THE UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

2014/2015 MID EXAMINATIONS.

1. GGY 2001 –Introduction to Geology –Paper 11 practical
2. GGY 3041 –Structural Geology Paper I Theory
3. GGY 3041 –Structural Geology –Paper II practical
4. GGY 3051 –Engineering Geology –Paper I Theory
5. GGY 3051 –Engineering Geology Paper II Practical
6. GGY 4071 –Igneous petrology –Paper I Theory
7. GGY 4071 –Igneous petrology –paper II
8. GGY 4091 –Low temperature and applied Geochemistry Paper I –Theory
9. GGY 4091 –Low temperature and applied Geochemistry Paper II –Practical
10. GGY 4101 –Geology of Zambia
11. GGY 5151 –Engineering Geology and Rock mechanics
12. GGY 5161 –Exploration Geophysics
13. GGY 5171 –Economic Geology of metalliferous mineral deposits paper 1 –Theory
14. GGY 5171 –Economic geology of metalliferous mineral deposits –practical
15. GGY 5171 –Economic Geology of Metalliferous mineral deposits –Paper II practical
16. MET 3145 –Mineral Processing.
17. MET 3429 –Computer techniques
18. MET 4111 –Communication and classification
19. MIN 4025 –Geostatistics
20. MIN 4035 –Operations Research
21. MIN 4045 –Underground Mining
22. MIN 4065 –Investment Analysis
23. MIN 4075 –Materials handling
24. MIN 4085 –Mine ventilation
25. MIN 4095 –Surface Mining

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY2001- INTRODUCTION TO GEOLOGY
PAPER II – PRACTICAL

INSTRUCTIONS: Answer all the questions. Use diagrams to illustrate your answers where ever it is necessary.

TIME: Three (3) Hours

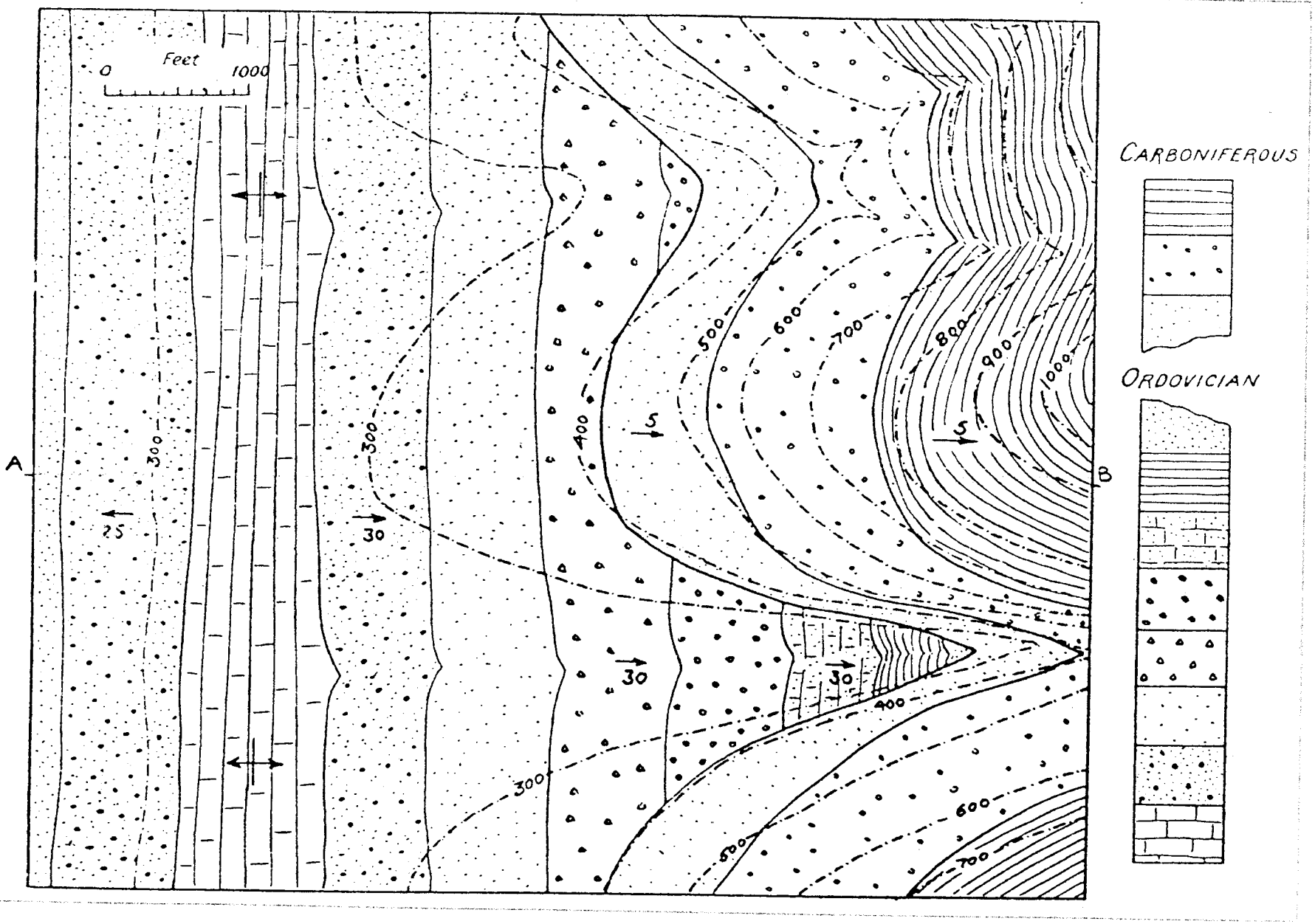
Q1. Describe the elements of symmetry which the given crystal models posses and use these features to identify the crystal systems which they represent. (15 %)

