 2008 SESSIONAL EXAMINATIONS

C 362: COLLOIDS AND ELECTROCHEMISTRY

24 APRIL 2009

TIME: THREE HOURS
ANSWER QUESTION 1 AND ANY FOUR (4) OUT OF FIVE OTHERS.
THIS EXAMINATION QUESTION PAPER HAS FIVE PAGES.

DATA
R = 8.314 J mol^{-1} K^{-1}; *F* = 96485 C mol^{-1}; 1 atm. = 101325 Pa
C = 12.01, H = 1.01, Ca = 40.08, Mg = 24.31

QUESTION 1(*TOTAL 40 MARKS: 8 marks for each part*)

a). (i) Consider a system in which the following reaction occurs:

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

For this system, state the number of phases, the number of chemical constituents, the number of components and use Gibbs Phase Rule to calculate the number of degrees of freedom.

(ii) Now consider a system in which the following reaction occurs:

$$NH_4Cl(s) \longrightarrow NH_3(g) + HCl(g)$$

Does Gibbs Phase Rule apply to this system? Explain your answer.

b). Calculate the limiting molar conductivity of silver chloride from the following data:

Salt	Limiting molar conductivity, S cm^2 mol^{-1}
KCl	149.9
KNO_3	145.0
$AgNO_3$	133.4

After correction for water conductivity, the conductivity of a saturated solution of silver ion is 1.887 x 10^{-6} S cm^{-1} at 25° C. Calculate the solubility and the solubility product of silver chloride at this temperature.

c). A mixture of methylbenzene, MB ($C_6H_5CH_3$) and benzene, B (C_6H_6) contains 30% by weight of methylbenzene. At 303.15 K, the vapour pressure of methylbenzene is 4892 Pa and that of benzene is 15744 Pa. Assuming that they form an ideal mixture, calculate the total pressure and the partial pressure of each component above the solution at 303.15 K.

d). Estimate the limiting current density at an electrode in which the concentration of the silver ion is 2.5 *m*mol at 25° C. The thickness of the Nerst diffusion layer is 0.40 mm. The ionic conductivity of silver ion at infinite dilution and 25° C is 6.19 *m*S m^2 mol^{-1}.

e). (i) Distinguish between specific viscosity and relative viscosity? What are their units?

(ii) The intrinsic viscosities of various fractions of nylon–6 (polycaprolactam) in *m*-cresol were measured at 298.15 K (Reimschussel and Dege 1971). The results were as follows:

$[\eta]$ (dm^3 g^{-1})	M_v (g mol^{-1})
0.43	4,460
1.10	17,600
1.59	30,800

Determine the values of the Mark-Houwink constants *a* and *K*. What are the units of *K*?

QUESTION 2 (*15 MARKS*)
Liquid naphthalene, $C_{10}H_8$ has a vapour pressure of 1.3 *k*Pa at 358.35 K and 5.3 *k*Pa at 392.45 K.

a). Calculate: (i) the molar heat of vaporization ΔH_{vap}; (ii) the normal boiling point, T_b; and (iii) the molar entropy of vaporization, ΔS_{vap} at its normal boiling point. What assumption(s) have you made in each calculation?

b). The triple point temperature, T_{tr} of naphthalene is 353.65 K. Calculate its triple point pressure, P_{tr}.

c). The density of $C_{10}H_8$ (s) is 1000 kg m^{-3} and that of $C_{10}H_8$ (l) is 980 kg m^{-3}. Will the melting point temperature at 101325 Pa be less than 353.65 K? Derive, but do not solve, an explicit equation for calculating this temperature.

QUESTION 3 (*15 MARKS*)

a). Derive an expression for dissociation constant, K for a weak electrolyte AB. Modify the equation so that it can be used to test experimental values of Λ at various concentrations by means of a straight line plot.

b). Kraus and Callis, [*J. Amer. Chem. Soc.*, **45**, 2624 (1923) obtained the following electrolytic conductivities, κ for the dissociation of tetra-methyl tin chloride, $(CH_3)_4SnCl$ in ethanol solution at 25° C and at various concentrations c:

$c/10^{-4}$mol dm^3	1.566	2.600	6.219	10.441
$\kappa/10^{-6}\ \Omega^{-1}\ cm^{-1}$	1.788	2.418	4.009	5.336

By the use of the linear plot you devised in part a), determine Λ° and K.

QUESTION 4 (*15 MARKS*)

Acetone and carbon disulfide do not form an ideal solution. The vapour pressures of acetone, $(CH_3)_2CO$ and carbon disulfide CS_2 at 308 K were measured and found as follows:

Mole fraction of CS_2, $X(CS_2)$ in the liquid phase.	Partial pressure $(CH_3)_2CO$ (bar)	Partial pressure CS_2 (bar)
0.00	0.45	0.00
0.05	0.45	0.11
0.10	0.41	0.24
0.20	0.39	0.37
0.40	0.36	0.47
0.60	0.31	0.54
0.80	0.26	0.57
0.90	0.20	0.65
0.95	0.13	0.66
1.00	0.00	0.67

a). Draw the *Pressure – Composition* phase diagram for acetone and carbon disulfide.

b) On the same diagram (i) draw plots to show the validity of both Raoult's and Henry's laws for each component; (ii) draw a plot for the total pressure to show the validity of Raoult's law if the solution were ideal. Label the plots appropriately; and (iii) what type of deviation does the phase diagram exhibit? Briefly explain your answer.

c) Calculate the change in the chemical potential, μ of CS_2 when its mole fraction in the mixture changes from 0.20 to 0.80.

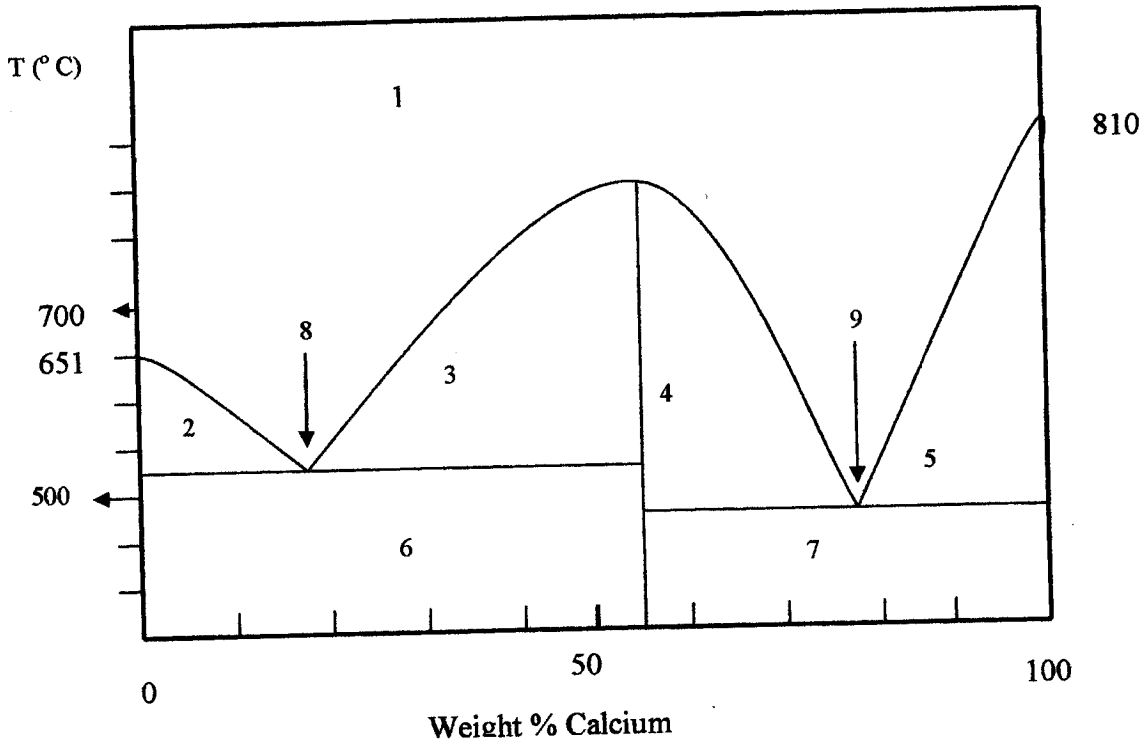
QUESTION 5 (*15 MARKS*)

An early study of hydrogen overpotential is that of H. Bowden and T. Redeal [*Proc. Roy. Soc.*, **A120**, 59 (1928)], who measured the overpotential for hydrogen evolution with a mercury electrode in dilute aqueous solutions of sulfuric acid at 25° C. Determine the exchange current density and transfer coefficient, α from their data:

J / mA^{-2}	2.9	6.3	28	100	250	630	1650	3300
η / V	0.60	0.65	0.73	0.79	0.84	0.89	0.93	0.96

Explain any deviation from the results expected from Tafel equation.

QUESTION 6 (*15 MARKS*)
The following is a *Temperature – Composition* phase diagram for the system magnesium-calcium:



Magnesium melts at 651 ° C and calcium melts at 810 ° C. A compound with calcium composition of 55 % weight calcium is formed and melts at 721 ° C.

a) Calculate the formula of the compound formed.

b). Identify all the numbered regions of the phase diagram. Use Gibbs Phase Rule to indicate the degree(s) of freedom for each numbered region. In identifying the regions indicate the *actual phases* present; for example: Region X: Ca (s), F = 2.

c). Sketch cooling curves for compositions of 40 % weight and 55 % weight calcium from 850 to 450 ° C. On the sketch, indicate the temperature at which a phase change occurs. Estimate the temperature of the phase changes from the phase diagram and indicate these on the curves.

END OF EXAMINATION FOR C 362

THE UNIVERSITY OF ZAMBIA
DEPARTMENT OF CHEMISTRY
SEMESTER II 2007 SESSIONAL EXAMINATIONS
C 362: COLLOIDS AND ELECTROCHEMISTRY
20TH FEBRUARY 2008

TIME: THREE HOURS
INSTRUCTIONS: 1. ANSWER *ANY FIVE (5)* OF SIX QUESTIONS
2. USE *SEPARATE* ANSWER BOOKS FOR SECTION A AND SECTION B

DATA

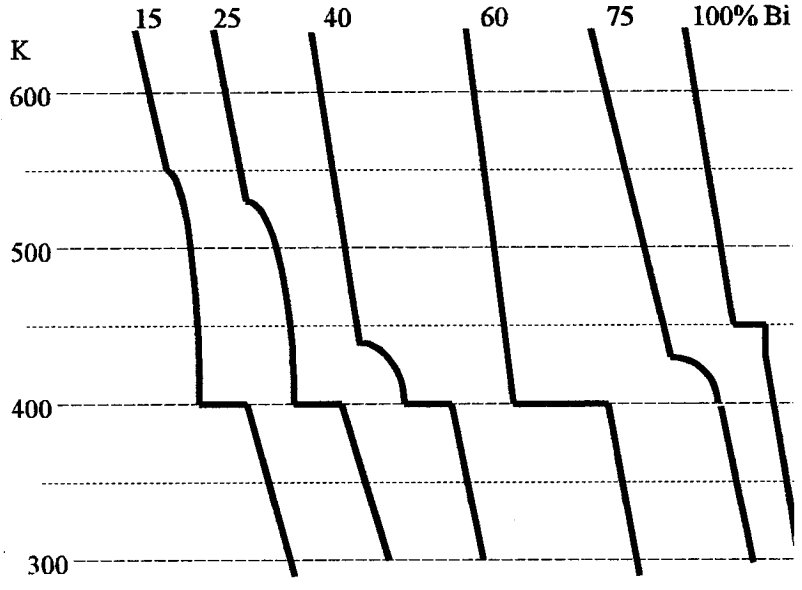
$R = 8.314\ J\ K^{-1}\ mol^{-1} = 8.314 \times 10^{-2}\ L\ bar\ K^{-1}\ mol^{-1}$; $N_A = 6.022 \times 10^{23}\ mol^{-1}$;
Atomic masses Cd = 112, I = 127, Bi = 209; F = 96485 C mol^{-1}

SECTION A

QUESTION 1

a) The equation F = C - P + 2 is an important one in Physical Chemistry. Identify the equation and explain all the symbols and the number 2 in the equation.

b) The following are cooling curves for mixtures of the two component cadmium-bismuth system indicating percentages of bismuth. The melting point of cadmium is 596 K.



(i) Draw the phase diagram. (ii) On the diagram indicate the melting point of each component and label each region to indicate what phases are present in that region. (iii) Label the eutectic point. (iv) calculate the mole fraction of cadmium in the eutectic composition.

QUESTION 2.

Consider one mole of nitric acid at its normal boiling point.

a) Write a complete equation for this change of state.

b) Derive the Clausius-Clapeyron equation for nitric acid at its normal boiling point. Clearly state all the assumptions made in its derivation.

c) The vapour pressure, P, of nitric acid was measured and found to vary with temperature as follows:

t(° C)	0	20	50	70	90
P (bar)	0.0192	0.0638	0.2271	0.6220	1.2481

Using the equation derived in part b) calculate the boiling temperature, the enthalpy of vaporization, the entropy and the Gibbs free energy of nitric acid at its normal boiling point.

QUESTION 3.

One of the laboratory experiments that you performed during the semester was a conductometric titration of a solution of hydrochloric and copper(II) chloride with sodium hydroxide.

a) Explain the general theory underlying the conductometric titration of sodium hydroxide against a solution of hydrochloric and copper(II) chloride. State what parameter(s) was(were) measured. Also state the advantage(s) of conductometric titrations over other titration methods.

b) A mixture of exactly 50 cm^3 of 0.0200 M HCl and 50 cm^3 of 0.0200 M acetic acid was titrated conductometrically with 1.00 M NaOH. The following data were obtained during the titration, with conductance expressed in arbitrary units:

V(NaOH):	0.0	0.40	0.80	1.20	1.60	1.80	2.20	2.60	2.80
Conductance:	37.0	28.0	16.0	12.0	14.5	15.5	20.0	27.5	31.5

Plot the experimental points of the titration curve and extrapolate the line segments to locate the end points. (i) state the values of the end points and (ii) the equivalence points. (iii) Explain the shape of this titration curve.

SECTION B

QUESTION 4.

The determination of transference numbers of cadmium and iodide ions by Hittorf's method gave the following data. A stock solution of cadmium iodide was prepared and by precipitation of iodide as AgI its concentration was determined as 0.002763 g of cadmium iodide per gram of solution. Another sample of this solution was placed in a Hittorf transference number cell and current was passed through the cell. It was found that 0.03462 g of cadmium was deposited at the cathode by the passage of current. Furthermore, analysis of the anode compartment solution, which weighed 152.643 g, indicated the presence of 0.3718 g of cadmium iodide.

a) What are the electrode reactions?

b) Indicate diagrammatically, using t_+ and t_- to represent the transference numbers, the changes in amounts of ions in the anode and the cathode compartments as a result of migration and electrode reactions.

c) How many coulombs of charge were passed through the cell in the experiment?

d) Calculate the transference numbers of Cd^{2+} and I^- in this cadmium iodide solution.

e) What was the change in the moles of CdI_2 in the cathode compartment?

QUESTION 5.

a) The limiting current density is given in terms of ionic diffusion coefficient D_+ which can be related to ionic conductivity λ_+. Derive an expression for the limiting current in terms of λ_+, the concentration of the ion c_+, and the thickness of the diffusion layer δ.

b) The ionic conductivity of Fe^{2+} is 40 S cm^2 mol^{-1}. The limiting current of platinum electrode of an area 40 cm^2 dipping into a solution of iron(II) chloride at 25 °C was measured at various concentrations whose results are given below:

$[FeCl_2]$ / M	0.250	0.125	0.063	0.031
I / *m*A	215	107	49	23

What was the thickness of the diffusion layer at each concentration?

QUESTION 6.

The resistance of a series of aqueous sodium chloride solutions, formed by successive dilution of a sample, were measured in a cell with a cell constant (the constant K in the relation $\kappa = \frac{K}{R}$) equal to 0.2063 cm^{-1}. The following values were found:

c /mol L^{-1}	0.00050	0.0010	0.0050	0.010	0.020	0.050
R / Ω	3314	1669	342.1	174.1	89.08	37.14
Conductivity κ						
Molar conductivity Λ						

a) Copy and complete the above table.

b) Verify that the molar conductivity follows Kolhrousch's law.

c) Determine the molar conductivity at infinite dilution and the coefficient ***b***.

d) Use the determined value of ***b*** and the information given below to predict the molar conductivity, the conductivity, the resistance it would show in the cell, of 0.01 mol L^{-1} sodium iodide at 25 °C.

$\lambda(Na^+) = 5.01$ *m*S m^2 mol^-; $\lambda(I^-) = 7.68$ *m*S m^2 mol^-.

----------END OF C362 EXAMINATION----------

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATIONS

C412: ADVANCED BIOCHEMISTRY II

TIME: THREE HOURS

INSTRUCTIONS:

1. PLEASE NOTE THAT THERE ARE TWO (2) SECTIONS IN THIS EXAMINATION PAPER, *SECTION A* AND *SECTION B*
2. ANSWER ANY FOUR (4) QUESTIONS FROM *SECTION A* AND ANY ONE QUESTION (1) FROM *SECTION B*
3. MAKE SURE YOU HAVE 5 PRINTED PAGES OF THIS EXAMINATION PAPER
4. FAILURE TO FOLLOW THESE INSTRUCTIONS WILL RESULTS IN LOSS OF MARKS

Section A

- Question 1

Total length of DNA in a human cell is approximately 2 metres long. The cell nucleus is about a million times smaller in diameter relative to length of DNA and yet the entire length of DNA must be packed inside the nucleus.

a) With above facts in mind **discuss** in detail how DNA is packaged inside a human cell.
b) **Explain** how the DNA so packed in the cell is replicated or transcribed.

[20 marks]

Cont'd on the next page

- Question 2

a) The following pair of primers in PCR has a problem with it. Briefly **explain** why these primers would not work well.

5'-GCCTCCGGAGACCCATTGG-3'
5'-TTCTAAGAAACTGTTAAGG-3'

b) Briefly **describe** how you would use site-directed mutagenesis to change a *BamHI* (GGATCC) restriction site into a *HindIII* site (AAGCTT).
c) Suppose you did an experiment in which you placed a plasmid containing a PCR generated DNA insert into *E. coli*. Briefly **describe** the method you would use to test for the uptake of the plasmid.

[20 marks]

- Question 3

A yeast genomic library was constructed by inserting *BamHI* digested yeast chromosomal DNA fragments into the *BamHI* site of the plasmid pBR322.

PBR322 has 4363 nucleotide pairs (bp) and it encodes an ampicillin resistance gene (containing a *PstI* site) and a tetracycline resistance gene (containing a *BamHI* and *SalI* site). The map positions of the resistance enzyme sites are *EcoRI* 4361, BamHI 375, *SalI* 651, *PstI* 3609, *BglII* does not cut.

40,000 ampicillin-resistant colonies were obtained, of these 37,000 were tetracycline-sensitive. The library was screened with an oligonucloetide encoding part of gene X and 3 positive colonies were obtained. One of these was retained for further study and subjected to restriction endonuclease mapping. The following results were obtained:

Cont'd on the next page

Restriction Enzyme(s)	Fragment sizes in kilobase pairs (Kbp)		
EcoRI	10.5		
EcoRI + BamHI	0.37	6.1	4.0
PstI	2.22	0.4	7.9
BglII	10.5		
EcoRI + BglII	5.4	5.1	
SalI	10.5		
BglII + SalI	1.4	9.1	

a) **What** proportion of the colonies contains inserts?
b) Using the formula $p = 1 - (1 - f)^n$, where p = probability of the library containing a particular gene, f = fraction of the genome in each recombinant clone and n = number of colonies, **calculate** the probability that the library contains any particular gene (Yeast genome size is 4×10^{10} bp and the average insert size in the library is 5×10^3 bp).
c) **Draw** a restriction map of the recombinant plasmid.
d) Suppose you were given an antibody which cross-reacted with protein X, instead of the oligonucleotide. **Explain** how you would use this to isolate gene X.

[20 marks]

- Question 4
  a) Briefly **describe** any 5 preservation methods.
  b) **Which** of the five is used in preservation of

  i) beer
  ii) milk

[20 marks]

Cont'd on the next page

- Question 5 **Identify** all (a to f) the cyt P450 reaction types shown in Fig. 1

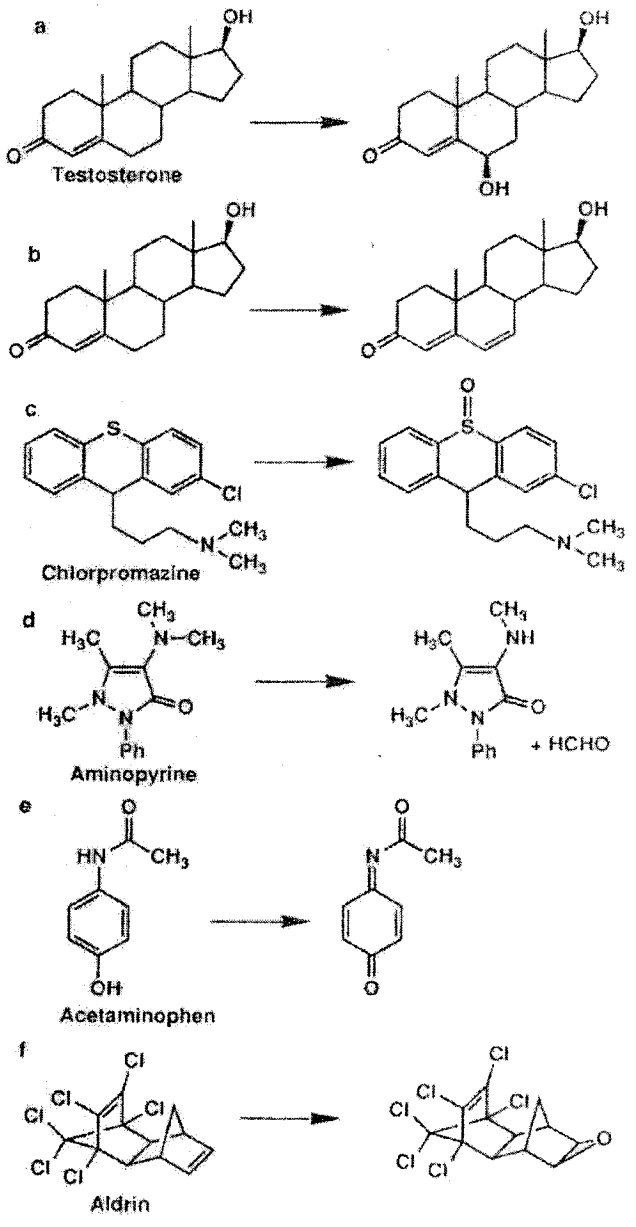


Fig. 1

[20 marks]

Cont'd on the next page

Section B

- Question 6

  Describe in detail the chemistry of HIV infectivity. What drugs are clinically approved for treatment of AIDS (use formulae)?

[20 marks]

- Question 7

  What is the complement system? Describe the mode of action of this system.

[20 marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF CHEMISTRY

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATION

C 422: APPLIED ANALYTICAL CHEMISTRY: ORGANIC COMPOUNDS

TIME: THREE HOURS

INSTRUCTIONS: ANSWER ANY 4 QUESTIONS FROM THE 5 QUESTIONS IN THIS PAPER
ALL QUESTIONS CARRY EQUAL MARKS
SHOW ALL YOUR WORKING AND REASONING CLEARLY

QUESTION 1

(a) Pesticides are an important element to national development, particularly to agriculture. However, the chemicals may have detrimental effects. Give 3 attributes of an ideal pesticide.
(b) 0.2g Urea sample ($(NH_2)_2CO$) was analysed by the Kjeldahl method. NH_3 was collected in 50ml 0.05M H_2SO_4 and the excess titrated with 0.05M NaOH, a procedure requiring 3.40ml. Calculate %urea in the sample.
(c) 3 Antioxidants are allowed to be used in fat-based foods by Zambian regulations. Name them and describe how to detect any two of them in such foods.
(d) Describe or explain the following terms: detergency, emulsifier, antioxidant and agglutination. Include in your answer their uses if any.
(e) Describe 3 reactions used in the identification of amines in organic compounds.

(15 MARKS)

QUESTION 2

(a) Potassium chromate in basic solution exhibits an absorption maxima at 372nm. A basic solution containing 3.00×10^{-5}M potassium chromate transmits 71.6% of incident radiation at 372nm, when placed in a 1cm cell. (i) What is the absorbance of this solution (ii) what is the molar absorptivity of potassium chromate at 372nm?
(b) What are the basic differences between detergents and soap? Outline how quality of these products can be evaluated.

(c) The phosphorous content was analysed by the gravimetric quinolinium phosphomolybdate method. If 3.114g of quinolinium phosphoate, $(C_9H_7)_3PMo_{12}O_{40}$ were obtained from a 1.00g sample. Find the $\%P_2O_5$ in the sample (use P = 30.97, O = 16, N = 14.01, Mo = 95.94).
(d) Describe an appropriate pre-treatment method that would effectively deal with the analysis in drug samples in which you have both alkaloids and barbiturates.
(e) Describe 3 methods of determining "crude fat" in foods.

(15 MARKS)

QUESTION 3

(a) A Sample of mineral ash gave a meter reading of 37. Solutions B and C containing the same quantity of unknown solution plus 40 and 80μg/ml of added K, respectively meter readings of 65 and 93. Calculate the quantity of unknown K in the original sample.
(b) Name 2 water- soluble vitamins found in food and briefly describe how to determine them in fruits and vegetables.
(c) What is the difference in principles of operation between dialysis, osmosis and ultrafilteration. Where would you apply such type of techniques?
(d) Describe the Van Slyke method used in gas analysis. What other method can be used instead of Van Slyke method in blood analysis?
(e) Discuss some reactions associated with vinyl as well as propenyl organic compounds.

(15 MARKS)

QUESTION 4

(a) The determination of SO_2 in a fruit drink was done thus: SO_2 gas was bubbled at a rate of 20L/minute through a trap containing H_2O_2. The H_2SO_4 produced in 30 minutes was treated with 5.62ml of 0.01M NaOH. What was the concentration of SO_2 in the sample in ppm given that the density of SO_2 is 2.86mg/ml (S = 32).
(b) Discuss the determination of a sweetener and caffeine in a soft drink.
(c) Sources of pesticides residues in soil are numerous. Presented with a soil sample suspected to contain an organo-mercurial pesticide, what test would you carry out to determine the nature of the contaminant.
(d) You have just made an N containing compound and you would like to know whether it is an amine or a nitro compound. What tests would you carry out to try and identify the compound?
(e) Describe how a health soap is made and discuss how its qualities are established.

(15 MARKS)

QUESTION 5

(a) Discuss the 3 ways of how to determine electrolytes in blood serum.
(b) H_2O_2 solution was analysed by adding excess standard $KMnO_4$ solution and back-titrating the unreacted $KMnO_4$ with Fe^{2+}. A 0.587g sample of H_2O_2 solution is taken in 25ml of 0.0125M $KMnO_4$ and back-titration needed 5.10ml of 0.112M Fe^{2+} solution. What $\%H_2O_2$ is in the sample. What other method can be used to determine the concentration of H_2O_2 solution?
(c) Describe the important components of *Mazoe* drink and discuss the determination of one of the minor components of this popular drink.
(d) Define the following terms: hydroxyl value, iodine value, peroxide value and include their uses in foods.
(e) For people living in malaria prone and tsetse fly infected areas, name 2 types of pesticides that could be used to protect both livestock and people.

