UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
SECOND SEMESTER 2001/2002

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GG 312	:	PETROLOGY (PAPERT 1 THEORY)
GG 312	:	PETROLOGY (PAPER II PRACTICAL)
GG 322	:	STRATIGRAPHY AND REMOTE SENSING (THEORY P.I)
GG 322	:	STRATIGRAPHY & REMOTE SENSING(PRACTICAL P.II)
GG 335	:	STRUCTURAL GEOLOGY I
GG 335	:	STRUCTURAL GEOLOGY II
GG 412	:	METAMORPHIC PETROLOGY I (THEORY)
GG 442	:	ECONOMIC GEOLOGY OF METALLIFEROUS ORE DEPOSITS (PAPER I THEORY)
GG 442	:	ECONOMIC GEOLOGY OF METALLIFEROUS ORE DEPOITS (PAPER II PRACTICAL)
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MG 319	:	II PRACTICAL EXAM
MI 322	:	STATISTICS AND COMPUTER APPLICATIONS
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MI 475	:	MINE ENVIRONMENT
MI 562	:	INVESTMENT ANALYSIS
MI 585	:	MINERAL HANDLING
MM 205	:	INTRODUCTION TO METALLURGY II (THEORY)
MM 205	:	INTRODUCTION TO METALLURGY II (PRACTICAL)
MM 332	:	CHEMICAL THERMODYNAMICS II
MM412	:	PHYSICAL METALLURGY II
MM 442	:	HYDROMETALLURGY
MM 452/ AGE 452	:	PROCESS CONTROL AND INSTRUMENTATION
MM 542	:	FUELS, FURNACES AND REFRACTORIES
MM 552	:	PROCESS DESIGN
MM 562	:	FOUNDRY

UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

SECOND SEMESTER EXAMINATION – 2001/2002

GG 202 – PHYSICAL GEOLOGY

INTRUCTIONS: ANSWER QUESTION ONE AND ANY OTHER THREE

TIME: 3 HOURS

Q1. (a) What is porosity and permeability? (4 marks)

(b) If the porosity of a material is 50% and the volume of open spaces is 70 cm^3. Determine the volume occupied by grains. Show how the determination is done. (5 marks)

(c) What is Darcy's Law? (2 marks)

(d) Two boreholes, A & B, drilled into an unconfined aquifer in the Lusaka dolostone are separated by a horizontal distance of 60 m. The level of water in borehole A lies at an elevation of 1300 m while in borehole B it is at 1230 m. If the conductivity of the water is measured and found to be 21 m/second while the cross-sectional area through which the water is flowing is 60 m^2. Determine the volume of water flowing and its flow velocity. Remember to show how you arrive at the values. (15 marks)

(e) Suggest how would you determine the time it takes water to flow from borehole A to borehole B. (2 marks)

Q2. (a) What is mass movement? (2 marks)

(b) What is an angle of repose and how does it vary with water content? (4 marks)

(c) Distinguish creep from slump (4 marks)

(d) How does absorption of water weaken unconsolidated material? (4 marks)

(e) What is talus and how does it form? (4 marks)

(f) Why would you expect that regions near a continental rift valley might have frequent mass movements? (6 marks)

Q3. (a) What is a stream? (2 marks)

(b) Name and describe 3 ways in which streams carry sediment. (6 marks)

(c) What is stream discharge? (2 marks)

(d) Suppose a stream is 21 m wide and 5.5 m deep. Water in this stream flows at a rate of 6 m/second. Determine the discharge for this stream. (5 marks)

(e) Make brief notes on the following:

(i) Alluvial fan (2 marks)

(ii) Trellis drainage pattern (2 marks)

(iii) Delta (2 marks)

(g) Distinguish between an influent stream and an effluent stream (3 marks)

Q4. (a) How are valley glaciers different from continental glaciers? (3 marks)

(b) Describe the main mechanisms of glacier flow. (5 marks)

(c) How do glaciers erode bedrock? (4 marks)
(d) Name & describe 3 kinds of glacial sediment (6 marks)
(e) The depletion of the ozone layer has caused raised temperatures. If this continues, discuss environmental problems that are likely to result. (6 marks)

Q5. (a) What is the difference between the way wind transports dust & the way it transports sand? (3 marks)
(b) What are the main features of wind erosion? (4 marks)
(c) Name and describe 3 types of sand dunes showing their relationship to wind direction & availability of sand (6 marks)
(d) What is desertification? (1 mark)
(e) What is loess and how is formed? (2 marks)
(f) Trucks continually have to haul away sand covering a coastal highway. What do you think might be the source of the sand? Could its encroachment be stopped? (6 marks)
(g) What evidence might you find in ancient sandstone that would point to its eolian origin? (5 marks)

----------Good Luck!!----------

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
GEOLOGY DEPARTMENT

SECOND SEMESTER EXAMINATIONS 2002/2003

GG 312 PETROLOGY
PAPER I THEORY

TIME: THREE HOURS
ANSWER: SIX QUESTIONS, TWO FROM EACH SECTION

ILLUSTRATE YOUR ANSWERS WITH FIGURES, DIAGRAMS ETC. WHEREVER POSSIBLE.

SECTION A

Q1 Briefly give the main characteristics of the gabbro family.

Q2 Outline the main textures for Volcanic igneous rocks.

Q3 What is magma? Briefly give an account of the main constituents of magma.

SECTION B

Q4 Give a brief description of the main textures found in detrital Sedimentary Rocks.

Q5 Write short notes on :
- i) Lithification
- ii) Lines tons limestone
- iii) Peat
- iv) Conglomerates
- v) Sorting

Q6 Describe in details sedimentary rocks of Carbonation origin.

SECTION C

Q7 Define metamorphism. Discuss in detail, regional metamorphism.

Q8 What are the main factors that control a metamorphic reaction? Briefly outline the role of each factor.

Q9 Explain the following terms:

i) geothermal gradient
ii) mylonite
iii) shock metamorphism
iv) retrograde metamorphism
v) foliation

END OF EXAMINATIONS
GOOD LUCK!

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
GEOLOGY DEPARTMENT

SECOND SEMESTER EXAMINATION

GG 312 PETROLOGY

PAPER II PRACTICAL

ANSWER ALL QUESTIONS
TIME: THREE HOURS

Q1 Identify and describe the structures and textures in samples A, B, C, D, E, and F.

Q2 Give a complete petrographic description of the samples G, H and I. Name the rocks.

END OF EXAMINATION
GOOD LUCK!

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – OCTOBER 2002

GG322

STRATIGRAPHY AND REMOTE SENSING

THEORY

PAPER I

TIME: THREE HOURS

ANSWER: ANY FIVE QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS. USE SKETCHES WHERE POSSIBLE FOR A FULL MARK

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1. Define the following terms:
   (a) Stratification
   (b) Geologic Cycle
   (c) Principle of original horizontality
   (d) Lithology
   (e) Biofacies

2. (a) Explain, with aid of diagrams, Walter's Law .
   (b) Outline the five main categories of fossil remains or evidence of life in the Precambrian.

3. (a) Describe the Characteristics Features of Lithostratigraphic Units.
   (b) In sequence stratigraphy, list and define the stratal units in descending order.

4. (a) Outline the 5 main activities recognized in early trace fossil studies as responsible for forming most trace fossils
   (b) (i) What are the differences between Relative and Absolute Ages.
   (ii) Describe two methods used in Radiometric Dating indicating their limitations

5. (a) The fossils contained in sedimentary rocks are used as tools in Biostratigraphy. Outline five (5) uses of fossils in Biostratigraphy.

   (b) Differentiate between the following:
   (i) Transgression and Regression
   (ii) Bed and Lamina
   (iii) Map and Fence Diagram

(iv) Diastem and Hiatus
(v) Seismic Stratigraphy and Magneto Stratigraphy

6. (a) As a Stratigrapher at the Geological Survey of Zambia, outline your major concerns when carrying out your duties.
(b) Fill in the missing words (.....) in the Geological Time Scale below.

EON	.....	**PERIOD**	.....	**AGE**
		Quaternary	Recent	
	CENOZOIC	.....	Pliocene ..... Oligocene ..... Paleocene	
				65 MY
.....	.....	Cretaceous ..... Triassic		
				.....
	PALEOZOIC	..... Pennsylvanian ..... Devonian ..... Ordovician		
				590 MY

PRECAMBRIAN (....., Archean)

END --- GOOD LUCK

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – OCTOBER 2002

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 is Remote Sensing? (2 marks)
(b) Differentiate between Passive and Active Systems (4 marks)
(c) With an aid of a diagram outline in detail, the various parts of an Electromagenetic Spectrum including windows and blinds (20 marks)

2. (a) There are 4 types of Resolutions in Remote Sensing. Outline these resolutions and where possible give examples of types of resolution one can obtain from SPOT and TM systems. (16 marks)

(b) Outline the components of GIS. (8 marks)

(c) Why is it important to enhance an image. Give five reasons for your answer. (10 marks)

3. As a Geologist working for the Geological Survey, you have been assigned to undertake a photogeological interpretation of the Southern Part of Zambia. You decide therefore to select 3 aerial photos so that you can undertake an initial interpretation. You are therefore required to:

(i) Provide a fully annotated photogeological interpretation on the central air photograph. (30 marks)

(ii) Provide a description of the photogeology of the annotated area. (10 marks)

END -- GOOD LUCK

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
GEOLOGY DEPARTMENT

GG335 STRUCTURAL GEOLOGY I
2001-2002 ACADEMIC YEAR
EXAMINATION – NOVEMBER 2002

Time: 3 hours

Instructions: Answer Any Five Questions

PART A (20 points) Define with sketches the following:

1. Strain ellipse
2. Microlithon
3. stylolite
4. intersection lineation
5. Finite neutral surface

PART B (20 points) Answer one of the following questions:

B1. Describe the primary and secondary structures that you know and explain how they form.

B2. Describe briefly:

1. simple shear
2. pure shear
3. deviatoric stress
4. shear strain
5. effective stress

PART C (20 marks) Describe with sketches the following:

1. Fold axis
2. Re-entrant
3. class Ib fold
4. Class II fold
5. Dip isogon

PART D. (20 marks)

Anderson explained the state of stress in faults in terms of stresses. Explain what is meant by a principal stress and describe Anderson dynamic classification of faults.

PART E (20 points)

Describe the term fabric and the different types of foliations that you encounter in deformed terranes. Explain briefly how they form.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
GEOLOGY DEPARTMENT

4 Nov 2002

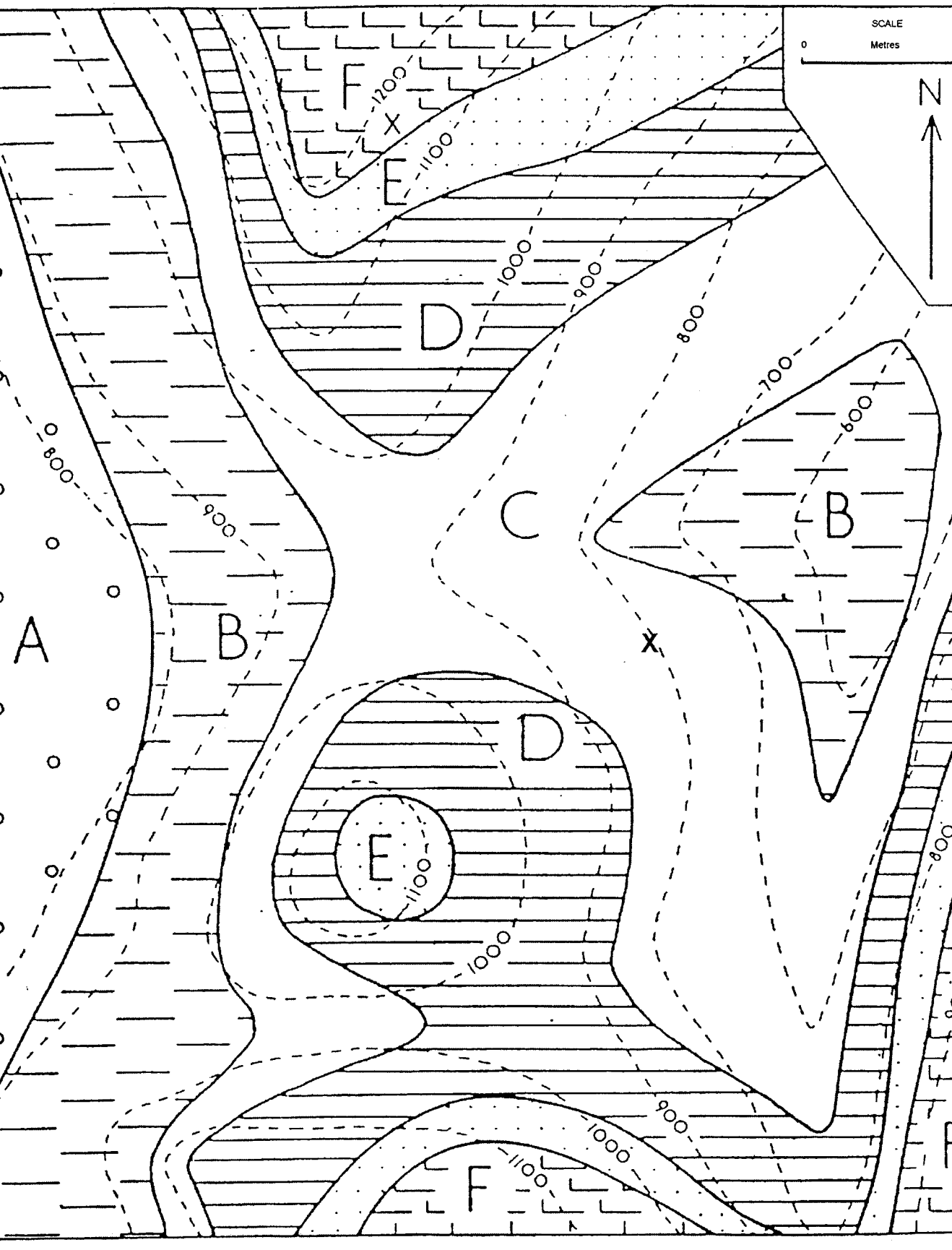
GG335 II (STRUCTURAL GEOLOGY)
2001-2002 ACADEMIC YEAR
PRACTICAL EXAMINATION – NOVEMBER 2002
Time: 3 Hours

PART A (60 points) Using the Map given do the following:

A1. Draw in the strike lines
A2. Determine the attitude of each bed
A3. Draw cross-section Y-Z.
A4. Determine the type of structure present.
A5. Determine the thickness of each bed true ✓
A6. Determine the maximum depth at which you expect the orebody outcropping at contact of B and C in the valley underlain by unit C
A8. Where would you place at least three vertical drill holes (DDH1, DDH2, and DDH3), within unit D, to intersect the mineralisation?
A9. Draw the stratigraphic table.
A10. Describe the history of the map area

PART B (40 points) Answer both of the following questions. Be brief.