Q2. Describe the physical and optical properties of the given mineral specimens (M1, M2, M3, M4, M5, M6) and identify them by stating their names and the mineral groups to which they belong. (30%)

Q3. Describe the mineralogical composition, texture and structure of the given rockspecimens (R1, R2, R3, R4, R5, R6) and use these features to identify them and establish the conditions under which they were formed. (45 %)

Q4. Describe the geological structures of the area shown on the given map(10 %)

----------END OF EXAMINATION----------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THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY3041- STRUCTURAL GEOLOGY
PAPER I – THEORY

ANSWER: ANY FIVE QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS
TIME: THREE (3) HOURS

Q1 Discuss four different types of lineation

Q2 a) What is the difference between "stress" and "strain"?
b) Use a graph diagram to show the response of brittle and ductile rocks to increasing stress

Q3 Use well labeled 3-D block diagrams to depict the following structural geometries:
a) Oblique left-lateral strike-slip fault
b) Oblique right-lateral strike-slip Fault
c) Oblique dip-slip fault
d) Reverse fault

Q4 Explain the following terms using 1 to 2 sentences with diagrams where appropriate
a) Cylindrical fold
b) Overturned anticline
c) Monocline
d) Kink fold
e) Host and graben

Q5 a) Contrast between ductile deformation and brittle deformation (What are the products of each)
b) Briefly describe four types of lineations

Q6 a) Draw a 3-D diagram of an upright, non-plunging fold structure with at least three layers distinguished by coloured pencils (or using different symbols). Clearly label all parts of the fold with brief explanations.

Q7 Contrast between the terms (Diagrams are required):
a) anticline and syncline
b) symmetric and asymmetric folds
c) normal and reverse faults
d) hanging wall and footwall
e) Dip and plunge

----------END OF EXAMNATION----------

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY3041- STRUCTURAL GEOLOGY
PAPER II – PRACTICAL

ANSWER: ANY FIVE QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS
TIME: THREE (3) HOURS

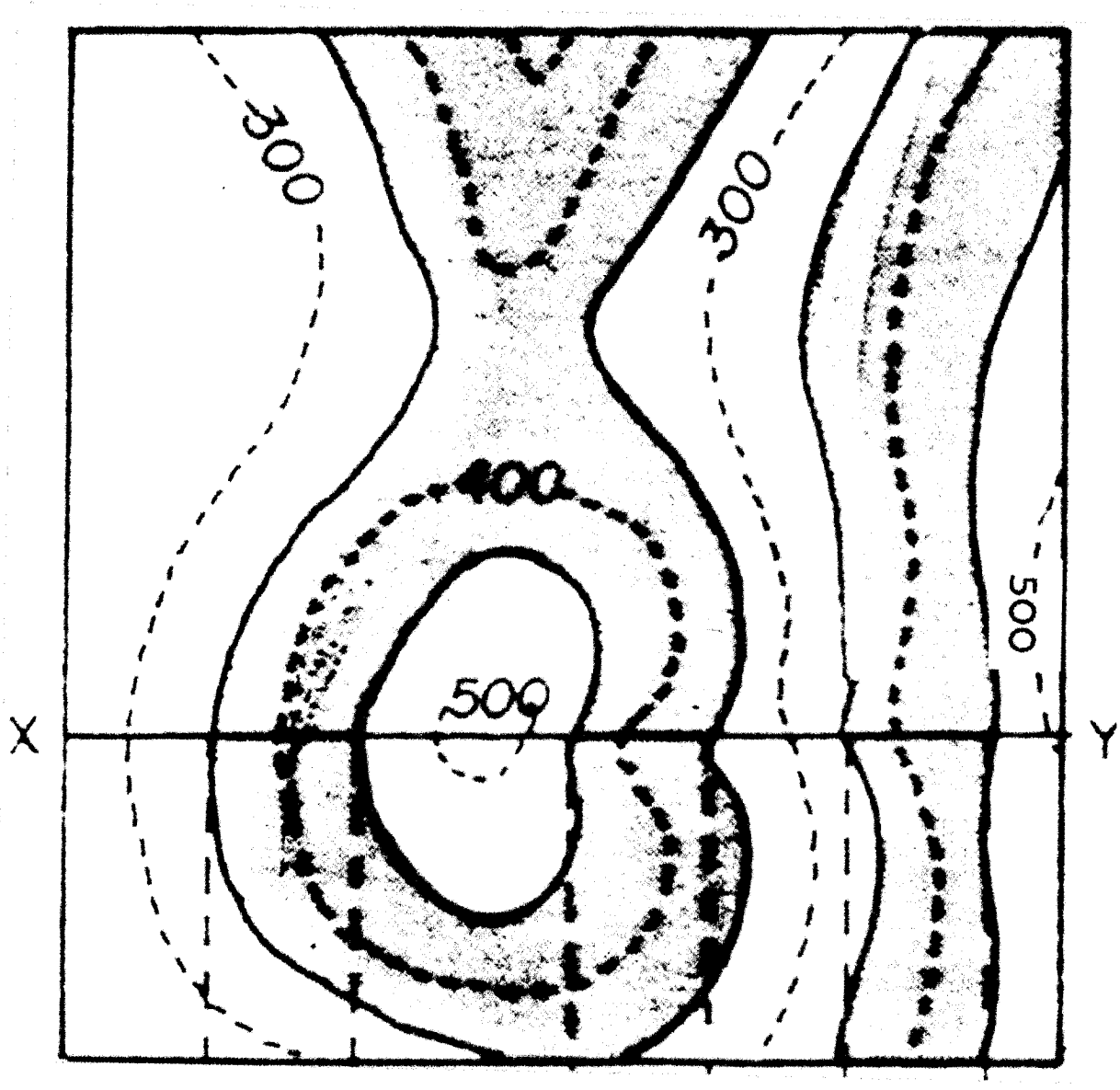
Q1. A geologist took foliation measurements as listed below. Use a stereo net to plot the poles of these foliation planes. (40 marks)