(15 MARKS)

END OF EXAMINATION QUESTIONS

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
2008 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

C452: ADVANCED ORGANIC CHEMISTRY II

TIME: THREE HOURS

INSTRUCTIONS:

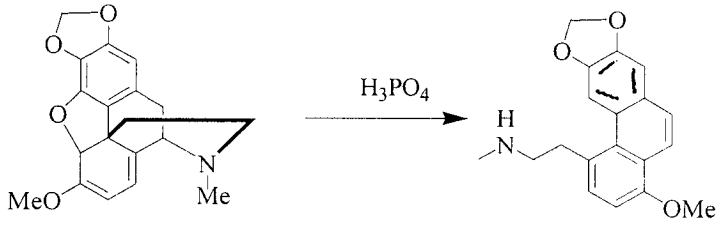
1. **Answer any FOUR (4) questions.**
2. **Present your answers in a logical manner.**
3. **All questions carry equal marks (30).**

Max. Marks: 120

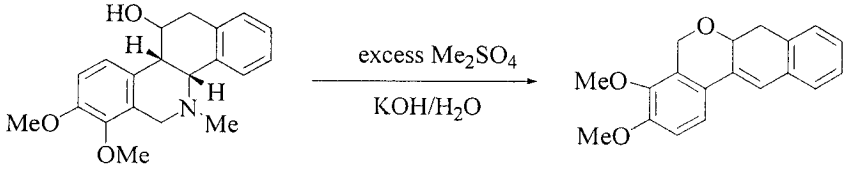
QUESTION ONE

(a) Propose plausible reaction mechanisms to account for the unanticipated products of the following reactions.

(i)



(II)



[20]

(b) The picryl substituent, $(NO_2)_3C_6H_2$, of the picrylbenzoic acid, $(NO_2)_3C_6H_2C_6H_4COOH$, has δ_m and δ_p values of 0.43 and 0.41 respectively. What conclusion can you draw from the above two values regarding the inductive effect transmitted from the *m*-position compared with that from the *p*-position? Show the structures of picrylbenzoic acids.

[10]

QUESTION TWO

(a) Deduce the structure of a disaccharide **B**, $C_{12}H_{22}O_{11}$, from the following data. Show your reasoning clearly.

Acidic hydrolysis of **B**, gave D-glucose and a D-hexose **C**, which gave a positive reaction with Tollen's reagent. Exahaustive methylation of **B** followed by mild acid hydrolysis gave 2,3,4-tri-O-methylglucose and 2,3,4,6-tetra-O-methyl derivative of **C** in equimolar ratio. Sodium borohydride reduction of **C** gave an optically inactive compound **D**, $C_6H_{14}O_6$. Ruff degradation of **C** produced an aldopentose **E**, which was oxidized by dilute nitric acid to an optically inactive dicarboxylic acid **F**, $C_5H_8O_7$.
The proton nmr spectrum of **B** showed two doublets, δ (ppm): 5.62 (d, 1H, J = 7.8 Hz) and 5.41 (d, 1H, J = 7.4 Hz), plus other signals at δ 4.5 – 3.4 ppm integrating for the remaining oprotons.

[16]

(b) The effect of substituents on the relative rates, ***log K/K₀***, of phenyltrimethylsilanes with aqueous methanolic perchloric acid at 51°C is given in the table below.

Substituent	δ^+	Log K/K_0
p-$N(CH_3)_2$	-1.70	7.50
p-OCH_3	-0.78	3.18
p-CH_3	-0.31	1.32
m-CH_3	-0.07	0.36
H	0.00	0.00
p-Cl	0.11	-0.87
p-Br	0.15	-1.00

(i) Demonstrate the correlation of the reaction with δ^+ values and provide the value of its constant, the *p* value.

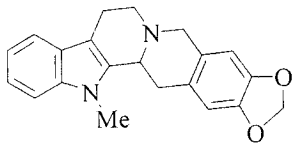
(ii) Name the type of the reaction in (b) (i) above and show its mechanism.

[14]

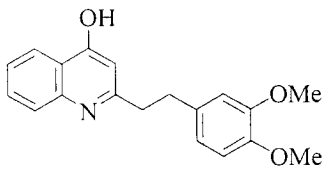
QUESTION THREE

(a) Using disconnection approach, propose a synthesis of the alkaloids **G** and **H**, structures shown below from readily available non-heterocyclic starting materials. Show the reagents, including solvents (if any), reaction conditions and the products for each step of your proposed synthesis.

G



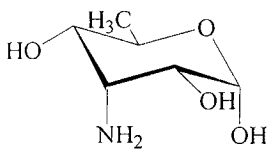
H



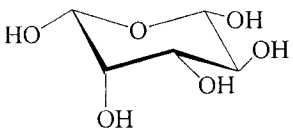
[20]

(b) How would you carry out the following transformations in good yield. Show all steps clearly.

(i) D-glucose ⟶



(ii) D-galactose ⟶

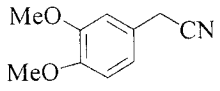


[10]

QUESTION FOUR

(a) Explain the reactions involved in the following synthesis of the alkaloid **M**. Show the reaction mechanisms.

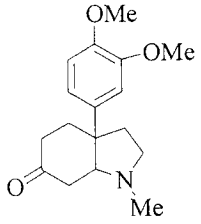
Successive treatment of a solution of 3.4-dimethoxyacetonitrile, structure shown below, in dimethylsulphoxide with dimethylsulphoxide anion and 1,2-dibromoethane gave **I**, $C_{12}H_{13}NO_2$, which showed a prominent absorption band at 2233 cm^{-1} in the **ir** spectrum.



3,4-dimethoxyacetonitrile

Reduction of **I** under controlled conditions with one(1) molar equivalent of DIBAL-H followed by acidic hydrolysis of the reaction mixture yielded a nitrogen free compound **J**, $C_{12}H_{14}O_3$. The **ir** spectrum of compound **J** showed three prominent bands, a strong band at 1715 cm^{-1}, a medium band at 2850 cm^{-1} and a weak band at 2750 cm^{-1} while the **^{1}Hnmr** spectrum showed, among other features, a singlet at 9.2 ppm (1H).

Codensation of **J** with methylamine gave **K**, $C_{13}H_{17}NO_2$, which isomerised to an enamine **L**, $C_{13}H_{17}NO_2$, upon short heating to 160 °C in the presence of ammonium chloride. Treatment of **L** with methyl vinyl ketone in ethanolic potassium hydroxide gave the alkaloid **M,** structure shown below.



Alkaloid M:

[18]

(b) A herbal traditional medicine for treatment of syphilis is claimed to contain alkaloids.

(i) How would you test for the presence of alkaloids in this medicine?

(ii) Briefly outline a procedure for the isolation of alkaloids.

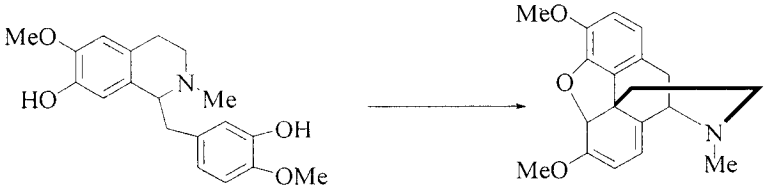
[12]

QUESTION FIVE

(a) On the first experiment, the δ_m and δ_p values for the formyl substituent were estimated to be 0.36 and 0.44 respectively by measurement of the pK_a values of *m*- and *p*-formylbenzoic acids. On the second experiment, the δ_m and δ_p values for the same formyl substituent were estimated to be 0.35 and 0.22 respectively by measurement of the rate of alkaline hydrolysis of *m*- and *p*-formylethylbenzoates in 56% aqueous acetone. Give an explanation to account for the observed discrepancy in the δ_m and δ_p values. **Note: it may be necessary to show the last reaction-the alkaline hydrolysis.**

[10]

(b) Isotopic labeling experiments have shown that in plants (-)- reticuline, structure shown below, is derived from the aminoacid phenylalanine and it is the key intermediate in the biosynthesis of the alkaloid **N**, structure shown below. On this basis propose a biogenetic pathway for (-)- reticuline and the alkaloid **N**.



(-) - Reticuline **Alkaloid N:**

[20]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
SEMESTER II 2007 SESSIONAL EXAMINATIONS

C492: ORGANIC INDUSTRIAL CHEMISTRY **19 FEBRUARY 2008**

Time : 3 hours
Instructions : Answer all questions

Question 1

(a) Briefly define explosives? What are the major differences between explosives meant for military purpose and those for civilian use?
(b) By means of a diagram show the relative positions of the number-average, weight-average and z-average molar masses on a molar mass distribution plot of a polymer.
(c) Suggest two advantages of the carbonatation process over the phosphatation process.
(d) By means of a reaction scheme show how an azo dye may be prepared.
(e) Mixed-acid nitration is a commonly used technique for effecting nitration. Why is the presence of sulfuric acid in quantity important?

Question 2

(a) Define the following terms as applied to plastics

(i) Crystallinity (ii) Glass transition temperature

(b) Compare and contrast the two types of polymerization systems: bulk and solution. For each case, clearly indicate major advantages of the techniques.
(c) The skeletal structure of polymeric materials affects the properties of polymers formed. Use schematic diagrams to illustrate (i) linear (ii) branched and (iii) crosslinked structure in polymers. Explain how these structures affect the physical properties of polymers.

Question 3

(a) Outline factors attributed to poor affination in sugar refining.
(b) (i) Comment briefly on mechanical and chemical methods of clarification in the sugar industry.
(ii) What are the disadvantages of using the mechanical method of clarification?
(c) Explain the term *false grain* and indicate factors that can lead to the formation of false grains.

Question 4

(a) Controlled drug release can be effected using a number of techniques. List these techniques with a note to explain how drug release is achieved using polymer based drug release systems.

(b) Draw a fully labeled diagram to illustrate the manufacturing process of three common antibiotics: penicillin, Erythromycin and Streptomycin.

(c) Write brief notes to describe the use and preparation of the drug class known as barbiturates.

Question 5

(a) (i) What is the purpose of tanning in the leather industry?

(ii) Describe in brief steps involved in vegetable tanning and give the key characteristics of leather processed using this method.

(b) Explain what the soaking process following drying in the production of leather achieves.

(c) Outline in a flow diagram the major elements involved in converting raw hides to leather for various applications.

End of Examination

The University of Zambia

School of Natural Science

Department of Computer Studies

FINAL EXAM SEMESTER II – February 2008

FUNDAMENTALS OF COMPUTER ARCHITECTURE (CST2032)

Instructions

1. There are **two sections** and a total of six questions in this question paper.
2. Each question carries **20 marks** only
3. You are required to **answer** a total of **five** questions only
4. **Section A** has **two** questions while **Section B** has **four** questions
5. **Answer** all questions in section A and any three questions in section B

Date: Tuesday, 26th February 2008

Time: 09:00hrs – 12:00hrs

Venue: Upper Dinning Hall

NOTE: Do not open this paper until you are told to do so

SECTION A – Answer all the questions in this section

1) Question One

a) Define the following [4]
   i) Computer Architecture
   ii) Computer organisation
   iii) Computer structure
   iv) Computer function

b) Using the letter A, give the general formula for each of the following [6]
   i) Unsigned Integer
   ii) Signed Magnitude Representation
   iii) Twos Complements Representation

c) Perform the following arithmetic conversion from [10]
   i) Base ten to base two
      (1) 25
      (2) 491
   ii) Base sixteen to base two
      (1) ABC5
      (2) ACD
   iii) Decimal digits to the IEEE – 32 bit floating point representation
      (1) 4525.313
      (2) 0.037241

---

2) Question Two

a) Perform the following calculations using 8 bits only and twos complements representation where possible. Comment on your answer. If there is an overflow expand the number of bits to 16 bits and give the collect answer. [10]

i) 117 – 124 = ☐ iii) -87 ÷ 4 = ☐

ii) 21 × (-15) = ☐ iv) 91 + 37 = ☐

b) Perform the following addition in floating point notation using IEEE 32 – bit representation. Leave your answer in normalised form as an IEEE 32 – bit representation. [10]

i) 137.1423 + 14.2471 = ☐

Section B – Answer any three questions in this section

3) Question Three

a) Define the following [4]
   i) Core
   ii) SRAM
   iii) DRAM
   iv) EEPROM

b) **List** the **four** basic functions of a computer, then **draw** a well labelled diagram showing a functional view of the computer [4]

c) **Draw** a well labelled diagram showing the **Top – Level Structure** of the computer [2]

d) Give two reasons why it is important to study Computer Architecture [4]

e) Draw a well labelled diagram showing the structure of the IAS Computer proposed by John Von Neumann. Give the function of each component [6]

---

4) Question Four

a) The basic function performed by a computer is execution of a program, which consists of a set of instructions stored in memory. The processor fetches the instructions from memory one at a time and executes each instruction. ***Sketch*** a well labelled diagram showing the **Basic Instruction Cycle**. [2]

b) Virtually all computers provide a mechanism by which other modules (I/0 memory) may interrupt the normal processing of the processor. List four common classes of interrupts and give a brief description of each. [8]

c) Although a variety of different bus implementation exists, there are a few basic parameters or design elements that serve to classify and differentiate buses. List the five elements of the Bus Design and discuss each one of them. [10]

---

5) Question Five

a) ***With*** the ***aid*** of a well labelled diagram, **describe** how the Cache Memory works. [2]

b) **Using** a well labelled diagram describe how the Cache Read Operation works [5]

c) List the eight key characteristics of computer memory system. Where possible give two examples for each characteristic. [7]

d) Although there is a large number cache implementation, there are a few basic design elements that serve to classify and differentiate cache architectures. **List the six elements of Cache Design** and where possible **give two examples** of each. [6]

---

6) Question Six

a) A disk is circular platter constructed of nonmagnetic material called substrate, coated with a magnetic material. Traditionally the substrate has been aluminium or aluminium alloys but recently glass substrates have been introduced. Give the five benefits of using the glass substrate. [5]

b) Peripheral devices can not and are not connected directly to the system bus (Figure 1). Give four reasons why this is so. [4]

c) The diagram below (Figure 1) shows the generic I/O module. List any four major categories of the functions of the I/O module [2]

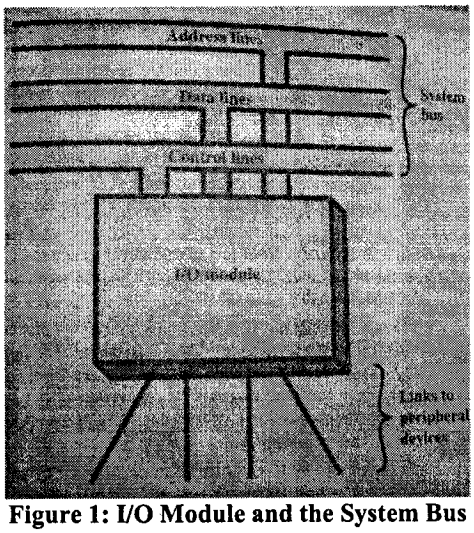


Figure 1: I/O Module and the System Bus

d) One of the key components of multiprogramming is scheduling. Briefly discuss the four types of scheduling [4]

e) Draw a well labelled diagram for Booth's Algorithm for twos complement multiplication [3]

f) The diagram below in Figure 2 shows the layers and views of the computer system in relation to the operating system. In relation to the diagram below give two objectives of an operating system [2]

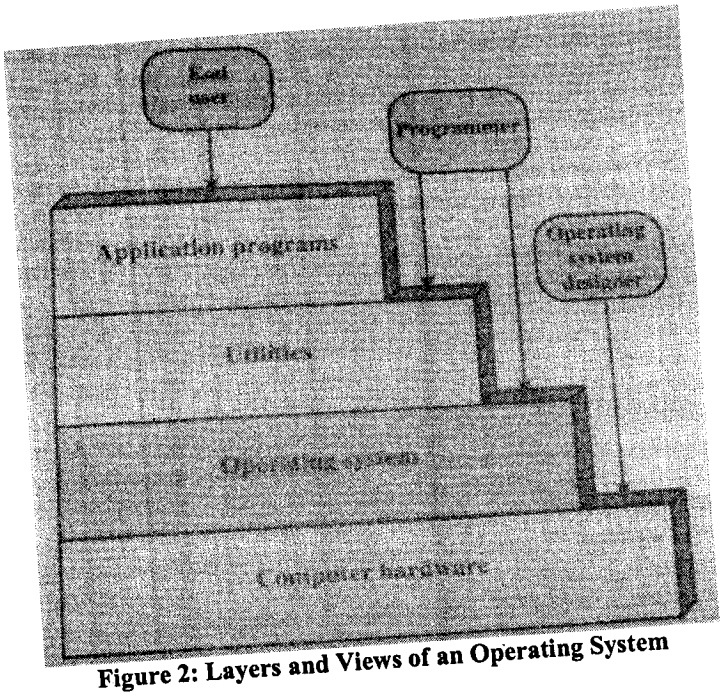
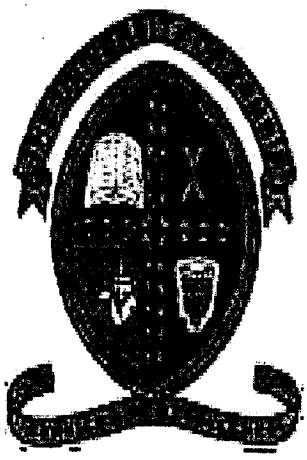


Figure 2: Layers and Views of an Operating System

ALL THE BEST



University of Zambia

School of Natural Sciences

Department of Computer Studies

CST2041

Introduction to Operating Systems

Final Exam

This exam has seven questions. Answer any five questions from the seven. Each question carries 20 points. Clearly indicate which questions you answer in your answer booklet.

"If you asked me to name the three scariest threats facing the human race, I would give the same answer that most people would: nuclear war, global warming and Windows." Dave Barry!

1. *"UNIX is basically a simple **operating system**, but you have to be a genius to understand the simplicity."* Dennis Ritchie.
   a) Define Belady's anomaly. Under what conditions will an algorithm not exhibit this behavior? **[4 pts]**
   b) Explain the difference between logical and physical addresses. Why are logical addresses important? **[4 pts]**
   c) Define Direct Memory Access. Under what conditions is it useful? **[4 pts]**
   d) One way to use contiguous allocation of a disk and not suffer from holes is to compact the disk every time a file is removed. Since all files are contiguous, copying a file requires a seek and rotational delay to read the file, followed by the transfer at full speed. Writing the file back requires the same work. Assuming a seek time of 5 msec, a rotational delay of 4 msec, a transfer rate of 8 MB/sec, and an average file size of 8 KB, how long does it take to read a file into main memory then write it hack to the disk at a new location? Using these numbers, how long would it take to compact half of a 16-GB disk? **[8 pts]**

2. *"The best way to prepare [to be a programmer] is to write programs, and to study great programs that other people have written. In my case, I went to the garbage cans at the Computer Science Center and fished out listings of their **operating system**."* Bill Gates

   a) Define an operating system. **[4 pts]**
   b) List eight examples of operating systems. **[4 pts]**
   c) Which of the following instructions should be allowed in Kernel mode only
      I. Disable all interrupts **[1 pt]**
      II. Read the time-of-day clock. **[1 pt]**
      III. Set the time-of-day clock. **[1 pt]**
      IV. Change the memory map. **[1 pt]**
   d) An alert reviewer notices a consistent spelling error in the manuscript of an operating systems textbook that is about to go to press. The book has approximately 700 pages, each with 50 lines of 80 characters each. How long will it take to electronically scan the text for the case of the master copy being in each of the levels of memory in the Table provided? For internal storage methods, consider that the access time given is per character, for disk devices assume the time is per block of 1024 characters, and for tape assume the time given is to the start of the data with subsequent access at the same speed as disk access. **[8 pts]**

Memory type	Typical access time	Typical capacity
Registers	1 nsec	<1 KB
Cache	2 nsec	1 MB
Main Memory	10 nsec	64-512 MB
Magnetic disc	10msec	5-50 GB
Magnetic tape	100 sec	20-100 GB

3. Consider the following system snapshot using the data structures in the Banker's algorithm, with resources A, B, C, and D, and processes P0 to P4:

Max				
	A	B	C	D
P0	6	0	1	2
P1	1	7	5	0
P2	2	3	5	6
P3	1	6	5	3
P4	1	6	5	6

Allocation				
	A	B	C	D
P0	4	0	0	1
P1	1	1	0	0
P2	1	2	5	4
P3	0	6	3	3
P4	0	2	1	2

Need				
	A	B	C	D
P0				
P1				
P2				
P3				
P4				

Available			
A	B	C	D
3	2	1	1

Using the Banker's algorithm, answer the following questions.

(a) Define a safe and unsafe state. **[4 pts]**
(b) How many resources of type **A**, **B**, **C**, and **D** are there? **[4 pts]**
(c) What are the contents of the Need matrix? **[4 pts]**
(d) Is the system in a safe state? Why? **[4 pts]**
(e) If a request from process **P4** arrives for additional resources of (1, 2, 0, 0), can the Banker's algorithm grant the request immediately? Show the new system state and other criteria. **[4 pts]**

4. All computers need to store information. One approach of storage is the use of file systems to manage the files containing this information.

a) Define regular and directory file types **[4 pts]**
b) List eight examples of file attributes. **[2 pts]**
c) List eight examples of file operations. **[2 pts]**
d) Define a physical and logical dump. What is the difference between the two? **[4 pts]**
e) Free disk space can be kept track of using a free list or bitmap. Assuming disk addresses require D bits for a disk with B blocks, F of which are free, state the condition under which the free list uses less space than the bitmap. For D having the value 16 bits, express your answer as a percentage of the disk space that must be free. **[8 pts]**

5. *"Technically, Windows is an **"operating system"**, which means that it supplies your computer with the basic commands that it needs to suddenly, with no warning whatsoever, stop operating."* Dave Barry

a) What are the 4 conditions for deadlock (include a short definition of each)? **[4 pts]**
b) Consider a demand paging system with three frames and the given page reference sequence (**A D B E A E F G A G E F**). How many page faults

does each of the LRU and FIFO page replacement algorithms generate? **[4 pts]**

c) What is the difference between a binary and a counting semaphore? Give a short example of where a counting semaphore is useful. **[4 pts]**

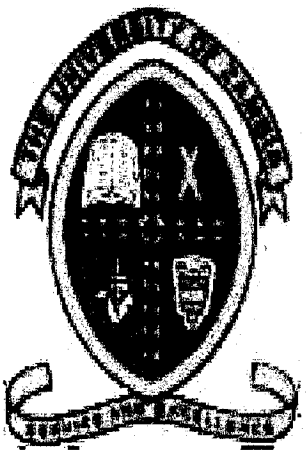
d) How much cylinder skew is needed for a 7200-rpm disk with a track-to-track seek time of 1 msec? The disk has 200 sectors of 512 bytes each on each track. **[8 pts]**

6. Five batch jobs A through E, arrive at the computer center at almost the same time. They have estimated running times of 10, 6, 2, 4, and 8 minutes. Their (externally determined) priorities are 3, 5, 2, 1, and 4, respectively with 5 being the highest priority. For each of the following scheduling algorithms, determine the mean process turnaround time. Ignore process switching overhead.

   a) Round robin. **[4 pts]**
   b) Priority scheduling. **[4 pts]**
   c) First-come, first served (run in order 10, 6, 2, 4, 8). **[4 pts]**
   d) Shortest job first. **[4 pts]**
   e) Briefly outline three algorithms that are used in Batch systems. **[4 pts]**

7. The debate over thread and process efficiency seems to be an eternal flame!

   a) What is a context? Provide a detailed description of all activities in a context switch. **[4 pts]**
   b) What is a race condition? **[2 pts]**
   c) What is thread cancellation? Define the term and list the two commonly used versions and their differences. **[4 pts]**
   d) Draw the state diagram of a process from its creation to termination, including all transitions, and briefly elaborate every state and every transition. **[4 pts]**
   e) Five jobs are waiting to be run. Their expected run times are 9, 6, 3, 5, and X. In what order should they be run to minimize average response time? (Your answer will depend on X.) **[6 pts]**



University of Zambia

School of Natural Sciences

Department of Computer Studies

CST2042 Final Exam

Introduction to Databases and File Systems

Time 3 Hours

This exam has three sections. Section A and B each have compulsory questions and each section carries 20 points. Section C has five questions and you are expected to answer any three of the five. Each question in Section C carries 20 points.

Section A (20 points)

Answer all questions in this section. Each question carries 1 point.

Elaborate the following concepts of the database environment:

1. Data Administrator
2. Database Administrator
3. Logical Database Designer
4. Physical Database Designer
5. Application Developer
6. End-Users
7. Data Storage, Retrieval and Update
8. Authorization Services
9. A User-Accessible Catalog
10. Support for Data Communication
11. Transaction Support
12. Integrity Services
13. Concurrency Control Services
14. Services to Promote Data Independence
15. Recovery Services
16. Utility Services
17. Data Definition Language
18. Data Manipulation Language
19. Structural Query Language
20. Query By Example

Section B (20 points)

Answer all questions in this section. Each question carries 2 points.

1. Compare and contrast the three levels of the ANSI-SPARC architecture.
2. Compare and contrast the three phases of database design.
3. What is a data model? State the main types of data models.
4. Discuss what a user view represents in the context of a database application.
5. Identify the stage(s) in database system implementation where it is appropriate to select a DBMS and describe an approach to selecting the 'best' DBMS.
6. Outline the various testing strategies available for testing that a database application appears to be working.

For each of the following queries state whether the query is valid. For the invalid ones explain why the query is invalid. For the valid ones show how each of the queries would be mapped onto a query on the underlying base table given the view below which is derived from the database's schema.

```
CREATE VIEW HotelBookingCount (hotelNo, bookingCount)
AS      SELECT h.hotelNo, COUNT(*)
        FROM Hotel h, Room r, Booking b
        WHERE h.hotelNo = r.hotelNo AND r.roomNo = b.roomNo
        GROUP BY h.hotelNo;
```

7.
```
SELECT hotelNo
FROM HotelBookingCount
WHERE hotelNo = 'H001';
```

8.
```
SELECT MIN(bookingCount)
FROM HotelBookingCount;
```

9.
```
SELECT hotelNo
FROM HotelBookingCount
WHERE bookingCount > 1000;
```

10.
```
SELECT hotelNo
FROM HotelBookingCount
ORDER BY bookingCount;
```

Section C [60 points]

There are five questions in this section. Answer any three questions. Each question carries a total of 20 points.