B1. Name the primary structures that you expect to find in the map area
B2. At location X a horizontal 5 m thick intrusive body exposed. Complete the outcrop of the intrusive body. 15 ✓


SCALE
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UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
GEOLOGY DEPARTMENT

SECOND SEMESTER EXAMINATIONS 2001/2002

GG 412 - METAMORPHIC PETROLOGY
PAPER I THEORY

TIME: Three Hours
ANSWER: Question 1 and any other four questions

Illustrate your answers with sketches, figures etc where possible

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Q1. Discuss the concept of metamorphic facies in as much details as possible 20%

Q2. Summarise the main physical and chemical factors that may control a metamorphic reaction. 20%

Q3. (a) Explain what is meant by the crystalloblastic series among metamorphic minerals and give examples. 10%

(b) What is meant by surface free energy 10%

Q4 Compare and contrast metamorphic rocks and magmatic rocks with regard to:-

(a) state of matter involved (liquid, solid, gas)
(b) Texture
(c) Chemical composition 20%

Q5. What are the main criteria for classification of metamorphic rocks. 20%

Q6 Define and discuss briefly

(a) Mylonites
(b) Geothermol banding
(c) Burial metamorphism
(d) Migmatites

20%

END OF EXAM

UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

SECOND SEMESTER EXAMINATIONS – 2001/2002

GG 442 – ECONOMIC GEOLOGY OF METALLIFEROUS ORE DEPOSITS

PAPER I: THEORY

INTRUCTIONS: ANSWER ANY FIVE QUESTIONS USING ILLUSTRATIONS WHEREVER POSSIBLE; ALL QUESTIONS CARRY EQUAL MARKS

TIME: 3 HOURS

Q1. (a) Name and describe the process that leads to the formation of the chromite deposits.(3 marks)

(b) Name and distinguish the two forms of chromite deposits giving an example deposit of each type. (12 marks)

(c) Are these deposits syngenetic or epigenetic and why? (2 marks)

(d) Name and describe the process that produced the Ni-Cu sulphide deposits.(3 marks)

Q2. Discuss volcanogenic massive sulphide (VMS) deposits in terms of: tectonic setting, (ii) major host and country rocks, (iii) mode of occurrence, (v) structural control, (iv) main ore and gangue minerals, (v) alteration types, and (vi) possible genesis (20 marks)

Q3. (a) Describe briefly how the following placer deposits form:

(i) Residual (2 marks)

(ii) Eluvial (2 marks)

(iii) Stream (2 marks)

(iv) Aeolian (2 marks)

(b) List six kind of minerals you would expect to be concentrated in the above deposits and why? (3 marks)

(c) Write brief notes on the following:

(i) Iron-rich laterites (4.5 marks)

(ii) Al-laterites (4.5 marks)

Q4. (a) There are 3 classes of vein deposits. Name and define these 3 classes. (4.5 marks)

(b) Veins are formed from hydrothermal fluids, which can be derived in three ways. Name and describe these three ways. (4.5 marks)

(c) In a given area occurs a nearly vertical tabular vein deposit containing mainly pyrite and bornite covered by a 2 m thick humus-bearing soil. This deposit is affected by rain water infiltrating the soil. Name the three

vertical zones and how these zones develop. Discuss how enrichment & what ore minerals would develop from supergene processes, giving typical chemical reactions. (11 marks)

Q5. (a) What is a skarn and how does it form? (3 marks)
(b) How does an endoskarn differ from an exoskarn? (4 marks)
(c) In what ways does a metamorphic hornfels differ from a skarn? (3 marks)
(d) A skarn associated with the same intrusion and country rocks would be narrow at great depth and wide at shallow depth and it is also evident that shallow-depth skarns form the best grade deposits. Discuss. (8 marks)
(e) Name four of the seven categories of skarn deposits. (2 marks)

Q6. (a) What are fluid inclusions and what conditions of ore formation can be estimated from fluid inclusions? (4 marks)
(b) Although minerals such as quartz, calcite and fluorite are generally suitable for fluid inclusion studies, they are not useful in estimating formation conditions of skarn deposits, why? (5 marks)
(c) By the way, why are the minerals in (b) generally suitable for fluid inclusion studies? (2 marks)
(d) Define what stable isotopes are and give examples of the three common stable isotopes. (5 marks)
(e) What information in general regarding ore deposits can be derived from stable isotopes? (4 marks)

----------Good Luck!!----------

UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

SECOND SEMESTER EXAMINATIONS – 2001/2002

GG 442 – ECONOMIC GEOLOGY OF METALLIFEROUS ORE DEPOSITS

PAPER II: PRACTICAL

INTRUCTIONS: ANSWER ALL QUESTIONS

TIME: 3 HOURS

Q1. Identify & describe ore minerals A, B, C, D, & E, using their physical properties.(25 marks)

Q2. You are provided with 3 polished sections (F, G, & H). Using the oremicroscope identify the ore minerals present and describe the observed textures. Discuss the possible origin of the observed textures. (75 marks)

----------Good Luck!!----------

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – OCTOBER 2002
GG 472
APPLIED GEOCHEMISTRY
PAPER I THEORY

TIME: THREE HOURS
INSTRUCTIONS: Answer one question from each section. All the questions carry equal marks. Use diagrams and equations wherever it is necessary.

SECTION A

1. The chemical composition of water of a river is given in Table 1.

Table 1

Ion	Concentration (moles/kg)
HCO_3^-	1.90×10^{-3}
SO_4^{-2}	2.65×10^{-4}
Cl^-	2.90×10^{-4}
NO_3^-	4.30×10^{-5}
Ca^{2+}	8.50×10^{-4}
Mg^{2+}	3.70×10^{-4}
Na^+	5.17×10^{-4}
K^+	4.90×10^{-5}
Fe^{2+}	2.50×10^{-6}
SiO_2	1.95×10^{-5}
H^+	4.60×10^{-7}

Use this data and the thermodynamic data given below to determine the state of saturation of this water with respect to calcite, quartz and microcline.

- $\text{Log}\gamma = Az^*2^* I^{1/2}$
  $A = 0.5085$
  $Ksp_{calcite} = 10^{-8.35}$

Species	ΔG_f^o (Kcal/mole)
Microcline	-892.8
Quartz	-204.75
Calcite	-269.80
Kaolinite	-906.84
K^+	-67.7
H_4SiO_4	-312.66
H_2O	-56.69
HCO_3^-	-140.26
CO_3^{2-}	-126.17

2. The composition of a basalt and the residual soil derived from it are given below:

	Basalt	Saprolite	gfw
SiO2	50.7	35.1	60
Al2O3	12.3	26.3	102
CaO	7.83	0.06	56
MgO	4.18	0.26	40
Na2O	2.53	0.02	62
K2O	1.71	0.13	94
Fe2O3	15.1	21.5	160
MnO	0.20	0.10	71
TiO2	3.19	3.96	80
P2O5	0.46	0.11	142
H2O	1.70	12.4	18
Total	100	100	

a) Calculate the fraction of each component that has been lost from the site of chemical weathering assuming that Al has not been mobilised from the site of chemical weathering.

b) Arrange the chemical elements given above in increasing order of mobility in this environment.

c) Discuss briefly the processes that have led to the transformation of the basalt into saprolite.

SECTION B

3. a) Construct an Eh-pH diagram for the system Pu-O-H at STP.
Assume that the activities for dissolved species of Pu = 10^{-8} moles/kg.

Species	ΔG_f^o (kcal/mole)
Pu^{3+} (aq)	-138.15
PuO_2(c)	-238.53
PuO_2^+(aq)	-203.10
H_2O (liq)	-56.69
H^- (aq)	0
H^+(aq)	0
H_2 (g)	0
O_2 (g)	0
OH^- (aq)	-37.59

b) Compare your diagram with figure 1 below and discuss how moisture and Eh-pH conditions in the geochemical environment may affect its ability to mobilize or immobilize Plutonium.

c) Use the Eh-pH diagrams to Asses the suitability of the sites in the following environments for the disposal of Pu-rich nuclear waste material.

i) Sandstone aquifer in the hot-dry desert.

ii) Dolomite aquifer in the tropical region.

iii) Granitic rock unit of very low porosity and permeability.

4. Discuss briefly the role of surficial processes in the formation of the following types of mineral deposits:

a) Supergene enrichment deposits of Cu.

b) Evaporite deposits

c) Bauxite deposits

SECTION C

5 a) Discuss the principle behind using vegetation in geochemical exploration.

b) Discuss the limitations of using these methods in exploration for minerals.

c) Give some examples of successes where vegetation surveys have been used.

6 a) Discuss briefly the three major environmental problems that are associated with copper mining in the Zambian Copperbelt.

b) What is Acid Mine Drainage?

c) Describe the major reactions that are involved in the development of Acid Mine Drainage.

d) Discuss briefly the potential for development of acid mine drainage and its neutralization at the following mines: 1) Nampundwe Mine in Lusaka, 2) Kabwe Pb-Zn Mine, 3) Maamba Coal Mine and 4) Mufulira Copper Mine.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – OCTOBER 2002
GG 472
APPLIED GEOCHEMISTRY

PAPER II PRACTICAL

TIME: THREE HOURS
INSTRUCTIONS: Answer all the questions.

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1. In a detailed survey for Pb deposits that are associated with Zn mineralisation the data given in figure 1 was acquired.
   a) Use an appropriate statistical technique to split the data set into the appropriate number of sub-populations.
   b) Contour the data and delineate anomalous areas.
   c) Propose and mark the most appropriate sites for further investigations.
   d) Discuss briefly how the major types of dispersion patterns in figure 1 have been formed.
   e) Explain how the distribution pattern of Pb would differ from that of Zn.

   (70%)

2. The chemical composition of the three mine waters are given in the table below. Use this data to Asses the suitability of these waters for human consumption.

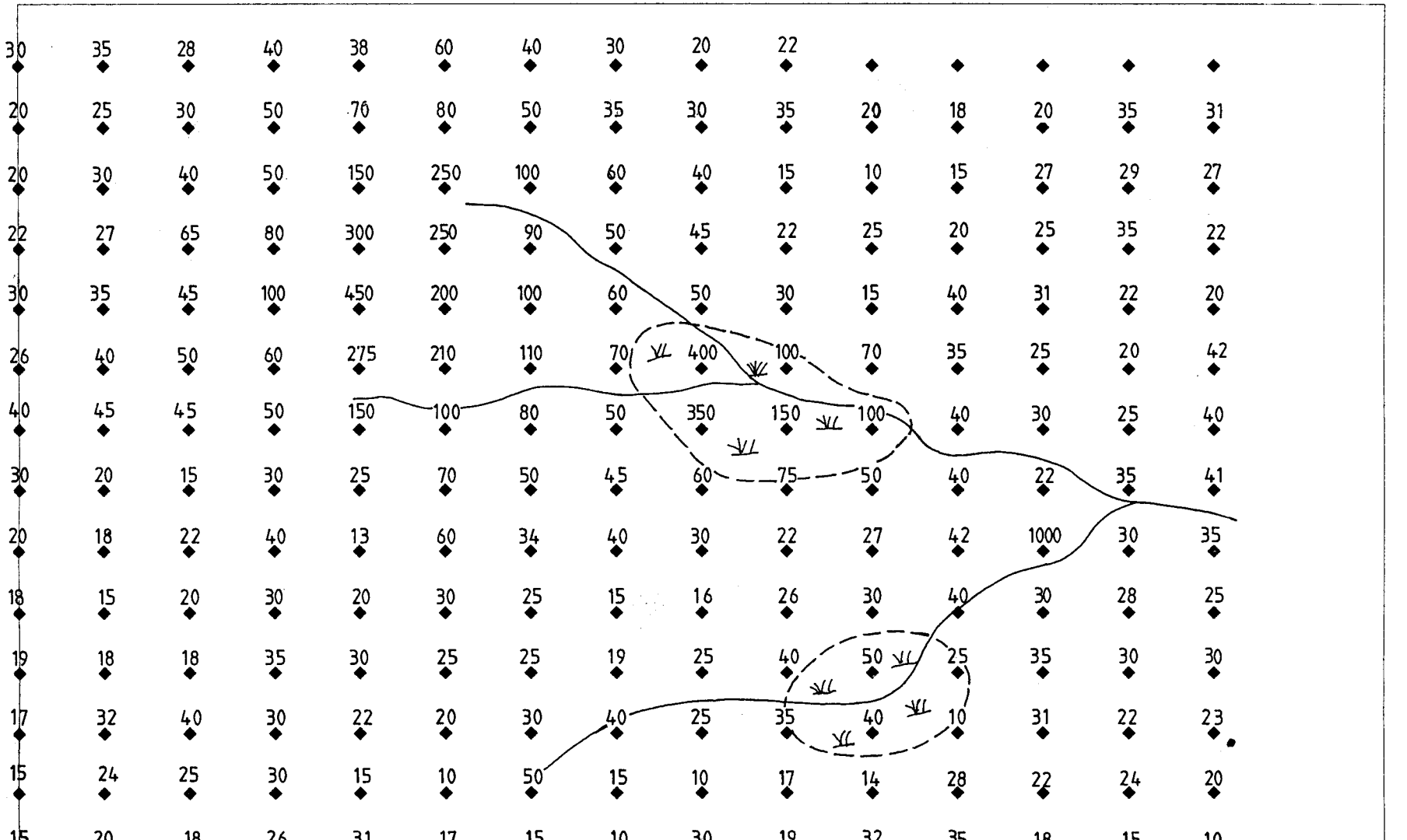
Parameter	Mine water A	Mine Water B	Mine Water C
PH	4.0	7.8	2.2
Zn	10	0.3	10000
Cu	0.04	.001	13
Cd	0.04	.01	22.5
Fe	1.5	0.6	15000
Pb	0.005	0.001	0.8
Sulphate	100	50	60000
Nitrate	13	7	78
TDS	3000	600	1200000

NOTE: The units for the concentration of all the parameters are mg/l except for pH.

(30 %)

END OF EXAMINATION

Figure 1. The Distribution of Zinc (ppm) in A Soil Block



THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
SECOND SEMESTER EXAMINATIONS 2001/2002

GG 542 ECONOMIC GEOLOGY OF NON-METALLIC MINERAL DEPOSITS

PAPER 1 - THEORY

TIME: Three hours
INSTRUCTIONS: Answer any five questions

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1. Describe the main stages in the development of an industrial minerals operation outlining the expected result of each stage

2. Describe the dry process of cement manufacture

3. Many grinding and polishing operations in industry consume a considerable amount of abrasives.

   (i) Outline the properties of such abrasives
   (ii) Describe the geological occurrence of two of the most commonly used industrial abrasives

4. (i) What are constructional materials and what have all these materials in common
   (ii) Outline the main economic constraints and social aspects related to working these materials

5. Outline the properties of road aggregate that Shmizu Construction Company should be using in constructing the Great East Road in Lusaka for
   (a) Sub-base
   (b) Road base
   (c) Wearing course

6. Discuss technological characteristics, which define the quality of non-metallic minerals.

THE UNIVERSITY OF ZAMBIA
UNIVERSITY SECOND SEMESTER EXAMINATIONS – 2002
GG 572, HYDROGEOLOGY EXAMINATIONS

TIME: THREE HOURS

ANSWER: FIVE QUESTIONS.

ALL QUESTIONS CARRY EQUAL MARKS.

1. (a) Draw the Hydrologic cycle. 10 Marks

   (b) Briefly define the following:

   i) Hyetograph

   ii) Hydrograph

   iii) Evapotranspiration

   iv) Depression Storage

   (v) Interception

   10 Marks

2. (a) Using the principle of conservation of Mass for a volume element of an aquifer, derive the Continuity Equation.

   10 Marks

   (b) Given ground water flow in homogeneous and isotropic medium, use the Continuity Equation to derive the Non steady State Equation.

   10 Marks

3. A borehole penetrating a confined aquifer is pumped at a uniform rate of 2500 cubic metres per day.

Draw downs during the pumping period are measured in an observation well 60 metres away. Given below are observations of time, t, and drawdown, s.

Determine transmissivity, T, and Storage Coefficient, S. 20 Marks

t, (min)	s, (m)
0	0
1.0	0.20
1.5	0.27
2.0	0.30
2.5	0.34
3.0	0.37
4	0.41
5	0.45
6	0.48
8	0.53
10	0.57
12	0.60
14	0.63
18	0.67
24	0.72
30	0.76
40	0.81
50	0.85
60	0.90
80	0.93
100	0.96
120	1.00
150	1.04
180	1.07
210	1.10
240	1.12

4. (a) Explain what geological and geochemical processes transform carbonate rocks into aquifers.

10 Marks

(b) In each of the nine provinces of Zambia, list the lithologies, if any, that would be targeted to supply groundwater for irrigation.

10 Marks

5. (a) The starting point for modelling chemical transport in groundwater is the Advection-Diffusion Equation in one dimension. Write down the Equation, and explain all the terms in the Equation.

10 marks

(b) In a lake sediment, the concentration of Mn^{2+} in the interstitial water increases linearly from 1 ppm at the sediment-water interface to 20 ppm at a depth of 100cm. Assuming a sedimentation rate of zero and constant porosity, what is the flux of Mn^{2+} to the sediment-water interface, in units of grams/cm^2/year?

Assume D solu = 5×10^{-6} cm^2 /sec (diffusion coefficient for Mn^{2+} in water).

ϕ = 0.7 (porosity)
θ = 1.3 (tortuosity)

10 marks

6. (a) Define the following:

i. D O C

ii. Carboxylic acid group

iii. Tortuosity

iv. Aliphatic Hydrocarbons

v. Aromatic Hydrocarbons

10 marks

(b) Explain what properties the Aromatic Hydrocarbons possess that make them some of the most important groundwater pollutants.