Strike	Dip	Direction
76	50	NW
75	40	NW
67	60	NW
90	55	N
48	65	NW
59	25	NW
47	50	NW
44	20	NW
92	40	NE
97	24	NE
70	17	NW
67	27	NW
79	82	NW
54	74	NW
80	72	NW
85	49	NW
74	65	NW
77	50	NW
78	82	NW
66	68	NW

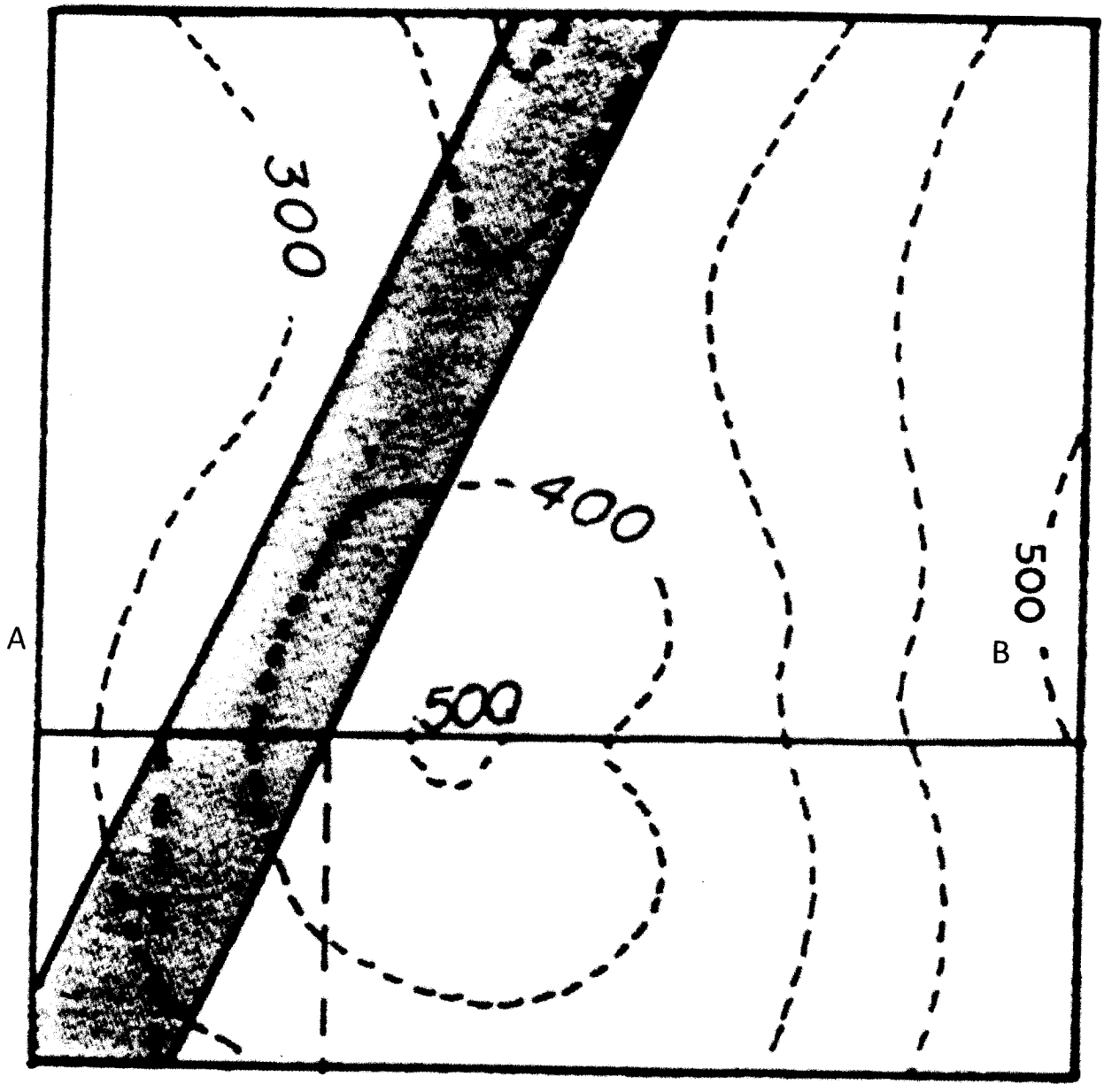
Strike	Dip	Direction
37	55	NW
102	52	NE
76	20	NW
72	15	NW
101	20	NE
84	44	NW
77	68	NW
47	23	NW
72	14	NW
81	20	NW
92	21	NE
72	68	NW
76	59	NW
140	45	NE
72	77	NW
77	65	NW
91	74	NE
72	70	NW
60	70	NW

Q2. The outcrop of a horizontal layer is parallel to the contour line. Study the figure below and construct a cross section along X-Y. Draw the corresponding geology on the cross section.