1.

a) Describe the types of facility you would expect to be provided in a multi-user DBMS. Which ones do you think would not be needed in a standalone PC DBMS? Justify your answer. **[5 points]**

b) Discuss the function and importance of the system catalog. **[2 points]**

c) Describe the main components in a DBMS and suggest which components are responsible for each facility identified in Question 1 (a) above. **[5 points]**

d) Given database users George and Linda, write SQL to give SELECT access to both users on a view called ZadeDBs. Assuming they violate their rights, write SQL to deny them the SELECT access to the database view. **[5 points]**

5. For the following relations (keys are shown with _s over the field name):

Student

sname	sid	age	gpa
Ann	1	21	3.5
Bob	2	19	3.4
Cal	3	20	2.6
Dee	4	22	4.0

Class_Grade

sid	cid	grade
1	1	A-
1	2	A
2	1	B
2	3	C
3	1	A
3	2	C
3	3	F
4	2	A

Class

cid	cdept	cnum
1	CS	1621
2	BIOL	1011
3	ECE	1315

a) How would you design the following queries in Relational Algebra: **[10 points]**
   i. The id#s of students who are 19 or 20.
   ii. The student names (sname) of those students who have taken CS 1621.
   iii. Students (names) who have taken a biology course or ECE course.
   iv. Students (names) who have taken every course in Class.
   v. Students (names) who have received an A.

b) Repeat question 2 with relational tuple calculus **[10 points]**

d) What is meant by the term 'client–server architecture' and what are the advantages of this approach? Compare the client–server architecture with two other architectures. **[8 points]**

2.

a) Define a Transaction Processing Monitor? **[5 points]**

b) The objective of the three-level ANSI-SPARC architecture is to separate each user's view of the database from the way the database is physically represented. Outline five reasons why this separation is desirable? **[5 points]**

c) Describe the approach taken to the handling of data in the early file-based systems. Discuss disadvantages of this approach. **[5 points]**

d) Discuss the advantages and disadvantages of DBMSs. **[5 points]**

3.

a) Describe the main advantages of using the prototyping approach when building a database application. **[5 points]**

b) Describe the process of evaluating and selecting a DBMS **[5 points]**

c) What are the main purposes of data modeling and identify the criteria for an optimal data model. **[5 points]**

d) Discuss the main approaches for managing the design of a database application that has multiple user views. **[5 points]**

4.

a) Given the following table Part(partNo, contract, partCost). Write SQL for creating a view called ExpensiveParts which contains distinct part numbers for parts that cost more than K1,000,000. **[5 points]**

b) What is view materialization? **[5 points]**

c) Discuss how you would maintain the view in Question 4(a) above as a materialized view and in what circumstances would you be able to maintain the view without having to make changes to the base table "Part". **[5points]**

The University of Zambia

School of Natural Science

Department of Computer Studies

FINAL EXAM SEMESTER II – February 2008

Introduction to Database and File Systems (CS2042)

Instructions

1. There are **two sections** and a total of **six questions** in this question paper.
2. Each question carries **20 marks** only
3. You are required to **answer** a **total** of **five questions**
4. **Section A** has **two** questions while **section B** has **four questions**
5. **Answer all** questions in **section A** and any **three** questions in **section B**

Date: Friday, 22nd February 2008

Time: 09:00hrs – 12:00hrs

Venue: ROOM 2A ED

NOTE: Do not open this paper until you are told to do so

SECTION A – Answer all the questions in this section

1) QUESTION ONE

a) What do the following stand for? [4 Marks]
   i) SQL
   ii) DDL
   iii) DML
   iv) RDBMS

b) In practice, the **DDL** statements are used to create the database structure and the access mechanisms, and then the **DML** statements are used to populate and query the tables. List the four **SQL DML** Statements and what each is used for. [4 Marks]

c) The **SELECT** statement is the most frequently used **SQL** command. One of the statements used in the **SELECT** statement is the **FROM** statement which specifies the table or tables to be used. Name the other five statements used in the **SELECT** statements in their sequence of procession. Remember to state the function of each of the named statements [5 Marks].

d) The **ISO** standard defines five aggregate functions. The first one is **COUNT** which returns the number of values in a specified column. **Name** the other **four** and what they return. [4 Marks]

e) The user interacts with Microsoft Access and develops a database application using a number of objects. List any 6 Microsoft Access Objects. [3 Marks]

---

2) QUESTION TWO

a) Using the **two tables** below, **Give** the results of the following queries below. [8 Marks]

Branch

branchNo	street	city	postCode
B005	22 Deer Rd	London	SW1 4EH
B007	16 Argyll St	Aberdeen	AB2 3SU
B003	163 Main St	Glasgow	G11 9QX
B004	32 Manse Rd	Bristol	BS99 1NZ
B002	56 Clover Dr	London	NW10 6EU

Staff

staffNo	fName	lName	position	sex	DOB	salary	branchNo
SL21	John	White	Manager	M	1-Oct-45	30000	B005
SG37	Ann	Beech	Assistant	F	10-Nov-60	12000	B003
SG14	David	Ford	Supervisor	M	24-Mar-58	18000	B003
SA9	Mary	Howe	Assistant	F	19-Feb-70	9000	B007
SG5	Susan	Brand	Manager	F	3-Jun-40	24000	B003
SL41	Julie	Lee	Assistant	F	13-Jun-65	9000	B005

i) **SELECT** branchNO, count (staffNO) AS mycount, **SUM**(salary) As mysum
FROM staff
GROUP BY branchNO
HAVING COUNT (StaffNO) > 1
ORDER BY branchNO

ii) **SELECT** staffNO, fName, lName, salary
FROM staff
ORDER BY Salary **DESC**

b) Using the two tables above write the queries for the following; [12 Marks]

i) Produce a list of monthly salaries for all staff showing the staff number, the first and last names, and the salary details.

ii) Find the total number of managers and their total sum.

iii) Find all staff who works in a London branch office

Section B – Answer any three questions in this section

3) QUESTION THREE

a) Microsoft Access provides 5 ways to create a blank table. Name and Give a brief description for each of the five ways. [5 Marks]

b) List the ten data types used by Microsoft Access Database System [5 Marks]

c) Give a brief description of each of the following. [4 Marks]
   i) Microsoft Access Forms
   ii) Microsoft Access Report

d) Give a brief description of the following in relation to Microsoft Access table design view [6 Marks]
   i) Field size property
   ii) Caption
   iii) Validation rule/validation Text Property

---

4) QUESTION FOUR

(a) Represent each of the following requirements with an ER diagram:

i) A company called ***Perfect Pets*** runs a number of clinics. A clinic has many staff and a member of staff manages at most one clinic (not all staff manage clinics). Each clinic has a unique clinic number (**clinicNo**) and each member of staff has a unique staff number (**staffNo**). [4 Marks]

ii) When a pet owner contacts a clinic, the owner's pet is registered with the clinic. An owner can own one or more pets, but a pet can only register with one clinic. Each owner has a unique owner number (**ownerNo**) and each pet has a unique pet number (**petNo**). [5 Marks]

iii) When the pet comes along to the clinic, it undergoes an examination by a member of the consulting staff. The examination may result in the pet being prescribed with one or more treatments. Each examination has a unique examination number (**examNo**) and each type of treatment has a unique treatment number (**treatNo**). [6 Marks]

(b) Represent the complete set of requirements in one ER diagram. [5 Marks]

---

5) QUESTION FIVE

(a) Two functions of a DBMS are *Transaction support* and *Concurrency control services.*

i. What is a transaction? Hence define *Transaction support.* [4 marks]

ii. Why is *Transaction support* important? [2 mark]

iii. Define *Concurrency control.* [2 marks]

(b) Use the lost update problem to illustrate the importance of *Concurrency control.* [6 marks]

(c) What is a System catalogue? State four items that it stores [6 marks]

---

6) QUESTION SIX

(a) A relational database represents a logical model in the form of a set of tables. Define the following terms associated with a relational database.

i. A candidate key [3 marks]

ii. The super key [2 marks]

iii. Cardinality [1 mark]

iv. The domain of an attribute [2 marks]

v. Null [2 marks]

(b) Integrity rules ensure that data is accurate. Explain the issues of Entity and Referential integrity. [5 marks]

(c) There are restrictions on types of modifications that can be made through views. Explain the two restrictions. [5 marks]

End of Exam

All the Best

THE UNIVERSITY OF ZAMBIA
DEPARTMENT OF COMPUTER STUDIES
CST3011 – ALGORITHMS AND DATA STRUCTURES

UNIVERSITY EXAMINATIONS SEMESTER I 2008

Monday, December 01, 2008

INSTRUCTIONS: **There are SIX (6) questions in this examination and you are required to answer ONLY FIVE (5) of them in any order. All questions have the same weight. Question ONE (1) is <u>COMPULSORY</u>**

DURATION: **3 Hours**

1.

a. Explain why is it necessary to perform algorithm analysis?
b. Explain the meaning of the following
    i. F(N) is O(N)

c. Prove the following statement
    i. $\sum_{i=1}^{N} i$ is $O(N^2)$ [Hint: evaluate the summation]
d. State L'Hopital's law
e. Hence or otherwise prove the following
    i. For any constant k $\log^k N = o(N)$
f. An algorithm takes 0.5ms for input size of 100. How long will it take for input size of 500 if the running time is the following:
    i. Logarithmic
    ii. Quadratic.

2.

a. Describe how each of the following sort mechanisms operate
   i. SelectionSort
   ii. ShellSort

b. For each of the sorting algorithms above show using tables, the passes as the following array is sorted. Each pass should indicate the comparisons and swaps involved. For ShellSort use the {5,3,1} sequence
   A = {10,5,6,4,12,11,7,8,2,1,3,9}

3.

a. Consider the following algorithm (known as the Horner's rule) to evaluate the polynomial $f(x) = \sum_{i=0}^{N} a_i x^i$

```
poly = 0;
    for(i = n; i>=0; i--)
        poly = x * poly + a_i
```

   where a_is are coefficients in the polynomial.
   i. Show how the steps are performed by this algorithm fo x = 3; $f(x) = 4x^4 + 8x^3 + x + 2$
   ii. What is the running time of this algorithm? [Calculate the number of operations involved in the evaluation]

b. Determine, for the typical algorithms that you use to perform calculations by hand, the running time to do the following
   i. Add two N-digit integers

4.

a. What are the four basic rules of recursion?

b. Write a recursive method that returns the number of 1's in the binary representation of a non-negative integer N. Use the fact that this is equal to the number of 1's in the representation of N/2 plus 1, if N is an odd number [Consider repeated division by 2]

c. Write a recursive method which takes in two positive integers M and N and returns the product of M and N. The Algorithm evaluates the product by repeated addition of M, N times ie M + M + .. + M (N times)

5.

a. Describe the following data structures
   i. Queue
   ii. Stack

b. Give two applications of each data structure above

c. Given a data structure called a Deque consisting of a list of items, on which the following operations are possible:

- Push(x): Insert item x on the front end of the Deque
- Pop(): Remove the front item of the Deque and return it.
- Inject(x): Insert item x on the rear end of the Deque
- Eject(): Remove the rear item from the Deque and return it

Give a linked list implementation this data structure using java in which all the routines described above take a constant order (O(1)) time of execution. Assume the structure holds integer types.

6.

a. Show the result of inserting 3, 1, 4, 6, 9, 2, 5, 7, into an initially empty binary search tree
b. Show the order in which the nodes are visited using
    i. Pre-order traversal
    ii. In-order traversal
c. Given the following expression a*b*(a + d) – e. Draw an expression tree
d. Hence give the prefix representation of the expression above.
e. Show how the prefix expression is evaluated using the stack.

**********END OF EXAMINATION**********

HAPPY FESTIVE SEASON

THE UNIVERSITY OF ZAMBIA
DEPARTMENT OF COMPUTER STUDIES
CST4021 – NUMERICAL ANALYSIS

UNIVERSITY EXAMINATION

Monday, November 24, 2008

INSTRUCTIONS: There are SIX (6) questions in this examination and you are required to answer ONLY FIVE (5) of them in any order. All questions have the same weight. Question ONE (1) is COMPULSORY

DURATION: 3 Hours

1.

a. Define the following
   i. Limit of a function f at a point x_0.
   ii. Continuity of a function at a point x_0.
   iii. Differentiability of a function at a point x_0

b. Show that the function

$$f(x) = \frac{x^3 + x^2 - x - 1}{x - 1}$$

is continuous at $x_0 = 1$

c.
   i. What number is represented by the following machine number

   1|1 0 00010 | 0000001000000000000001010

   ii. What are the next smallest and largest machine numbers of the number above

d. Given a number p = 999999, what is the range of numbers which approximate the p to 5 significant digits?

2.

a. State, without proof, the fixed point theorem

b. Let $f(x) = x^2 - 2$, find a function g(x) from f, such that g has a unique fixed point in [1,2]. [Show, precisely, how your g has a unique fixed point in the interval]

c. Using the sequence from b above, find $x_5$the approximation of the fixed point of g in the given interval

3. .

a. Show that the Secant method can be rewritten as follows

$$x_{n+1} = \frac{x_{n-1}f(x_n) - x_n f(x_{n-1})}{x_n - x_{n-1}}$$

b. Show why this formula is still inferior to the original one in terms of implementing a computer program that approximates the roots using the Secant method.

c. Using the Secant method, compute x_6 the approximation of the root of the following function $f(x) = x^3-10$.[Hint: first find the interval in which the root exists and pick x_0 and x_1 the initial approximations from the interval]

4.

a. Suppose $x_j = j\ for\ j = 0, 1, 2, 3$ and it is known that $P_{0,1} = 2x + 1, P_{0,2}(x) = x + 1, P_{1,2,3}(x) = 3$. Find $P_{0,1,2,3}(2.5)$

b. Approximate f(0.5) using the following data and the Newton forward divided-difference formula.

x	0.0	0.2	0.4	0.6	0.8
f(x)	1.00000	1.22140	1.49182	1.82212	2.22554

5.

a. Suppose the following data has been experimentally collected

x	1.00	0.01	1.02
f(x)	1.27	1.32	1.38

Approximate $f'(1.005)$ Using the centered difference formula.

b. Use the Trapezoidal and Simpsons rule to approximate the following definite integrals.

$$\int_0^{0.1} x^{1/3} dx$$

c. Compare the approximations to the actual value and find the error bound in each case.

6.

a. Show that the system of equations below is solvable.

$$2x_1 + 4x_2 - x_3 = -5$$
$$x_1 + x_2 - 3x_3 = -9$$
$$4x_1 + x_2 + 2x_3 = 9$$

b. Solve the system of equations using the Gaussian Elimination Method with backward substitution

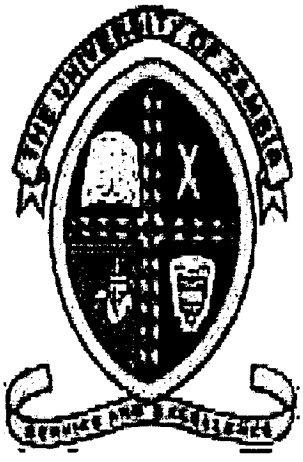
c. Show that the following matrix is invertible

$$\begin{matrix} 4 & 0 & 1 \\ 2 & 1 & 0 \\ 2 & 2 & 3 \end{matrix}$$

d. Compute the inverse of the matrix

**********END OF EXAMINATION**********

♣♣♣♣♣HAPPY FESTIVE SEASON♣♣♣♣♣



University of Zambia

School of Natural Sciences

Department of Computer Studies

CST4131 Final Exam

Advanced Object Oriented Programming with Java

This exam has four sections. Section A, B and C have compulsory questions and each carriy 15, 15 and 30 points respectively. Section D has three questions and you are expected to answer any two of the three. Each question in Section D carries 20 points.

Section A (Multiple choice questions) **[15 points].**

Each question carries **1 point**. Answer all the questions.

1. What will happen when you attempt to compile and run the following code?

```
class Background implements Runnable{
  int i=0;
          public int run(){
                  while(true){
                          i++;
                          System.out.println("i="+i);
                          } //End while
                return 1;
   }//End run

}//End class
```

   a) It will compile and the run method will print out the increasing value of i.
   b) It will compile and calling start will print out the increasing value of i.
   c) The code will cause an error at compile time.
   d) Compilation will cause an error because while cannot take a parameter of true.

2. Which statement is true of the following code?

```
public class Rpcraven{
  public static void main(String argv[]){
  Pmcraven pm1 = new Pmcraven("One");
  pm1.run();
  Pmcraven pm2 = new Pmcraven("Two");
  pm2.run();

  }
}

class Pmcraven extends Thread{
private String sTname="";
Pmcraven(String s){
  sTname = s;

}
public void run(){
  for(int i =0; i < 2 ; i++){
          try{
           sleep(1000);
          }catch(InterruptedException e){}

          yield();
          System.out.println(sTname);
          }

  }
}
```

a) Compile time error, class Rpcraven does not import java.lang.Thread
b) Output of One One Two Two
c) Output of One Two One Two
d) Compilation but no output at runtime

3. Which statement is true of the following code?

```
public class Agg{
public static void main(String argv[]){
  Agg a = new Agg();
  a.go();
  }
  public void go(){
          DSRoss ds1 = new DSRoss("one");
          ds1.start();
  }
}

class DSRoss extends Thread{
private String sTname="";
DSRoss(String s){
  sTname = s;
}
public void run(){
  notwait();
  System.out.println("finished");
}
public void notwait(){
  while(true){
          try{
                  System.out.println("waiting");
                  wait();
                  }catch(InterruptedException ie){}
          System.out.println(sTname);
          notifyAll();
          }
  }

}
```

a) It will cause a compile time error
b) Compilation and output of "waiting"
c) Compilation and output of "waiting" followed by "finished"
d) Runtime error, an exception will be thrown

4. What method of your applet is called by the browser when it wishes to display it on the monitor?

a) paint()
b) drawLine()
c) setBackground(0

d) setColor()

5. Which of the following is NOT an advantage to using inheritance?

   a) Code that is shared between classes needs to written only once.
   b) Similar classes can be made to behave consistently.
   c) Enhancements to base class will automatically be applied to derived classes.
   d) One big superclass can be used instead of many little classes.

6. In which class is the wait() method defined. Select the one correct answer.

   a) Applet
   b) Runnable
   c) Thread
   d) Object

7. What HTML tags should begin and end an applet section in a web page?

   a) `<applet>  </applet>`
   b) `<body>  </body>`
   c) `<h1>  </h1>`
   d) `<html>  </html>`

8. What class must be `extended` when you code an applet?

   a) AWT
   b) JDK
   c) Applet
   d) Graphics

9. A simple distributed application uses the Java classes Socket and ServerSocket to communicate between the client and server. The following code fragments are taken from the client and the server. Indicate (using 1, 2, 3, 4) the time sequence in which they must occur for successful communication.

```
 i.   theServerSocket.accept();

 ii.  Socket theClientSocket = new Socket( HOST, PORT );

 iii. ServerSocket theServerSocket = new ServerSocket( PORT );

 iv.  theClientSocket.getOutputStream().println("Hello" );
```

   a) i, ii, iii, iv

   b) ii, i, iii, iv

   c) iii, ii, I, iv

   d) iii, i, ii, iv

10. Which method doesn't map to the respective interface?

   a) `Comparable - compareTo()`
   b) `Comparator - equals()`
   c) `ListIterator - getPrevious()`
   d) `Iterator - remove()`

11. Which of the following is in the same hierarchy

   a) Map
   b) List
   c) Collection
   d) Set

12. Say that there are three classes: Computer, AppleComputer, and IBMComputer. What are the likely relationships between these classes?

   a) Computer is the superclass, AppleComputer and IBMComputer are subclasses of Computer.
   b) IBMComputer is the superclass, AppleComputer and Computer are subclasses of IBMComputer.
   c) Computer, AppleComputer and IBMComputer are sibling classes.
   d) Computer is a superclass, AppleComputer is a subclasses of Computer, and IBMComputer is a sublclas of AppleComputer

13. Assume that class A extends class B, which extends class C. Also all the three classes implement the method test(). How can a method in a class A invoke the

test() method defined in class C (without creating a new instance of class C). Select the one correct answer.

a) test();
b) super.test();
c) super.super.test();
d) ::test();
e) C.test();
f) It is not possible to invoke test() method defined in C from a method in A.

14. Which of these is a core interface in the collection framework?

a) Tree
b) Stack
c) Queue
d) Array
e) LinkedList
f) Map

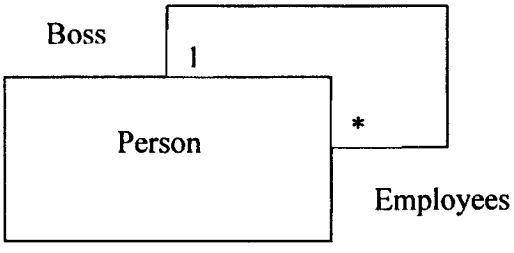
15. What type of inheritance does Java have?

a) single inheritance
b) double inheritance
c) multiple inheritance
d) class inheritance

Section B (true or false questions) [15 points]

Each question carries **1 point**. Answer all the questions.

Given the UML diagram below which of the following sentences (Question 1 to 4) can apply to the class model?



1. "Be your own boss"
2. "Neither a leader nor a follower be"
3. "Sitting at the top of the tree"

4. "Too many Chiefs not enough Indians"
5. The source code for an applet can be compiled by the usual *javac* compiler.
6. WeakHashMap is a subclass of HashMap.
7. An *object* can be a subclass of another object.
8. It is possible to call an abstract method from a non abstract method.
9. A subclass inherits both member variables and methods.
10. A class that is abstract may not be instantiated
11. A method defined as private indicates that it is accessible to all other classes in the same package.

A class *Animal* has a subclass *Mammal*. Use this relationship to answer questions 12 to 15 below:

12. Because of single inheritance, *Mammal* can have no subclasses.
13. Because of single inheritance, *Mammal* can have no other parent than *Animal*.
14. Because of single inheritance, *Animal* can have only one subclass.
15. Because of single inheritance, *Mammal* can have no siblings.

Section C (Short answer questions) [30 points].

Each question carries **2 points.** Answer all the questions.

1. What is the difference between an Abstract class and Interface?
2. How do you initialize an Applet?
3. When is the update() method call for Applets used?
4. What is JNI?
5. How is thread synchronization enforced inside a monitor?
6. What is meant by flickering in GUI applications?
7. When talking of threads what is defined as a spurious wakeup?
8. What is the wait() and notify() method used for in threads?
9. Why can't applets connect via sockets, or bind to a local port?
10. What is the synchronized keyword?

11. When is it appropriate to use a ServerSocket or DatagramSocket in an application?

12. What code could be used to get the IP address of a machine from its hostname?

13. What code could be used to search for a hostname for an IP address?

14. What are the field/method access levels (specifiers) and class access levels?

15. What is the difference between notify() and notifyAll() methods?

Section D [40 points].

Answer any **two** questions. Each question carries **20 points**. **Note**: Code snippets should used unless it's specified that the whole class should be coded.

1. Consider a bank whose accounts can be accessed and updated by any of a number of automatic teller machines (ATMs). Each ATM could be a separate thread, responding to deposit and withdrawal requests from different users simultaneously. Write code for an Applet that implements the depositing and withdrawing of money keeping in mind the integrity of the balance. **[20 points]**

2. Code a class for a server that listens to linear connections and echoes back the user's request. The server establishes a socket connection on Port 4700. Write code for a client class to test the server. **[20 points]**

3.
   a) Create an array of type double and *fill( )* it with random doubles. Print the results. **[3 points]**
   b) Create a new class called *Gerbil* with an int *gerbilNumber* that's initialized in the constructor. Give it a method called *hop( )* that prints out which gerbil number this is, and that it's hopping. Create an *ArrayList* and add a bunch of *Gerbil* objects to the List. Now use the *get( )* method to move through the List and call *hop( )* for each *Gerbil*. **[7 points]**
   c) Modify the previous steps so you use an *Iterator* to move through the List while calling *hop( )*. **[3 points]**
   d) Take the *Gerbil* class in step 2 and put it into a *Map* instead, associating the name of the *Gerbil* as a *String* (the key) for each *Gerbil* (the value) you put in the table. Get an *Iterator* for the *keySet( )* and use it to move through the *Map*, looking up the *Gerbil* for each key and printing out the key and telling the *gerbil* to *hop( )*. **[3 points]**
   e) Create a List (try both *ArrayList* and *LinkedList*) and fill it with *Gerbils*. For each List print the first and last items and then remove them and reprint the first and last items. **[3 points]**

2

THE UNIVERSITY OF ZAMBIA

DEPARTMENT OF COMPUTER STUDIES
SECOND SEMESTER EXAMINATION 2008

CST 4252: ELECTRONICS FOR COMPUTING IV

TIME: 3 HOURS
INSTRUCTIONS: ANSWER ANY FOUR QUESTIONS
TOTAL MARKS 100
ALL QUESTIONS CARRY EQUAL MARKS

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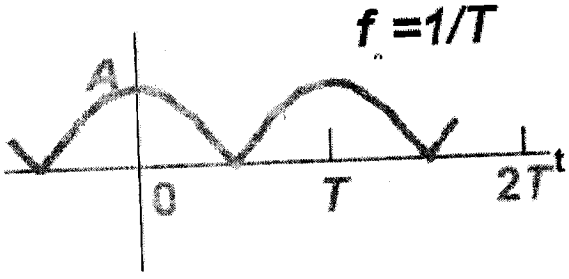
1. a) Make brief notes on the following [9]

i) Sources of interference and how to remedy them.

ii) Comparison of differential encoding schemes.

b) Find the trigonometric Fourier expansion for the waveform given below [16]

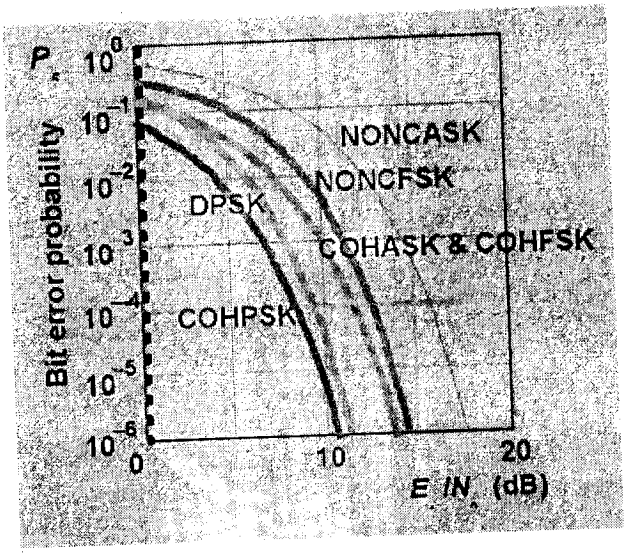


2. a) i) If a 128 symbol state modem is designed to transfer data at a rate of 1.048 Mbps, what is the minimum bandwidth for the transmission cable if Baseband signaling is used? [6]

ii) What is the maximum S/N ratio (in dB) that can be tolerated using this cable? [6]

iii) Find the E_b/N_o ratio in dB [4]

b) What Signal to Noise ratio (S/N) is required to achieve a bandwidth efficiency of 1.5 for NONCASK, COFSK, COHPSK and DPSK? Assume that the required error rate is 10^{-4}. [9]



3. a) [9]

i) What two mechanisms cause frequency errors within a communications link using ASK modulation.

ii) Explain the following terms
   a. adjacent channel interference
   b. co-channel interference
   c. multipath interference

b) A link has an average thermal noise power of –300 dBm at a temperature of 15°C . At what temperature would thermal noise power reduce by half? [7]

c) A cable is measured to have a flat gain response with frequency over the band of interest, but is found to have a phase response that changes proportionally with frequency. If the group delay response is 50 ns for every 2 MHz, what is the phase increase per MHz. [5]

d) Draw a constellation diagram for a four level ASK modulation format using $\cos(\omega_c t - 45^\circ)$ carrier when the modulation input is [4]

i) a four level bipolar signal.
ii) a four level unipolar signal

4.

a) Explain the difference between coherent and non coherent FSK(using PLL) modulation. Include the block diagram of the detection circuit. [11]

b) A coherent binary ASK data system has a phase error that cause a 25 % reduction of the recovered signal power. What is the phase error? [6]

c) A vector modulator is fed with a perfect quadrature sinewave at the input, but there is a small phase error of 5° between the notional quadrature inputs of the carrier signal. What will be the ratio in dB between the sum and difference outputs of the vector modulator as a result of this phase error? [8]

5.

a) i) What is differential encoding and what is its advantage? [4]

ii) Draw the waveform of the binary sequence 11001010111 using Manchester and differential Manchester encoding. [8]

b) An ASK format is used to transmit data at a rate of 50,000 bps over a cellular phone link with bandwidth occupying the frequencies from 400Hz to 8400 Hz. [13]

i) How many symbol states are required in order to achieve this level of performance?

ii) If the capacity of the channel is 80 kbps, what is the maximum S/N (in dB) ratio needed for noise free communication.

iii) What would be the number of symbol states if Baseband transmission is used with the same bandwidth.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 112: INTRODUCTION TO HUMAN GEOGRAPHY II

TIME: **Three hours.**

INSTRUCTIONS: **Answer any four questions. Candidates are advised to make use of illustrations and examples wherever appropriate. Use of a Philips University Atlas is allowed.**

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1. Define culture and show how Africa was developing in the cultural sphere before colonialism.