10 marks

END OF EXAM

UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
GEOLOGY DEPARTMENT

MG 319 I
THEORY EXAM

URATION: 3 Hrs

NSTRUCTIONS: Answer **ANY FOUR** questions.

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uestion 1: **Computer Development**

a/ The computers we are using now are of the fourth generation. Describe each generation, stating their age, internal components and external storage medium.

b/ Generally, computers are grouped into three classes namely, Main Frame, Mini-Computer and Micro-Computer including Personal Computers. What two characteristics do these classes have in common?

c/ Because disks are so important to using and managing data within your computer the operating system includes a number of disk-related commands. Describe three important commands.

[25 marks]

uestion 2: **Windows Environment and Microsoft Office**

a/ Name the two types of Windows.

b/ Define an icon and name its use.

c/ Name the four standard groups of applications in the Program Manager.

d/ Though there is a keyboard alternative for every mouse operation, using a mouse is generally easier and faster than a keyboard. Describe the four mouse operations.

[25 marks]

Question 3: File Management

a/ Why is it important to organize files and software in a clear, understandable and recognizable way?

b/ Explain why it is important to defragment your computer.

c/ Distinguish Program Files from Data Files.

d/ What is a File Extension in File Names?

e/ Describe a Path Name?

[25 marks]

Question 4: Terminology and Definitions

a/ What do you understand by the term Download?

b/ Define a Pull-down (drop-down) menu

c/ What is a Scrollbar?

d/ What is a Program?

e/ Define a Clipboard

[25 marks]

Question 5: <u>The Computer</u>

a/ Draw a well labeled diagram of all hardware components of the computer, listing their uses?

b/ Name three types of removable drives and their maximum storage capacities.

c/ What is the main purpose of a screen saver?

[25 marks]

END OF EXAM

UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
GEOLOGY DEPARTMENT

MG 319 II
PRACTICAL EXAM

URATION: 3 Hrs

NSTRUCTIONS: Answer **ALL** questions. Use formulas where equired.

---

uestion 1: **Microsoft Word**

pen the Microsoft Word document **Practical_Qn**, saved on your omputer in the directory **C:\Mg319\Practical exam** or **:\Mg319\Practical exam** or **G:\Mg319\Practical exam** (depending n the PC given). Edit and format it to look exactly like the ard copy Microsoft Word document given to you. Save the ormatted document as **Answer_Qn1** in the same directory as oove.

[55 marks]

ints:

ne pictures to be inserted in the document are saved in the directory nown above;

nere are four heading types;

ont size for Title Page = 14 and **Bold**;

ont size for Headings = 12

ont size for the rest of the document = 10;

ll font type = Arial;

nsert page numbers

nsert Table of Contents on the second page.

Question 2: **Microsoft Excel Spread Sheets**

Open the Microsoft Excel Spread Sheet document **Table_Qn**, saved on your computer in the directory shown in **Question** above. Save the completed table as **Answer_Qn2** in the directory shown above.

a/ Complete the table by filling in the fourth column.

b/ Use a Bar Chart to construct a graph of Item against Total Amount (ZMK).

c/ Use a 3-D Pie chart to construct a graph of Item against Total Amount (ZMK).

d/ Find the average unit price.

e/ Calculate the maximum quatity.

f/ Out of the Total Amount (ZMK), what percentage constitutes Manila Paper? Indicate answer below the table.

[45 marks]

END OF EXAM

THE UNIVERSITY OF ZAMBIA
School of Mines
Mining Engineering Department

MI322 - STATISTICS AND COMPUTER APPLICATIONS

Semester Two Final Examination

November 2002

ANSWER ALL QUESTIONS
(THREE Hours)

(i) With clear definition of the variables involved, what formulae are used in the following circumstances?

(a) To estimate the sample variance when the population mean η is known.

(b) To estimate the statistic in a normal distribution if the standard deviation σ is not known.

(c) To estimate the statistic for which we believe, say, that two sets of 10 yields obtained with methods A and B could be treated as *random samples from appropriate populations* of yields with approximately the same form; in particular, that they have the same variance σ^2

(d) To estimate the statistic if the only evidence about σ is from the $n_A = x$ runs made with method **A** and $n_B = x$ runs made with method **B**.

[12 points]

(ii). What are the FOUR BASIC WAYS with which one can get the FIRST STATISTICAL IMPRESSION of data? ***[8 points]***

2 MI322 Monk Company contemplated introducing a new drilling machine. To do so, a trial was undertaken to compare the performance of drilling machines A to a trial machine B. Suppose that four trials done on successive days in the order *A, A, B, B* gave the results 23, 28, 37, 33 (m/hr) and also that, immediately before this trial, a series of drilling data on successive days with machine *A* gave the results 25, 23, 27, 31, 32, 35, 40, 38, 38, 33, 27, 21, 19, 24, 17, 15, 14, 19, 23, 22 (m/hr). Using the external reference distribution, compute the significance level for the null hypothesis $\eta_B = \eta_A$, when the alternative is $\eta_B > \eta_A$. Is there evidence that *B* gives higher output than *A*?

[20 points]

Prove that the SLOPE of the least-squares regression line of ***y*** and ***x*** can be written as

$$b = \frac{\sum(x = \bar{x})(y - \bar{y})}{\sum(x - \bar{x})^2}$$

[8 points]

Northern Frontier Gold Mining Company wanted to predict the hole alignment deviation for their open pit drilling. This, the Company thought, would help them design optimal benches and blasting patterns. Tests were conducted and results obtained are shown in Table 3.1. With the help of regression analysis, derive an equation for alignment deviation for drill holes at the open-pit.

Table 3.1

Hole depth (m)	8	22	35	40	57	73	78	87	98
Number of measurements	6	9	2	8	4	5	7	1	3
Alignment deviation (cm)	6.16	9.88	14.35	24.06	30.34	32.17	42.18	43.23	48.76

[12 points]

Four different loaders were tested for their performance. The allocation of drivers and loading times were random. The average tonnage pulled per hour was then recorded, as shown in Table 4.1. In clear steps, determine if there is a difference in the performance of the loaders.

Table 4.1

A	**B**	**C**	**D**
62	63	68	56
60	67	66	62
63	71	71	60
59	64	67	61
	65	68	63
	66	68	64
			63
			59

[20 points]

The results shown in Table 5.1 were obtained from a test on the wear of two different materials used on soles of mine safety boots. The hypothesis H_0 of interest is not always the null hypothesis of "no difference". Suppose that increased wear of the cheaper material could be tolerated so long as it was not greater than 0.10, do the data contradict the hypothesis H_0 that $\delta = \delta_0 = 0.10$ (the alternative H_1 being that $\delta > 0.10$)?

able 5.1 Data on the amount of wear of soles of mine safety shoes measured with two different materials A and B.

Boy	Material ***A***	Material ***B***	**B – A** difference ***d***
1	13.2(L)	14.0(R)	0.8
2	8.2(L)	8.8(R)	0.6
3	10.9(R)	11.2(L)	0.3
4	14.3(L)	14.2(R)	-0.1
5	10.7(R)	11.8(L)	1.1
6	6.6(L)	6.4(R)	-0.2
7	9.5(L)	9.8(R)	0.3
8	10.8(L)	11.3(R)	0.5
9	8.8(R)	9.3(L)	0.5
10	13.3(L)	13.6(R)	0.3
		average difference =	~~0.42~~ 0.41

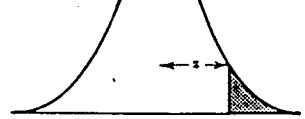


TABLE A. Tail area of unit normal distribution

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641
0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
3.5	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
3.6	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
3.7	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
3.8	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
3.9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

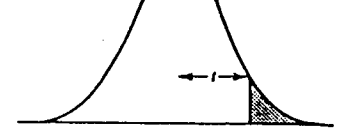


TABLE B1. Probability points of the t distribution with ν degrees of freedom

	tail area probability									
ν	0.4	0.25	0.1	0.05	0.025	0.01	0.005	0.0025	0.001	0.0005
1	0.325	1.000	3.078	6.314	12.706	31.821	63.657	127.32	318.31	636.62
2	0.289	0.816	1.886	2.920	4.303	6.965	9.925	14.089	22.326	31.598
3	0.277	0.765	1.638	2.353	3.182	4.541	5.841	7.453	10.213	12.924
4	0.271	0.741	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	0.267	0.727	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6	0.265	0.718	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	0.263	0.711	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8	0.262	0.706	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	0.261	0.703	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10	0.260	0.700	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.587
11	0.260	0.697	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	0.259	0.695	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13	0.259	0.694	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	0.258	0.692	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15	0.258	0.691	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16	0.258	0.690	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17	0.257	0.689	1.333	1.740	2.110	2.567	2.898	3.222	3.646	3.965
18	0.257	0.688	1.330	1.734	2.101	2.552	2.878	3.197	3.610	3.922
19	0.257	0.688	1.328	1.729	2.093	2.539	2.861	3.174	3.579	3.883
20	0.257	0.687	1.325	1.725	2.086	2.528	2.845	3.153	3.552	3.850
21	0.257	0.686	1.323	1.721	2.080	2.518	2.831	3.135	3.527	3.819
22	0.256	0.686	1.321	1.717	2.074	2.508	2.819	3.119	3.505	3.792
23	0.256	0.685	1.319	1.714	2.069	2.500	2.807	3.104	3.485	3.767
24	0.256	0.685	1.318	1.711	2.064	2.492	2.797	3.091	3.467	3.745
25	0.256	0.684	1.316	1.708	2.060	2.485	2.787	3.078	3.450	3.725
26	0.256	0.684	1.315	1.706	2.056	2.479	2.779	3.067	3.435	3.707
27	0.256	0.684	1.314	1.703	2.052	2.473	2.771	3.057	3.421	3.690
28	0.256	0.683	1.313	1.701	2.048	2.467	2.763	3.047	3.408	3.674
29	0.256	0.683	1.311	1.699	2.045	2.462	2.756	3.038	3.396	3.659
30	0.256	0.683	1.310	1.697	2.042	2.457	2.750	3.030	3.385	3.646
40	0.255	0.681	1.303	1.684	2.021	2.423	2.704	2.971	3.307	3.551
60	0.254	0.679	1.296	1.671	2.000	2.390	2.660	2.915	3.232	3.460
120	0.254	0.677	1.289	1.658	1.980	2.358	2.617	2.860	3.160	3.373
∞	0.253	0.674	1.282	1.645	1.960	2.326	2.576	2.807	3.090	3.291

Source: Taken with permission from E. S. Pearson and H. O. Hartley (Eds.) (1958), *Biometrika Tables for Statisticians*, Vol. 1, Cambridge University Press.

Parts of the table are also taken from Table III of Fisher and Yates: *Statistical Tables for Biological, Agricultural and Medical Research*, published by Longman Group Ltd., London (previously published by Oliver and Boyd, Edinburgh), by permission of the authors and publishers.

UNZA
Surface Mine Design MI435 Examination
End of Semester II, 2002
25 October 2002

Five questions ONLY to be answered in three hours. Read questions and instructions very carefully.

Question 1

(a) State the main modules or groupings of a surface mine project information system.
(b) Illustrate schematically the linkages of information modules in due diligence studies for a surface mine.
(c) Define the term 'HDI' and describe the relationship between the HDI of a resident population and the type of technology applicable in surface mine design. The type of technology should be stated explicitly, and explained.
(d) Define the term 'information time bomb' and the impact it has on the outcome of mining project.

Question 2

Describe the methodology for the data acquisition phase of geological orebody modelling for surface mine design, specifically commenting on:
(a) Types and mechanisms of drilling equipment used;
(b) Exploration drilling phases;
(c) Exploration drilling patterns; and
(d) Exploration hole spacing.

Question 3

(a) Define and explain the usage of illustrative 'plans' and 'sections' in the design and operation of surface mines.
(b) Discuss salient points, and illustrate simply, each of the following:

(i) Transverse dip section;
(ii) Bench plan;
(iii) Longitudinal strike section;
(iv) Vertical longitudinal projection;
(v) Spot height plan;
(vi) Composite contour plan; and
(vii) Bedrock topography.

Question 4

(a) Name and briefly describe two major open pit optimisation techniques.
(b) Identify the open pit optimisation method used in the accumulation computation tables on the attached diagram 1 (tables 1 and 2), and complete the computations by filling in the six blanked out numbers on table 2. Use arrows to indicate the preliminary estimate of the ultimate pit on table 2.

Question 5

(a) Define the term 'polygonal nearest neighbour'? Explain the use of the polygonal nearest neighbour method in calculations.

(b) Identify the open pit optimisation method used in the accumulation computation tables on the attached diagram 2 (tables 3, 4 and 5), and complete the computations by filling in the ten blanked out numbers on tables 4 and 5. Use arrows to indicate the preliminary estimate of the ultimate pit on table 5.

Question 6

(a) Identify and describe briefly three methods used in geotechnical template design for open pits.

(b) Explain the difference in terminology between 'volumetric' and 'tonnage' stripping ratios. Suggest reasons why there may be differences, or not, between 'volumetric' and 'tonnage' instantaneous stripping ratio values for a particular pushback.

(c) Every open pit cut or pit design must be sensitised and tested for viability through financial or profit modelling. Set out one hypothetical profit model 'spreadsheet-style' for an open pit design from mining through metallurgical processes to the point where undiscounted contribution is derived. Assume hypothetical but reasonable figures for your chosen metal.

Question 7

(a) Explain and illustrate the 'detailed' design and layout of an open pit cut, bench by bench, within an optimised period shell, using the 'bottom-up' sequence.

(b) Identify and describe the main surface mining unit and functional processes.

(c) Describe and illustrate two methods of open pit waste dumping.

See attached diagrams 1 and 2 below.

Question 4 Diagram 1 (contains Tables 1 and 2 only)

e 1 Slope 1:1

Revenue Values per Block (also called block economic values) in any monetary unit

	-1	-1	-1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1
	-1	-1	-1	-1	1	1	-1	1	1	1	-1	-1	-1	-1	-1
	-1	-1	-1	-1	-1	1	1	1	1	1	-1	-1	-1	-1	-1
	1	-1	1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	-1
	-1	-1	-1	-1	-1	-1	-1	1	1	-1	-1	-1	-1	-1	-1
	-1	-1	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

e 2 Slope 1:1

	-1	-1	-1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1
	-4	-4	-2	0	4	4	2	4	4	2	-2	-4	-4	-4	-4
	-9	-7	-5		3	7	7		7	3	-3	-7	-9	-9	-9
	-12	-12	-6	-4	0	6	14	12	8	4	-4	-10	-14	-16	-16
	-19	-13	-11	-7	-3	5	11	17	11		-5	-13	-19	-23	-25
	-24	-20	-14	-12		0	6	10	10	0	-10		-24	-30	-34
	-33	-27	-21	-13	-11	-5	-3	-3	-3	-3	-13	-23	-29	-37	-43

End of Question 4 Diagram 1 Tables 1 and 2:

Name of student:.....
Student Computer Number:.....

N.B: After filling in the blanks, hand the whole page back to the invigilator with your other answer sheets, clearly labelled with your name.

Please turn to next page for Question 5
Diagram 2

Question 5 Diagram 2 (Contains Tables 3, 4 and 5 only)

Table 3 Question 5 Diagram 2 (contains Tables 3, 4 and 5)

Net Revenue Values per Block (also called block economic values) in any monetary unit

-1	-1	-1	-1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	1	1	-1	1	1	1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	1	1	1	1	1	-1	-1	-1	-1	-1
-1	1	-1	1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1	1	1	-1	-1	-1	-1	-1	-1
-1	-1	-1	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

Table 4 Slope 1:1

-1	-1	-1	-1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1
-2	-2	-2	-2	0		2	0	2	2	2	-2	-2	-2	-2	-2
-3	-3	-3	-3	-1	1	3	1	3	3	3	-3	-3	-3	-3	-3
-4	-2	-4	-2	-2	0	2	2	4	4	4	-4	-4		-4	-4
-5	-3	-5	-3	-3	-1	1	1	5	5	3	-5	-5	-5	-5	-5
-6	-4	-6	-2	-4	-2	0		4	4	2	-6	-6	-6	-6	-6
-7	-5	-7	-3	-5	-3	-1	-1	3	3	1	-7		-7	-7	-7

Table 5 Slope 1:1

-1	-1	-1		1	2	4	6	7	10	14	16		16	15	14
-3	-3	-3	-3	-1	3	5	6	9	13	17	18	17	15	14	13
	-6	-6	-6	-4		6	7	11	15	20	19	16	14	12	11
-10	-8	-10	-8	-8	-4	2	8	12	17	22	18	15	12	10	8
-15	-13	-13	-13	-11	-9	-3	3		18	21	17	13	10	7	5
-21	-19	-19		-17	-13	-9	-3	7	17	20	15	11	7	4	1
-28	-26	-26	-22	-20	-20	-14	-10	0	10	18	13	8	4	0	-3

End of Diagram 2 (Tables 3, 4 and 5)

Name of student:.....