(30 marks]



Q3. The outcrop of a vertical rock layer is always straight and parallel to its strike regardless of the topography. Study the figure below and construct a cross section along A-B. Draw the corresponding geology on the cross section. (30 marks)



----------END OF EXAMNATION----------

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY 3051 - ENGINEERING GEOLOGY
PAPER I – THEORY

TIME: 3 HOURS
ANSWER: ~~ANY~~ **QUESTION 1** AND ANY OTHER **THREE** QUESTIONS. QUESTIONS 2-6 CARRY EQUAL MARKS

1. i) A fault where the footwall is displaced downward relative to the hanging wall is a) a normal fault b) a reverse fault c) a right-slip strike slip fault d) a left-slip strike slip fault e) a structure that is entirely my fault
   ii) The footwall of a fault is always a) on the right of the fault b) on the left of the fault c) under the fault d) displaced downward e) none of these.
   iii) The strike of a layer is a) the angle at which that layer intercepts a horizontal surface, b) the degree to which the layer has compressed during mountain building c) a line formed by the intersection of the layer with the Earth's surface d) usually horizontal e) all of these.
   iv) A reverse fault is one where a) the hanging wall is displaced upward relative to the footwall b) the footwall is displaced upward relative to the hanging wall, c) the dip of the fault plane is vertical, d) there is no relative displacement of the hanging wall and footwall e) the footwall moves to the right of the hanging wall.
   v) An anticline is a structure in which a) the oldest rock layers are located at the top of the structure, b) the rock layers dip away from the axis of the structure c) rock layers are down-warped d) all of the above are correct e) none of these are correct.
   vi) For rocks to be folded, they must a) behave as brittle solids, b) behave as fluids c) behave as plastic solids d) be metamorphic e) be volcanic.
   vii) Folding of rocks is usually associated with a) divergent plate boundaries b) transform plate boundaries c) convergent plate boundaries d) old plate boundaries e) the middle of plates.
   viii) Strike-slip faults are a) the same as transform faults b) the same as normal faults c) the same as reverse faults, d) the same as thrust faults e) all of these.
   ix) Faults characterized by horizontal displacement are known as a) normal faults b) strike slip faults c) reverse faults d) dip slip faults e) none of these.
   x) In a simple anticline, the oldest rock layers occur a) on the flanks of the fold b) near the axis of the fold, c) where the axis plunges d) anticlines contain only young rocks e) none of these.
   xi) The angle of inclination formed by a rock layer and the Earth's surface is a) the dip of the layer b) the azimuth of the layer c) the strike of the layer d) the orientation of the layer e) the line of the layer.
   xii) Faults characterized by vertical displacement are known as a) left-lateral strike slip faults b) right lateral strike slip faults c) strike slip faults d) dip slip faults e) none of these.

Use your knowledge of Bowen's Reaction Series and igneous rock classification (questions xiii-xxi):

Silica Content	Mineral Composition	Phaneritic Texture	Aphanitic Texture
High	xiii	xiv	xv
Intermediate	xvi	xvii	xviii
Low	xix	xx	xxi

xiii) a) gabbro, basalt, granite, b) sodium feldspar, pyroxene, muscovite, c) muscovite, quartz, potassium feldspar, d) olivine, pyroxene, calcium feldspar, e) none of these.
xiv) a) gabbro, b) diorite, c) granite, d) basalt, e) andesite
xv) a) rhyolite, b) gabbro, c) granite, d) basalt, e) diorite.
xvi) a) olivine, calcium feldspar, pyroxene, b) calcium feldspar, sodium feldspar, potassium feldspar, c) quartz, granite, muscovite, d) pyroxene, amphibole, biotite, e) hornblende, biotite, sodium feldspar
xvii) a) andesite, b) rhyolite, c) granite, d) basalt, e) diorite
xviii) a) andesite, b) rhyolite, c) granite, d) basalt, e) diorite.
xix) a) quartz, biotite, olivine, b) olivine, quartz, sodium feldspar, c) quartz, muscovite, potassium feldspar, d) quartz, pyroxene, sodium feldspar, e) none of these
xx) a) gabbro, b) rhyolite, c) granite, d) basalt, e) diorite
xxi) a) gabbro, b) rhyolite, c) granite, d) basalt, e) diorite
xxii) The process whereby rocks are changed to sediment is called a) lithification, b) solidification c) deposition, d) weathering, e) compaction.
xxiii) A layer in which the grain size becomes smaller vertically through the layer is called a) foliated, b) graded bedding, c) cross-bedded, d) is not observed in nature, e) none of these.

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xxiv) Cross-bedding observed in river sand can be used a) to determine the direction the water was flowing, b) to determine the speed of the river, c) determine the height of the waves in the river, d) to determine the temperature at the time the ripples formed, e) none of these.

xxv) Which of the following lists is arranged in order from lowest to highest grade of metamorphic rock? a) gneiss, slate, schist, phyllite b) gneiss, schist, phyllite, slate c) slate, gneiss, phyllite, schist d) slate, phyllite, schist, gneiss e) phyllite, gneiss, slate, schist.

2. a) i) Describe the three major classes of rocks and the criterion used in this categorisation.
   ii) List **three** common rock types in each of the three main classes.
   b) Rocks that originate from solidification of molten magma occur either as extrusive or intrusive bodies. Describe:
      (i) The main mode of occurrence of each group.
      (ii) How and why textures of these two groups of rocks differ.
   c) List three major intrusive rocks against their extrusive equivalents.