2. Define resources and suggest ways in which 'potential resources' can be transformed into 'actual resources' in Africa.

3. Explain the meaning of 'natural resource tenure', and show why it is important to study land tenure in any given community.

4. Define industrialization and suggest possible lessons that Africa can learn from the experiences of England with respect to the promotion of this process.

5. Describe Rostow's model of economic growth and show whether it is applicable to the experiences of African countries.

6. Compare and contrast the neo-Malthusian and neo-Marxist theories of population and explain whether they are relevant to the situation in Africa.

END OF EXAMINATION.

CANDIDATE'S COMPUTER NUMBER: .....

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 175: INTRODUCTION TO MAPPING TECHNIQUES IN GEOGRAPHY

PAPER I: PRACTICAL
MAPS AND AIR PHOTOGRAPHS

TIME: Three Hours

INSTRUCTIONS: Answer all questions. The use of a Philip's University Atlas and a certified calculator is allowed. Candidates are encouraged to make use of illustrations wherever appropriate.

MATERIALS PROVIDED:

A4 Metric graph paper
A4 Tracing paper
Topographic Map Sheet 1628 A4

FOR USE BY EXAMINER

Question	Examiner's Mark	Moderator's Mark
Q1		
Q2		
Q3		
Q4		
Q5		
Total		

SECTION A: GENERAL QUESTIONS

Answer all questions in this section in the spaces provided on this question paper.

1. (a) What are the two major sources of distortion on vertical air photographs? [2 marks]

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(b) Assuming that an air photo survey is carried out in the vicinity of the University of Zambia's Great East Road Campus at a height of 3,800 metres above the ground and the camera used has a focal length of 152 millimetres. Answer the questions below:

(i) What is the mean scale of the air photograph? [3 marks]

(ii) The distance between the two ends of the Goma Lakes is 150 metres, how long will the distance be on the air photo? [3 marks]

(iii) The length of the Biology building in the air photograph is 0.3 millimetres long. What is the length of the building on the ground? [3 marks]

(iv) Assuming that the length of an ordinary air photograph is 25 centimetres by 25 centimetres (25 cm x 25 cm), what is the equivalent ground area in square kilometres? [3 marks]

(c) Using the contour method, draw an annotated diagram to show a conical hill at a 20 metre contour interval with a river flowing on the slope with its source near the summit. [2 marks]

(d) With the help of a diagram, describe an annular drainage pattern and briefly, explain the characteristics of the topography on which it develops. [3 marks]

(e) Draw a line scale in metric units for a map drawn on a scale of 1:20,000, given that the maximum space available is 19 centimetres. (4 marks)

2. Write short explanatory notes on all of the following:

(a) Grid references [3 marks]

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(b) Categories of map symbols [3 marks]

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(c) Calculation of gradient on a topographic map [3 marks]

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(d) Oblique air photographs [3 marks]

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(e) Characteristics of a good map symbol [3 marks]

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3. (a) Convert the scale of 1:50,000 to a scale in words. [3 marks]

(b) Express 1: 6,000,000 as a scale in words. [3 marks]

(c) Using a scale of 1:100,000, calculate the dimensions to scale of an area measuring 20 kilometres by 12 kilometres (20km x 12km) [2 marks]

(d) Express one centimetres to a kilometre as a scale in figures [2 marks]

(e) Why should the vertical scale on a profile be exaggerated? [2 marks]

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SECTION B: QUESTIONS BASED ON MAP SHEET 1628 A4

Answer question four in the spaces provided on this question paper and question five on either a sheet of A4 metric graph or plain papers provided.

4. (a) When was the first edition of map sheet 1628 A4 published and by whom? [2 marks]

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(b) Identify and name the dominant type of vegetation found in Lusengezi National Forest No. 204. [1 mark]

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(c) In which direction does the Lusitu River generally flow? [2 markr]

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(d) Using map evidence only, explain how one could read a Four-Figure Grid Reference ol map sheet 1628 A4. [4 marks]

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(e) What drainage pattern does the Namatelo River system generally exhibit? [1 mark]

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(f) What pieces of evidence are there on Map Sheet 1628 A4 to show that some of the villages have administrative functions? [2 marks]

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(g) What is the approximate size of Lusengezi National Forest No. 204 in square kilometres and state the method that you have used to measure the area? [2 marks]

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(h) What is the Six Figure Grid Reference of Headman Sinadambwe's village along the Lusengesi River Valley? [2 marks]

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(i) Determine the direction of Peter Majansi Village in Grid Square 4796 from the road junction in Grid Square 4999 as a compass direction and also as a bearing from Grid North. [2 marks]

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(j) Calculate the average gradient along a straight line between Grid Reference Point 540002 and the summit of Nalula Hill in Grid square 5401 in degrees. [3 marks]

(k) If you were travelling northwards to Ngangula along the D367 road, what other Map Sheet would you require? [1 marks]

.....

.....

(l) What drainage feature is associated with Bungua Hill? [1 mark]

.....

.....

(l) Along what relief feature does the D500 road to Fumbo Mission pass south of northing 88? [1 mark]

.....

.....

(n) Using map evidence only, suggest two possible reasons that could have influenced the selection of the site of Chief Sinadambwe's headquarters. [2 Marks]

.....

.....

.....

.....

.....

.....

(o) Using map evidence only, identify and name the major occupation of the inhabitants of the area covered by Map Sheet 1628 A4. [2 marks]

.....

.....

.....

(p) What is the general relationship between the major roads and settlement on Map Sheet 1628 A4? [2 marks]

.....

.....

.....

.....

.....

5. On a sheet of A4 metric graph or plain papers provided, draw a map on a scale of 1:100,000 extending from eastings 39 to 51 and northings 90 to 02. On your map show the followings features:

(i) Chalala and Kayubila/Mulamba rivers

(ii) The D500 and D 387/ D 501 roads

(iii) Lusengezi National Forest No. 204

(iv) Jake Mulendemai Village

(v) Siakalinda School

(vi) Shade the area above 800 metres [20 marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
DIRECTORATE OF DISTANCE EDUCATION

2008 ACADEMIC YEAR DISTANCE EDUCATION FINAL EXAMINATIONS

GEO 175: INTRODUCTION TO MAPPING TECHNIQUES IN GEOGRAPHY
PAPER I: PRACTICAL
MAP READING, ANALYSIS AND INTERPRETATION

IMPORTANT
AMMENDMENTS AND CHANGES TO EXAMINATION QUESTION PAPER

Please note that two different versions of Map sheet 1131 C4 were purchased not by design but rather by mistake and unintentionally and this has prompted to make some changes to the already prepared examination.

The changes are as follows:

Question 4 (a) The question should read as follows:

When was Map Sheet 1131 published and by whom?

Question 4 (j) should read as:

Determine the direction of the road junction in Grid Square3187 from Grid Reference Point260920 as a compass direction and also as a bearing from True North. [2 marks]

Question 4 (m) should read as:

What landscape feature is associated with the Power Line south of northing 90 on Map Sheet 1131 C4?

Question number 5 (i) should read as:

The Lwitikila and it main unnamed tributary.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

GEO 212: GEOGRAPHY OF ZAMBIA

TIME: Three hours

INSTRUCTIONS: Answer any **four** questions.
All questions carry **equal marks**. Use of a Philips' University Atlas is allowed. Candidates are encouraged to use illustrations wherever appropriate.

---

1. Write short explanatory notes on **all** of the following.

   a. Ashley and Maxwell's (2001) five principles for a successful rural development strategy,
   b. Advantages and disadvantages of using geothermal energy,
   c. UN Habitat's definition of a slum,
   d. Ferrallitic Soils,
   e. The pre-colonial migrations between AD 1500 and AD1700.

2. Discuss the factors that influence the distribution of rainfall in Zambia.

3. 'Despite convincing successes scored by some agriculture- based countries in using the powers of agriculture for poverty reduction and as an engine of growth, agriculture has not been used to its full potential in Zambia'. Discuss.

4. Discuss the distinct aspects of Zambia's location and show its advantages and disadvantages.

5. Examine the assertion that 'privatization of the mines has done more harm than good to the mining sector in Zambia'.

6. Discuss the factors constraining the rapid growth of tourism in Zambia and suggest ways in which the government can overcome them.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
DIRECTORATE OF DISTANCE EDUCATION
2008 ACADEMIC YAER DISTANCE EDUCATION FINAL EXAMINATIONS

GEO 212
THE GEOGRAPHY OF ZAMBIA

TIME: THREE (3) HOURS

INSTRUCTIONS: ANSWER ANY FOUR QUESTIONS. ILLUSTRATE YOUR ANSWERS WHEREVER POSSIBLE. USE OF AN APPROVED ATLAS IS ALLOWED.

---

1. Describe the geomorphic and tectonic processes that have acted on Zambia's land surface and the features they have produced.
2. What are the main geologic systems found in Zambia? Demonstrate how geology has influenced relief in Zambia.
3. Examine how socio-economic development has impacted on the quality of the biophysical environment in Zambia.
4. Outline the problems that the urban poor in Zambia face and explain how they cope.
5. Describe the trend in Zambia's socio-economic development since 1964.
6. 'A nation's population is both an *agent* for, and a *beneficiary* of, development.' Discuss.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
DIRECTORATE OF DISTANCE EDUCATION

2008 ACADEMIC YEAR DISTANCE EDUCATION FINAL EXAMINATIONS

GEO 272: TECHNIQUES IN GEOGRAPHY II

TIME : **THREE HOURS**
INSTRUCTIONS : **Answer FOUR questions**
ALL questions carry equal marks
Use of a calculator is allowed.

---

1. Blood cholesterol levels were recorded for a number of persons sampled in a medical study group and the data presented in Table 1 were obtained. Answer the questions below.

Table 1: Blood Cholesterol Levels for Sampled Persons

239	212	249	227	218	310	281	330	226	233	223	161	195	233
249	284	245	174	154	256	196	299	210	301	199	258	205	195
227	244	355	234	195	179	357	282	265	286	175	195	163	297

a) Calculate the Arithmetic mean for the data presented in Table 1.

b) Compute the Median for the data presented in Table 1.

c) Compute the Mode for the data presented in Table 1.

c) Which one of the values you obtained above is the most suitable measure of location among the values you obtained. Defend your answer.

2. Write short explanatory notes on each of the following:

a) Statistics as a science;

b) The superiority of the ratio scale as compared to the interval scale;

c) Distinction between class boundaries and class limits;

a. Continuous as compared to descrete data
b. Inferential statistics

3. A random sample was taken from three political parties and questioned regarding their opinion toward a tax reform programme. Do the data presented in Table 2 indicate that the patterns of opinion are significantly different among the three political parties? Use the 0.01 significance level.

Table 2: Opinions in of party members on a tax reform progrogramme

Party	Favour	Indifferent	Opposed
A	138	83	64
B	64	67	84
C	125	52	34

4. To determine the maximum stopping ability of cars when their brakes are fully applied a chosen number of cars were to be driven at different speeds and the distance each required to come to a complete stop is was determined. The various initial speeds selected for each car and the stopping distances recorded are given in Table 3. Assuming that the all data presented in the said Table 3 were randomly collected and conform to Chebyshev's theorem; would one be right to conclude that the distance each car requires to cover before stopping is significantly a function of its specific speed? Aim at a 99 percent accuracy in obtaining your results.

Table 3: Data on Speed and Stopping distance of Selected cars

Initial Speed (Km/ph)	**Stopping distance (Metres)**
16.3	20
26.7	20
39.2	30
63.5	30
51.3	30
98.4	40
65.7	40
104.1	50
155.6	50
217.2	60
18.0	15
25.5	12
160.0	75
200.0	48

Source: Hypothetical data.

5. Presented in Table 4 are a number of fish ponds and the area each one of them covers. Assuming that data from each of these samples are skewed, would one be justified to conclude that the areas covered by number of ponds in Zemba, Mang'ombe, Chinsali and Kaoma are significantly different. Use the 0.05 level of significance.

Table 4: Sizes of Fish Ponds (in Square Metres) in Zemba, Mangombe, and Kaoma Areas

Zemba	Mang'ombe	Chinsali	Kaoma
12	16	25	38
45	08	14	06
75	10	11	29
11	22	17	21
85.5	25.9	10	04.6
14	34	06	14
99	14	15	23
77	28	19	25
66	17	24	
44			

6. Twelve pigs aged one month each were fed on the same type of food according to the periods indicated in Table 5. Establish whether there is a relationship between the two variables to show that the longer the time a pig spends eating the more weight it gains after one month. Data presented in Table 5 is meant to assist you make a justifiable decision. Answer the questions below.

Table 5: Relationship between the time (in hours per day) a pig spends eating and the weight (in Kg) it gains after one month

Time	Weight gained
12	18
10	11
05	10
16	25
04	08
11	16
08	14
09	12
13	20
15	24

i) Plot your data on the graph paper that is provided to you.
ii) Producer a regression equation.
iii) Interpret your simple regression equation.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 272: QUANTITATIVE TECHINIQUES IN GEOGRAPHY II

TIME: Three hours

INSTRUCTIONS: Answer any four questions. All questions carry equal marks.
Use of an approved calculator is allowed.

---

1. A random sample of n_1 =288 voters registered in Province A showed that 141 voted in the last general election. Another random sample of n_2 =216 registered voters in Province B showed that 125 voted in the most recent general election. Do these data indicate that the population proportion of voter turnout is higher in Province B than in Province A at 0.05 level of significance?

2. The type of raw material used to construct stone tools found at the Archaeological site X is shown in Table 1. A random sample of 1486 stone tools was obtained from a current excavation site.

Table 1: Distribution of stone tools at Archaeological Site X.

Raw Material	Regional Distribution of Stone Tools (%)	Observed Number of Tools at Current Excavation Site
Basalt	61.3	906
Obsidian	10.6	162
Welded tuff	11.4	168
Pedernal chert	13.1	197
Other	3.6	53

Source: Hypothetical

At 0.01 level of significance, test the claim that the regional distribution of raw materials fits the distribution at the current excavation site.

3. Measurements were made on random samples of three kinds of soil and yielded the following results on infiltration rates in mm/hour as shown in Table 2:

Table 2: Infiltration Rates for three types of soils

Soil Type	Infiltration rates (mm/hour)									
A	4	6	3	5	2	8	2	2		
B	6	2	3	3	4	2	4	4		
C	5	4	8	7	9	6	3	1	4	5

Source: Hypothetical

Assuming that the population distribution from which the three samples were drawn cannot be verified, test the claim that the three kinds of soils have different infiltration rates at 0.01 level of significance.

4. (a) A GEO 474 student undertaking research on the river discharge worked out his summaries as follows:

$\bar{x}$ = 530 litres/ sec

s = 165 litres/sec

(i) What assurance can this student give his supervisor that he had captured recordings between 530 and 700 litres/sec?

(ii) How possible was it for the student to record water discharge below 270 litres/sec?

(iii) Assuming that the student had a score of 1 500 litres/sec of water in his data set, what advice would you give him if you were his supervisor?

(b) A fruit juice manufacturing company carried out thirty (30) tests on the various juices it produced in order to establish the shelf life (in months). The findings are shown in Table 3.

Table 3: Shelf life of thirty (30) varieties of fruit juices (in months).

24	20	19	21	24	24
25	24	21	27	30	24
23	28	24	24	19	21
26	25	24	22	24	19
25	24	25	23	23	22

Source: Hypothetical

(i) Calculate the: a) Mean
b) Median
c) Mode

ii) Confirm whether the shelf life of these juices conform to Chebyshev's rule.

5. Use the two randomly distributed data sets presented in Table 4 to determine if any of them is a function of the other. Aim for the 99 percent accuracy level in your analysis.

Table 4: Land cleared (in hectares) per week and number of labourers working at the same pace per week

Land cleared per week	20	35	15	10	16	40	22	38	4	42	12	30	8	20
Number of labourers	18	30	24	8	16	35	20	32	5	42	9	28	25	22

Source: Hypothetical

6. Study Figure 1 and answer the following questions:

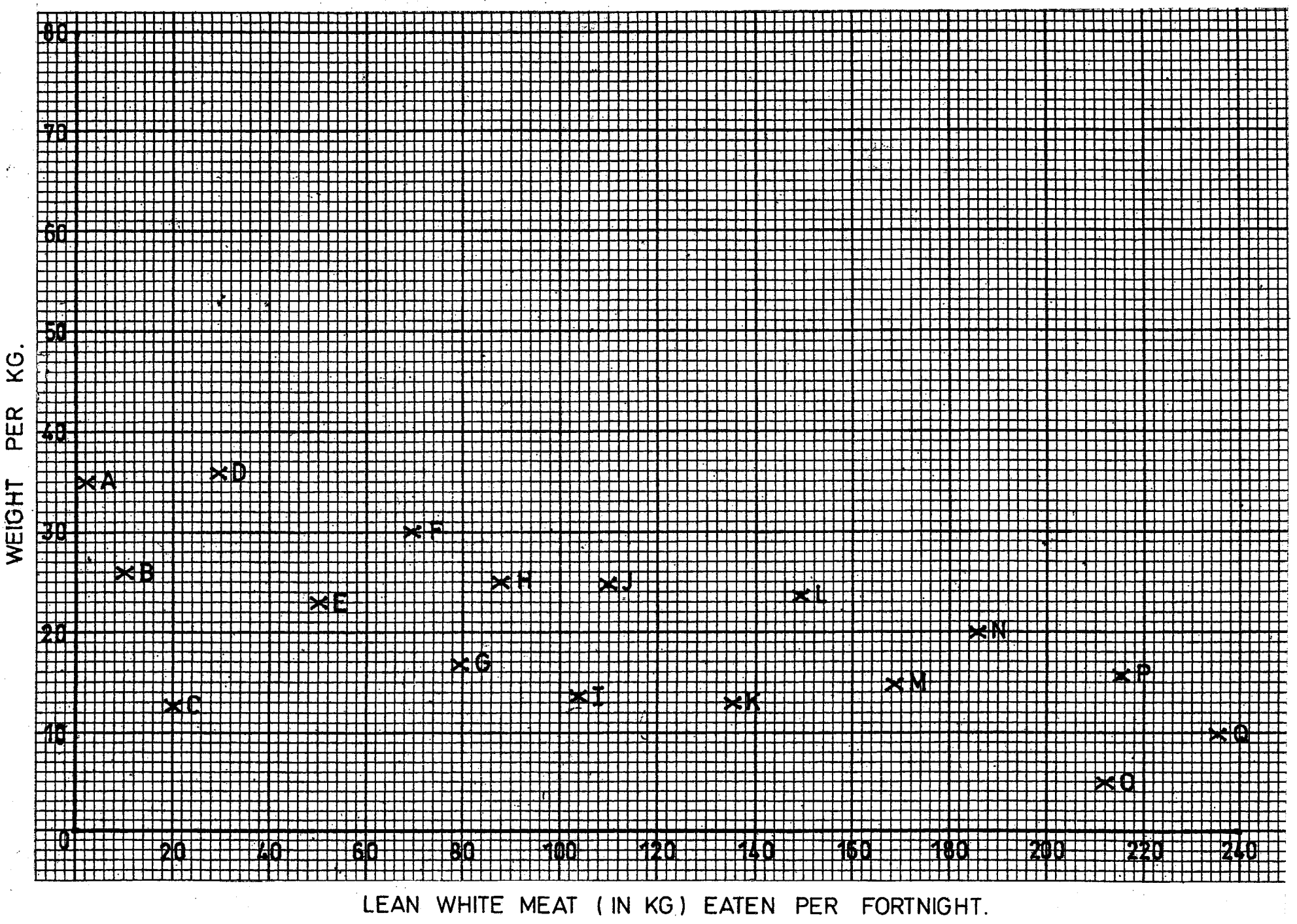
a) Determine the simple regression equation

b) Explain your simple regression equation.

c) Draw the line of best fit on Figure 1

d) Determine the weight of a person who consumes 114 Kilograms of lean white meat per day.

END OF EXAMINATION


WEIGHT PER KG.
80
70
60
50
40
30
20
10
0
20
40
60
80
100
120
140
160
180
200
220
240
A
B
C
D
E
F
G
H
I
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K
L
M
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Q
R
LEAN WHITE MEAT (IN KG.) EATEN PER FORTNIGHT.

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – FEBRUARY 2008

GG322: STRATIGRAPHY AND REMOTE SENSING

PRACTICAL

PAPER II

TIME: THREE HOURS
ANSWER: ALL QUESTIONS. NEATLY DRAWN SKETCHES/ DIAGRAMS RECOMMENDED FOR A FULL MARK.

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1 (a) What does following abbreviations stand for?

(i) UTM (2 marks)
(ii) TIFF (2 marks)
(iii) EMR (2 marks)
(iv) GPS (2 marks)

(b) Differentiate between the following:

(i) TIFF and GeoTIFF ..... (4 marks)
(ii) Spectral Signature and Spectral Response ..... (4 marks)
(iii) Path and Row..... (4 marks)
(iv) Cross-track and Along-track scanners..... (4 marks)

(c) With neatly labeled sketches, where possible differentiate between the following:

(i) Vector Model and Raster Model (4 marks)
(ii) Aerial photographs and satellite images (4 marks)
(iii) Transmission and Reflection (4 marks)
(iv) Passive and Active Sensors (4 marks)
(v) Energy and Radiation (4 marks)

2. (a) List the sensor systems known today ..... (5 marks)
(b) How many satellites are required to get an accurate GPS position? Explain your answer.....(4 marks)
(c) In what ways can you improve accuracy in a GPS set-up?..... (2 marks)
(d) List the data sources i.e. various forms of data that you could enter into a GIS project .....(5 marks)

3. As a Geologist, you have been assigned to undertake a research study in Zambia.

(a) You decide to select 2 aerial photos so that you can undertake an initial photo-geological interpretation. You are therefore required to:

(i) Provide a fully annotated photogeological interpretation on the portion that you are able to obtain a stereo vision i.e. able to see in three dimensions. .....(30 marks)

(ii) Provide a description of the photogeology i.e. the geology of the annotated area.....(10 marks)

END -- GOOD LUCK

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER EXAMINATION

GEO 482: ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT II

TIME : Three hours
INSTRUCTIONS: Answer any FOUR QUESTIONS. All questions carry equal marks.

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1. The current Global Economic Crisis has many negative social, economic, political as well as ecological connotations. What are the major ecological challenges arising from this economic crisis.

2. Give an elaborate exposition of the social, economic as well as ecological effects of acid deposition.

3. Proverbs 22 verse: 1 of the Bible tells us that the poor and the rich have one thing in common; they are both created by the Lord. Various research findings also indicate that the poor and the rich affect the environment in multiple ways. Explain.

4. 'Wetlands have different definitions and descriptions, but despite such diversity, they have one thing in common'. They are all threatened. Discuss

5. Fisheries are critically dependent upon the water environment. Various types of pollution as well as climate change affect fisheries. Elucidate

6. Explain the waste management concepts, using the waste management hierarchy

---

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 492: NATURAL RESOURCES ECONOMICS

Time: Three hours

Instructions: Answer any four questions.
All questions carry equal marks.
The use of an approved calculator and Phillips University Atlas is allowed.
You are encouraged to use illustrations wherever appropriate.

---

1. Explain how the investment of inframarginal rents can result in the maintenance or improvement economic output of a country.

2. Demonstrate the effects of using private and social discount rates in public projects.

3. Evaluate the use of the Contingent Valuation Method (CVM) in the evaluation of natural resources.

4. Describe an economic approach that can be used to select a pollution control method by a regulatory body.

5. Describe the basic concepts that were used to develop the bio-economic model of fisheries management.

6. Discuss the implications of including off site environmental effects on the benefits of converting a forest for agricultural purposes.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 495: ENVIRONMENTAL HAZARDS AND DISASTERS

TIME: Three Hours

INSTRUCTIONS: Answer any four questions. All questions carry equal marks. The use of a Philip's University Atlas and a certified calculator is allowed. Candidates are encouraged to make use of illustrations wherever appropriate.

---

1. With the help of specific examples, outline and discuss any two contrasting models of risk perception.

2. 'Land use planning has been identified as one way of reducing vulnerability to disaster but it has some practical limitations'. Outline and discuss the major practical limitations of this strategy with reference to Zambia.

3. 'Risk assessment depends on the availability of a good database accumulated over a long period of time but this is not the case for many threats, especially the newer technological hazards where the historical database may be quite inadequate to support a reliable assessment of risk'. How would you assess risk in such a case?

4. 'The Kafue River has in the immediate past experienced plant infestations which threatened the ecosystem as well as hydro power generation.' Outline and discuss the measures that were undertaken by the relevant authorities and their limitations.

5. With the help of examples, explain Smith's (2000:38) contention that "the world trend is probably towards more disaster related deaths and damages despite the many positive steps being taken to reduce disasters".

6. With the help of an annotated diagram, discuss the contention that hazards exist at the interface between the natural events and human use systems.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 922: GEOGRAPHY OF REGIONAL PLANNING AND DEVELOPMENT

TIME: **Three** hours
INSTRUCTIONS: Answer any **four** questions. Use of a Philips' University atlas is allowed. Candidates are encouraged to use illustrations wherever appropriate.

---

1. Explain the reasons why development theorists differ in opinion on the fate of the world's poorest nations.

2. 'Africa has continued to experience social and economic crises despite some countries having gone through Structural Adjustment Programmes'. Discuss.

3. Explain how high population growth, religion, illiteracy, disease, and culture retard the development process.

4. Discuss the assertion that 'Globalization is irreversible and irresistible', (Blair in Buckman, 2004).

5. "Imagine Zambia without Copper" (Ezekwesili, 2009). As a GEO 922 student how would you advice the Government to diversify the economy through the agricultural sector in order to enhance economic growth.

6. Examine how railway corridors are potential areas of economic development.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 932: URBAN GEOGRAPHY

TIME: Three hours
INTRUCTIONS: Answer any **four** questions
All questions carry equal marks.
Candidates are encouraged to use illustrations wherever appropriate.

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1. Write short explanatory notes on **all** of the following;
   a) The urban routeway
   b) Characteristics of the urban informal sector
   c) The colonial city
   d) Urban systems
   e) The Location theory of urban growth

2. Discuss the contention that unplanned settlements are 'slums of hope', outlining the social, economic and cultural contributions of these areas.