Student Computer Number:.....

N.B: After filling in the blanks, hand the whole page back to the invigilator with your other answer sheets, clearly labelled with your name.

UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
Department of Mine Engineering

End of Semester II, Final Examination, 2001/2002
MI475: Mine Environment

TIME ALLOWED: ***3 hours***

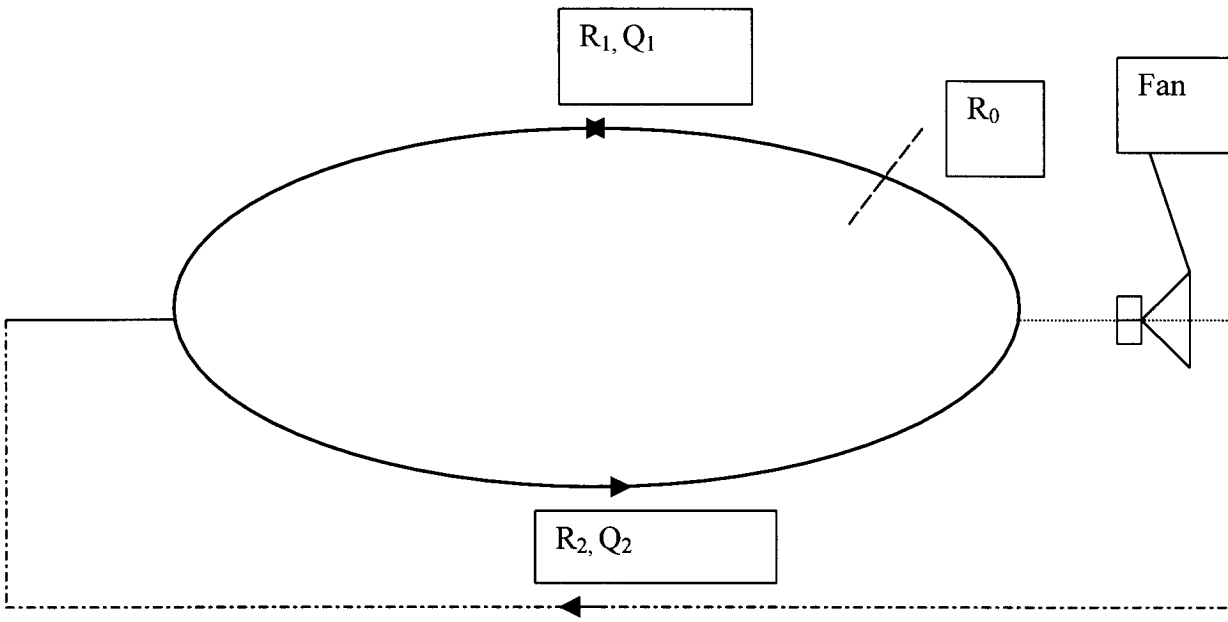
INSTRUCTIONS: This examination paper consists of six questions. You are only allowed to answer five (5) questions. Questions one (1), two (2) and three (3) are compulsory.
Note: Marks will be given for neatly drawn illustrations/diagrams. Wrongly presented illustrations will also attract negative marks.

Question 1 (20 Marks)

(I) Refer to diagram 1 below. In order to regulate air flow in the two branches with initial aerodynamic resistances of $\mathbf{R_1}$ and two $\mathbf{R_2}$, It is decided to carry out a "Negative air flow regulation" by introducing a ventilation window with unknown Resistance R_0. The initial values of $\mathbf{R_1}$ and $\mathbf{R_2}$ are 0.1 and 0.3 $NS^{-2}m^{-8}$ respectively, while $\mathbf{Q_1}$=39.87 m^3/s and $\mathbf{Q_2}$=28.2 m^3/s. If the characteristic of the fan installed in the circuit is given by **P=500 – 5Q**, find the resistance R_0 of the ventilation window that when placed in series with $\mathbf{R_1}$ will reduce the airflow by 5 m^3/s (q_1 =-5 m^3). **(10 Marks)**

(II) With the help of a simple diagonal ventilation network, derive equations for determining circuit characteristics (resistance, quantity of air flow and Pressure drops). **(5 Marks)**

(111) Estimate the pressure drop in a 0.50 m diameter pipe of uniform cross section area. The length of the duct is 100 m, while the average velocity of air is 2.5 m /s. Take any appropriate value of coefficient of viscosity μ.
(5 Marks)



Question 2 (20 Marks)

(I) An installed fan connected to a ducting measuring 75 m by 540 mm provides ventilation for an engine room through this duct. The fan is found to have the following characteristics:

Fan characteristics	Point 1	Point 2	Point 3
Air quantity, m^3/s	3.0	4.0	5.0
Static pressure, Pa	880	722	450

If the density of air handled by the fan is **1.25 kg/m^3** and that the friction coefficient *k* for the duct determined at an air density of **1.2 kg/m^3** is **0.004 NS^{2}m^{-4}**, **a)** calculate the quantity of air circulated by the fan. Assume the shock pressure loss in the duct at the entrance to the duct to be 18% of the friction pressure loss in the duct. **b)** What will be the increase in the fan quantity if an evasse of an outlet diameter of **1120 mm** and an efficiency of **80 %** is fitted at the delivery end of the duct? **(10 Marks)**

(11) Name five major factors that have to be considered when selecting a mine fan.

(5 Marks)

III) Fans can either be installed in series or in parallel. Explain what necessitates these types of installations and under what conditions they are done?

(5 Marks)

Question 3 (20 Marks)

(I) Describe in detail various methods of ventilation systems used in mines and where possible, draw a simple ventilation diagrams to illustrate your explanation. What are the advantages and disadvantages of each of this ventilation system?

(12 Marks)

(II) With the help of clear diagrams explain the ventilation systems in development ends citing as clearly as possible the location of forcing and exhaust fans. **(8 Marks)**

Question 4(20 Marks)

(I) A pipe carrying compressed air runs from the shaft-top up to the shaft bottom. The depth of the shaft is 800 m, while the temperatures at the shaft top and shaft bottom are 300 and 303 k respectively. If the moisture contents of air at the shaft-top and shaft-bottom are m_1=25 and m_2=28 g/kg of dry compressed air respectively, find the amount of heat added to the mine air by this compressed air. Take mass flow rate M=1.2 kg/s; specific heat of compressed air C_p=1005 j/kg.K and latent heat of evaporation of water l=- 2500j/g **(12 Marks)**

(II) Describe the process of auto-compression of mine air in the shaft.

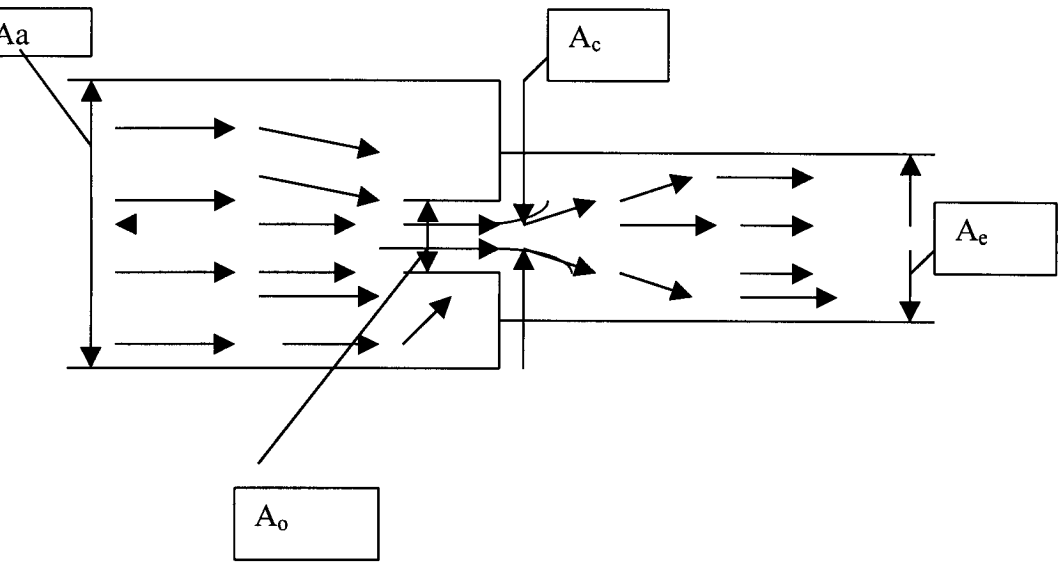
(8 Marks)

Question 5 (20 Marks)

(I) Explain how you understand by the following terms:

Static head of airway **(1 Marks)**
Velocity head of air way **(1 Marks)**
Shock losses in airway **(1 Marks)**
Kinematic viscosity **(1 Marks)**
Shock factor **(1 Marks)**

(II) Consider the diagram below showing the flow pattern of air at area change. A_a, A_o and A_e are cross section areas at various points of corresponding mine airways. A_c – vena contracta



Given that the coefficient of contraction for the said flow pattern is $C=A_c/A_o$, Derive the values of shock factors X_a, X_o and X_e corresponding to velocity pressures at A_a, A_o and A_e. **(10 Marks)**

(III) How do you understand by the term "Resistance of leakage air ways" and how is pressure drop computed in this case? **(5 Marks)**

Question 6 (20 Marks)

I) Describe five (5) major factors that cause Natural Ventilation in Mines and three (3) artificial aids to this type of ventilation.

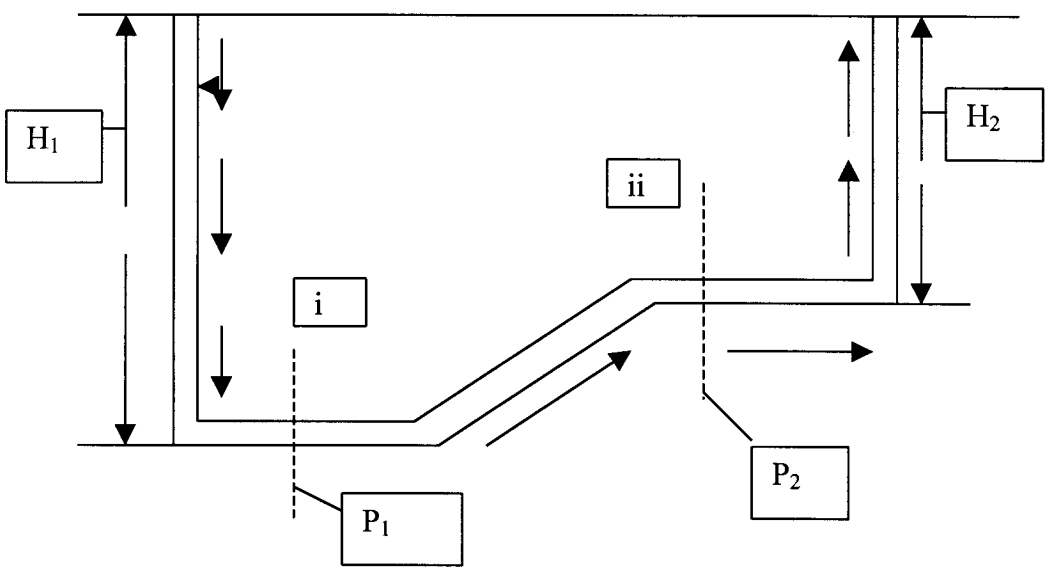
(8Marks)

(II) Find the natural Ventilation pressure prevailing at one of the mines for following conditions:

Mining depth 500 m
Average temperature in down cast shaft 297.5 K
Average temperature in up cast shaft 300.5 K
Barometric reading at pit bottom 100.5 KPa
Barometric reading at pit top 95.50 KPa **(6 Marks)**

(III) Below is a simple diagram expressing the law of air motion in the mine openings. Taking the walls of these openings to be leakage free, and the mass of air passing through these openings to be constant, derive the expression for the equation of continuity. Take P_1 and P_2 as static pressures at cross section areas i and ii respectively; H_1 and H_2 – Corresponding heights at these points.

(6Marks)



***** END OF EXAMINATION *****

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS SEMESTER II - 2002
MI 562 – INVESTMENT ANALYSIS

TIME: THREE HOURS
ANSWER: ALL QUESTIONS

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1. a) Before implementing a mining project, why are feasibility studies conducted? (5 points)
   b) Discuss some of the major sources of financing a mining project (5 Points)
   c) Explain why small-scale mining has difficulty in raising finances. (5points)
   c) Explain briefly how the Lusaka Stock Exchange can be used to raise capital for mine development. (5 points)

2. Discuss briefly the major factors that may affect a mining investment decision by foreign investors? (20 points)

3. Discuss the major risks for a mining project. (20 points)

4 A mine is considering the purchase of a new conveyor system to increase the capacity of its waste disposal system. The remaining life at the expanded capacity is 8 years. Management has narrowed the field of choice to 3 alternatives. Cost of capital is 10%, depreciation of capital expenditures is allowable for tax purposes at 30% on a declining balance basis and the effective tax is 45%. Taking these factors into account, the following are the anticipated after-tax cash flow estimates:

After-tax Estimates $x10^3$

Alternative	Capital Expenditure (US$)	Annual Operating cost (US$)	Salvage value (US$)
A	381	104	66
B	557	69	99
C	841	36	132

   a) Which is the preferred alternative? (10 points)
   b) If alternative "A" had a 10-year life and alternative "B" a 12-year life, which will be a preferred choice? (10 points)

5. Consider the following mine investment alternatives without salvage values at the end of life:

Alternative	Output per year (tonnes)	Initial investment (US$)	Annual operating costs (US$)
A	12,000	100,000	36,000
B	18,954	150,000	60,000
C	23,116	185,000	80,000
D	29,180	260,000	90,000

Note: The alternatives are mutually exclusive.