3. a) Give the empirical formula of Coulomb's Law and describe the quantities involved
   b) Geologic materials may usually be classified into three main groups on the basis of their shear strength parameters. Illustrate these, with the aid of diagrams.
   c) The following results were obtained from a shear box test on specimens of soil compacted to in-situ density:

Normal stress (kNm^{-2})	50	100	200	300
Shear stress (kNm^{-2})	36	80	154	235

   Determine, whether failure would occur within this soil mass at a point, where shear stress is 300 kNm^{-2} and normal stress of 350 kNm^{-2}? Give reason(s) for your answer

4. a) Briefly describe the two main forms of deformation.
   b) When subjected to a triaxial compression test at a confining pressure of 260 kN m^{-2}, a soil sample failed at 950 kN m^{-2}. If the angle of shearing resistance at failure for this sample was 22.5°, **determine** the **shear and normal stresses** that acted on, and perpendicular to, the failure plane, respectively
   c) During a site investigation, a soil sample with was collected from the UNZA East Park Mall construction site. The sample had a length to diameter ration of 3:1 and subjected to a vertical load, in the lab, of 35 kN. At failure, the sample experienced 14 mm and 2 mm changes in length and diameter, respectively. Calculate:
      i) The sample's longitudinal and diametric strains
      ii) The modulus of elasticity (also called Young's modulus) for the sample
      iii) Poisson's ratio *(Diameter of an NX-core sample is 5.4 cm)*

5. a) Define permeability. What three features influence this property in a geologic body?
   b) During site investigations for the UNZA East Park Mall Shopping Complex, a soil sample, 162 mm long and 54 mm in diameter, was collected from the site for permeability testing in the lab. If the diameter of the stand-pipe was 20 cm and the head decreased from 1.5 m to 1.2 m in 10.5 minutes, **calculate** the hydraulic conductivity of the sample in m/sec.
   c) Give **four** reasons for carrying out a site investigation and describe its various stages

6. a) For each of the following questions, pick the correct answer from the following: *(a) Granitic (felsic), (b) andesitic (intermediate), (c) basaltic (mafic), (d) ultramafic.*
      i) Igneous rocks of this composition crystallise at very high temperatures.....
      ii) Rocks of this composition contain minerals quartz and potassium feldspar.....
      iii) Rocks of this composition contain minerals pyroxene and ca-rich plagioclase feldspar.....
      iv) Rocks of this composition crystallise at lowest (coolest) temperatures.....
   b) Write short notes on the following:
      i) Why there are so many silicate minerals in the Earth's crust.
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END OF EXAMINATION. GOOD LUCK!

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY 3051 - ENGINEERING GEOLOGY
PAPER I – THEORY

TIME: 3 HOURS

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xiv) a) gabbro, b) diorite, c) granite, d) basalt, e) andesite

xv) a) rhyolite, b) gabbro, c) granite, d) basalt, e) diorite.

xvi) a) olivine, calcium feldspar, pyroxene, b) calcium feldspar, sodium feldspar, potassium feldspar, c) quartz, granite, muscovite, d) pyroxene, amphibole, biotite, e) hornblende, biotite, sodium feldspar

xvii) a) andesite, b) rhyolite, c) granite, d) basalt, e) diorite

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THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY 3051 - ENGINEERING GEOLOGY
PAPER I – THEORY

TIME: 3 HOURS
ANSWER: ~~ANY~~ **QUESTION 1** AND ANY OTHER **THREE** QUESTIONS. QUESTIONS 2-6 CARRY EQUAL MARKS

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   xiv) a) gabbro, b) diorite, c) granite, d) basalt, e) andesite
   xv) a) rhyolite, b) gabbro, c) granite, d) basalt, e) diorite.
   xvi) a) olivine, calcium feldspar, pyroxene, b) calcium feldspar, sodium feldspar, potassium feldspar, c) quartz, granite, muscovite, d) pyroxene, amphibole, biotite, e) hornblende, biotite, sodium feldspar
   xvii) a) andesite, b) rhyolite, c) granite, d) basalt, e) diorite
   xviii) a) andesite, b) rhyolite, c) granite, d) basalt, e) diorite.
   xix) a) quartz, biotite, olivine, b) olivine, quartz, sodium feldspar, c) quartz, muscovite, potassium feldspar, d) quartz, pyroxene, sodium feldspar, e) none of these
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   xxi) a) gabbro, b) rhyolite, c) granite, d) basalt, e) diorite
   xxii) The process whereby rocks are changed to sediment is called a) lithification, b) solidification c) deposition, d) weathering, e) compaction.
   xxiii) A layer in which the grain size becomes smaller vertically through the layer is called a) foliated, b) graded bedding, c) cross-bedded, d) is not observed in nature, e) none of these.

xxiv) Cross-bedding observed in river sand can be used a) to determine the direction the water was flowing, b) to determine the speed of the river, c) determine the height of the waves in the river, d) to determine the temperature at the time the ripples formed, e) none of these.

xxv) Which of the following lists is arranged in order from lowest to highest grade of metamorphic rock? a) gneiss, slate, schist, phyllite b) gneiss, schist, phyllite, slate c) slate, gneiss, phyllite, schist d) slate, phyllite, schist, gneiss e) phyllite, gneiss, slate, schist.