3. "The battle for a clean environment will be lost and won in cities" (Tannerfeldt and Ljung, 2006:64). Discuss.

4. Evaluate the intended impact of the Urban and Regional Planning law reform process being undertaken by the Ministry of Local Government and Housing.

5. 'Cities exert influences which are not proportional to their size'. Analyse this statement in light of the significance of urban places in Africa.

6. Explain how Urban Geography has developed as a field of study.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 952: GEOGRAPHICAL HYDROLOGY

TIME: Three hours

INSTRUCTIONS: Answer any FOUR questions.

All questions carry equal marks. Candidates are advised to make use of illustrations and examples wherever appropriate.

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1. Discuss the river basin planning approach using the United States of America and India as case studies.

2. What are the major factors affecting evapotranspiration of a region and outline the appropriate methods that can be applied to estimate evapotranspiration.

3. Outline and explain the factors that affect the interception loss from vegetation.

4. Discuss the major techniques used in determining soil moisture.

5. Diagrammatically illustrate the major components of a hydrograph and discuss the assumptions made when constructing hydrographs.

6. With the use of a diagram explain the Soil-Plant-Atmosphere-Water (SPAW) System and critically discuss its relevance to hydrology.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 955: GEOMORPHOLOGY

TIME: Three hours

INSTRUCTIONS: Answer any FOUR questions.

All questions carry equal marks. Candidates are advised to make use of illustrations and examples wherever appropriate.

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1. Write short explanatory notes on ALL of the following:

   a) Regional metamorphism
   b) Primary seismic waves
   c) Froude Number
   d) Probable maximum flood
   e) Buried and exhumed paleosol

2. Discuss how the Plate tectonics theory helps geomorphologists understand the interrelationships of rocks, earthquakes and volcanism.

3. 'Climamorphogenetics emphasizes that different climatic regions experience different morphological processes'. Discuss.

4. Diagrammatically outline the evolutionary occurrence of channel planforms found in Zambia and distinguish their characteristics.

5. Discuss the major characteristics of Mäckel's three physiographic regions of Zambia.

6. With the use of diagrams outline the typical bed forms in the lower and upper flow regimes for alluvial sand bed channels.

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATION

GEO 962: BIOGEOGRAPHY

TIME: Three hours

INSTRUCTIONS: Answer any four (4) questions

All questions carry equal marks.

---

1. Write short explanatory notes on all of the following:
   a) Climatic relicts
   b) Taxonomical classification of living organisms
   c) Ecological tolerance
   d) Natural selection
   e) Speciation

2. ".....the Theory of Island Biogeography is not of merely academic interest" (Cox and Moore, 1985:116). Discuss.

3. In what ways and to what extent can the nature of the biota of mammals and flowering plants that developed on each continent be attributed to the gradual fragmentation of continents and the climatic changes that took place during Cenozoic era?

4. Critically analyse the factors that influence the distribution and abundance of plants and animals on the surface of the earth.

5. Imagine you have been appointed as a Park Manager of the National Park located adjacent to human settlements in Luangwa Valley in Zambia. The park is prone to perennial burning. Explain the factors you will take into consideration when developing and implementing the fire management plan for the National Park.

6. Discuss the role of domestication of plants and animals in the development of modern agriculture.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY SECOND SEMESTER DIFERRED EXAMINATIONS – MARCH, 2008

GEO 971 – AIRPHOTOGRAPHY (PAPER II)

INSTRUCTIONS: ANSWER ALL QUESTIONS. TIME: 3 HOURS

1. A client asks you to take normal size airphotographs of an area 300km long and 30 km wide. Assuming a flying height of 10000m, camera focal length of 150mm, forward overlap of 30% and a side lap of 20%:

   a) Determine how many airphotos would be required to cover the whole area. (5 marks)
   b) If your client complains that the number of airphotos you have determined in 1a, above, is too many what options would you suggest to reduce the number? (5 marks)

2. You are studying the vegetation cover in Luangwa North Game Reserve area to determine whether the vegetative cover is shrinking or expanding. You have a choice of using any one or combination of the following remote sensing materials: true colour, false colour, infra-red black and white and ordinary black and white airphotographs, all taken in 1980, 1989, and 1999. As an expert in airphoto interpretations, provide the following:

   a) your selection of the most suitable remote sensing material to use in this assignment. Give reasons for your selection. (5 marks)
   b) an outline of the approach you would use to determine the magnitude and rate of change in the vegetation cover. (5 marks)

3. a) The distance between UNZA bus stop and Lusaka International Airport road junction measures about 500mm on a map with a scale of 1:25 000. The same distance measures about 600mm on an airphoto. What would the scale be on the airphoto? (5 marks)

   b) A tree appears on a two stereo airphoto pair. On photo 'A' the difference between the top and base of the tree is 4mm while on airphoto 'B' the difference is 2mm . Assuming the distance between the two principle points is 10cm, determine how high above the ground the plane was fying when it took the photographs. (5 marks)

4. Explain the likely disturbances that may occur when Electromagnetic Radiation is propagated through the atmosphere. (10 marks)

5. A building appears on an airphoto with a relief displacement of 3mm and a radial distance from the principle point of 10cm. If the flying height was 10000m above datum:

   a. determine the height of the building (5 marks)
   b. how are the radial distance and flying height related to displacement? (5 marks)

6. How is remote sensing applied in water resources surveys? (10 marks)

7. How is information registration done on airphotography? (10 marks)

END OF EXAM

UNIVERSITY OF ZAMBIA
UNIVERSITY SECOND SEMESTER EXAMINATIONS
FEBRUARY, 2008

GEO 971: AIR PHOTOGRAPHY (PAPER I)

INSTRUCTIONS: ANSWER ALL QUESTIONS. **TIME:** 3 HOURS

1. a) Explain and illustrate the part of the electromagnetic spectrum often used in aerial photography. (5 marks)

   b) Why is the principle of spectral response patterns used in the study of earth surface features recorded on aerial photographs? (5 marks)

2. Explain on how the following may aid in aerial photo interpretation:

   a) Shape b) Site or place c) Texture (15 marks)

3. Explain the differences in the structure and function between true colour and colour infra-red films. (10 marks)

4. What do you understand by the following remote sensing terms:

   a) Oblique airphotos b) Drift errors c) Panchromatic film
   d) Airphoto ground distance e) Relief displacement
   (10 marks)

5. What is a flight plan? (10 marks)

6. Give the main types of commonly used airphotos (not films), explaining their characteristics, advantages and disadvantages. (10 marks)

7. How may airphotos be used in soil surveying? (10 marks)

8. How is airphotography used in locating and mapping of the extent of water bodies? (10 marks)

END OF EXAM

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER EXAMINATIONS

GEO 972 - SATELLITE REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS

TIME: Three hours
INSTRUCTIONS: Any four questions
NOTE: All questions carry equal marks

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1. Write short explanatory notes on ALL of the following:

   a) Electromagnetic energy
   b) Scanning mechanisms
   c) Image pixel
   d) Low pass and high pass filters
   e) Feature space

2. Discuss the current status of satellite remote sensing.

3. Explain the differences between the Landsat Thematic Mapper (TM) and SPOT 4 High Resolution Visible (HRV).

4. 'Satellite imagery data are not always perfect'. Explain.

5. Explain the steps undertaken in supervised classification and the advantages of such a classification procedure.

6. Explain the view that a Geographic Information System (GIS) is a decision support process.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINTAION

GEO 995: ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT I

TIME : Three hours (3 hrs)
INSTRUCTIONS: Answer any FOUR QUESTIONS. All questions carry equal marks.

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1. Why should all Nations cooperate in the essential task of eradicating poverty as an indispensable requirement for sustainable development?

2. If carrying capacity 'blames' anyone, it 'averages' the blame. It blames the rich for using too many resources, as well as the poor for being too numerous. Elucidate.

3. Provide a theoretical exposition as to why poverty must not only be understood in the sense of inadequate income but holistically as a deprivation of a series of basic needs.

4. Discuss the notion that 'Population problems are a consequence of social problems which are a result of economic problems resulting from political structures in a country'.

5. What is carrying capacity and what can cause the carrying capacity of an environment to change over time?

6. Human societies have been altering the earth since time immemorial. But the pace and scale of degradation that is taking place today is historically new. Discuss.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
Directorate of Distance Education

2008/9 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M111: Mathematical Methods I

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS : Answer any **Five** (5) questions from this paper
Omission of essential working may result in loss of marks
Calculators and Mathematical tables are **NOT** allowed in this paper

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1. (a) Let U = [–7 , 10] be the universal set, and let A = (–2 , 8), B = [1 , 8] and C = (–7 , 6) be subsets of U.
Find
(i) $A \cap (B - C)$
(ii) C'
(iii) $(A \cup C)'$

(b) (i) Express $\frac{2\sqrt{3}+1}{2-\sqrt{3}}$ in the form $a+b\sqrt{3}$ where a and b are rational numbers.

(ii) If α and β are roots of the equation $x^2+4x-2=0$, find the sum $\frac{1}{\beta^2}+\frac{1}{\alpha^2}$

(c) Solve the inequality $\frac{x}{x-3} \geq \frac{1}{2}$

2. (a) (i) Let $(1 + 3i)z = 5(1 + i)$. Express z in the form $a + bi$ where a and b are rational numbers.

(ii) Express $1.45\overline{45}$ in the form $\frac{a}{b}$ where a and b are integers.

(b) Prove the identity $\frac{1-\cos 2A+\sin 2A}{1+\cos 2A+\sin 2A} = \tan A$

(c) Let $f(x) = -2x^2 + 11x - 15$. Find the maximum or the minimum point of $f(x)$. Hence sketch the graph of $f(x)$.

3. (a) The table below shows an operation '*' on a set G = { 1 , 5 , 7 , 11 }.

*	1	5	7	11
1	1	5	7	11
5	5	1	11	7
7	7	11	1	5
11	11	7	5	1

(i) Is the operation a binary operation? Give reason for your answer.
(ii) Is the operation commutative?
(iii) Evaluate (5 * 1) * 11 and (5 * 7) * (7 * 11)

(b) Let $f(x) = \dfrac{2x}{3x-2}$ and $g(x) = \dfrac{1}{x^2}$

(i) State the domain of f and the range of g.
(ii) Find the composite function $(fog)(x)$.
(iii) Find the inverse of $f(x)$.

(c) The graph of $f(x) = 5 + 2\cos(x+k)^0$, $0 \le x \le 360^0$ passes through the point (30° , 5).
(i) Find the smallest value of k
(ii) Solve the equation $f(x) = 4$.

4. (a) Evaluate the following limits:

(i) $\lim\limits_{x \to -2} \dfrac{x^2}{3x^2+7}$

(ii) $\lim\limits_{x \to 3} \dfrac{x^2-9}{2x^2-5x-3}$

(iii) $\lim\limits_{x \to \infty} \dfrac{3+2x-5x^2}{2x^2+7}$

(b) Differentiate the function $f(x) = \dfrac{1}{x}$ from the first principle.

(c) Let $f(x) = -3\cos(2x-\pi)$, $0 \le x \le 2\pi$
(i) Find the amplitude, the shift and the period of f(x).
(ii) Sketch the graph of $f(x)$.
(iii) Find the values of x such that $f(x) = \dfrac{3}{2}$.

5. (a) Given that $x = 2$ is a root of the equation $\alpha^2 x^2 + 2(2\alpha - 5)x + 8 = 0$

(i) find the possible value(s) of α

(ii) Hence find the corresponding value of the other root.

(b) The complex numbers z_1 and z_2 are given by;
$z_1 = 24 + 7i$ and $z_2 = 4 - 3i$

(i) Express $\frac{z_1}{z_2}$ in the form $a + bi$ where a and b are rational numbers.

(ii) Given that $z_1 + \alpha z_2$ is real, where α is a real number, find the value of α.

(iii) Given that $z_1 + (p + iq)z_2 = 0$ where p and q are real numbers, find p and q.

(c) Determine with reasons whether each function below is even, odd or neither:

(i) $f(x) = x^3 - \frac{3}{x}$

(ii) $g(x) = x^2 - x + \sin x$

(iii) $h(x) = 5 + 3\cos 2x$

6. (a) Find $\frac{dy}{dx}$ of the following functions:

(i) $y = x\cos(3x^2 + 1)$

(ii) $y = \ln(x^3 - 2x^2)$

(ii) $y = \frac{\sin x}{1 + \cos x}$

(b) Given that $f(x) = \sqrt{2 - x}$

(i) State the domain and the range of $f(x)$

(ii) Sketch the graph of $y = f(x)$

(c) Let $x - 2$ be a factor of $f(x) = x^3 - x^2 + ax + b$.

(i) Find a relation between a and b

(ii) Given that the remainder when $f(x)$ is divided by $x - 3$ is 10,find the values of a and b

(iii) Hence factorise $f(x)$ completely.

End of Exam

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

2008 ACADEMIC YEAR
SECOND SEMESTER EXAMINATIONS

M162: INTRODUCTION TO MATHEMATICS, PROBABILITY AND STATISTICS II

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS:
1. Answer any **Five** (5) Questions
2. Show All Essential Working
3. Calculators are NOT allowed

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1. (a) (i) Evaluate $\lim_{x\to 1}(3x-2)(2x+3)$

(ii) Find the derivative of $f(x)=x^2+6x$ from first principles.

(b) (i) Find the equation of the tangent to the curve $y=2x^2+3x-1$ at the point $(1\ ,\ 4)$.

(ii) Evaluate $\int_0^1 x(x^2+1)dx$

(c) Evaluate $\int \frac{x+1}{(x^2+2x-5)^2}dx$

2. (a) Find $\frac{dy}{dx}$ if

(i) $y=\frac{x^2+1}{2x-3}$

(ii) $(x+2y)^2=x$

(b) Find all the critical points of the function $f(x)=x^3-3x^2+6$, stating whether they are minimum, maximum or inflection points. Hence or otherwise sketch the graph of $f(x)$.

(c) A counter is drawn from a box containing 10 red, 15 black and 5 yellow counters. Find the probability that the counter is

(i) red

(ii) not black

(iii) black or yellow

3. (a) Determine if the function $f(x)=\begin{cases}3x-2, & x\le 2\\ x^2, & x>2\end{cases}$

is continuous at $x=2$.

(b) A continuous random variable X has the following probability density function

$$f(x)=\begin{cases}kx^2, & 0\le x\le 2\\ 0, & otherwise\end{cases}$$

(i) Show that $k=\frac{3}{8}$

(ii) Find $P(0\le X\le 1)$

(iii) Find E(X)

(iv) Find Var(X)

(c) From a group of 5 men and 3 women, 4 are chosen to serve on a committee. Find the

(i) total number of ways of choosing the committee.

(ii) probability that 2 men and 2 women are chosen.

4. (a) The following data represent marks of 20 students in a mathematics test:

14	9	26	20	29	16	10	34	20	25
28	27	24	21	32	22	30	17	18	25

(i) Construct a grouped frequency distribution table taking equal classes intervals 5 – 9, 10 – 14, ...

(ii) Construct a frequency histogram and a frequency polygon on the same axes using the classes in (i) above.

(b) The probability function for a discrete random variable X is given as

x	–2	–1	0	1	2	3
$P(X=x)$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{5}$	y	$\frac{1}{5}$	$\frac{1}{6}$

(i) Show that $y=\frac{1}{10}$.

(ii) Find the cumulative distribution function of X.

(iii) Find $P(X>-1)$

(iv) Find E(X)

(c) Consider the word MATHS. Find the number of ways of arranging

(i) all the letters of this word in a line.

(ii) three letters chosen from this word in a line.

5. (a) Given the set of numbers

7 7 2 3 4 2 7 9 4

Find the

(i) range

(ii) mode

(iii) median

(iv) mean using the assumed mean $\bar{x}_a = 4$

(v) variance

(b) A box contains 4 black, 6 white and 2 red balls. A ball is picked at random from the box and not replaced. A second ball is then picked. Find the probability that the

(i) first ball picked is white and the second ball picked is red.

(ii) second ball picked is black.

(c) Evaluate $\int \sin^{-1} x \ dx$

6. (a) If events A and B are such that $P(A) = \frac{1}{3}$, $P(B) = \frac{1}{4}$ and $P(A \cap B) = \frac{1}{10}$.

(i) Find $P(A \mid B)$.

(ii) Find $P(A \cup B)$.

(iii) Determine if A and B are mutually exclusive.

(iv) Determine if A and B are independent.

(b) The probabilities that a girl goes to school by car, bicycle or on foot on any given day are 0.2, 0.3 and 0.5 respectively. The probabilities of her being late by these methods are 0.6, 0.3 and 0.1 respectively.

(i) Find the probability that she is late for school.

(ii) If she is late, find the probability that she went to school on foot.

(c) Find $\frac{dy}{dx} = \frac{\cos x}{1 - \sin x}$

END OF EXAMINATION

The University of Zambia
School of Natural Sciences
Department of Mathematics & Statistics

2008/9 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M212 – MATHEMATICAL METHODS IV

INSTRUCTIONS:
1. Answer any **Five (5)** of the seven Questions Only.
2. All questions carry equal marks.
3. Show all essential working to obtain full marks.
4. Indicate the question number for each question attempted on the cover of the main answer book.

TIME ALLOWED: **Three (3)** hours.

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1. (a) (i) Find the symmetric equations of the line which is orthogonal to the direction vectors of the lines

$L_1 : x = -2 - 3t,\ y = 1 + 4t,\ z = -5t$;
$L_2 : x = 3 + 7t,\ y = -2 - 2t,\ z = 8 + 3t$

(ii) Find the parametric equations for the line tangent to the curve

$$\mathbf{R}(t) = e^t\mathbf{i} + e^{-t}\mathbf{j} + \sqrt{2}\,t\mathbf{k}$$

and an equation for the plane normal to the curve at the point $P(1,1,0)$.

(b) (i) Find the distance between the planes Π_1 and Π_2

$\Pi_1 : 6x + 9y - 18z = 17$;
$\Pi_2 : 2x + 3y - 6z = 6$

(ii) Find the area of the triangle with vertices $P_1(1,3,5)$, $P_2(2,-1,3)$ and $P_3(-3,2,6)$

2. (a) The plane curve is given by the equation

$$\mathbf{R}(t) = (\ln \sin t)\mathbf{i} + (\ln \cos t)\mathbf{j}.$$

Find the unit normal vector to the curve at $t = \frac{\pi}{6}$.

(b) For the space curve given parametrically by

$$x = 3t^2,\ y = 2t^3,\ z = 3t.$$

(i) Find its length from $t = 0$ to $t = 4$.

(ii) Find its curvature κ in terms of the parameter t.

3. (a) Use the definition of limits to show that $\lim_{(x,y)\to(3,-1)} (x - 7y) = 10$.

(b) (i) If $z = \frac{xy}{x - y}$, show that

$$x^2 \frac{\partial^2 z}{\partial x^2} + 2xy \frac{\partial^2 z}{\partial x \partial y} + y^2 \frac{\partial^2 z}{\partial y^2} = 0$$

(ii) If $w = \sin xyz$, $x = s^2 r$, $y = r^2 s$, $z = r - s$, use the chain rule for partial derivatives to find $\frac{\partial w}{\partial r}$ and $\frac{\partial w}{\partial s}$.

4. (a) (i) Use partial derivatives to approximate the number

$$\sqrt{(0.01)^2 + (4.05)^2 + (2.96)^2}.$$

(ii) A right circular cone is measured and found to have diameter 10 cm and slant height 13 cm. There is a maximum error of 0.03 cm in the measurements. Use the total differential to find the maximum error in the calculation of the curved surface area.

(Curved surface area $= \pi\left(\frac{D}{2}\right)l$, where l is the slant height).

(b) A surface is defined by a function $f(x, y) = 2x^3 - 24xy + 16y^3$. Determine the nature of its critical points.

5. (a) Solve the differential equations:

(i) $(x^2 - y^2)dx - 3xydy = 0,\ y(1) = 0.$

(ii) $\frac{dy}{dx} + y = xy^2.$

(b) Show that the given differential equation is exact

$$(3x^2 - 2xy + 2)dx + (6y^2 - x^2 + 3)dy = 0,$$

and, hence find its general solution.

6. (a) Solve the second order differential equations:

(i) $y''+y'-2y = 0,\ \ y(0) = 4,\ y'(0) = 1$

(ii) $y''+y' = e^{-x}$

(b) Solve the differential equation

$$y''+y = \cos x$$

7. (a) Find the distance of the point $P_0(1,-2,3)$ from the plane through the points $P_1(1,3,5)$, $P_2(2,-1,3)$ and $P_3(-3,2,-6)$.

(b) (i) Prove that if f is any differentiable function, then $z = f(x^2 - y^2)$ is a solution of the partial differential equation

$$x\frac{\partial z}{\partial y} + y\frac{\partial z}{\partial x} = 0.$$

(ii) By eliminating the constants A and B, find a differential equation satisfied by the family of curves given by

$$y = Ae^{2x} + Be^{-3x}.$$

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
Department of Mathematics & Statistics

2008 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M 292 : INTRODUCTION TO PROBABILITY

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS:
(i) Answer any **Four (4)** questions out of the five (5).
(ii) Full credit will only be given when all the essential working is shown.
(iii) Write your computer number in all the answer booklets, and indicate on the main answer booklet the questions you have answered.

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1. (a) Define the following:

   (i) Independence of two events.

   (ii) Partition of a sample space.

   (iii) Permutation.

   (b) (i) Prove that the value of the correlation coefficient of any two random variables X and Y is always in the interval $[-1, 1]$ i.e. $e_{XY} \in [-1, 1]$.

   (ii) Three missiles whose probabilities of hitting a target are 0.6, 0.7 and 0.8 respectively, are fired at a target. Assuming independence, what is the probability that the target is hit.

   (iii) A days production of 100 fuses is inspected by a quality control inspector who takes a random sample of 10 fuses without replacement and tests them. If she finds 2 or fewer defective fuses, she accepts the entire lot of 100 fuses. What is the probability the lot is accepted if it contains 20 defective fuses?

   (c) A random variable X, has a commulative distribution function (cdf)

$$F_X(t) = \begin{cases} 0 & if \quad t < -1 \\ \frac{1}{3} & if \quad -1 \le t < 0 \\ \frac{5}{6} & if \quad 0 \le t < 2 \\ 1 & if \quad t \ge 2 \end{cases}$$

(i) Find the probability function of X.

(ii) Find the mean and variance of X.

2. (a) Define the following:

(i) Conditional probability of event B given event A.

(ii) A random variable.

(iii) Moment generating function.

(b) Given that X is a Binomial random variable i.e. X ~ B (n , p).

(i) Derive the moment generating function (mgf) of X.

(ii) Using the mgf in (i) derive the mean and variance of X.

(c) Let X and Y be the concentration levels of two pollutants in parts per million (ppm) at a certain of a body of water. If the joint probability density function is given by:

$$F_{X,Y}(x, y) = \begin{cases} \frac{x + y}{8000} & , \quad 0 < x < 200 \, , \; 0 < y < 200 \\ 0 & otherwise \end{cases}$$

(i) Find the marginal probability density functions of X and Y.

(ii) Find the conditional probability density function of X given that Y = 10 ppm.

(iii) Find the probability that the concentration level of X will be at most 14 ppm given that Y = 10 ppm.

3. (a) Define the following:

(i) Negative Binomial random variable (no pdf expression).

(ii) Commulative distribution function.

(iii) Covariance of X and Y.

(b) Let X and Y be two random variables with joint probability density function given by

$$F_{X,Y}(x, y) = \begin{cases} \frac{2}{3}(x + y)e^{-x} & , \ 0 < x < \infty, \ 0 < y < 1 \\ 0 & \text{otherwise} \end{cases}$$

Find the following:

(i) Marginal probability density functions of X and Y.

(ii) Covariance of X and Y.

(c) (i) If X has a Poisson distribution with $P(X = 0) = 0.2$, find $P(X > 3)$

(ii) A man and a woman decide to meet for lunch at Manda-hill at the sub-way. If each person independently arrives at a time uniformly distributed between 12:00 hrs and 13:00 hrs. Find the probability that the first to arrive has to wait longer than 10 minutes.

(iii) A worker who drives to work has 7 traffic lights on her route. The probability that any of the traffic lights is red (she has to stop) when she reaches it is 0.20, and that the traffic lights are far enough apart to operate independently. Let X be the number of traffic lights she has to stop. Find $P(X \geq 5)$.

4. (a) Define the following terms:

(i) Independence of two continuous random variables X and Y.

(ii) Correlation coefficient of two random variables X and Y.

(iii) Conditional probability function of Y given $X = a$.

(b) (i) The probability that a certain type of electronic component will fail during first hour of operation is 0.005. If 400 of these electronic components are tested independently, find the probability that at most three will fail during the first hour.

(ii) A door to door salesman will say he has a good day when in fact he did with probability 1, but the probability only 0.6 that he will say he had a good day when, in fact he did not. Only $\frac{1}{4}$ of his selling days are actually good ones. What is the probability that he has a good day if he says he had a good day?

(c) Let X be a random variable with Geometric distribution i.e. $P(X = x) = P(1 - P)^x$, $x = 0, 1, 2, 3, \ldots$.

(i) Derive the moment generation function (mgf) of X.

(ii) Using the mgf in (i), find the mean and variance.

5. (a) Two random variables X and Y have a joint probability function given by:

$$F_{X,Y}(x, y) = \begin{cases} e^{-\frac{x}{y}} e^{-y} & 0 < x < \infty,\ 0 < y < \infty \\ 0 & \textit{otherwise} \end{cases}$$

Find the following:

(i) Marginal probability density function of Y.

(ii) Moment generating function of Y.

(iii) Conditional probability function of X given Y = 3.

(iv) P(X > 2 | Y = 3).

(b) (i) State Chebyshev's inequality.

(ii) Consider the discrete random variable X with the following distribution

x	-1	0	1	2
$P(X = x)$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$

(iii) Find the mean and variance of X.

(iv) Compute $P\left(\frac{1}{3} - \frac{1}{2}\sqrt{\frac{19}{2}} < X < \frac{1}{3} + \frac{1}{2}\sqrt{\frac{19}{2}}\right)$ and compare with the bound given by Chebyshev's inequality.

(c) Given that a random variable X has commutative distribution function given by

$$F_X(t) = \begin{cases} 0 & \textit{if}\quad t < -1 \\ \dfrac{x^2 + 2x + 1}{16} & \textit{if}\quad -1 \le t < 3 \\ 1 & \textit{if}\quad t \ge 3 \end{cases}$$

(i) Find the probability density function of X.

(ii) Find the mean and variance of X.

END GOOD LUCK!

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M422: MODULE AND FIELD THEORY

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS : There are two sections in this paper
Answer **Five** (5) questions from this paper and **at least Two (2)** from each section

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Section A: Field Theory
Answer **at least Two**(2) questions from this section.

1. (a) Define
   (i) an algebraic extension F of a field K
   (ii) a perfect field

   (b) Let F be a finite field of characteristic p. Show that F is perfect.

   (c) Consider the polynomial $f(x) = x^2 + 2x + 2$ in $Z_3[x]$
   (i) Show that $f(x)$ is irreducible over Z_3
   (ii) Let $F = \dfrac{Z_3[x]}{\langle x^2 + 2x + 2 \rangle}$ and let α be a zero of $f(x)$ in F. Express in terms of α the elements of F. Hence , if possible, express $f(x)$ as a product of linear factors in F[x].