If the unit price per tonne of output is US$5 per tonne, the minimum acceptable rate of return is 10%, and a life of 10 years is being considered, what will be the most economically attractive alternative based on:

a) The discounted payback period (5 points)
b) The Net Present Value (5 points)
c) The Rate-of-return (5 points)
c) Given the different investment requirements, which is the best alternative? (5 points)

6. Answer True or False to these statements:

a) The Net Present Value depends on the discount rate and declines with its increase. (2 points)
b) The internal-rate-of return can be defined as the highest cost of capital that can be sustained by the project. (2 points)
c) The Net Present Value and Equivalent Value criteria in project evaluation will give identical results if the investment requirements and project lives are identical. (2 points)
d) The cost of capital includes the associated inflation and risk. (2 points)
e) In the calculation of the cost of capital, equity and retained earnings are ignored since this is part of the owners' contribution to the project. (2 points)
f) Inflation is ignored in project evaluation because it affects all input parameters equally. (2 points)
g. Taxes especially non-cash flow based ones such as royalties do not affect the profitability of the project. (2 points)
h. The rate and method of depreciation used is selected by the company because it affects the amount of taxes to be paid. (2 points)
i. Bonds are a form of debt that is always secured by collateral. (2 points)
j. Unlike during the primary offer of shares on the Stock Exchange, during secondary trading, shares are now offered at a discount. (2 points)

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
DEPARTMENT OF MINING ENGINEERING

2001/2002 - 2ND SEMESTER EXAMINATION

MI 585: MATERIALS HANDLING **TIME: 3 HOURS**

Q 1 a) Based on the notion of "Circular Analysis, state and explain the importance of equipment selection in Mine Optimization. **(10)**

(b) Write brief notes and comment on the major factors affecting the selection of equipment in materials handling for both surface and underground mining. **(10)**

Q2. (a) Write brief notes on the principles and purposes of drilling in mining with emphasis on the application and limitations of:-

- Percussion Drilling **(04)**
- Rotary Drilling **(04)**
- Roto-percussion Drilling **(04)**

(b) State and with the aid of corresponding sketches, explain the principles underlying bit penetration in percussion drilling paying special attention to; chip formation, crater formation, influence of flushing medium and type on chip bailing. **(08)**

Q 3 (a) With the aid of a sketch, list and describe the roles of the major components of a large Rotary Blasthole Drill **(06)**

(b) Given the following average figures for:

(i) Rotary Blasthole Drilling parameters

- Compressive Strength ..... 28×10^3 psi
- Pull-down Pressure ..... 120×10^3 psi
- Revolutions per Minute..... 85rpm
- Blasthole diameter ..... 15 in (381 mm)

and

(ii) Blasting Parameters

- Bench height ..... 10.0 m
- Highwall angle ..... 70°
- Rock density ..... 2,35 g/cm^3
- Explosive Density ..... 0,85 g/cm^3
- Coefficient of Spread ..... c = 1,5 to 2
- Number of rows per blast ....n = 3 + delay sequencing

Calculate:-

(i) Penetration rate of the Rotary Blasthole drill
(ii) Blast Design parameters
(iii) Explosives Consumption per hole

(iv) Rock broken per hole
(v) Powder factor
(vi) Spread of broken muck-pile **(14)**

Q 4 Given that a quarry with consolidated limestone requires producing a total volume of 5 million bank cubic meters of aggregate to satisfy the requirements of a construction project. You are required to determine and justify the loading and haulage equipment types knowing:

(a) Materials Characteristics

Type	Limestone
SG – Loose	1.85 t/m^3
SG – Bank	2.25 t/ m^3

(b) Loading Equipment Alternatives

Front-End-Loader		Hydraulic Shovel	
Type	CAT 994	Type	DEMAG H-185
Bucket Capacity (m^3)	16.0		16.0
Bucket Fill Factor (%)	90		95
Av. Cycle Time (sec)	40		30
Minutes per Hour (min)	50		50
Availability (%)	90		90
Utilization (%)	90		90

(c) Haulage Truck Alternatives

	Type 1 CAT-777	Type 2 CAT-785	Type 3 CAT-789
Capacity (m3)	51	78	105
Pay Load (tones)	86	136	177
Spot Time (sec)	20	20	20
Waiting Time	10	10	10
Travel Distance (m)	4 000	4 000	4 000
Travel Speed – loaded	30km/hr	25km/hr	25km/hr
Travel Speed – empty	60km/hr	60km/hr	60km/hr
Maneuver/dump time	30 secs	30 secs	30 secs

Knowing that the quarry operates 3 x 8 hr shifts per day and 260 days per year, you are required to:

I Determine the maximum production achievable by each loading equipment type in BCM/Hr and Tonnes/Hr **(05)**

II Select and justify which loading equipment type and truck size combination you would deploy in the quarry **(05)**

III For the truck size selected, determine:
a) Number of passes to fill the truck
b) Loading time per truck
c) Loaded trucks per Hour
d) Truck production in BCM and tonnes per hour

e) Loading and haul equipment fleet sizes to be made available for the handling of the 5 million BCM per annum. **(10)**

Q 5 a) Write brief notes on Hoisting under the following sub-headings:

- Composition, classification and types of hoisting systems
- Shaft tasks and types
- Headgear (Headframe) types and tasks
- Winding tower types **(12)**

b) With the aid of corresponding sketches, discuss the principles of the design and operation of Friction (KOEPE) Hoists. **(08)**

Q 6 a) State and briefly comment on the steps involved in the selection of the correct size of a Front-End-Loader (FEL) **(10)**

b) Describe the application and operation of a Front-End-Loader as an underground haulage machine (LHD-Mode) as compared to its use as a loading machine in surface mines, paying special emphasis to the machine characteristics and limitations. **(10)**

Q 7 a) With the aid of corresponding sketches, show the main features of a Hydraulic Excavator and a Rope Shovel employed as the main surface mine excavation and loading machine. **(10)**

b) List and comment on the differences in the operational characteristics of a Hydraulic Excavator as compared to a Rope Shovel (Break-out force, crowding force, total cycle time, economic life; etc) **(10)**

GOOD LUCK!

THE UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

2001/2002 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

MM 205: INTRODUCTION TO METALLURGY

TIME: THREE HOURS
ANSWER ANY FIVE QUESTIONS AND EACH HAS 20 MARKS. USE SEPARATE BOOKLETS FOR EACH PART.

PART A: METALLURGY AND MINERAL PROCESSING

1

(a) What are unit operations and unit processes? What do metallurgical flow sheets represent and mention five pieces of information that a flow sheet will contain.

(b) How is mineral liberation achieved during size reduction and what important property does the process of flotation as applied to sulphide ores depend on?

2

(a) Define the terms *recovery* and *grade* as used in the mineral concentration process. Explain why a compromise has to be made in the attainment of the optimum levels of the two parameters.

(b) Explain the significance of the following terms

(i) **size distribution** of a ground mineral sample

(ii) mass or volume **specific surface** of mineral particles in relation to chemical reactions

3

(a) The mechanisms of are breakage applicable during size reduction depend on the type of equipment in use. Illustrate the resulting size distribution on a graph if size reduction is taking place by the following mechanisms;

(i) abrasion
(ii) compression and
(iii) impact.

Why is abrasion typical in both crushing and grinding?

(b) Distinguish between roasting and calcination with the help of appropriate equations.

What is matte smelting? Explain the role of sulphur in the smelting of chalcopyrite and what is the current practice in the recovery of sulphur?

PART B: INTRODUCTION TO GEOLOGY

4

(a) Describe the Nebular Theory of Pierre Laplace.
(b) State the two arguments against the Big Bang Theory.

5

(a) Using well labeled diagrams, describe in detail the following:
(i) Internal Structure of the Earth
(iii) The Rock Cycle

(b) Name of the three major types of rocks
(c) and give examples

6

(a) List the eight major elements forming up the minerals in the earth, stating their relative percentages.

(c) Classify the following minerals under the most appropriate class and indicate their chemical formulae:

(i) Chalcopyrite

(ii) Graphite

(iii) Dolomite

(iv) Gypsum

(v) Magnetite

(vi) Hematite

(vii) Calcite

(viii) Gold

(ix) Quartz

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

2001/2002 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

MM 205: INTRODUCTION TO METALLURGY II (PRACTICAL)

TIME: THREE HOURS
ANSWER ALL QUESTIONS

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1 Describe the rock specimens A, B, C, D and E in terms of:

(i) Colour
(ii) Mineralogical composition
(iii) Texture
(iv) Structure
(v) Type
(vi) Name

2 Describe the major properties of mineral specimens F, G, H, I and J. Name the specimens and indicate their mineral class.

3 Draw a sketch of every crystal model given K, L, M and N. Indicate how many axes of symmetry they have and to what crystal class they belong.

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

2001/2002 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATIONS

MM 332: CHEMICAL THERMODYNAMICS II.

TIME : THREE HOURS

INSTRUCTIONS: QUESTION ONE AND ANY OTHER FOUR. ALL QUESTIONS CARRY EQUAL MARKS

The Henrian activity coefficient Υ^{o}_{Al} for Aluminium in liquid iron-Aluminium alloys is reported to be 0.063 at 1600°C. Calculate the standard free energy of formation of Al_2O_3 at 1600° C for each of the following four standard states for A:

a) $2Al(l, pure) + 3/2O_2(g) = Al_2O_3(s)$
b) $2Al(l, h) + 3/2O_2(g) = Al_2O_3(s)$
c) $2Al(l, wt) + 3/2O_2(g) = Al_2O_3(s)$
d) $2Al(l, at) + 3/2O_2(g) = Al_2O_3(s)$

$\Delta G^{o} = -1{,}682{,}927 + 323.239T$ J/mol.

Molecular weights if Aluminium and Iron are 26.98 and 55.85 respectively.

(a) Derive the expression for the depression of the freezing point of a Solvent A due to the addition of a small amount of non-volatile solute B.

(b) A 1-litre flask contains hydrogen at 27°C and 1 atmosphere. The flask is connected to another flask having a volume of 2 litres and containing oxygen at 27°C and 0.6 atmosphere. The gases diffuse into each under isothermal conditions. Calculate the partial pressure of both hydrogen and oxygen at this temperature.

(a) Liquids A and B form ideal solutions. They are isomeric. A solution of composition N_A is found to have a vapour pressure of 650mm Hg at 50°c. It is then distilled until half has been collected as condensate. The condensate has a composition $N^{C}_{A} = 0.60$ and the residual liquid a composition of $N^{L}_{A} = 0.40$ and vapour pressure of 600 mm Hg at 50°C. Calculate N_B, P^{o}_{A} and P^{o}_{B}.

b) A solute, B obeys the following relation in a dilute binary solution of a solvent A and solute B :

$$f_B = kN_B^{\frac{3}{2}}$$

Where N_B is the mole fraction of the solute. Derive the expression for the fugacity of the solvent f_A. .

4. An iron-chromium alloy is brought to equilibrium with a H_2 - H_2O mixture in which $\frac{P_{H_2O}}{P_{H_2}} = 0.00353$, in a pure Alumina crucible at 1700° C. The equilibrium is represented by:

$$H_{2(g)} + [O]_{Fe,Wt\%} = H_2O_{(g)}$$

The alloy at equilibrium contains Cr: 1.90%, Al: 0.031% and O: 0.0032% by weight. The values of the various interaction parameters are:

$\varepsilon_o^o = 0 \quad \varepsilon_o^{Cr} = -0.058 \quad \varepsilon_o^{Al} = -3.15$

Calculate the free energy change of the above reaction at 1700° C.

5. Myles investigated the vapour pressure of solid silver and solid silver-palladium alloys in the temperature range 1092 – 1221°K. The vapour pressure in (mm Hg) were expressed as function of temperature as follows for pure solid silver

$$\log P = \frac{-13{,}696}{T} + 8.727$$

For solid Ag – Pd alloy $N_{Ag} = 0.802$

$$\log P = \frac{-13{,}795}{T} + 8.649$$

a) Calculate the fugacity of silver in pure state and in the alloy at temperature 1200°K.

b) Calculate the activity and activity coefficient of silver in the Ag – Pg solid solution at 1200°K.

6. The inversion of sucrose proceeded as follows in a certain experiment

Time (Min.)	0	30	60	90	130	180
Sucrose inverted (Moles/dm^3)	0	0.1001	0.1946	0.2770	0.3726	0.4676

The initial concentration of sucrose was 1.0023 moles per dm^3. Calculate the first order rate constant and the half life of the reaction.

7. The voltage of the cell is given as follows:

Ag | $Ag_2SO_{4(s)}$ | | Sat'd soln of $H_2SO_{4(aq)}$ | | $Hg_2SO_{4(s)}$ | Hg

Is found to be 0.140 V at 25° C and it's temperature coefficient is 0.00015 volts/°C.

(a) give the half electrode reactions and the overall reaction.
(b) Calculate ΔG, ΔH and ΔS for the cell reaction.

Does the cell absorb or emit heat as cell reaction proceeds?

Gas constant R = 8.314 J/K/mol, Faraday's constant 96487 C/g- equivalent
= 0.08206 liter.atm/g.moles. K
1 Atmosphere = 760 mm Hg
= 101325 N/m^2, Pa

END OF MM 332 EXAMINATION, GOOD LUCK.

THE UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

2001/2002 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

MM 412: MINERAL PROCESSING II

IME: **THREE HOURS**
NSWER **ANSWER QUESTION 1 AND ANY OTHER FOUR, BUT KEEP YOUR ANSWERS BRIEF AND TO THE POINT. RELATIVE WEIGHT OF EACH QUESTION INDICATED IN BRACKETS**

---

uestion 1

tate briefly what you understand by the following terms, used in mineral processing:

the wash ratio in filter cake washing
reslurry washing
reverse flotation
differential flotation
consolidation trickling
cobbing
magnetic susceptibility
remanence
coagulation
flocculation

[20 %]

uestion 2

) What do you understand by the 'concentration criterion' in gravity separation?

State in a few words what use is made of this criterion in the separation of minerals by gravity methods.

) What are the main factors determining whether the feed particle is rejected, held in the bed, or passed down through in jigging?

) Outline the usual sequence of operation in the heavy media separation process.

) What are the main requirements for a medium to be used in heavy media separation?

(e) Draw a simplified flowsheet of a heavy media separation plant, using a cone separator and ferrosilicon as medium, and show how the medium is recovered.

Explain your flowsheet in a few words.

(f) What are the main applications of heavy media separation?

[20 %]

Question 3

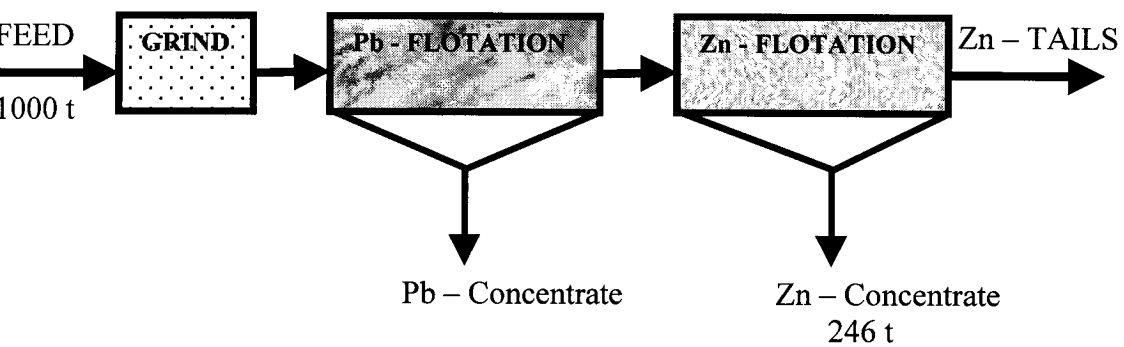
(a) Describe the operation of a column flotation cell with the aid of a clearly labelled diagram indicating the various zones that can be distinguished.

(b) Explain the role played by the following reagents used in mineral flotation:

- collectors
- frothers
- modifiers

(c) Make a working diagram of a Denver DR flotation cell. Indicate the direction of the pulp flow and the froth zone in your diagram.

(d) Given below, is the flotation circuit of a lead-zinc ore, which produces a lead concentrate, a zinc concentrate and a zinc tailings as follows:



Product	Weight (t)	Assay (%)		Weight (t)		Recovery (%)	
		Pb	Zn	Pb	Zn	Pb	Zn
Feed	1000	10.0	12.8	-	-		
Pb-cons	-	50.0	-	-	-	-	-
Zn-cons	246	1.6	26.0	-	-	-	-
n-tailing	-	1.0	5.6	-	-	-	-

Complete the above metallurgical balance for one shift, during which 1000 tonnes of this ore were treated.

[20 %]

Question 4

(a) Briefly state the differences between diamagnetic, paramagnetic and ferromagnetic substances.

(b) What factors limit in practice the intensity of the applied magnetic field?

(c) Because of these limitations, what else is done in industrial practice to obtain a high magnetic force on the particles to be separated?

(d) Make a working diagram of a three-stage induced-roll magnetic separator in operation and briefly explain how such equipment functions.

(e) In industrial concentration of minerals by magnetic separation, flocculation, or agglomeration of particles occur, which entrain gangue and bridge the gaps between the poles. How can this flocculation and entrainment of gangue be minimised and if possible prevented?

(f) Explain briefly what you understand by high-tension separation with the help of a sketch. What sorts of particles are found in the non-conducting and conducting products?

What are the main avenues along which charge can be acquired by a particle?

[20 %]

Question 5

(a) Describe the operation of a thickener with the aid of a clearly labelled diagram, showing the various zones that can be distinguished.

What do you understand by the 'solids-handling capacity' of the thickener?

(b) Draw a schematic diagram of a horizontal belt filter used in a countercurrent cake washing operation. Clearly indicate the routing of the various process streams in your diagram.

Referring to your diagram, briefly describe and explain this cake washing operation.