2. a) i) Describe the three major classes of rocks and the criterion used in this categorisation.
   ii) List **three** common rock types in each of the three main classes.
   b) Rocks that originate from solidification of molten magma occur either as extrusive or intrusive bodies. Describe:
      (i) The main mode of occurrence of each group.
      (ii) How and why textures of these two groups of rocks differ.
   c) List three major intrusive rocks against their extrusive equivalents.

3. a) Give the empirical formula of Coulomb's Law and describe the quantities involved
   b) Geologic materials may usually be classified into three main groups on the basis of their shear strength parameters. Illustrate these, with the aid of diagrams.
   c) The following results were obtained from a shear box test on specimens of soil compacted to in-situ density:

Normal stress (kNm^{-2})	50	100	200	300
Shear stress (kNm^{-2})	36	80	154	235

Determine, whether failure would occur within this soil mass at a point, where shear stress is 300 kNm^{-2} and normal stress of 350 kNm^{-2}? Give reason(s) for your answer

4. a) Briefly describe the two main forms of deformation.
   b) When subjected to a triaxial compression test at a confining pressure of 260 kN m^{-2}, a soil sample failed at 950 kN m^{-2}. If the angle of shearing resistance at failure for this sample was 22.5°, **determine** the **shear and normal stresses** that acted on, and perpendicular to, the failure plane, respectively
   c) During a site investigation, a soil sample with was collected from the UNZA East Park Mall construction site. The sample had a length to diameter ration of 3:1 and subjected to a vertical load, in the lab, of 35 kN. At failure, the sample experienced 14 mm and 2 mm changes in length and diameter, respectively. Calculate:
      i) The sample's longitudinal and diametric strains
      ii) The modulus of elasticity (also called Young's modulus) for the sample
      iii) Poisson's ratio *(Diameter of an NX-core sample is 5.4 cm)*

5. a) Define permeability. What three features influence this property in a geologic body?
   b) During site investigations for the UNZA East Park Mall Shopping Complex, a soil sample, 162 mm long and 54 mm in diameter, was collected from the site for permeability testing in the lab. If the diameter of the stand-pipe was 20 mm and the head decreased from 1.5 m to 1.2 m in 10.5 minutes, **calculate** the hydraulic conductivity of the sample in m/sec.
   c) Give **four** reasons for carrying out a site investigation and describe its various stages

6. a) For each of the following questions, pick the correct answer from the following: *(a) Granitic (felsic), (b) andesitic (intermediate), (c) basaltic (mafic), (d) ultramafic.*
      i) Igneous rocks of this composition crystallise at very high temperatures.....
      ii) Rocks of this composition contain minerals quartz and potassium feldspar.....
      iii) Rocks of this composition contain minerals pyroxene and ca-rich plagioclase feldspar.....
      iv) Rocks of this composition crystallise at lowest (coolest) temperatures.....
   b) Write short notes on the following:
      i) Why there are so many silicate minerals in the Earth's crust.
      ii) Anticline and Syncline and how they are formed
      iii) The three types of fold shapes
      iv) The four main factors that cause and control metamorphism.
      v) Three major types of discontinuities and their significance in engineering practice.
      vi) Geologic events that are implied if a granite body is found exposed at the surface.

----------END OF EXAMINATION. GOOD LUCK!----------

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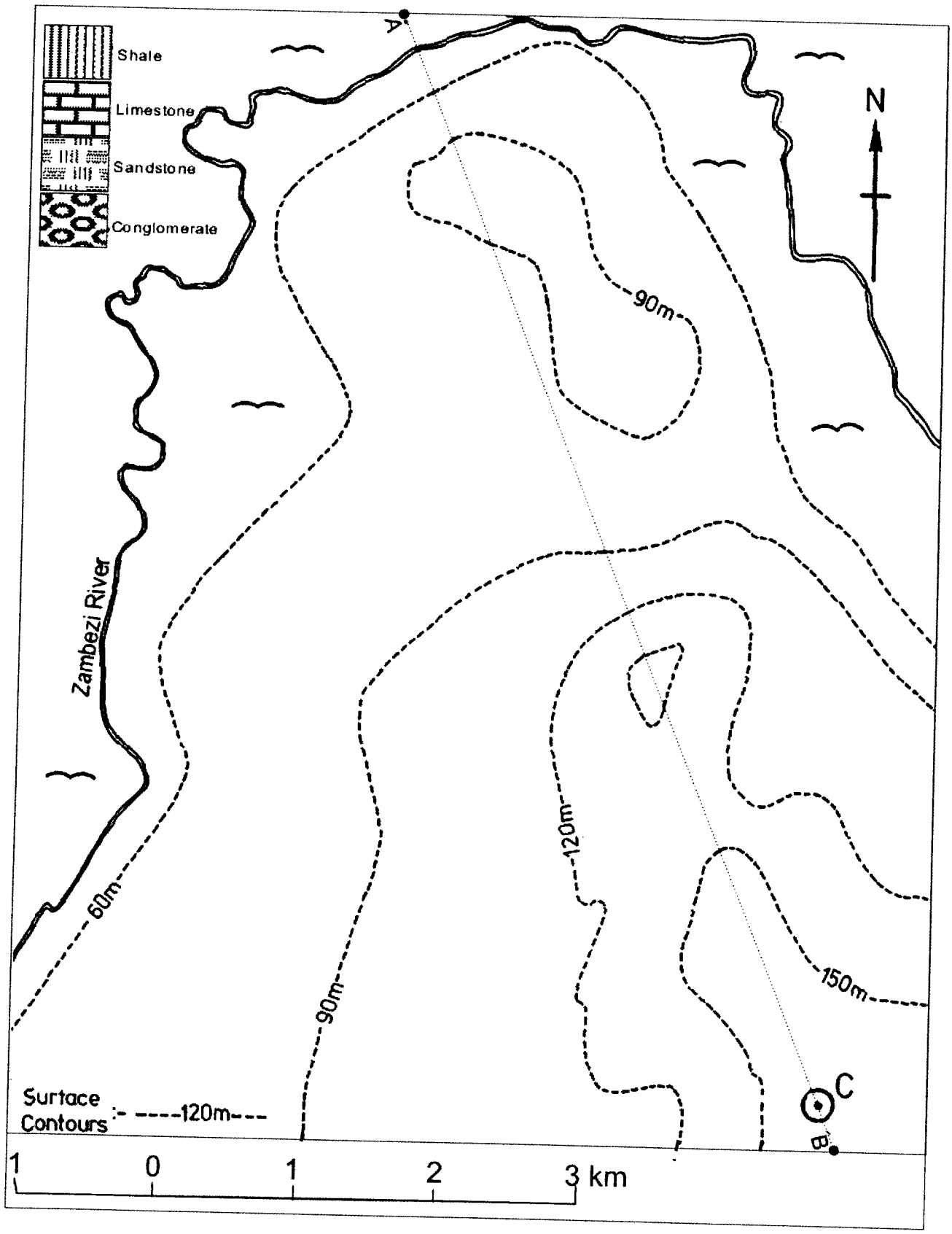
THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY3051 - ENGINEERING GEOLOGY
PAPER II - PRACTICAL