2. (a) Define or state
   (i) a splitting field
   (ii) the Kronecker's theorem

   (b) Let K be a field and $f(x)$ a non zero polynomial of K[x]. Show that there exists a splitting field F for $f(x)$ over K

   (c) Consider the Galois extension $Q(\sqrt{2}, \sqrt{5})$ of Q, where Q is the field of rational numbers. Let α be a non identity element of the Galois group $G(Q(\sqrt{2}, \sqrt{5}) : Q)$.
   (i) Show that α has order 2
   (ii) Determine any fixed field of { e , α }where e is the identity.

3. (a) Define
   (i) a normal extension L of a field K
   (ii) a normal closure of an extension L of a field K

   (b) Let α be the real cuberoot of 2 and consider the polynomial $f(x) = x^3 - 2$ in Q[x], the polynomial ring over the field of rational numbers.
   (i) Show that the extension $Q(\alpha) : Q$ is not a normal extension
   (ii) Obtain the normal closure of the extension $Q(\alpha) : Q$

   (c) Let F, E and K be fields such that F is an extension of E and E is an extension of K. Let $a_1, a_2, a_3, ..., a_m$ be elements of F that are linearly independent over E and $b_1, b_2, b_3, ..., b_n$ be elements of E that are linearly independent over K.
   (i) Show that the *mn* products $a_i b_j$, i = 1, 2 , ...*m*, j = 1 , 2, ...*n* are linearly independent
   (ii) If further [F : E] = m and [E : K] = n where *m* and *n* are real numbers. Show that the *mn* products $a_i b_j$ in (i) form a basis of F as a vector space over K .

4. (a) Define
   (i) an automorphism of a field F
   (ii) a radical extension of a field F

   (b) Let F be an extension of a field K. Show that the set of all K – automorphisms of the field F forms a group under the composition of functions.

   (c) (i) Determine the Galois group of the polynomial $f(x) = x^4 - 4x^2 + 5 \in Q[x]$
   (ii) Determine whether the polynomial $f(x) = x^5 - 10x + 5 \in Q[x]$ is solvable by radicals.

Section B – Module Theory:
Answer **at least Two** (2) questions from this section

5. (a) Define each of the following terms
   (i) M is a finitely generated R – module
   (ii) the element m of an R – module M is a torsion element

   (b) (i) Show that if each element m of an R – module M has a unique expression of the form $m = \sum_{i=1}^{t} r_i m_i \ , \ r_i \in R$,
   then each m_i is a torsion free element.
   (ii) Prove that the subset T of an R – module M defined by
   $T = \{ m \in M : m$ is a torsion element $\}$, is an R – submodule of M, and that the quotient module M/T is torsion – free .

   (c) Prove that if M is a torsion free module over a principal ideal domain R then it is free

6. (a) Define each of the following terms as applied to left R – module :
   (i) an R – module M is an internal direct sum of $M_1, M_2, \ldots\ldots, M_r$
   (ii) the module M is R – free .

   (b) (i) Let M be an R – module , and let $M_i \ \ (i = 1, 2, \ldots\ldots, n)$ be submodules such that the conditions
   $M = \sum M_i$ and $M_i \cap \sum_{i \neq j} M_j = \{0\}$ hold.
   Then prove that $M = \oplus \sum M_i$
   (ii) Let the R – module M be freely generated by subset
   $X = \{M_1, M_2, \ldots\ldots, M_s\}$ and N be freely generated by the subset
   $Y = \{e_1 (= (1,0,0,\ldots,0)), e_2 (= (0,1,0,\ldots,0)), \ldots e_s (= (0,0,\ldots,0,1))\}$
   Then prove that $M \cong N$.

   (c) Show that the $\mathbf{Z}$ – module $\mathbf{Z}$ is $\mathbf{Z}$ – free, hence determine whether $\mathbf{Z}_n = \{z \in \mathbf{Z} \bmod n\}$ is $\mathbf{Z}$ – free.

7. (a) Define each of the following terms as applied to R – modules M
   (i) a torsion submodule T of M
   (ii) a free R – module F

   (b) Given that a submodule N of an R – module M and the quotient module M/N are both finitely generated, then show that M is also finitely generated.

   (c) Let M be a finitely generated module over a principal ideal domain R. Then prove that $M = T \oplus F$, where F is a free R – submodule of M and T is a torsion submodule of M.

End of Exam

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

DEPARTMENT OF MATHEMATICS & STATISTICS

UNIVERSITY SECOND SEMESTER EXAMINATIONS

APRIL 2009

M432 - REAL ANALYSIS VI

INSTRUCTIONS:

1. Answer any **five(5)** questions.
2. All questions carry equal marks.

TIME ALLOWED: Three (3) hours

[TURN OVER]

1. (a) Let (X, d) be a metric space and $\{x_n\}_{n=1}^{\infty}$ a sequence in X.

   (i) When is $\{x_n\}_{n=1}^{\infty}$ called a Cauchy sequence?

   (ii) When is X said to be complete?

   (b) The usual metric on $\mathbb{R}$ is $d : \mathbb{R} \times \mathbb{R} \to \mathbb{R}$ defined by $d(a, b) = |a - b|$. Prove that $\mathbb{R}$ is a complete metric space.

   (c) If (X, d) is a metric space, $\{x_n\}_{n=1}^{\infty}$ and $\{y_n\}_{n=1}^{\infty}$ cauchy sequences in X, prove that with the usual metric, the sequence $\{d(x_n, y_n)\}_{n=1}^{\infty}$ converges in $\mathbb{R}$.

2. (a) Let X and Y be linear spaces over a field $\mathbb{F}$. Define the following:

   (i) a norm on X.

   (ii) a linear transformation $L : X \to Y$.

   (b) (i) Prove that the norm function $\|.\| : X \to \mathbb{R}$ from X onto $\mathbb{R}$ is continuous.

   (ii) Let X be a linear space. Let $\|.\| : X \times X \to \mathbb{R}$ be a norm on X. Prove that $|\|x\| - \|y\|| \leq \|x - y\|$ for all $x, y \in X$.

   (c) Let $X = C[0, 1]$, Prove that $\|f\| = \max_{0 \leq x \leq 1} |f(x)|$ defines a norm on X.

3. (a) Define the following:

   (i) a Banach space.

   (ii) an operator on a normed linear space X.

   (b) Let X and Y be normed linear spaces and L a linear transformation of X onto Y. Prove that the following are equivalent.

   i. L is continuous.

   ii. L is continuous at the origin.

   iii. there exists a real number $K \geq 0$ such that $\|L(x)\| \leq K\|x\|, \forall\, x \in X$.

   iv. If $B = \{x : \|x\| \leq 1\}$ is a closed unit ball in X, then the image $T(B)$ is a bounded set in Y.

[TURN OVER]

4. (a) Let X and Y be normed linear spaces and $L \in \mathcal{L}'(X,Y)$. Let

$$\begin{aligned} N &= \inf\{M \in \mathbb{R} : \|L(x)\| \leq M\|x\|, x \in X\}, \\ P &= \sup\{\|L(x) : x \in X, \|x\| \leq 1\} \text{ and} \\ S &= \sup\{\|L(x)\| : x \in X, \|x\| = 1\} \end{aligned}$$

Prove that $\|L\| = N = P = S$.

(b) Let X, Y and $\mathcal{L}(X,Y)$ be normed linear spaces. Further, let $\|L\| = \sup\{\|L(x)\| : \|x\| \leq 1\}$ be the norm on $\mathcal{L}(X,Y)$. Prove that if Y is a Banach space, then so is $\mathcal{L}(X,Y)$.

(c) Show that l_2 with an inner product of two vectors

$$\begin{aligned} x &= (x_1, x_2, \ldots, x_n, x_{n+1}, \ldots) \\ y &= (y_1, y_2, \ldots, y_n, y_{n+1}, \ldots) \end{aligned}$$

defined by $\langle x, y\rangle = \sum_{i=1}^{\infty} x_i \overline{y_i}$ is an inner product space.

5. (a) Let X be a normed linear space over a field $\mathbb{F}$. Define the following:

(i) the conjugate space X^* of X.

(ii) a bounded linear functional f on X.

(b) Prove that a linear functional f defined on a normed linear space X is bounded if and only if it is continuous.

(c) Prove that the space $(l_p^n)^*$ is isometrically isomorphic to l_q^n, where $\frac{1}{p} + \frac{1}{q} = 1$.

6. (a) Define the following:

(i) a Hilbert space H.

(ii) an orthonormal set S in a Hilbert space H

(b) (i) Let X be an inner product space. Let $x \in X$, prove that $\{x\}^{\perp}$ is a closed subspace of X.

(ii) Let H be a Hilbert space. Prove that $\|x\|^2 = \sum |\langle x, e_i\rangle|$ for all $x \in H$ implies that $\{e_i\}$ is a complete orthonormal subset in H.

(c) If M is a proper closed linear subspace of a Hilbert space H, prove that there exists a non zero vector z_0 in H such that $z_0 \perp M$.

■ END OF EXAMINATION ■

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M912: Mathematical Methods VI

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS : Attempt any **Five** (5) questions from this paper.
Show all essential working for full credit.

---

1. (a) Let γ be a curve given parametrically by $\gamma(t) = \mathbf{i} + t\mathbf{j} + e^t\mathbf{k},\ 0 \le t \le 4$.
Calculate the line integral $\int_\gamma \cos z dx + e^x dy + e^y dz$.

(b) A surface S is given parametrically by the equation
$\mathbf{r}(u,v) = u\cos v\mathbf{i} + u\sin v\mathbf{j} + u^2\mathbf{k},\quad 0 \le u \le 4,\quad 0 \le v \le 2\pi$

(i) Calculate $\dfrac{\partial \mathbf{r}}{\partial u} \times \dfrac{\partial \mathbf{r}}{\partial v}$

(ii) Given that the area of the surface S is $\dfrac{\pi(65\sqrt{65}-1)}{n}$ where n is an integer, find the value of n.

(c) The cylinder $x^2 + y^2 = 2x$ cuts out a portion of a surface S from the upper part of the cone $x^2 + y^2 = z^2$. Calculate the surface integral
$\iint_S (x^4 - y^4 + y^2z^2 - z^2x^2 + 1)dS$.

2. (a) Find the potential function $f(x,y,z)$ for the vector field
$\mathbf{F}(x,y,z) = (2xyz + z^2 - 2y^2 + 1)\mathbf{i} + (x^2z - 4xy)\mathbf{j} + (x^2y + 2xz - 2)\mathbf{k}$.

(b) Let ∂S denote the boundary of the surface S given by
$z = x^2 + y^2,\ x^2 + y^2 \le 1$. Use Stoke's theorem to calculate the line integral $\oint_{\partial S} y^2dx + xdy + z^2dz$.

(c) Use the method of Frobenius to find the roots of the **indicial equation** to the differential equation $4xy'' + 2y' + y = 0$. (Note that you don't need to find the solution of the differential equation).

3. (a) When is a sequence of functions $y_n(x)$, $n = 0, 1, 2, 3, \ldots\ldots$ said to be orthogonal with respect to the weight function $\phi(x)$ on the interval $[a, b]$?

(b) Let $C(1,e)$ be the space of continuous functions on the interval $(1, e)$ and let $(f,g) = \int_1^e \log x f(x) g(x) dx$ be an inner product on $C(1,e)$.

(i) Find $\|f\|$ if $f(x) = \sqrt{x}$.

(ii) Find a non zero linear polynomial $g(x) = a + bx$ which is orthogonal to the constant function $f(x) = 1$.

(c) Let $(x, y) = \int_0^1 x(t) y(t) dt$ be an inner product on the space of polynomials.

(i) Show that the polynomials $x_0(t) = 1$, $x_1(t) = 2t - 1$ and $x_2(t) = 6t^2 - 6t + 1$ are orthogonal.

(ii) Find an orthonormal set $\{y_0, y_1, y_2\}$ which spans the same subspace as the set $\{x_0, x_1, x_2\}$ in (i).

4. (a) Let a periodic function $f(x)$ be defined in one period by

$$f(x) = \begin{cases} -\dfrac{\pi}{2}, & -\pi \le x < 0 \\ \dfrac{\pi}{2}, & 0 \le x \le \pi \end{cases}$$

Find the Fourier series of $f(x)$.

(b) Find the cosine series of the function $f(x) = x^2$, $-\pi \le x \le \pi$. Hence determine the value of the sum $\sum_{n=1}^{\infty} \dfrac{1}{n^2}$.

(c) Find the complex form of the Fourier series of the periodic function whose definition in one period is $f(t) = e^{-t}$, $-1 < t < 1$.

5. (a) A fluid flow has flux density vector $\mathbf{F}(x, y, z) = x\mathbf{i} - (2x + y)\mathbf{j} + z\mathbf{k}$. Calculate the mass of fluid flowing through the hemisphere $x^2 + y^2 + z^2 = 1$, $z \ge 0$ in the direction of the unit normal to the surface.

(b) Let $f(t)$ be a function whose Laplace transform is given by $L[f] = F(s)$. Show that $\dfrac{d}{ds} F(s) = -L[tf(t)]$.

(c) Find the function $f(t)$ whose Laplace transform is

$$F(s) = \ln\left(\frac{s^2 - 1}{s^2}\right).$$

6. (a) Consider the functions $f(x) = x^3$ and $g(x) = x^2|x|$ on the interval $[-1, 1]$

(i) Show that their Wronskian $W(f, g)$ vanishes identically.

(ii) Show that f and g are not linearly dependent.

(b) Find the Laplace transform of the functions

(i) $f(t) = \dfrac{e^{-3t}\sin 2t}{t}$.

(ii) $f(t) = e^{-3t}\int_0^t x\sin 2x dx$.

(c) Use the convolution theorem to find a particular integral of the equation $y'' + 2ay' + a^2 y = f(t)$ where $y'(0) = y(0) = 0$.

7. (a) Show that $y(x) = x^2$ is a solution to the differential equation $x^2 y'' + xy' - 4y = 0$. Find the second solution and hence write the general solution of the equation.

(b) Find the general solution of the system of equations

$$\begin{cases} \dfrac{dx}{dt} = 7x + 6y \\ \dfrac{dy}{dt} = 2x + 6y \end{cases}$$

(c) Use power series about the origin to find two solutions to the Hermite's equation $y'' - 2xy' + 2py = 0$ where p is a constant.

End of Exam!

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
Department of Mathematics & Statistics

2008 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M 962 : TIME SERIES ANALYSIS

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS: In the following questions $\{a_t\}$ denote a zero mean white noise process with variance σ_a^2 and B is the back shift operator.

Answer any **Five (5)** questions. All questions carry equal marks.

---

1. (a) The following tables represent number of holidays booked at Zambezi Sun (measured to the nearest 10) and the centered four – quarterly moving Averages respectively:

	Bookings			
	Q_1	Q_2	Q_3	Q_4
2006	220	260	260	350
2007	200	240	240	330
2008	220	280	310	390
2009	250			

Centered four quarterly moving average

	Q_1	Q_2	Q_3	Q_4
2006			*	265.0
2007	260.0	255.0	255.0	262.5
2008	276.25	292.5	303.75	
2009				

(i) Give the missing value where * is appearing in the moving averages table.

(ii) Assuming an additive model, calculate the seasonal component for each quarter.

(b) The following table gives monthly unemployed females between ages 20 and 25 in Lusaka from January 2008 to December 2008 (in thousands).

January	February	March	April	May	June
375	384	383	326	344	375
July	August	September	October	November	December
419	424	429	399	376	288

Obtain the one – step ahead forecast for the monthly unemployed females for January to December 2008 using the simple exponential smoothing with initial value $\hat{x}_1 = x_1$ and smoothing parameter $\alpha = 0.5$.

(c) The value of the Ljung – Box test statistics based on the first 20 sample autocorrelations of a time series is 23.23. Let $Prob.\left\{\chi^2_{(20)} > 31.4\right\} = 0 \cdot 05$. Give a conclusion about the autocorrelations of the generating process.

2. (a) Let $Z_1, Z_2, \ldots, Z_n$ be an observed time series from a stationary stochastic process $\{ Z_t \}$. Let r_k be the k^{th} autocorrelation of the time series.

(i) Write the formula for r_k.
(ii) Give an estimator of the standard error of r_k.

(b) The following sample autocorrelations were obtained from a time series of length $N = 200$ observations

k	1	2	3	4	5	6	7	8	9	10
r_k	–0.38	–0.08	0.11	–0.08	0.02	0.00	0.00	0.00	0.07	–0.08

Test the following hypothesis

(i) $\rho_1 = 0$
(ii) $\rho_2 = 0$
(iii) $\rho_3 = 0$

where ρ_k represents the k^{th} autocorrelation of the stationary stochastic process from which the above time series has been observed.

(c) Let $\{ a_t \}$ be a zero mean white noise process. Determine which of the following processes are second order stationary

(i) $X_t = (-1)^t a_t$
(ii) $X_t = a + bt + a_{t-1}$
(iii) $Z_t = a_{t-1}\ a_t$

3. (a) Let $\{ Z_t \}$ be a stochastic process described by

$$\dot{Z}_t = 0 \cdot 75\ \dot{Z}_{t-1} - 0 \cdot 5\ \dot{Z}_{t-2} + a_t$$

(i) Show that $\{ Z_t \}$ is stationary.

(ii) Find the first four autocorrelations of $\{ Z_t \}$ and display them on a correlogram.

(iii) State what pattern the correlogram should reveal.

(b) The first ten partial autocorrelations of a time series of 250 values are given in the following table:

K	1	2	3	4	5	6	7	8	9	10
$\hat{Q}_{KK}$	.67	−.45	−.04	−.08	.05	−.01	.03	−.01	−.04	−.01

Discuss with appropriate tests of hypothesis if these sample PACF indicate an AR(2) process.

(c) Let $\{ X_t \}$ be a zero mean weakly stationary process with autocovariance function $r_K = \alpha^k$, $K \geq 0$. Consider another process $\{ Y_t \}$, where $Y_t = \frac{1}{2}\left(X_t + X_{t-1} \right)$. Let Γ be the first autocovariance of the process $\{ Y_t \}$.

Show that $\Gamma = \left(\frac{1+\alpha}{\alpha} \right)^2$.

4. (a) Consider the ARIMA (0, 2, 2) process

$(1 - B)^2 Z_t = (1 - 0.9B + 0.5B^2) a_t$. Let the AR representation of this process be $Z_t = \Pi_1 Z_{t-1} + \Pi_2 Z_{t-2} + \ldots + a_t$.

(i) Find the first four Π weights.

(ii) Given $Z_{20} = 15.2$, $Z_{19} = 17.8$, $Z_{18} = 19.1$, forecast Z_{21} and Z_{22}.

(b) Consider the process $(1 - B) Z_t = (1 - \theta B) a_t$.

Explain what characteristics the sample ACF of a time series and it first difference series should have for the above model to be appropriate description of the time series.

(d) Suppose a process $\{ Z_t \}$ is generated according to $Z_t = a_t + \cdot 5 (a_{t-1} + \ldots + a_1)$ for $t \geq 1$.

(i) Investigate if $\{ Z_t \}$ is stationary.

(ii) Investigate if $(1 - B) Z_t$ is stationary.

5. (a) Show that for the stationary process $Z_t - \phi Z_{t-1} = a_t - \cdot 5\, a_{t-1}$.

(i) $\gamma_0 = \left(\dfrac{1.25 - \phi}{1 - \phi^2} \right) \sigma_a^2$

(ii) $\gamma_1 = \left[\dfrac{\phi(1 \cdot 25 - \cdot 5\phi) - \cdot 5}{1 - \phi^2} \right] \sigma_a^2$

(b) Assume the process of part (a) was fitted into an observed time series for which $\hat{\sigma}_z^2 = 10$ *and* $\hat{\rho}_1 = 0 \cdot 5$. Find initial estimates for ϕ *and* σ_a^2.

(c) Consider the process $(1 - 1.2\,B + \cdot 6\,B^2)(X_t - 30) = a_t$ where $\sigma_a^2 = 1$. Suppose we have the observations $X_{28} = 34.7$, $X_{29} = 32.8$, $X_{30} = 27.1$.

(i) Forecast X_{31} and X_{32} at $t = 30$.

(ii) Find the 95% forecast limits for the forecasts in (i).

(iii) Suppose observation at $t = 31$ turns out to be $X_{31} = 31.3$. Update the forecast for X_{32}.
You may use the following updating equation:

$$\hat{Z}_{n+1}(l) = \hat{Z}_n(l+1) + \psi_l [Z_{n+1} - \hat{Z}_n(1)]$$

6. (a) The stationary process $Z_t = a_t + \theta a_{t-1}$ was fitted to a time series which has the following sample statistics

$\hat{\gamma}_0 = 4$, $\hat{\rho}_1 = 0 \cdot 25$

Estimate θ and σ_a^2 to 2 places of decimal.

(b) Let $\hat{Z}_n$ represent one step ahead forecast of Z_{n+1} made at time n for the process of part (a). Show that $\hat{Z}_n = \hat{\theta} Z_n - \hat{\theta}^2 Z_{n-1} + \ldots (-\hat{\theta})^n Z_1$.

(c) The following data was observed on the time series of part (a).

T	94	93	92	91	90
Z_t	1.1	2.1	$-\cdot 5$	2.6	-1

Estimate $\hat{Z}_{94}$.

END OF EXAMINATION.

THE UNIVERSITY OF ZAMBIA

School of Natural Sciences
PHYSICS DEPARTMENT
University Examinations 2008/9

P198: *Introductory Physics-II*

(OPTION B)

Instructions: In addition to **Q_1** which is compulsory and for which you use the answer sheet provided, answer **four (4)** more questions. They are of equal marks. All necessary calculations must be clearly shown. Clearly indicate on the answer script cover page which questions you have attempted.

Time: 3 hours **Maximum marks: 100**

Do not forget to write your computer number, clearly on the answer book.

Formulas, data you might find useful:

$$\Delta Q = mc\Delta T\ ;\ \Delta Q = mL_f\ ; \Delta Q = mL_v\ ;\ \frac{\Delta Q}{\Delta t} = \frac{kA\Delta T}{\Delta x}\ ;\ \Delta L = \alpha L_o \Delta T\ ;\ PV = nRT$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}\ ;\quad PV^{\gamma} = \text{ constant},\quad \Delta Q = \Delta U + P\Delta V\ .\quad \Delta S = \frac{\Delta Q}{T}\quad ;\quad e = 1 - \frac{Q_L}{Q_H}\ ;$$

$$e = 1 - \frac{T_L}{T_H}\ ;\ E = \varepsilon\sigma T^4\ ;\ COP = \frac{Q_L}{Q_H - Q_L} = \frac{T_L}{T_H - T_L}\ ;\ \Delta W = P\Delta V\ ;\ c_v/R(N_2) = 3.48;$$

$$C_v = \frac{3}{2}R\ \text{(mono)} = \frac{5}{2}R\,\text{(diatomic)};\ c_p = \frac{5}{2}R\,\text{(mono)} = \frac{7}{2}R\,\text{(diatomic)}$$

$$\Delta W = nRT\ln\left(\frac{V_f}{Vi}\right);\ P_1V_1^{\gamma} = P_2V_2^{\gamma};\ K.E_{av.} = \frac{3}{2}kT\ ;\ \Delta Q = nC\Delta T$$

$$V = V_o(1 + \gamma\Delta T)\ ;\ F = kx.\ P_A = 1\times10^5 \text{Nm}^{-2}.\ T = 4\pi^2\frac{l}{g}\ ;\ \omega = 2\pi f\ ;\ a = -\omega^2 x\ ;\ F = kx;$$

$$\omega = \sqrt{\frac{k}{m}}\ ;\ k = \frac{2\pi}{\lambda}\ ; v = \omega\sqrt{(x_o^2 - x^2)}\ ;\ P_a + \frac{1}{2}\rho v^2 + \rho g h_1 = P_b + \frac{1}{2}\rho v_2^2 + \rho g h_2\ ;$$

$A_1v_1 = A_2v_2$; $F_D = 6\pi\eta r v_t$; $\gamma = 3\alpha$; $E = k\frac{Q}{r^2}$; $V = \frac{kQ}{r}$; $E = -\frac{\Delta V}{\Delta x}$; $Q = CV$

$E = \frac{1}{2}QV$; $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + ... + \frac{1}{C}$; $C_{eq} = C_1 + C_2 + C_3 + ... + C_n$

$\sum I = 0.$; $\sum V = 0$; $e = -\frac{\Delta\phi}{\Delta t}$; $P = IV$; $F = qE$; $C = \frac{\varepsilon_o A}{d}$

$F = BIL$; $F = qvB\sin\theta$; $E = \frac{1}{2}qV$; $P = IV = I^2R$; $F = qvB$; $F_c = \frac{mv^2}{r}$; $v = \omega r$

$\frac{f}{f'} = \left[1 - \left(\frac{v_1}{v_w}\right)\right] / \left[1 - \left(\frac{v_s}{v_w}\right)\right]$; $I(\text{dB}) = 10\log_{10}(I/I_o)$;

$R_{eq} = \sum R_i$; $\frac{1}{R_{eq}} = \sum \frac{1}{R_i}$;

1 rev = $360^\circ = 2\pi$ rads

Volume of sphere $V = \frac{4}{3}\pi r^3$

Area of sphere = $4\pi\pi^2$

Electronic charge, $e = 1.6\times10^{-19}$

$P_A = 1.01\times10^5$ Pa

$\rho_w = 1000$ kgm^{-3}

1 calorie = 4.18 J

Specific latent heat of fusion for ice, $L_f = 335 \times 10^3$ J/kg

Specific latent heat of vaporization for steam, $L_v = 2.26 \times 10^6$ J/kg

Specific heat capacity of water, $c_w = 4.2 \times 10^3$J kg^{-1} K^{-1}.

Wherever necessary use :

$g = 9.8 m/s^2$ 1 metric ton = 1000 kg

$P_A = 1.01 \times 10^5 N/m^2$

1 cal. = 4.18 J

$\varepsilon_0 = 8.85 \times 10^{-12} C^2/Nm^2$

$c = 3 \times 10^8$ m/s

$h = 6.63 \times 10^{-34}$ J-s

1 pascal =1 N/m^2

1eV = 1.6×10^{-19} J

$e = 1.6 \times 10^{-19}$ C

$m_e = 9.11 \times 10^{-31}$ kg

$k = 9 \times 10^9 Nm^2/C^2$

$\mu_0 = 4\pi \times 10^{-7} N/A^2$

$\rho_{water} = 1000 kg/m^3$

$G = 6.67 \times 10^{-11} Nm^2/kg^2$

Efficiency of a Carnot engine, $e = 1 - T_2/T_1 = \frac{work\ done}{input\ heat\ at\ high\ temperature}$

Q1: (A) In simple harmonic motion, it is found that the total energy of a system

(a) is independent of the amplitude;
(b) is inversely proportional to the amplitude;
(c) depends on the square of the amplitude
(d) is independent of the mass of the oscillating object.

(B) When there are no frictional effects in simple harmonic motion, the total mechanical energy of a system

(a) changes with time;
(b) varies with displacement;
(c) slowly dissipates itself as heat;
(d) is constant.

(C) For frequencies up to a few thousand cycles per second, the compressions and rarefactions of longitudinal waves in a fluid are

(a) adiabatic
(b) isothermal;
(c) stationary;
(d) transverse.