(c) Describe the upstream method of tailings-dam construction with the aid of a clearly labelled diagram.

Outline the advantages and disadvantages of this method.

What are the most serious problems associated with the disposal of tailings and how are they minimised?

[20 %]

Question 6

(a) Briefly describe the steps, necessary for the attachment and adhesion of solid particles to air bubbles in a mineral pulp.

(b) Describe the concepts of a 'disjoining pressure', of a 'critical film thickness' and of an 'induction time' in flotation.

(c) What is the effect of the adsorption of a suitable collector upon the critical film thickness and the induction time?

(d) A zinc-lead sulphide ore, assaying 12.6 % PbS and 17.4 % ZnS, is treated by flotation.

With the assumption that the only minerals in the ore are galena, sphalerite and silicate gangue, calculate:

- the theoretically possible recoveries of gn and of sl after two minutes flotation and after six minutes flotation;

- the theoretical concentrate grade (% PbS and % ZnS) after two minutes flotation and after six minutes flotation.

The specific rates of flotation under the conditions chosen were found to be:

galena	0.6 min^{-1}
sphalerite	0.1 min^{-1}
water	0.05 min^{-1}
silicates	0.02 min^{-1}

You may assume flotation to be first-order and these flotation rates to remain constant during the flotation times considered. You may also assume all the gn and sl to be floatable under the conditions chosen.

[20 %]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES

2001/2002 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

MM422: PHYSICAL METALLURGY II

HREE HOURS
CTIONS: ANSWER ALL THE QUESTIONS

---

plain the following terms:
Bragg's law
Structure factor
) Reciprocal lattice
) Weiss Zone Law

n the powder photograph of copper (f.c.c.), a {420} reflection was found but a {210} reflection vas not. These observations are due to what are known as "systematic absences." For f.c.c. naterials, the only reflections allowed are for h, k, and l all even or all odd. With the aid of a 001> projection of the f.c.c. unit cell, show why the {420} reflection would be present and the 210} reflection absent.

hat is the Pilling-Bedworth rule?

escribe the anodic protection of materials against corrosion.

ith the aid of appropriate sketches, describe how you would use polarization diagrams to etermine the effectiveness of corrosion inhibitors.

25°C, $E_{Fe/Fe}^{2+}$ = -0.44V and $E_{Al/Al}^{3+}$ = -1.67V. If you were trying to make a choice between steel l aluminium based on the best corrosion resistance, which would you intuititively choose? Is the oice consistent with the E values above? If not, explain the discrepancy.

hat is the phenomenon on which almost all strengthening mechanisms of materials are based?

ingle crystals are very much weaker than they theoretically should be, because dislocations can perate to produce slip at low values of resolved shear stress. In what way can the presence of rain boundaries in polycrystals lead to higher yield strengths than those of single crystals?

or each of the materials given below, list those strengthening mechanisms that measurably ontribute to the strength of the material in its stated form.
) Pure aluminium sheet, rolled from 0.6 cm to 0.3 cm in thickness.
i) 70%Cu-30%Zn polycrystal.
ii) 4.5%Cu-95.5%Al, water-quenched from single phase region and held for 1 hour at 204°C.
v) A very large steel component requiring a hard wear-resistant surface.

(a) Distinguish between hardness and hardenability.

(b) Is it possible for two steels to have the same hardenability but different hardnesses? Explain v briefly.

(c) Figure 1a is the Fe-rich end of the Fe-Fe_3C phase diagram. Figure 1b is a time-temperat transformation (TTT) curve for an Fe-1wt.%Mn - 0.8 wt.% Cr - 1.8 wt.%Ni - 0.6 wt.%C s Consider the "C curves" in Figure 1b in the range of about 745 to 535°C. The three curves (g from left to right) indicate:

(i) 1% transformation to proeutectoud ferrite
(ii) 1% transformation to pearlite
(iii) 100% transformation

Consider an alloy which is isothermally transformed at just above 540°C. At this temperature curves (i) and (ii) are coincident i.e. the austenite transforms to 100% pearlite. Conversely, temperature of say 660°C the austenite transforms to proeutectoid ferrite and pearlite. Explai detail the above observations.

(a) What is the ductile-brittle transition?

(b) Justify why steels with low ductile-brittle transition temperatures should be the most expensive.

(c) Write a short account of the need to consider fatigue in engineering design.

(d) In a steel plate 30 cm wide and 0.64 cm thick, there is a 2.5 cm long crack along the edge ($E = 2 \times 10^{11}$ Pa and $G_c = 35000$ N/m).

(i) Calculate the force required to propagate the crack the remaining 27.5 cm across the widt the plate.

$$\sigma_f = \sqrt{\frac{2E\gamma}{\pi c}}$$

(ii) Calculate the force required to break the plate in simple tension if there were no crack. Ass that the fracture strength is 689 MPa.

END OF EXAMINATION

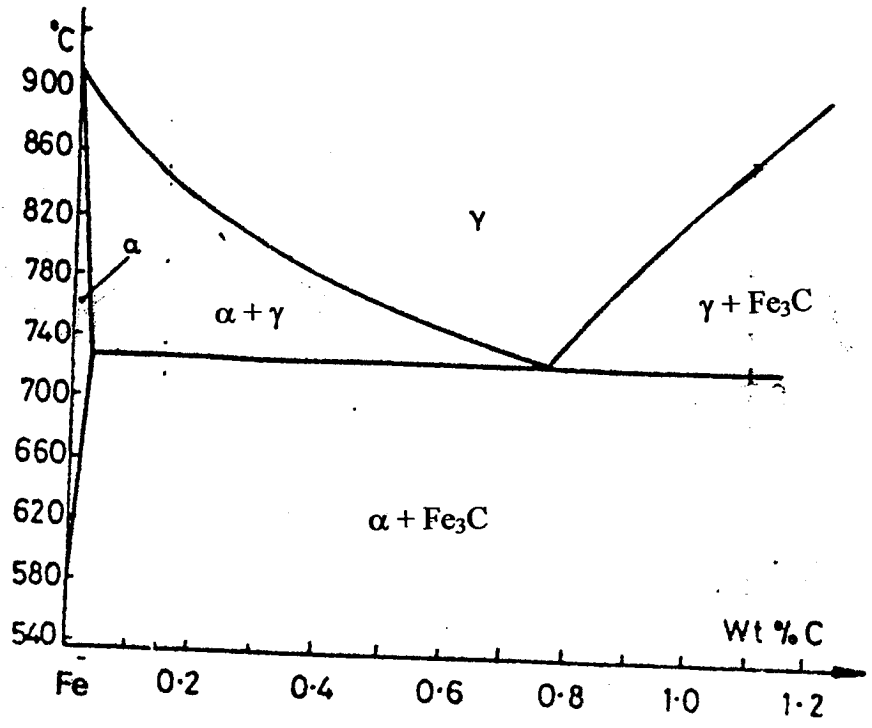


Figure 1a

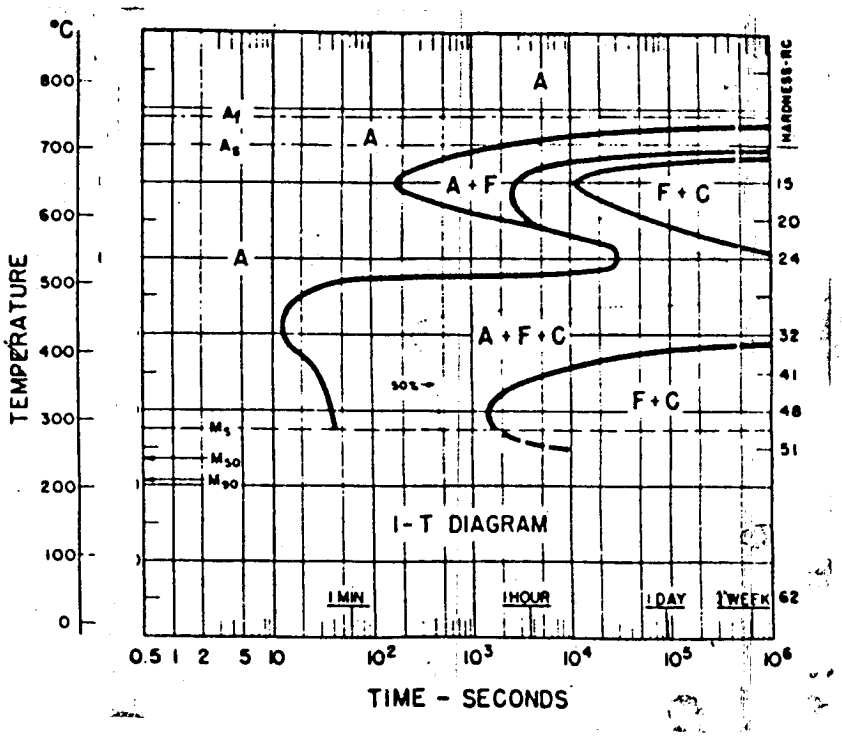


Figure 1b

THE UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

2001/2002 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

MM 442:HDROMETALLURGY

TIME: THREE HOURS
ANSWER ALL QUESTIONS

1.a. In a laboratory leaching experiment, a nickel ore with 2.1% Ni is leached to yield one dm^3 of (pregnant) solution. The concentration of this solution is too high to be measured directly by atomic absorption spectrophotometry (AAS). Therefore, 2 ml of the pregnant solution is pipetted and made up to 250 cm^3 of a solution "P" using distilled water. Ten millilitres of "P" is pipetted and made up to 50 cm^3 with distilled water, to obtain solution "Q". If "Q" is found by AAS to analyze 3.8 ppm Ni, what is the mass of nickel ore leached if the percentage of nickel leached in the experiment has to be 84.3% after calculation?

1.b. Consider the case of leaching a concentrate with spherical particles in which the reaction proceeds topochemically. Assuming that the rate determining step during the leaching of the concentrate is the chemical reaction at the reaction interface and that the reaction obeys first order kinetics, show that the following relationship is valid in the process:

$$\alpha = 1 - (1 - Kt)^3$$

where α is the fraction of sample reacted at time t and K is a constant. State any other assumptions made in your derivation.

1.c. How would you use leaching experiments conducted at different temperatures to determine if a leaching reaction is rate limited by diffusion or by chemical reaction at the reaction interface.

2. In a continuous agitation leaching operation 2.25 tonnes of solute-free lixiviant is used for every 1.25 tonnes of a concentrate. The concentrate contains 10% of leachable values, 10% moisture, and the remainder is insoluble material. All leachable values dissolve in the leaching vessel before the pulp is introduced into the first thickener of a 3 stage counter current decantation washing unit. For every 1.25 tonnes concentrate leached, five tonnes of pure wash water is added in the last thickener which yields a disposable residue.

(i) Draw a clearly labelled diagram which would best represent the operation as described above.

(ii) What is the amount of pregnant solution produced for every 1.25 tonnes of concentrate leached, assuming an underflow sludge with 30%, 40%, and 50% solids in the first, second, and last thickener, respectively?

(iii) With a further assumption that the repulping efficiency is 95%, 90%, and 85% in the first, second and last thickener, respectively, calculate the percentage of dissolved values recovered into the pregnant solution.

(iv) What measures may be used to increase the dissolved value recovery in the circuit. Point out any demerits of any suggestions you make.

3.a. Outline the industrial methods for crystallizing metals and inprganic salts from hydrometallurgical solutions.

3.b. In the neutral leaching of zinc calcine, a 2 molal Zn^{2+} solution is approaching equilibrium with $Zn(OH)_2$ and $Fe(OH)_3$. Calculate the equilibrium Fe^{3+} concentration and pH of the solution when for the reactions, $Zn(OH)_2 = Zn^{2+} + 2OH^-$ and $Fe(OH)_3 = Fe^{3+} + 3OH^-$ the equilibrium constants are $4.5 * 10^{-17}$ and $6 * 10^{-38}$, respectively.

3.c. It is known that when carbon dioxide is bubbled through water it forms a weak dibasic acid H_2CO_3 whose overall dissociation constant at 25 °C is $2.08 * 10^{-18}$.

If carbon dioxide is bubbled through an aqueous solution containing Zn^{2+} so as to precipitate zinc carbonate, calculate the minimum solution pH for the residual Zn^{2+} activity in solution not to exceed 10^{-3}. Take the solution temperature as 25 °C and the equilibrium activity of H_2CO_3 in solution as 0.1. The solubility product of zinc carbonate is $1.00 * 10^{-10}$ at 25 °C.

4.a. What are the similarities and differences of precipitating metals from solution using hydrogen gas and hydrogen sulhide gas.

4.b. What is the ionic activity of nickel under equilibrium conditions following precipitation of metallic nickel from a solution of pH = 5.5 in contact with 1 atmosphere of hydrogen gas at 25 °C? $E^{\circ}_{Ni} = -0.25$ V

4.c. Is the nickel ion activity as calculated above increased or decreased with:

(i) a decrease in pH of the solution?

(ii) an increase in hydrogen pressure?

UNIVERSITY OF ZAMBIA

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2001/2002 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATIONS

MM 452/AGF 452: PROCESS CONTROL AND INSTRUMENTATION

TIME : THREE HOURS

INSTRUCTIONS: ANSWER TWO QUESTIONS FROM SECTION A
and **THREE QUESTIONS FROM SECTION B**

All additional data that the student will require are attached.

SECTION A

1. (a) The student-teacher learning process is inherently a feedback process intended to reduce the system error to a minimum. The desired output is the knowledge being studied and the student may be considered the process. Construct a feedback model of the learning process and identify each block of the system.

(b) In the home, the refrigerator has a temperature setting, a thermostat to measure the actual temperature and error, and a compressor motor for power amplification. Draw a block diagram of this feedback process.

(c) Describe each of the following equations, giving its order, degree and telling whether it is ordinary or partial and linear or nonlinear. *If it is nonlinear, give the reason.* The equations are as follows:

(i) $y'' + 2y' + \cos y = 0$

(ii) $y'' + (a + b\cos 2x)y = 0$

(iii) $y\dfrac{\partial^2 y}{\partial x^2} = \dfrac{\partial^2 y}{\partial x \partial t}$

(iv) $\dfrac{d(xy')}{dx} + (y')^2 + x^2 y = 0$

(d) If C_1 is an arbitrary constant, find a differential equation of minimum order of which the following is a general solution:

$$y = e^{-x} + C_1 e^{-2x}.$$

2. (a) Solve the following equation:

$$x\frac{dy}{dx} + 3y = 8x^5 \qquad \text{where } y = 0 \text{ when } x = 1.$$

(b) Using Laplace transforms or otherwise, find a solution of the differential equation

$$\frac{d^2y}{dt^2} + 2\frac{dy}{dt} + 5y = 4e^{-t}$$ which satisfies the condition $y(0) = 0$, $y'(0) = 0$ when $t = 0$. Also, calculate $y(\pi/2)$, $y(\pi)$ and $y(2\pi)$.

3. (a) The function f(t) has the Laplace transform

$$f(s) = \frac{(1 - 2e^{-s} + e^{-2s})}{s^2}$$

Find f(t) and f(1.5).

(b) Solve the following equations for y(t):

(i) $\int_0 y(t)dt = \frac{dy}{dt}$, $y(0) = 3$.

(ii) $\frac{dy}{dt} + 3y + 2\int_0 y(t)dt = 2u(t-1)$, $y(0) = 1$.

SECTION B

4. A thermometer is located in a bath at a temperature x which varies with time. You are required to calculate the response of the thermometer y for a particular change in x.

(a) Derive the transfer function between Y(s) and X(s) as deviation variables.

(b) Using the transfer function in part (a) do the following:

(i) A thermometer having a time constant of 2 min is initially at 50 ^{0}C. It is immersed in a bath at 100 ^{0}C at t = 0. Determine the temperature reading at t = 3 min.

(ii) If at t = 3.5 min the thermometer is removed from the bath and quickly placed in a bath at 75 ^{0}C, determine the maximum temperature indicated by the thermometer. What will be the indicated temperature at t = 30 min?

5. A step change of magnitude 4 is introduced into the transfer function

$$\frac{Y(s)}{X(s)} = \frac{10}{(2s^2 + 0.3s + 0.5)}$$

Determine the

(i) ultimate value of Y(t),
(ii) maximum value of Y(t),
(iii) per cent overshoot,
(iv) period of oscillation.