TIME: **THREE** (3) HOURS
ANSWER: ALL QUESTIONS

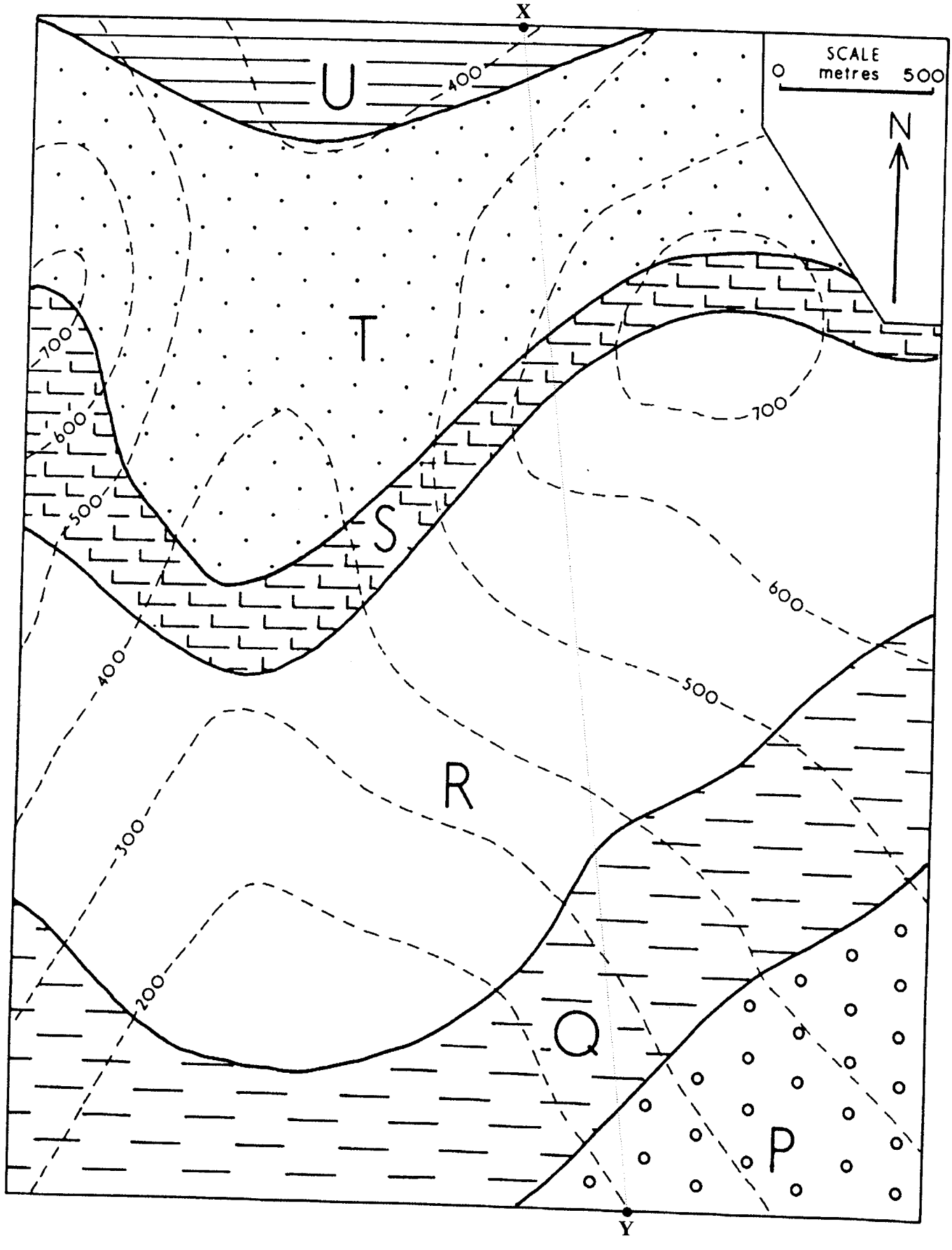
1. Map 1 shows the location of a vertical borehole drilled on a site located at point C. The borehole has an elevation of 170 m above sea level and intersected shale between 0 and 20 metres; limestone between 20 and 50 metres; sandstone between 50 and 80 metres; and conglomerate between 80 and 170 metres. If all the bedding and foliation planes encountered in the borehole display a horizontal attitude:
   a) Complete the geological map of the entire area
   b) Draw a geological cross-section (to scale) along the line A – B and shade on it the Rock Formations intersected by the borehole. (***Note:*** The solid geology is obscured below the 60 m contour by alluvium).
   c) If you are interested to exploit limestone and sandstone as construction materials, determine their thicknesses.
   d) From which rock in (c) would you extract more construction material? Why? **(35%)**
2. Map 2 shows geological boundaries separating outcrops of dipping strata P, Q, R, S, T and U.
   a) Draw structure contours for each geological boundary.
   b) Calculate the amount and direction of dip.
   c) Draw the section X-Y
   d) Determine the true thickness of beds Q, R, S and T (contours are in metres) **(40%)**
3. A prospective construction site is underlain by different geological formations as shown in Map 3. For this Map:
   b) Determine the dip and dip direction of the different strata
   c) Draw a profile along line A-B showing the topography and geologic cross-section showing the different lithologies in the area.
   d) Determine the age relationships of the rocks in the area. **(25%)**