(D) Computing the Carnot efficiency by idealizing a real engine gives

(a) the real efficiency;
(b) a possible value for the efficiency;
(c) an upper limit to the efficiency
(d) the lower limit to the efficiency

(E) A Dewar flask in which liquid nitrogen is stored is silvered on the outside so that

(a) the container will be readily identifiable;
(b) absorption of radiant heat is minimized
(c) the volatile contents will be shielded from electric fields
(d) heat will not be conducted over the surface of the flask.

(F) A steel wheel bearing is 1 mm smaller in diameter than an axle. The bearing can be made to fit the axle without removing any material by

(a) warming the axle sufficiently till the bearing fits
(b) cooling the bearing sufficiently till it fits
(c) cooling both parts till the bearing fits
(d) warming the bearing sufficiently till it fits

(G) Capacitors of different capacitances connected in parallel have

(a) The same electric field intensities between their plates;
(b) The same charge;
(c) A resultant capacitance that is less than the sum of the individual capacitors;
(d) The same voltage between their plates.

(H) The heat generated per coulomb of charge when a 2A current passes through a $10\,\Omega$ resistor is

(a) 20 joules/coulomb
(b) 20 watts
(c) 5 joules/coulomb
(d) 40 watts

(I) Kirchhoff's rules in electric circuit network analysis are derived from

(a) the work-energy theorem
(b) the conservation of momentum
(c) the conservation of energy
(d) the conservation of energy and electric charge laws

(J) When a moving charged particle enters a uniform magnetic field in a direction parallel to the field lines, the particle experiences

(a) A change in direction
(b) A change in the velocity magnitude
(c) No change in its motion
(d) Changes in its energy

Q2: (a) Define simple harmonic motion (S.H.M) [2]

(b) A body of mass 200 gram is executing simple harmonic motion with an amplitude of 20 mm. The maximum force which acts on the mass is 0.064N. Calculate

(i) its maximum velocity [6]
(ii) its period of oscillation [3]

(c) The equation $y = a\sin(\omega t - kx)$ represents a plane wave travelling along the x-axis, y being the displacement at the point x at time t. Given that $a = 1.0\times10^{-7}$m, $\omega = 6.6\times10^{3}$ s^{-1} and $k = 20$m^{-1}, Find

(i) the direction of the wave and state how you arrive at your answer; [2]

(ii) the speed of the wave; [5]

(iii) the maximum speed of a particle of the medium due to the wave. [2]

Q3: (a) Define specific *latent heat of fusion* for a material and the *specific heat capacity of a material.* [4]

(b) The graph, figure 1, refers to an experiment in which an initially solid specimen of nitrogen absorbs heat at a constant rate. Nitrogen melts at 63K, and the specific heat capacity of solid nitrogen is 1.6×10^{3} JKg^{-1}K^{-1}. Calculate

(i) the specific latent heat, L_f of fusion of nitrogen [5]

(ii) the specific heat capacity of the nitrogen in its liquid form. [3]

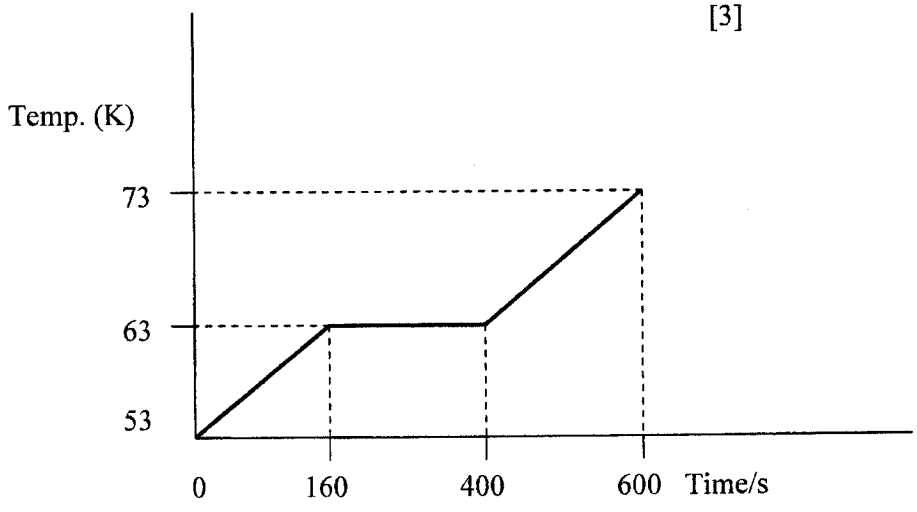

Figure 1

(c) A gas undergoes a cyclic process *ABCDA*, figure 2. Table 1 shows the increase in internal energy, ΔU, which takes place during each of the changes A to B, B to C and C to D. It also shows that in both of sections A to B and C to D, no heat is supplied to the gas.

Table 1

	Increase in internal energy/J	Heat supplied to gas /J	Work done on gas/J
A to B	1200	0	
B to C	-1350		
C to D	-600	0	
D to A			

Using the first law of thermodynamics and any necessary data from the graph, complete the table. You will find it helpful to proceed in the following order: [8]

(i) work done on gas from A to B and C to D

(ii) work done on gas for B to C and D to A

(iii) Heat supplied to gas for B to C and D to A

(iv) Increase in internal energy for D to A.

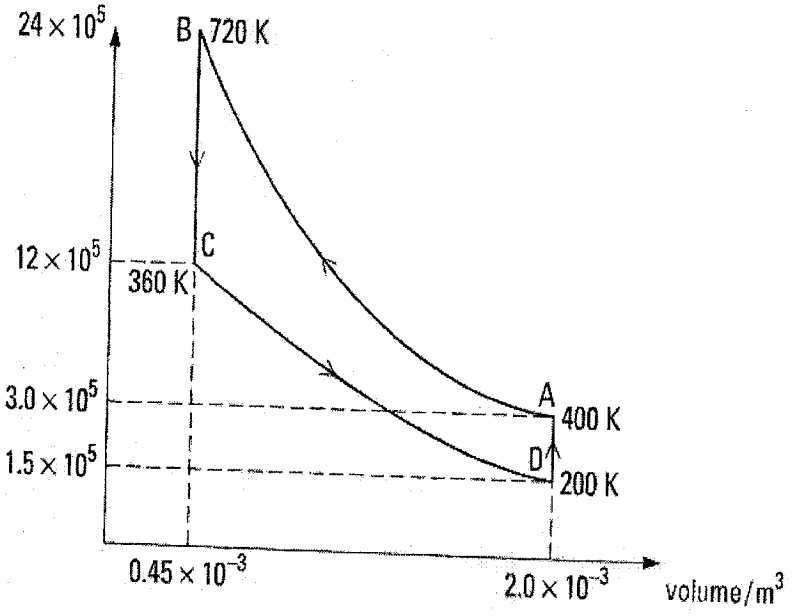

Figure 2

Q4: (a) Air is streaming past a horizontal airplane wing 10m long and 2m in width, such that its speed is $120ms^{-1}$ over the upper surface and $90ms^{-1}$ at the lower surface. If the density of air is 1.3 kgm^{-3}, find

(i) the difference in pressure between the top and the bottom of the wing. [4]

(ii) find the gross lift on the wing and its mass equivalence. [3]

(b) A large tank contains water to a depth of 1m. Water emerges from a small hole positioned at a height h from the bottom of the tank in the side of the tank, figure 3. Using Bernoulli's principle and necessary approximations, show that the velocity v at which water emerges from the hole is given by

$$v = \sqrt{2g(1-h)} \qquad [7]$$

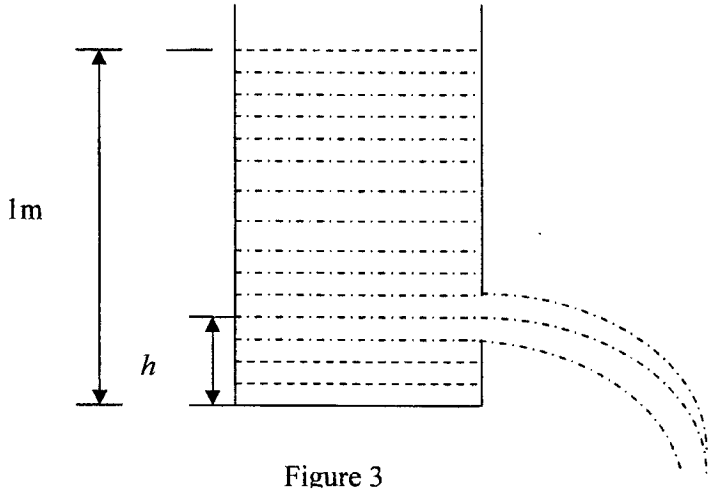

Figure 3

(c) When a small spherical object falls through a fluid of viscosity η, its speed v increases but the motion is impeded by the force of air resistance F_r. Show that the object eventually reaches a constant velocity called **terminal velocity**, v_t, given by

$$v_t = \frac{2r^2}{9\eta}(\rho_s - \rho_f)$$

where r is the radius of the sphere, while ρ_s and ρ_f are the densities of the sphere and fluid respectively. [6]

Q5: (a) A hollow aluminium cylinder is to be fitted over a steel piston. At 20°C the inside diameter of the cylinder is 0.99% of the outside diameter of the piston. To what common temperature should the two pieces be heated in order that the cylinder just fits the piston? $\alpha_{steel} = 11 \times 10^{-6}\ ^{o}C^{-1}$ and $\alpha_{aluminium} = 24 \times 10^{-6}\ ^{o}C^{-1}$.

[8]

(b) (i) In engineering tables of thermal expansivities, values for γ (the average coefficient of cubical expansion) are usually not given. State a reason for this omission. [3]

(ii) Starting with a regular cube, figure 4, of side l_o, show that the coefficient of linear expansion α and the coefficient of volume expansion γ are related by $\gamma = 3\alpha$ Clearly state all the necessary approximations. [9]

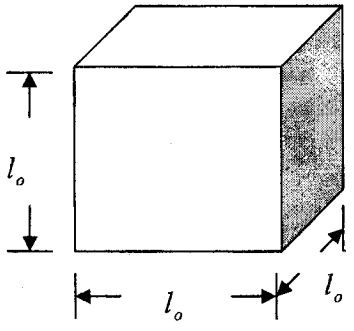

Figure 4

Q6: (a) If in a certain region the net electric field is zero, can we confidently say the electric potential in the same region is zero? Explain. [2]

(b) (i) Three point charges, Q_o = -5μC, Q_1 = + 3μC and Q_2 = +4μC are positioned as shown, figure 5. Calculate the **magnitude** and **direction** of the resultant electric field E_R at point P located 3 m directly above Q_1.

[9]

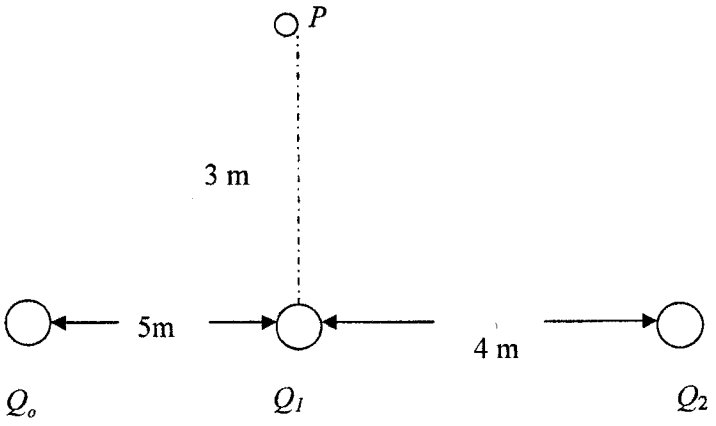

Figure 5

(ii) Calculate the electric potential at P in figure 5 [4]

(c) Figure 6 is a plot of the variation of an electric potential V with distance x in a certain region of space. From this plot derive a plot of the variation of the electric field with distance, $E(x)$. [5]

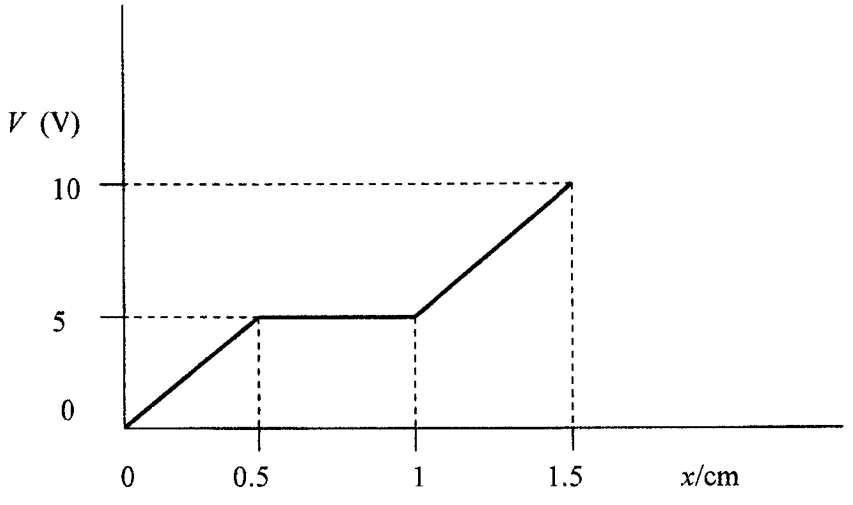

Figure 6

Q7: (a) A constant electric field $E(x)$ is parallel to the x axis. In what direction can a charge (negative or positive) be displaced in this field without any external work being done on the charge? Support your answer with a brief explanation. [3]

(b) A 200μF capacitor is charged by connecting it to a 40V battery. The battery is then removed without discharging the capacitor. Later, a 50μF uncharged capacitor is connected in parallel with the 200μF capacitor. Find the [10]

(i) initial charge Q_o stored on the 200μF capacitor when connected to the 40V battery;

(ii) potential difference V between the plates of the 200μF capacitor when connected to the 50μF capacitor;

(iii) charge Q that has been transferred from the 200μF capacitor to the 50μF capacitor in the process.

(c) (i) Explain why the *potential difference* between the terminals of a battery is not always the same as its emf. [3]

(ii) A bulb is used in a torch which is powered by two identical cells in series, each of emf 1.5V. The bulb then dissipates power at the rate of 625 mW and the potential difference across the bulb is 2.5V. Calculate the internal resistance r of each cell [4]

Q8: (a) A thin copper rod 1 m long and mass 50g carries a current through it such that the rod just floats in a magnetic field of 2T. Calculate the value of this current. [3]

(b) (i) State Kirchhoff's two laws for electric circuit analysis. [2]

In figure 7, $R_1 = 2\Omega$, $R_2 = 6\Omega$, and $R_3 = 4\Omega$. The two batteries have voltages of 24V and 27V each. Use Kirchhoff's rules to calculate the

values of I_1, I_2 and I_3 and state the meaning of any negative currents that may result from your analysis. [6]

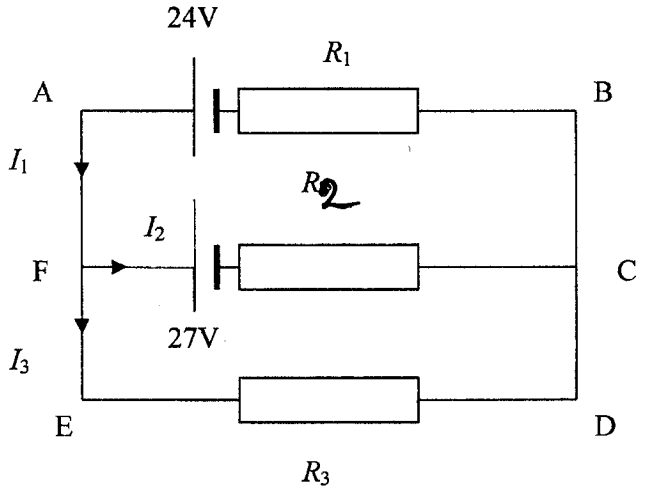

Figure 7

(c) A singly charged (short of an electron) positive ion has a mass equal to 2.5×10^{-26}kg. After being accelerated through a potential difference of 250V, the ion enters a magnetic field of 0.5T along a direction perpendicular to the field. Calculate

(i) the radius of the path of the ion in the magnetic field; [6]

(ii) the frequency of rotation of the ion in Hz [3]

END OF EXAM

UNIVERSITY OF ZAMBIA

DEPARTMENT OF PHYSICS

2009 SECOND SEMESTER UNIVERSITY EXAMINATIONS

P332

STATISTICAL PHYSICS

DURATION: Three hours.

INSTRUCTIONS: Answer any four questions from the six given. *Each question carries 25 marks with the division of marks within each question indicated by the numbers in parenthesis next to the question.*

MAXIMUM MARKS: 100

DATE: WEDNESDAY 15th April 2009.

Formulae that may be needed:

1.
$$\ln n! = n \ln n - n$$

2.
$$f(a+h) = f(a) + \frac{h}{1!}f'(a) + \frac{h^2}{2!}f''(a) + \ldots + \frac{h^n}{n!}f^{(n)}(a) + \ldots$$

3. Definition of generalized force
$$\chi_\alpha = \frac{\partial E}{\partial x_\alpha}$$

4. Mean work $\overline{dW}$
$$\overline{dW} = \sum_{\alpha=1}^{n} \overline{\chi_\alpha} dx_\alpha$$

5.
$$\frac{1}{1-x} = 1 + mx + \frac{m(m+1)}{2!}x^2 + \frac{m(m+1)(m+2)}{3!}x^3 + \ldots$$

QUESTION 1

(a) In the problem of the random walk, with each step of equal length, the probability $P(m)$ of a particle being m steps from the origin after N steps is given by

$$P_N(m) = \frac{N!}{(N-n_1)!n_1!}p^{n_1}q^{(N-n_1)}$$

The symbols have there usual meaning which you must give. Prove the above formula from first principles. (20 marks)

(b) For $N = 3$ in the random walk problem with equal step length, draw a table to show the possible values of n_1, n_2, m and the number of ways the same value of n_1, n_2 and m can occur. Show the latter diagrammatically with arrows. Use the table or otherwise to give the probabilities for all the possible values of m.

(5 marks)

QUESTION 2

(i) Describe in detail, including mathematical steps, the thermal interaction of two systems A and A' with a view to deriving the condition for $P(E)$ to be a maximum and give the three forms of this condition. (20 marks)

(ii) What can you say about the state A and A' when $P(E)$ is a maximum?

(2 marks)

(iii) From the derivation above identify and state the three equivalent conditions for equilibrium.

(3 marks)

QUESTION 3

(a) Use the relations

$$\beta = \frac{\partial \ln \Omega}{\partial E}, \quad \overline{X}_\alpha = \frac{1}{\beta}\frac{\partial \ln \Omega}{\partial x_\alpha}, \quad \Omega = CV^N\chi(E)$$

to answer the following questions:

(i) Give the expression for pressure when only one external parameter, the volume V, describes the system. (3 marks)

(ii) Use your result and the above equations to derive the equation of state for an ideal gas.

(4 marks)

(iii) Show that the energy of an ideal gas depends only on temperature, but not on volume.

(3 marks)

(b) Derive the expression for a canonical distribution by considering a system in contact with a heat reservoir. (15 marks)

QUESTION 4

(a) Consider an isolated system consisting of a large number N of a very weakly interacting localized particle of spin $\frac{1}{2}$. Each particle has a magnetic moment μ which can point either parallel or antiparallel to an applied field H. The energy E of the system is then $E = -(n_1 - n_2)\mu H$, where n_1 is the number of spins aligned antiparallel to H.

(i) Consider the energy range between E and $E + \delta E$ where δ is very small compared to E but is macroscopically large so that $\delta E >> \mu H$. What is the total number of states $\Omega(E)$ lying in this energy range? (7 marks)

(ii) Write down an expression for $\ln \Omega(E)$ as a function of E. Simplify this expression by applying Stirling's formula in simplest form. (9 marks)

(b) Consider a system of 5 spin-$\frac{1}{2}$ particles in equilibrium in a magnetic field H. The total energy is measured to be $-\mu H$.

(i) Calculate the probability for an electron to have spin parallel to H.

(3 marks)

(ii) Calculate the probability for an electron to have spin antiparallel to H.

(3 marks)

(iii) Calculate the mean value of the magnetic moment μ. (3 marks)

QUESTION 5

(a) A box is separated by a partition which divides its volume in the ratio 3:1. The larger portion of the box contains 1000 molecules of Ne gas; the smaller, 100 molecules of He gas. A small hole in the partition, and one waits until equilibrium is attained.

(i) Find the mean number of molecules of each type on either side of the partition. (4 marks)

(ii) What is the probability of finding 1000 molecules of Ne gas in the larger portion and 100 molecules of He gas in the smaller (i.e. the same distribution as in the initial system)? (4 marks)

(b) Using the canonical ensemble

$$P_r = \frac{\exp(-\beta E_r)}{\sum_r \exp(-\beta E_r)}$$

derive expressions in terms of the *Zustandsumme* for

(i) the mean energy $\overline{E}$, (4 marks)

(ii) the dispersion $\overline{(\Delta E)^2}$, (6 marks)

(iii) the work done dW by a quasi-static system characterized by a single external parameter. (5 marks)

(vi) the generalized force χ for the system of part (iii). (2 marks)

QUESTION 6

For a gas of identical particles in a volume V in equilibrium at temperature T the partition function is

$$Z = \sum_R \exp(-\beta E) = \sum_R \exp[-\beta(n_1\epsilon_1 + n_2\epsilon_2 + \ldots)]$$

(a) The mean $\overline{n}_s$ of the number of particles in state s is

$$\overline{n}_s = \frac{\sum_R n_s \exp[-\beta(n_1\epsilon_1 + n_2\epsilon_2 + \ldots)]}{\sum_R \exp[-\beta(n_1\epsilon_1 + n_2\epsilon_2 + \ldots)]}$$

Express this in terms of Z. (5 marks)

(b) Put your result for $\overline{n}_s$ from part (a) in the form of a product of sums. (3 marks)

(c) Derive $\overline{n}_s$ for the Fermi-Dirac case. (17 marks)

END

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008/2009 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATIONS

P342 : Digital Electronics I

Time : Three hours. **Maximum marks = 100**

Attempt any four questions.
All questions carry equal marks.
The marks are shown in brackets.

Q1. (a) (i) Draw a logic circuit using basic logic gates for the expression. [3]

$$Y = A.B.C + \overline{A}.\overline{B}.\overline{C} + B$$

(ii) Simplify the expression and draw the logic circuit for the simplified expression. [6]

(b) What is meant by triggering of flip flops? Discuss different types of triggering with figures. [10]

(c) The following network of diodes and a resistor is capable of performing a logic function by applying a combination of LOW and HIGH signals to the inputs indicated.

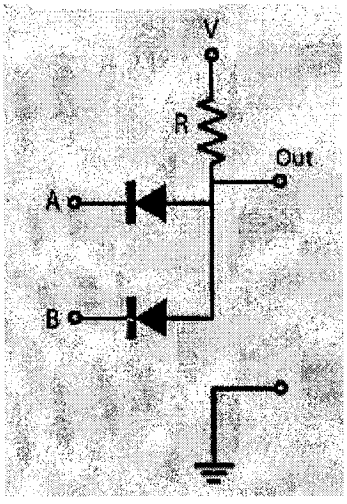

Figure 1

(i) Explain what happens if any of the two inputs A and B is connected to LOW. [2]

(ii) Under what conditions would this network give a HIGH at its output? Explain. [2]

(iii) What logic function does this circuit accomplish? Draw the truth table. [2]

Q2. (a) Simplify using De Morgan's theorem

$$\overline{\left(A + \overline{\overline{B}\,\overline{C}} + CD\right)} + \left(\overline{\overline{BC}}\right)$$ [5]

(b) Describe with suitable sketches asynchronous ripple counter of mod-12. Draw the waveforms. [17]

(c) Convert the octal number $(536.57)_8$ to its equivalent hexadecimal number. [3]

Q3. **(a)** Explain why a clock signal is important in the design of sequential systems. [5]

(b) Describe the working of clocked D flip flop with necessary diagrams and explain how an SR flip flop can be converted to a D flip flop. [5+7]

(c) Implement the following multi output combinational logic circuit using a 4-to-16 line decoder. [8]

$F_1 = \sum m\,(1,2,4,7,8,11,12,13)$
$F_2 = \sum m\,(2,3,9,11)$
$F_3 = \sum m\,(10,12,13,14)$
$F_4 = \sum m\,(2,4,8)$

Q4. **(a)** What is a full adder? Draw the circuit diagram of a full adder with truth table illustrating the expressions for sum and carry. [15]

(b) Draw the circuit diagram of a basic TTL NAND gate. [6]

(c) (i) Add $(AECF1)_{16}$ and $(15ACD)_{16}$. [2]

(ii) Subtract $(3A7)_{16}$ from $(1274)_{16}$. [2]

Q5. **(a)**Explain the operation of a 4-bit serial-in-parallel-out shift register with diagram. [7]

(b) Construct a monostable multivibrator using transistors and explain how it works. [8]

(c) **(i)** Write the following expression in canonical form. [8]

$$\left(A + B + \overline{C}\right)\left(A + D\right)$$

(ii) Convert $(1011100.1000101)_2$ to its equivalent hexadecimal number. [2]

Q6. (a) (i) Draw diagrams and explain the operation of a binary weighted digital to analog converter. [7]

(ii) If the input binary data is 0110, what is the corresponding analog output voltage?[2]

(b) Discuss the function of a CPU. Draw the diagram showing the connection different buses to CPU and explain the function of each bus. [7]

(c) Write short notes on [9]

(i) Word length

(ii) Priority Encoder

(iii) RAM and ROM

END OF P342 EXAMINATION

The University of Zambia
Physics Department
University Examinations 2007/2008
Second Semester
P-412 : Nuclear Physics

All questions carry equal marks. The marks are shown in brackets. Attempt <u>any four</u> questions. Clearly indicate on the answer script cover page which questions you have attempted.

Time : Three hours. **Maximum marks = 100.**

Do not forget to write your computer number clearly on the answer book.

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Wherever necessary use :

$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/Nm^2	$m_{hydrogen\ atom}$ = 1.007825 a.m.u.
m_n = 1.008665 a.m.u. = 939.551 MeV	m_{alpha} = 4.002603 a.m.u.
1 a.m.u. = 931.5 MeV = 1.6604×10^{-27} kg	$m_p = 1.67 \times 10^{-27}$ kg = 938.28 MeV
$c = 3 \times 10^8$ m/s	$m_e = 9.11 \times 10^{-31}$ kg = 0.511 MeV
$h = 6.63 \times 10^{-34}$ J-s	$e = 1.6 \times 10^{-19}$ C
$\hbar = 6.58 \times 10^{-22}$ MeV-s $= 1.05 \times 10^{-34}$ J-s	*1*eV = 1.6×10^{-19} J
1 fermi = 10^{-15} m	1 barn = 10^{-28} m^2
Avogadro's constant = 6 x 10^{23} per mole	Velocity of light = 3 x 10^8 m.sec^{-1}.
$\frac{e^2}{4\pi\varepsilon_0}$ = 1.44 MeV-fermi	$\hbar c$ = 197.33 MeV-fermi $m = \frac{m_0 c^2}{c^2} \equiv \frac{MeV}{c^2}$

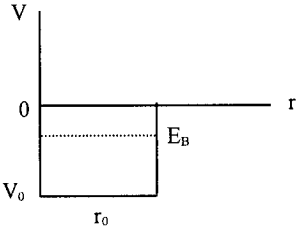
$(1s_{½})^2$, $(1p_{3/2})^4$,$(1p_{½})^2$,$(1d_{5/2})^6$, $(2s_{½})^2$, $(1d_{3/2})^4$, $(1f_{7/2})^8$, $(2p_{3/2})^4$, $(1f_{5/2})^6$, $(2p_{½})^2$, $(1g_{9/2})^{10}$, [50]. $E = \frac{\hbar^2}{2\Im}\left[J(J+1) - BJ^2(J+1)^2\right]$. $\Delta E_C = \frac{3}{5}\frac{e^2}{R}\left[Z^2 - (Z+1)^2\right]$

Q1. The electrostatic energy of a charge q uniformly distributed throughout a sphere of radius R is $U = \frac{3}{5}\frac{e^2}{R}\frac{1}{4\pi\varepsilon_0}$, [$W_{Coul.} = \frac{3}{5}\frac{q^2}{R}$].