6. A process has the following transfer function

$$G_2 = \frac{K_M}{(\tau s + 1)}$$

If a PI controller is used with τ_I equal to τ and unity feedback, draw the block diagram. Then calculate

(a) the value of the controller gain in terms of K_M that gives a closed-loop damping coefficient of 1.0 (critical damping),

(b) the closed-loop time constant using this value of gain,

(c) the steady state error for a unit step change in set point.

7. (a) An electronic proportional controller is used to control temperature within the range of 40 ^{0}C to 90 ^{0}C. The controller is adjusted so that the output current goes from 4 ma (valve fully open) to 20 ma (valve fully closed). The proportional band is set at 25. Find the gain and the temperature range necessary to cause the valve to go from full open to fully closed for a constant set point. If the set point of the controlled temperature is 65 ^{0}C, calculate the corresponding temperatures for the valve to go from fully open to full closed.

(b)Repeat part (a) with the proportional band set at 75%.

(c) A unit step change in error is introduced into a PID controller. If $K_c = 10$, $\tau_I = 1$ and $\tau_D = 0.5$, derive the expression for the response of the controller P(t). What is P(0) and P(2)?

8. A feedback control system has a characteristic equation

$$s^4 + 12s^3 + 64s^2 + 128s + K_c = 0.$$

The parameter K_c must be positive. What is the maximum value of K_c before the system becomes unstable? When K_c is equal to the maximum value, the system oscillates. Determine the radian frequency and period of oscillation.Calculate the other two corresponding roots.

END OF EXAMINATION IN MM 452/AGF 452

Additional information to assist the students in this examination is found below.

Table of Laplace Transforms

f(t)	f(s)	f(t)	f(s)
u(t)	$\frac{1}{s}$	tu(t)	$\frac{1}{s^2}$
$t^n u(t)$	$\frac{n!}{s^{n+1}}$	$e^{-at}u(t)$	$\frac{1}{s+a}$
$t^n e^{-at}u(t)$	$\frac{n!}{(s+a)^{n+1}}$	sin kt u(t)	$\frac{k}{s^2+k^2}$
cos kt u(t)	$\frac{s}{s^2+k^2}$	sinh kt u(t)	$\frac{k}{s^2-k^2}$
cosh kt u(t)	$\frac{s}{s^2-k^2}$	$\delta(t)$,unit impulse	1

Inversion by partial fractions

METHOD 1

Suppose $L\{x(t)\} = x(s) = \dfrac{F(s)}{(s+k_1+jk_2)(s+k_1-jk_2)}$

where F(s) is some real function of s.

Let the function x(s) after partial fraction expansion become

$$x(s) = F_1(s) + \left(\frac{a_1+jb_1}{s+k_1+jk_2} + \frac{a_1-jb_1}{s+k_1-jk_2}\right)$$

where a_1 and b_1 are constants evaluated in the partial fraction expansion and $F_1(s)$ is a series of fractions arising from F(s).

Then the inverse transform arising from the complex root reduces to

$$2e^{-k_1 t}(a_1 \cos k_2 t + b_1 \sin k_2 t)$$

METHOD 2

Suppose x(s) after partial fraction expansion becomes

$$x(s) = F_1(s) + \frac{Bs+C}{(s+a)^2+k^2}$$

Then $$x(s) = F_1(s) + B\frac{s+a}{(s+a)^2+k^2} + \left(\frac{C-aB}{k}\right)\frac{k}{(s+a)^2+k^2}$$

The inverse transform arising from the above becomes

$$x(t) = F_1(t) + Be^{-at}\cos kt + \left(\frac{C-aB}{k}\right)e^{-at}\sin kt$$

THE UNIVERSITY OF ZAMBIA

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2001/2002 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

MM 542: FUELS, FURNACES AND REFRACTORIES

TIME: THREE HOURS
ANSWER ALL QUESTIONS

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1. (a) What are the three assumptions considered in the determination of an ideal flame temperature? [3 %]

(b) A fuel containing 22.4 % CO, 12.6% CO_2 and 65% N_2 by volume is burned with the theoretically required amount of air in a furnace designed to heat solids. The gases enter the furnace at 20°C and leave it at 700°C and 1 atm.

(i) Calculate the adiabatic flame temperature. [9 %]
(ii) If in (i) above the fuel had to be preheated to 250°C, what would the adiabatic flame temperature be? [8 %]

Data:

$(\Delta H^{o}_{298})_{CO}$ = - 110,530 J/mole

$(\Delta H^{o}_{298})_{CO2}$ = - 393,770 J/mole

Heat capacity data (in J/g.mole. oK):

$Cp_{,CO2} = 44.17 + (9.04 \times 10^{-3}T) - (8.54 \times 10^{5}/T^{2})$

$Cp_{,CO} = 28.43 + (4.10 \times 10^{-3}T) - (0.46 \times 10^{5}/T^{2})$

$Cp_{,N2} = 27.88 + (4.27 \times 10^{-3}T)$

$Cp_{,O2} = 29.98 + (4.19 \times 10^{-3}T) - (1.674 \times 10^{5}/T^{2})$

2. (a) How are high temperatures developed in practice using solid fuel? [2 %]

(b) Describe **four** factors affecting the temperature attained in the combustion of a fuel. [4%]

(c) Outline **five** sources of gaseous fuels and state the advantages of gaseous over solid and liquid fuels. [6 %]

(d) Define the term "calorific value" [2 %]

(e) What is meant by "carbonisation" of coal and what is main objective of this process. [6 %]

3. (a) Outline the general route followed in the manufacture of refractories. [7.5 %]

(b) Outline **five** most important properties of refractory materials that are considered in the selection of refractories for furnace lining. [2.5 %]

(c) Describe how each of the above **five** properties are determined. [10 %]

4. (a) With the aid of a sketch, describe the important allotropic forms of silica. [4 %]

(b) Outline **four** properties of silica refractories. [4 %]

(c) What are the main factors that are considered in furnace construction. [7 %]

(d) Describe the operation of a Multihearth Roaster. [5 %]

5 (a) Write the chemical reaction for the production of doloma. [2 %]

(b) What is meant by a doloma brick "Perishing" and "Dusting"? [6 %]

(c) Why do you need to "stabilise" the dolomite brick before manufacture? [2 %]

(d) Describe, briefly, the manufacture of fired stabilised dolomite bricks. [5 %]

(e) Write the chemical reaction occuring during firing when dolomite is stabilised with serpentine. [2 %]

(f) Define "special refractories" [3 %]

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

2001/2002 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATIONS

MM 552: PROCESS DESIGN

TIME : **THREE HOURS**

INSTRUCTIONS: ANSWER ANY FIVE QUESTIONS
All additional data that the student will require are attached.

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1. (a) Show how the following set of equations may be partitioned and indicate the order of solution:

$$\begin{aligned} f_1(x_1, x_2, x_3) &= 0 \\ f_2(x_1) &= 0 \\ f_3(x_3) &= 0 \\ f_4(x_3, x_4) &= 0 \end{aligned}$$

(b) You are working in a laboratory and are requested to melt 200 kg of stainless steel, AISI Type 304, with an analysis of 17.5% Cr, 8.5% Ni and 0.5% Mn. Assuming no losses during the melting, compute the charge that you would use for the following available materials:

% :	Cr	Ni	Fe	Mn
alloy scrap	68	20	10	2
ferrochromium	75		25	
electro Ni		100		
electro Fe			100	

2. (a) The phase rule for ordinary systems is given as $f = C - P + 2$. Suppose that the equilibrium between phases of a single-component metallic system is affected by the applied magnetic field in addition to the temperature and pressure. Determine the maximum number of phases that can co-exist.

(b) A reduction process requires a feed of C, O_2 and MO. This feed produces liquid M and a gas phase containing CO and CO_2. For thermodynamic reasons, the ratio of CO and CO_2 in the product is desired to be K. The mass of MO fed (F kg) to the system and the mass of CO (β kg) in the output gas are given. Set up the equations that must be solved to find the mass of C (W_C), the mass of O_2

(W_{O_2}) and the mass of CO_2 (W_{CO_2}) in the input and output streams. Precedence-order the set of equations to find a sequence that will result in the solution of the set.
Atomic masses: C,12; O,16; M,65.

3. (a) A gas mixture containing 25% H_2 and 75% CH_4 is being heated from 473 K to 673 K at 101.3 kPa pressure. Calculate the total amount of heat needed per kmol of the mixture.

(b) The gas SO_2 is oxidised at 101.32 kPa in a catalytic converter to SO_3 using 150% excess air. The reaction is

$$SO_2(g) + 1/2\ O_2(g) \rightarrow SO_3(g)$$

Only 75% conversion to SO_3 is obtained. The SO_2 and the air enter at 573 K and the exit gas mixture leaves at 673 K. There is a heat exchanger in the converter which removes heat. How many kJ are absorbed by the exchanger for 1 kmol SO_2 added? The ΔH_c^0 for the reaction as written is -98.11×10^3 kJ/kmol at 298 K and the mean heat capacity of SO_3 is 63.68 kJ/(kmol)(K).

4. (a) Briefly describe two different contexts in which depreciation may be considered.

(b) Derive the formula for the present worth of an ordinary annuity, P, where R is the amount due for every period and i is the interest rate for a period of n years.

(c) You are given the following data for two investments:

Investment number	Total initial fixed capital investment in K1,000,000	Working capital investment in K1,000,000	Annual cash flow to project after taxes in K1,000,000	Life of project in years
1	170	10	52	7
2	210	15	59	8

(i) In each case, calculate the net present worth at an interest rate of 15%.
(ii) Verify that the discounted-cash-flow rate of return for investment no 1 is 22%.

5. Hot water is to be heated with hot exhaust gas. The exhaust gas enters the exchanger at 523 K and leaves at 383 K. The cold water enters at 298 K and leaves at 373 K with a flow rate of 2 kg/s. The heat capacity of the water is 4180 J/(kg)(K). The overall heat transfer coefficient is estimated to be 150 W/(m^2)(K). Calculate the heat transfer surface area for the following heat exchanger arrangements:

(i) double-pipe counterflow,
(ii) one-shell pass, two-tube passes,
(iii) two-shell passes, four-tube passes,
(iv) cross-flow with both fluids unmixed.

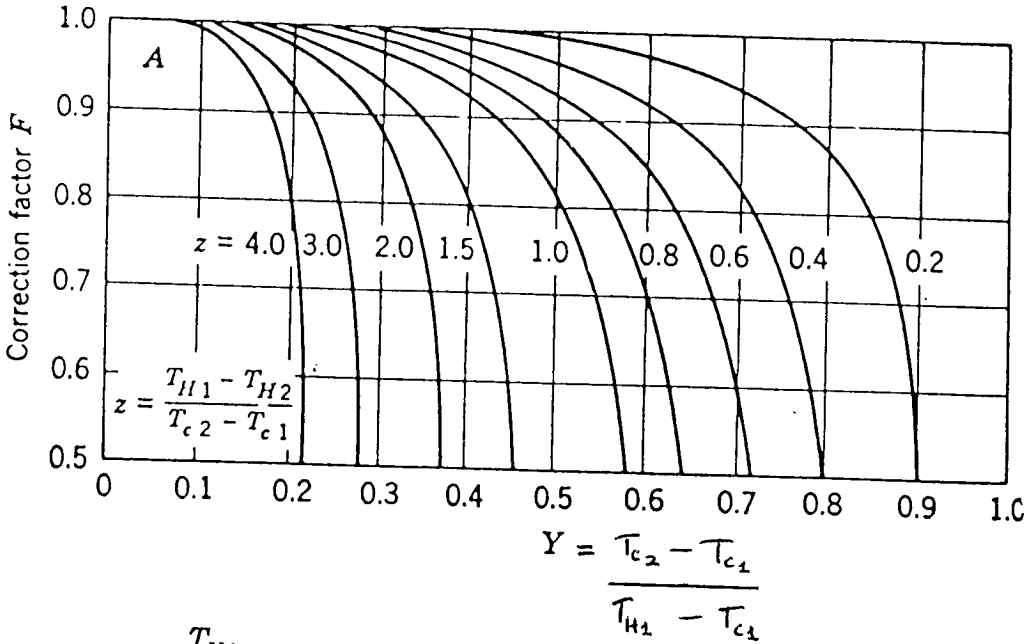
6. (a) Define the term specific speed of a centrifugal pump and deduce an expression for it in terms of the head H, the discharge Q and the speed N. What are the dimensions of the specific speed and how is it related to the type number?

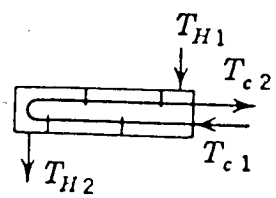
(b) A multi-stage centrifugal pump is required to lift 1.8 m^3/min of water from a mine. The total head including friction is 750 m. If the speed of the pump is 2900 rev/min, find the least number of stages if the specific speed per stage is not to be less than 150 in the given units. What would the minimum number of stages be if the pump speed were reduced to 2000 rev/min, everything else remaining the same?

END OF EXAMINATION IN MM 552

TABLE 1.6-1. *Mean Molar Heat Capacities of Gases Between 298 and TK (25 and T°C) at 101.325 kPa or Less (SI Units: c_p = kJ/kg mol · K)*

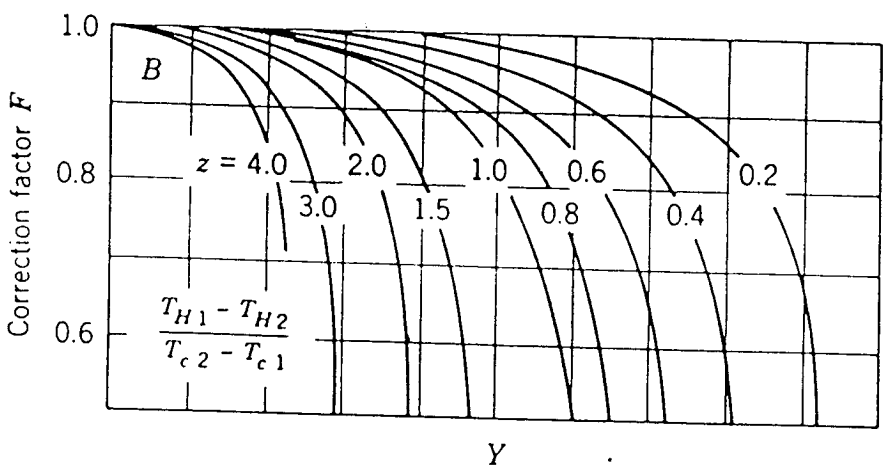
T(K)	T(°C)	H_2	N_2	CO	Air	O_2	H_2O	CO_2	CH_4	SO_2
298	25	28.86	29.14	29.16	29.19	29.38	33.59	37.20	35.8	39.9
373	100	28.99	29.19	29.24	29.29	29.66	33.85	38.73	37.6	41.2
473	200	29.13	29.29	29.38	29.40	30.07	34.24	40.62	40.3	42.9
573	300	29.18	29.46	29.60	29.61	30.53	34.39	42.32	43.1	44.5
673	400	29.23	29.68	29.88	29.94	31.01	35.21	43.80	45.9	45.8
773	500	29.29	29.97	30.19	30.25	31.46	35.75	45.12	48.8	47.0
873	600	29.35	30.27	30.52	30.56	31.89	36.33	46.28	51.4	47.9
973	700	29.44	30.56	30.84	30.87	32.26	36.91	47.32	54.0	48.8
1073	800	29.56	30.85	31.16	31.18	32.62	37.53	48.27	56.4	49.6
1173	900	29.63	31.16	31.49	31.48	32.97	38.14	49.15	58.8	50.3
1273	1000	29.84	31.43	31.77	31.79	33.25	38.71	49.91	61.0	50.9
1473	1200	30.18	31.97	32.30	32.32	33.78	39.88	51.29	64.9	51.9
1673	1400	30.51	32.40	32.73	32.76	34.19	40.90	52.34		