(i) Using this in the case of positron beta decay, derive an expression for the decrease in Coulomb energy. [8]

(ii) Hence calculate the predicted value of the maximum kinetic energy of the positrons emitted by $^{23}_{12}Mg \rightarrow ^{23}_{11}Na + \beta^+$ using the constant-density nuclear model, $R = r_0 A^{1/3}$ where $r_0 = 1.45 \times 10^{13} cm$. Assume the nuclear binding energy to be the same in both the nuclei. [12+5]

Q 2. A neutron is bound in the lowest possible state *(l = 0)* to a heavy nucleus. The binding energy is E_B = 25 MeV (E = -25 MeV). The potential acting on the neutron is V_0 = 50 MeV; the radius r_0 of the well is not known :



i) solve the radial wave equation for $l = 0$ inside and outside the well, and sketch the wave function u [8]

ii) apply boundary conditions at $r = r_0$ to obtain an equation between the pertinent wave numbers and r_0 [8]

iii) find the numerical values of the wave numbers and solve the equation mentioned under (ii) for r_0. [9]

(For the reduced mass use m = *1 a.m.u.).*

Q 3. The semi-empirical mass formula for the mass of a neutral atom is

$$M(A,Z) = ZM_p + (A-Z)M_N - c_V A + c_A A^{2/3} + c_c \frac{Z(Z-1)}{A^{1/3}} + c_s \frac{(A-2Z)^2}{A} \pm \delta,$$

where M_H and M_N are the masses of the hydrogen atom and the neutron respectively in atomic mass units.

(i) Show that it can be written for a given A as $M(Z,A) = \alpha A + \beta Z + \gamma Z^2 \pm \delta$ where α, β, and γ are appropriately defined constants and δ is the pairing energy contribution. [4]

(ii) Hence show that the reaction energy Q for $\beta^- - \text{decay}$ and $\beta^+ - \text{decay}$ Z => $(Z+1)$ and Z => $(Z-1)$ at constant even A becomes $Q = 2\gamma\,(+(\,Z_{min} - Z) - (½)\,) \pm 2\delta$ and $Q = 2\gamma\,(-(\,Z_{min} - Z) - (½)\,) \pm 2\delta$ where Z_{min} is the charge of the most stable isobar. [16]

(iii) Use the expression $Z_{min} = \frac{\beta}{2\gamma} = \frac{4a_4 + M_n - M_p}{2\left[\frac{a_3}{A^{1/3}} + \frac{4a_4}{A}\right]}$ to establish whether $^{142}_{54}Xe$ is β^- unstable or β^+ unstable. [5]

Given, a_1 = 14.1 MeV a_2 = 13MeV a_3 = 0.595 MeV a_4 = 19 MeV , and a_5 = 33.5 MeV.

Q4. (a) How does the inclusion of a strong spin-orbit coupling in the single-particle shell model of the nucleus lead to the splitting of a state of given l? Show that the splitting is proportional to $(2l + 1)$. [12]

(b) The ground state spins and parities of the following nuclei are given in brackets. Compare these values with the predictions of the single-particle shell model of the nucleus. $^{11}_{5}B(\frac{3^-}{2})$, $^{16}_{7}N(2^-)$, and $^{25}_{13}Al(\frac{5^+}{2})$. [6]

(c) The ground state of $^{39}_{20}Ca$ has spin-parity value of $\frac{3^+}{2}$. The next higher states have $\frac{1^+}{2}$, $\frac{7^-}{2}$ and $\frac{3^-}{2}$. Interpret these values on the basis of the single-particle shell-model. [7]

Q5(a) (i) Explain in short the terms "allowed" and "forbidden" beta transitions and "degree of forbiddenness". [9]

(ii) Distinguish between the Fermi and the Gamow-Teller selection rules in beta decay of nuclei. [6]

On the basis of these selection rules, deduce :

(i) the degree of forbiddenness, and
(ii) the type (Fermi, G-T, or mixed) of the following J^π beta transitions :

$0^+ \rightarrow 1^+$ $\frac{5}{2}^+ \rightarrow \frac{7}{2}^-$ $\frac{1}{2}^+ \rightarrow \frac{1}{2}^+$ $0^+ \rightarrow 0^+$ [6]

(b) What do you understand by "super-allowed" transitions? Under what circumstances is such a transition most probable? [4]

Q6. (a) Show that an alpha particle with total energy E_o incident on a potential barrier of energy V $(V>E_o)$ and of thickness b has a quantum probability of penetrating it. [9]

(b) $^{108}_{47}Ag$ has a spin and parity 1^+. It is beta-unstable with a mean life-time of 3.4 minutes. It has an excited state at 109 keV excitation energy, spin and parity 6^+, which is an isomeric state with a mean life of 180 years. Explain how an excited state of a nucleus can be more stable than the ground state. Draw the energy level diagram. [4]

(c) A fictitious nuclide has a $J = ½^+$ ground state and approximately evenly spaced excited states with $J = 9/2^+, 3/2^-, ½^+, 5/2^+, 7/2^-$ in order of ascending energy.

(i) Draw an energy level diagram for this nuclide [3]

(ii) Indicate on this diagram the most likely gamma transition (down) from each level (five lines in all). Write beside the lines their multipolarity (E_1, M_2 etc). [5]

(d) Explain the origin of electric and magnetic multipole transitions in gamma decay of a nucleus. [4]

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THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2008/2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

P442: DIGITAL ELECTRONICS II

Time: Three Hours **Maximum Marks = 100**

Attempt any four questions.
All questions carry equal marks.
The marks are shown in brackets.

8085 / 8080A Instruction summary by Functional Groups

DATA TRANSFER (COPY)

Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic
40	MOV B,B	58	MOV E,B	70	MOV M,B	1A	LDAX D
41	MOV B,C	59	MOV E,C	71	MOV M,C	2A	LHLD
42	MOV B,D	5A	MOV E,D	72	MOV M,D	3A	LDA
43	MOV B,E	5B	MOV E,E	73	MOV M,E	2	STAX B
44	MOV B,H	5C	MOV E,H	74	MOV M,H	12	STAX D
45	MOV B,L	5D	MOV E,L	75	MOV M,L	22	SHLD
46	MOV B,M	5E	MOV E,M	77	MOV M,A	32	STA
47	MOV B,A	5F	MOV E,A	78	MOV A,B	01	LXI B
48	MOV C,B	60	MOV H,B	79	MOV A,C	11	LXI D
49	MOV C,C	61	MOV H,C	7A	MOV A,D	21	LXI H
4A	MOV C,D	62	MOV H,D	7B	MOV A,E	31	LXI SP
4B	MOV C,E	63	MOV H,E	7C	MOV A,H	F9	SPHL
4C	MOV C,H	64	MOV H,H	7D	MOV A,L	E3	XTHL
4D	MOV C,L	65	MOV H,L	7E	MOV A,M	EB	XCHG
4E	MOV C,M	66	MOV H,M	7F	MOV A,A	D3	OUT
4F	MOV C,A	67	MOV H,A	06	MVI B	DB	IN
50	MOV D,B	68	MOV L,B	0E	MVI C	C5	PUSH B
51	MOV D,C	69	MOV L,C	16	MVI D	D5	PUSH D
52	MOV D,D	6A	MOV L,D	1E	MVI E	E5	PUSH H
53	MOV D,E	6B	MOV L,E	26	MVI H	F5	PUSH PSW
54	MOV D,H	6C	MOV L,H	2E	MVI L	C1	POP B
55	MOV D,L	6D	MOV L,L	36	MVI M	D1	POP D
56	MOV D,M	6E	MOV L,M	3E	MVI A	E1	POP H
57	MOV D,A	6F	MOV L,A	0A	LDAX B	F1	POP PSW

ARITHMETIC

Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic
80	ADD B	CE	ACI	D6	SUI	23	INX H
81	ADD C	90	SUB B	DE	SBI	33	INX SP
82	ADD D	91	SUB C	09	DAD B	05	DCR B
83	ADD E	92	SUB D	19	DAD D	0D	DCRC
84	ADD H	93	SUB E	29	DAD H	15	DCR D
85	ADD L	94	SUB H	39	DAD SP	1D	DCR E
86	ADD M	95	SUB L	27	DAA	25	DCR H
87	ADD A	96	SUB M	04	INR B	2D	DCR L
88	ADC B	97	SUB A	0C	INR C	35	DCR M
89	ADC C	98	SBB B	14	INR D	3D	DCR A
8A	ADC D	99	SBB C	1C	INR E	0B	DCX B
8B	ADC E	9A	SBB D	24	INR H	1B	DCX D
8C	ADC H	9B	SBB E	2C	INR L	2B	DCX H
8D	ADC L	9C	SBB H	34	INR M	3B	DCX SP
8E	ADC M	9D	SBB L	3C	INR A		
8F	ADC A	9E	SBB M	03	INX B		
C6	ADI	9F	SBB A	13	INX D		

LOGICAL

Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic
37	STC	A9	XRA C	B3	ORA E	BD	CMP L
A0	ANA B	AA	XRA D	B4	ORA H	BE	CMP M
A1	ANA C	AB	XRA E	B5	ORA L	BF	CMP A
A2	ANA D	AC	XRA H	B6	ORA M	FE	CPI
A3	ANA E	AD	XRA L	B7	ORA A	07	RLC
A4	ANA H	AE	XRA M	F6	ORI	0F	RRC
A5	ANA L	AF	XRA A	B8	CMP B	17	RAL
A6	ANA M	EE	XRI	B9	CMP C	1F	RAR
A7	ANA A	B0	ORA B	BA	CMP D	2F	CMA
E6	ANI	B1	ORA C	BB	CMP E	3F	CMC
A8	XRA B	B2	ORA D	BC	CMP H		

BRANCHING

Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic
C3	JMP	D7	RST 2	EC	CPE
C2	JNZ	DF	RST 3	F4	CP
CA	JZ	E7	RST 4	FC	CM
D2	JNC	EF	RST 5	C9	RET
DA	JC	F7	RST 6	C0	RNZ
E2	JPO	FF	RST 7	C8	RZ
EA	JPE	CD	CALL	D0	RNC
F2	JP	C4	CNZ	D8	RC
FA	JM	CC	CZ	E0	RPO
E9	PCHL	D4	CNC	E8	RPE
C7	RST 0	DC	CC	F0	RP
CF	RST 1	E4	CPO	F8	RM

CONTROL

Hex	Mnemonic
00	NOP
76	HLT
F3	DI
FB	EI
20	RIM
30	SIM

Q1. (a) (i) Given the number A = 125_8, form the twos, eights, and tens complements of A in binary, octal, and tens notations, respectively. [4]

(ii) Convert the number 3244_5 to binary. [4]

(b) (i) Define a microprocessor and microcomputer respectively. [3]

(ii) Explain the functions of a data register and accumulator in a microprocessor. [5]

(c) (i) Explain the functions of a program counter and instruction decoder. [2]

(ii) With the help of an appropriate block diagram which includes arithmetic logic unit, data register and accumulator, explain how two non-negative numbers are added in a microprocessor. [7]

Q2. (a) Design an *AND – to – OR* gate combinational network for the Boolean algebra expression *F* given as

$$F = \overline{A}\overline{B}C\overline{D} + \overline{A}B\overline{C}D + \overline{A}BCD + ABCD + A\overline{B}C\overline{D}$$ [8]

(b) Draw a Karnaugh Map in four variables *A, B, C* and *D* for the expression *F* given as

$$F = C\overline{D} + A\overline{B}\overline{D}$$ [8]

(c) Draw a Karnaugh map in six variables *A, B, C, D, E* and *F*. [9]

Q3. (a) (i) Explain step-by-step procedure by which a computer executes a program. [10]

(ii) Explain the necessity for condition codes (flags) in a microprocessor. [5]

(b) (i) From which location will the next instruction be fetched if the BRA instruction is located at 30_{16} and the relative address is 4_{16}? [5]

30	*BRA*
31	*4*
32	–
33	–
34	–
35	–
36	–

(ii) What is the relative address if we want to jump to location *A7* and the *BRA* instruction is located at *B2*. [5]

A7
A8
A9
AA
AB
AC
AD
AE
AF
BO
B1
B2
B3
B4

Q4. **(a)** Draw a diagram of a typical microprocessor. The diagram should include all the necessary components of a microprocessor. Show all the interconnections between the components. Describe the functions of all the components. [11]

(b) (i) Write a program for multiplication of non-negative integers using the instruction subset shown below. [7]

(ii) Write a flow diagram of your program and translate your program into machine codes. [7]

		ADDRESSING MODE			
INSTRUCTION	**MNEMONIC**	**IMMEDIATE**	**DIRECT**	**RELATIVE**	**INHERENT**
Load Accumulator	*LDA*	*86*	*96*		
Clear Accumulator	*CLRA*				*4F*
Decrement Accumulator	*DCA*				*4A*
Increment Accumulator	*INCA*				*4C*
Store Accumulator	*STA*		*97*		
Add	*ADD*	*8B*	*9B*		
BRANCH Always	*BRA*			*20*	
Branch if carry set	*BCS*			*25*	
Branch if zero	*BEQ*			*27*	
Branch if Minus	*BMI*			*2B*	
HLT	*HLT*				*3E*

THE UNIVERSITY OF ZAMBIA
PHYSICS DEPARTMENT
UNIVERSITY EXAMINATIONS – SECOND SEMESTER 2008-09
P485 - PHYSICS OF RENEWABLE ENERGY RESOURCES AND ENVIRONMENT

TIME: 3 HOURS MAX MARKS: 100

ATTEMPT ANY **FOUR** (4) QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS. THE MARKS ARE SHOWN IN SQUARE BRACKETS.

You may use the following information:

Boltzmann constant k = 1.38×10^{-23} JK^{-1}
Gas constant R = 8314 J/kmol.K
1 electron volt = 1.6×10^{-19} J
Stefan's constant σ = 5.67×10^{-8} W/m^{2}K^4
Sun's radius R_s = 6.96×10^8m
Mean Earth-Sun distance r_0 = 1.496×10^{11}m
Solar constant I_{sc} = 1367 Wm^{-2}
Earth's radius R_e = 6.37×10^6m
Planck's constant h = 6.6×10^{-34}J.s
Speed of light c = 3×10^8m.s^{-1}

In the usual notation

$$E_0 = \left(\frac{r_0}{r}\right)^2 = 1 + 0.033 \cos\left(\frac{360\, d_n}{365}\right)$$

$$\delta = 23.45° \sin\left[\frac{360}{365}(d_n + 284)\right]$$

$$\cos\theta_z = \sin\delta \sin\phi + \cos\delta \cos\phi \cos\omega$$

$$\tan\psi = \frac{\cos\delta \sin\omega}{\cos\delta \sin\phi \cos\omega - \sin\delta \cos\phi}$$

$$\cos\theta = (\sin\varphi \cos\beta - \cos\varphi \sin\beta \cos\gamma) \sin\delta + (\cos\varphi \cos\beta + \sin\varphi \sin\beta \cos\gamma) \cos\delta \cos\omega + \cos\delta \sin\beta \sin\gamma \sin\omega$$

$$\omega = 15^{\circ}(12 - t); \quad \omega_s = \cos^{-1}(-\tan\phi \tan\delta)$$

Solar time = clock time + $4(L_l - L_s)$ min + EOT

Wien's Law: $\lambda_{max} T = 2898\ \mu m.K$

The emissive power of a black body $B_\lambda(T)$ (in W/m^2 per unit wavelength range) is

$$B_\lambda(T) = \frac{2\pi h c^2}{\lambda^5\left(e^{\frac{hc}{\lambda kT}} - 1\right)}$$

Direct flux on an inclined surface

$$F^{dir} = \cos\theta \exp\left(-\frac{\tau}{\cos\theta_z}\right) I_{sc}$$

Fresnel's equations

$$r_{\parallel} = \left[\frac{n_r^2\cos\theta_i - n_i\sqrt{n_r^2 - n_i^2\sin^2\theta_i}}{n_r^2\cos\theta_i + n_i\sqrt{n_r^2 - n_i^2\sin^2\theta_i}}\right]^2$$

$$r_{\perp} = \left[\frac{n_i\cos\theta_i - \sqrt{n_r^2 - n_i^2\sin^2\theta_i}}{n_i\cos\theta_i + \sqrt{n_r^2 - n_i^2\sin^2\theta_i}}\right]^2$$

Overall reflectance and transmittance of a single glazing are

$$R = r\left[1 + \frac{\alpha^2(1-r)^2}{1-\alpha^2 r^2}\right]$$

$$T = \frac{\alpha(1-r)^2}{1-\alpha^2 r^2}$$

Q5. (a) Determine the content of the accumulator after the following program has run.

```
MVI C, 7FH
MVI B, 3EH
MOV A,B
RLC
RLC
ANI 7FH
HLT
```

[7]

(b) Find the output of the program given below. The memory location 2475H contains 00H and the memory location 3794H contains 11H. With appropriate figures, show the contents of registers upon execution of each instruction. [14]

```
LXI   B,2475H
LXI   D,3794H
LDAX    B
MOV   L,A
LDAX    D
STAX  B
MOV   A,L
STAX  D
HLT
```

(c) Explain what is meant by stack? [4]

Q6. (a) Ten bytes of data are stored in memory locations starting at XX20H. Add all the data bytes. Use register B to save any carries generated, while adding the data bytes. Draw the flowchart and write the program to store the sum at two consecutive memory locations, XX70H and XX71H. [15]

(b) A microcomputer is designed to control the various appliances and lights in a house. [10]

Air conditioner, Heater, Radio, Light 1, Light 2, Light 3, Light 4, Light 5

Design the circuit and write a program to implement the following.

Keep the air conditioner on continuously without affecting the functions of other appliances, even if someone turns it off.

END OF P442 EXAMINATION

In a single current heat exchanger the exit temperature is

$$T_{f,e} = T_B - (T_B - T_{f,i}) \exp\left(-\frac{\overline{U}_L L}{\dot{m} C_f}\right),$$

and the heat extraction rate is

$$\dot{Q} = \dot{m} C_f (T_B - T_{f,i}) \left[1 - \exp\left(-\frac{\overline{U}_L L}{\dot{m} C_f}\right)\right].$$

The carrier concentration in an intrinsic semiconductor is

$$n_i = p_i = AT^{3/2} exp\left(-\frac{\varepsilon_g}{2kT}\right)$$

The resistivity of an extrinsic material is

$$\rho = \frac{1}{e(n\mu_n + p\mu_p)}$$

The reverse saturation current density is

$$J_0 = DT^3 exp\left(-\frac{\varepsilon_g}{kT}\right)$$

The forward current density is

$$J = J_0 (e^{\frac{eV}{kT}} - 1)$$

The J-V characteristic equation for a single cell is

$$J = \overline{K} F - J_0\left(e^{\frac{eV}{kT}} - 1\right)$$

Yearly variation of the equation of time

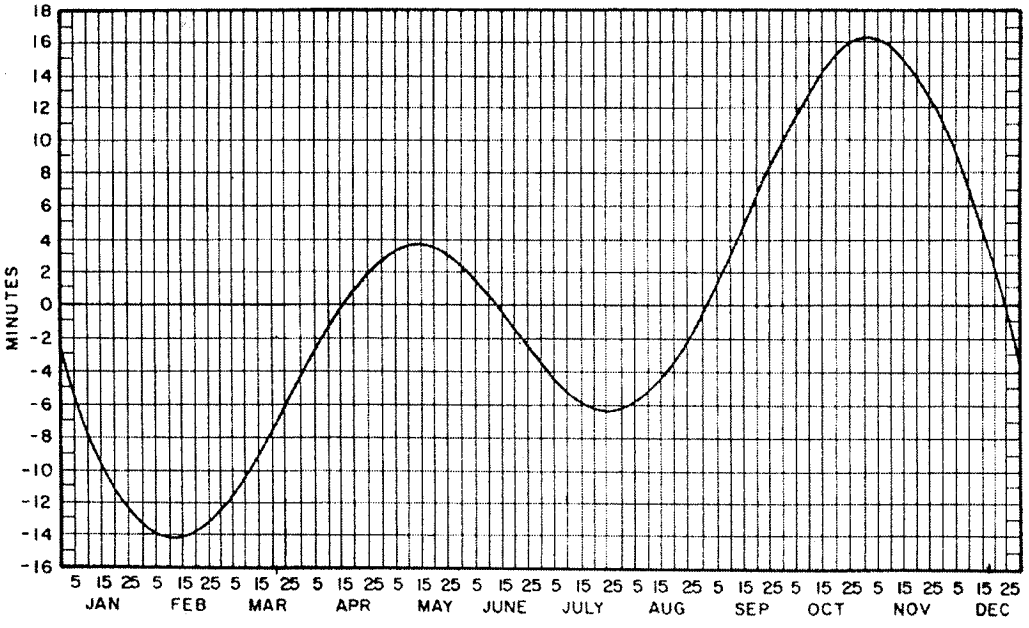

TABLE *The function $f(x)$*

$x(\mu m\text{-}K)$	$f(x)$	$x(\mu m\text{-}K)$	$f(x)$	$x(\mu m\text{-}K)$	$f(x)$
1100	0.001	4600	0.580	8100	0.860
1200	0.002	4700	0.594	8200	0.864
1300	0.004	4800	0.608	8300	0.868
1400	0.008	4900	0.621	8400	0.871
1500	0.013	5000	0.634	8500	0.875
1600	0.020	5100	0.646	8600	0.878
1700	0.029	5200	0.658	8700	0.881
1800	0.040	5300	0.669	8800	0.884
1900	0.052	5400	0.680	8900	0.887
2000	0.067	5500	0.691	9000	0.890
2100	0.083	5600	0.701	9100	0.893
2200	0.101	5700	0.711	9200	0.895
2300	0.120	5800	0.720	9300	0.898
2400	0.140	5900	0.730	9400	0.901
2500	0.161	6000	0.738	9500	0.903
2600	0.183	6100	0.746	9600	0.905
2700	0.205	6200	0.754	9700	0.908
2800	0.228	6300	0.762	9800	0.910
2900	0.251	6400	0.770	9900	0.912
3000	0.273	6500	0.776	10000	0.914
3100	0.296	6600	0.783	11000	0.932
3200	0.318	6700	0.790	12000	0.945
3300	0.340	6800	0.796	13000	0.955
3400	0.362	6900	0.802	14000	0.963
3500	0.383	7000	0.808	15000	0.969
3600	0.404	7100	0.814	16000	0.974
3700	0.424	7200	0.819	17000	0.978
3800	0.443	7300	0.824	18000	0.981
3900	0.462	7400	0.830	19000	0.983
4000	0.483	7500	0.834	20000	0.986
4100	0.499	7600	0.840	30000	0.995
4200	0.516	7700	0.844	40000	0.998
4300	0.533	7800	0.848	50000	0.999
4400	0.549	7900	0.852		
4500	0.564	8000	0.856		

Q.1. (a) Define:

(i) Ecliptic plane
(ii) Equatorial plane
(iii) Declination
(iv) Perihelion
(v) Aphelion [5]

(b) A photovoltaic panel with an efficiency of 8% and surface area of $4m^2$ is placed horizontally in Livingstone (latitude 18°S and longitude 26°E). Calculate the power produced by the solar panel on 1 June at 10.00 a.m. clock time if the optical thickness of the atmosphere is r = 0.2. The standard longitude for Livingstone is 30°East of the Greenwich meridien. Assume there is no diffuse flux. [20]

Q.2. The Sun can be regarded as a blackbody at a temperature of 5777K. The measured value of the solar constant is $1367W/m^2$.

(a) Estimate the value of the solar constant if

(i) the Sun were to cool down to 5000K. [4]

(ii) the Sun were to cool down to 5000K and the Earth-Sun distance were halved. [4]

(b) Assuming the Earth and the Sun to be black bodies and using the values of the solar constant and other Earth-Sun parameters as given,

(i) Calculate the equilibrium temperature of the earth, if the earth's albedo is 0.3 and there is no atmosphere. [4]

(ii) Explain why the calculated temperature of the Earth in b(i) above is different from its actual temperature, which is 15^0C. Clearly but briefly describe the underlying phenomenon. [4]

(c) A solar panel consists of an absorber plate placed under a glazing. The glazing only transmits wavelengths smaller than 2.0 μm. The absorber absorbs all wavelengths except those in the interval 0.40 μm < λ < 0.60 μm which it reflects. The collector is 2 m^2 in area and is oriented above the atmosphere in such a way that the direct solar beam is incident at an angle of 60^0. Find the heating power produced in the absorber due to the absorption of solar radiation. You may use the black body temperature of the Sun to be 6000K and solar constant $1367W/m^2$. [9]

Q.3. (a) Clearly list the assumptions made and show that for two parallel planes at temperatures T_1 and T_2 ($T_2 > T_1$) the net radiative flux transferred from the hotter surface is given by

$$J = \frac{\sigma (T_2^4 - T_1^4)}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1}.$$

Find J if
(i) one of the surface is a perfect reflector,
(ii) both the surfaces are perfect reflectors,
(iii) one of the surface is a perfect absorber. [13]

(b) A horizontal flat plate collector has an absorbing plate and a glazing separated by a distance of 10cm. The emittance of the plate is ε_p = 0.9 and that of the glazing is ε_g = 0.6. The temperatures of the plate and the glazing are 90°C and 40°C, respectively. Estimate the convective and radiative flux transfers from the absorber plate to the glazing. Given the value of the convection coefficient h_d = 3.3 W/m^2-°C. [12]

Q.4.

(a) Clearly but briefly distinguish between surface reflectance and overall reflectance of a glazing. [2]

(b) Show that the overall reflectance R and the overall transmittance T for a single glazing are given in terms of the surface reflectance r and the bulk transmittivity α by

$$T = \frac{\alpha(1 - r)^2}{1 - \alpha^2 r^2}.$$

$$R = r\left[1 + \frac{\alpha^2 (1 - r)^2}{1 - \alpha^2 r^2}\right].$$

[10]

(c) Direct solar radiation (unpolarized) is incident normally on a glazing of thickness 1.5cm. The refractive index of the glazing material is 1.60 and the extinction coefficient k=0.03cm^{-1}. If the intercepted flux is F_{inc}=500W/m^2, find

(i) the surface reflection coefficient. [2]
(ii) the flux leaving the lower surface of the glazing. [5]
(iii) the flux reflected backwards [4]
(iv) Is $R+T=1$? Give reason. [2]