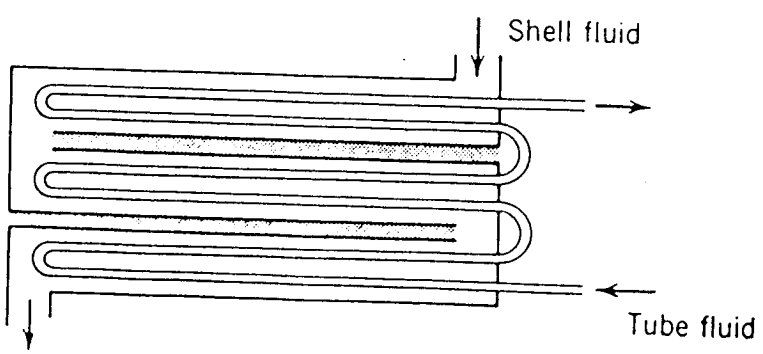




Correction Factor Plot for Exchanger with One Shell Pass and Two, Four, or any Multiple of Tube Passes

(a)





(b)

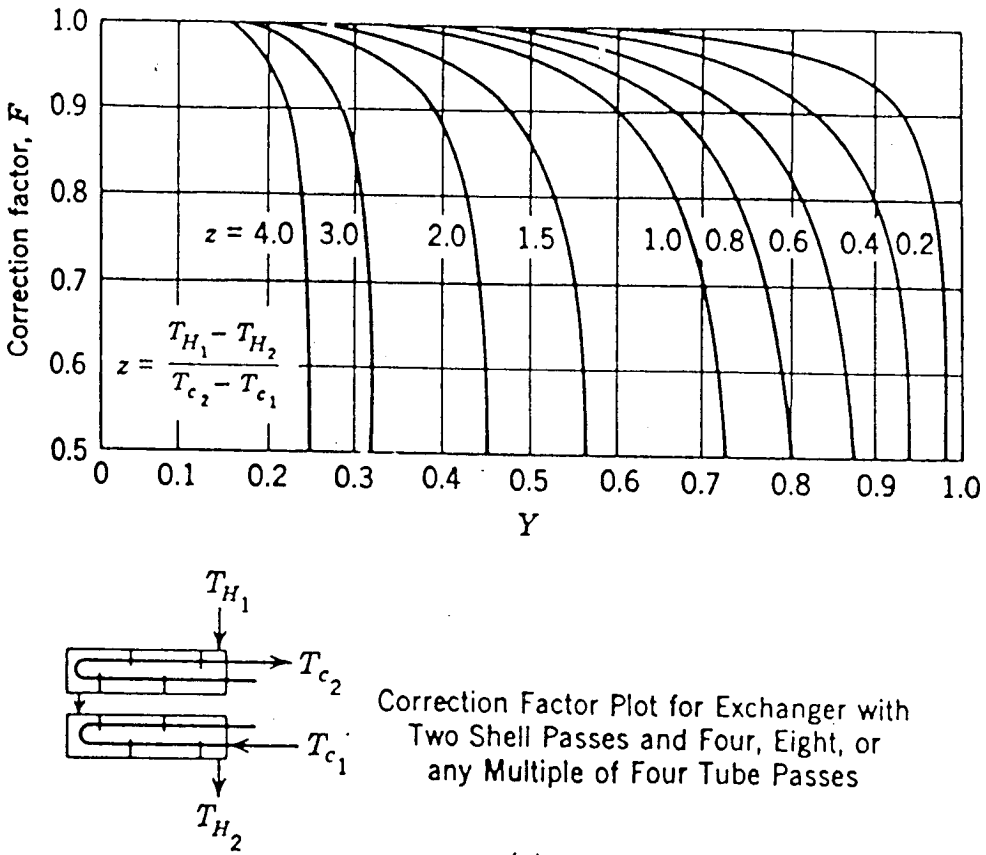
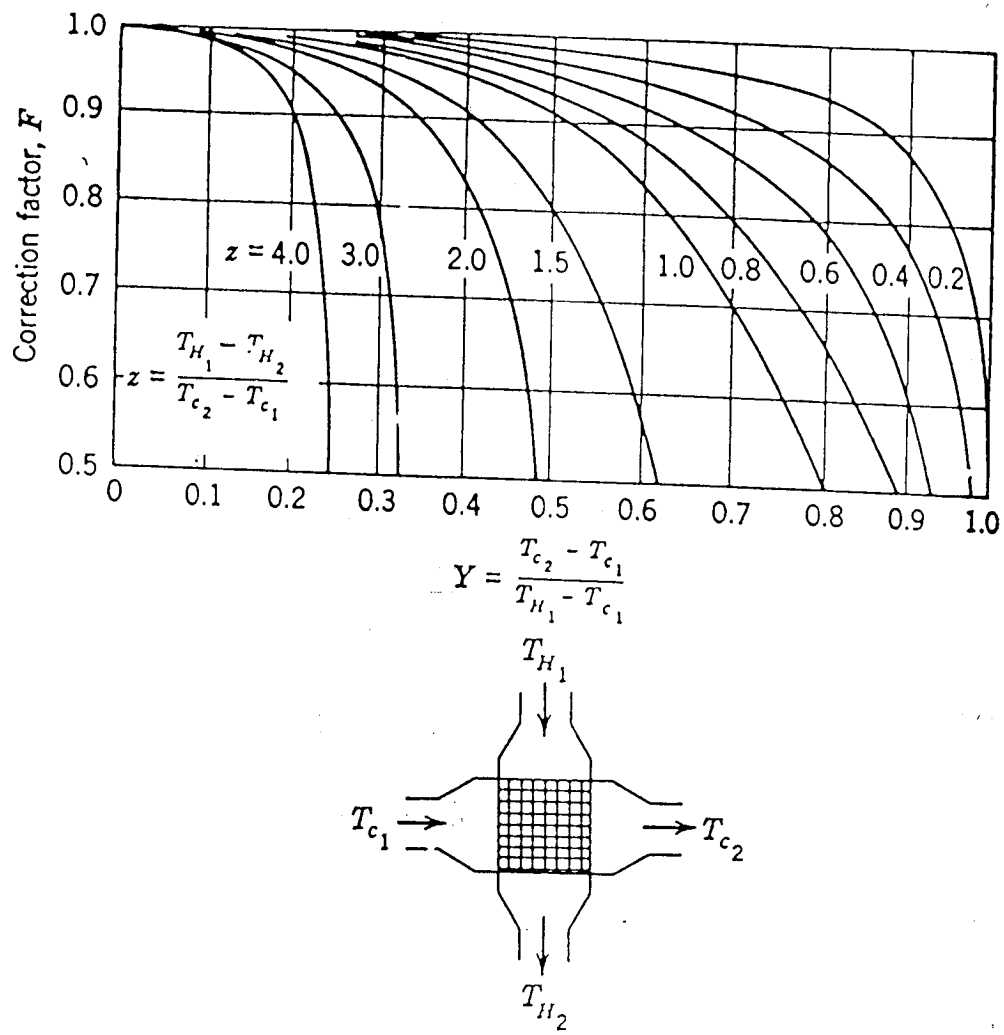
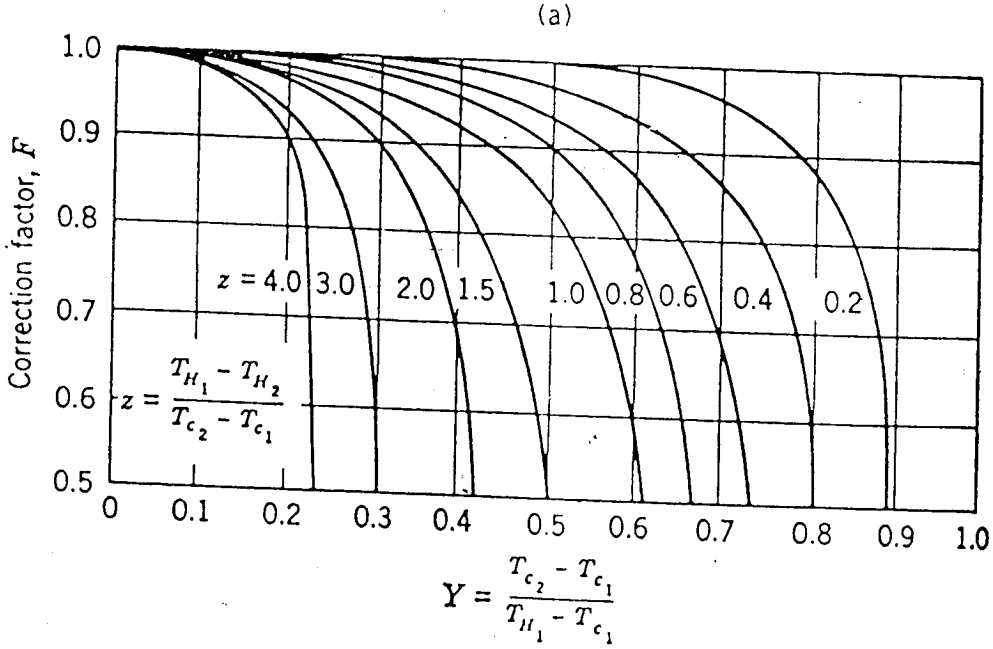


Figure 22.9 Correction factors for three shell-and-tube heat exchanger configurations. (a) One shell pass and two or a multiple of two tube passes. (b) One shell pass and three or a multiple of three tube passes. (c) Two shell pass and two or a multiple of two tube passes. (From R. A. Bowman, A. C. Mueller, and W. M. Nagle, *Trans. A.S.M.E.*, **62**, 284, 285 (1940). By permission of the publishers.) Correction factors, F, based on counterflow LMTD.


Correction factor, F
1.0
0.9
0.8
0.7
0.6
0.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
z = 4.0
3.0
2.0
1.5
1.0
0.8
0.6
0.4
0.2
$z = \frac{T_{H_1} - T_{H_2}}{T_{c_2} - T_{c_1}}$
$Y = \frac{T_{c_2} - T_{c_1}}{T_{H_1} - T_{c_1}}$
T_{H_1}
T_{c_1}
T_{c_2}
T_{H_2}

(a)


Correction factor, F
1.0
0.9
0.8
0.7
0.6
0.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
z = 4.0
3.0
2.0
1.5
1.0
0.8
0.6
0.4
0.2
$z = \frac{T_{H_1} - T_{H_2}}{T_{c_2} - T_{c_1}}$
$Y = \frac{T_{c_2} - T_{c_1}}{T_{H_1} - T_{c_1}}$
T_{H_1}
T_{c_1}
T_{c_2}

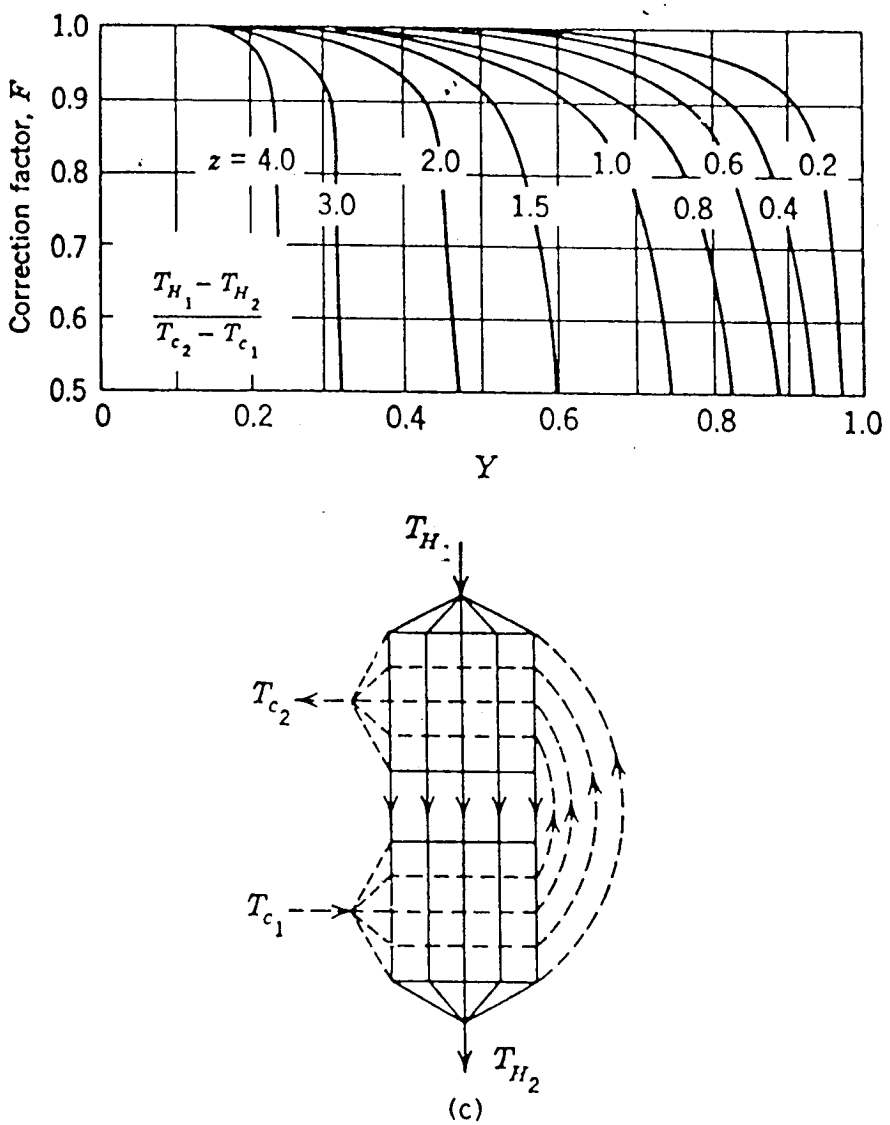


Figure 22.10 Correction factors for three crossflow heat-exchanger configurations. (a) Crossflow, single-pass, both fluids unmixed. (b) Crossflow, single-pass, one fluid unmixed. (c) Crossflow, tube passes mixed; fluid flows over first and second passes in series. (From R. A. Bowman, A. C. Mueller, and W. M. Nagle, *Trans. A.S.M.E.*, **62**, 288, 289 (1940). By permission of the publishers.)

THE UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

2001/2002 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

MM 562: FOUNDRY

TIME: THREE HOURS
ANSWER ALL FIVE QUESTIONS AND EACH HAS 20 MARKS

---

1 Distinguish between homogeneous and heterogeneous nucleation. Explain why the free energy change due to surface creation term in the total free energy change equation is positive.

As nucleates diminish in size, the ratio of surface area to volume, 3/r, becomes significant, explain this

2

(a) Manufacturing routes for metal products are many and varied. An ordinary "G clamp" may be directly cast, machined from a metal bar or forged.

Contrast the three production options in relation to

(i) the properties of the G clamp
(ii) relative costs of production
(iii) limitations of each production option

(b) Suggest some reasons why scrap metal is an important resource for the casting industry.

3

(a) What is the importance of a gating system during feeding of a casting and state the two fundamental fluid flow laws upon which the design of gating systems is dependent.

(b) What advantages does bottom gating possess over other types of gating in a casting and if any state its limitations.

4

(a) A block of initial dimensions l_o, w_o and t_o is deformed to new dimensions l, w and t.

(i) How would you express the total volume strain the block of metal has undergone in terms of its component strains ε_l, ε_w, and ε_t. Assume that V_o and V are initial and new volumes respectively.

(ii) If you assume constant volume during plastic deformation, what would be the sum of the three "true" or logarithmic strain components?

5

(a) From the data in the table, calculate the yield of useful ingot material and explain the iron and magnesium recoveries obtained in a laboratory melt of an aluminium alloy. The melt was degassed using hexachlorethane and grain refined with a 200 gramme addition of Al-5% Ti – 1% B alloy.

Material (kg)		Composition (wt.%)				
		Cu	**Mg**	**Si**	**Fe**	**Mn**
Input or charge						
Ingot	8.000	4.5	0.08	0.20	0.15	0.30
Scrap	2.000	4.3	0.40	0.60	0.50	1.00
Al-Si	0.094	-	-	50.00	-	-
Al-Mn	0.124	-	-	-	-	25.00
Mg	0.036	-	100.00	-	-	-
Output or products						
Ingots	9.050	4.40	0.40	0.71	0.25	0.70
Samples	0.290	-	-	-	-	-

(b) Briefly discuss the operations of the crucible and induction furnaces in terms of the

(i) sources of heat and its transfer to the charge as well as relative efficiency and

(ii) types of alloys that may treated by each of the furnaces

END OF EXAMINATION