..... END OF EXAINATION. GOOD LUCK!! .....

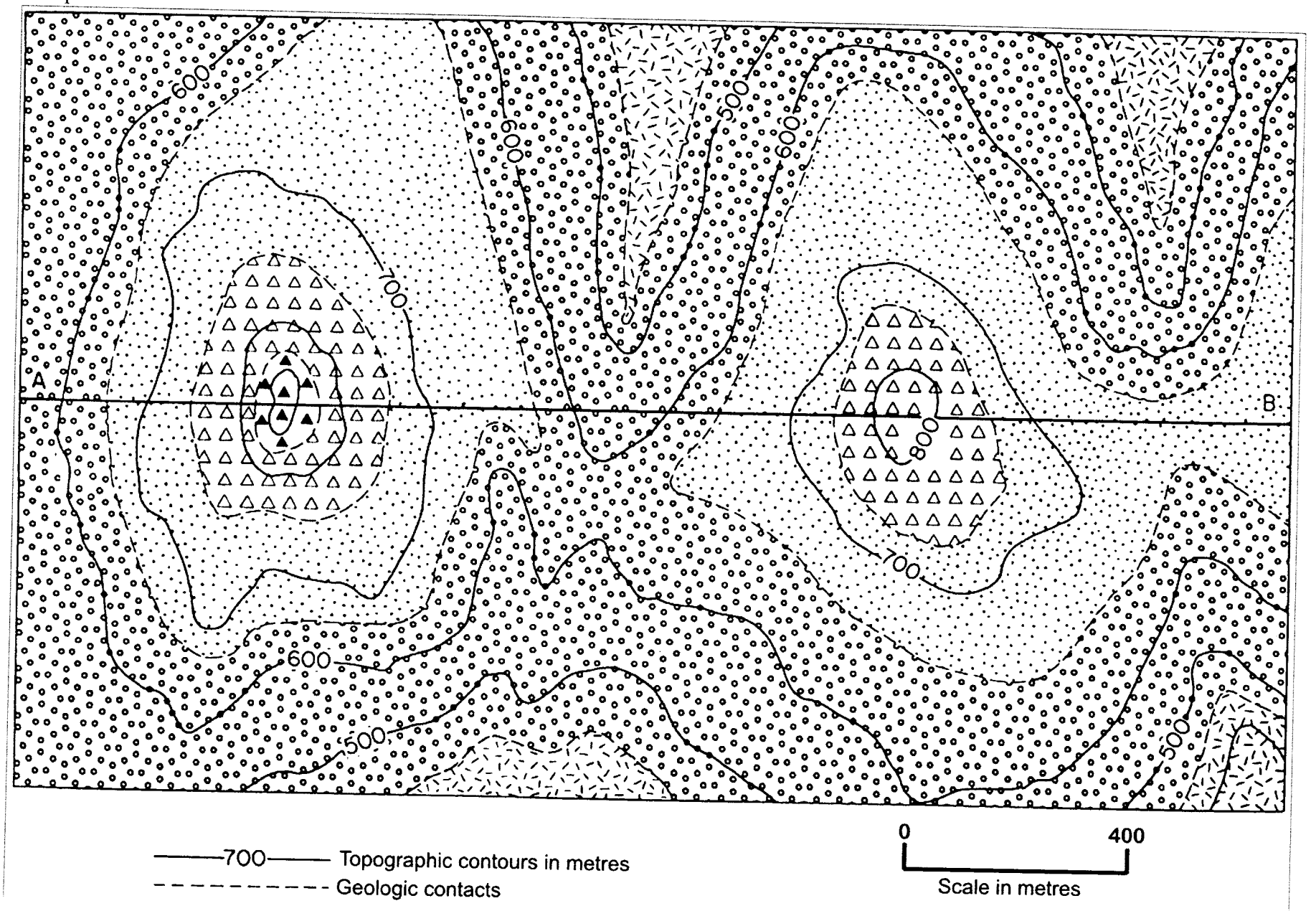
Map 1


Shale
Limestone
Sandstone
Conglomerate
A
B
C
N
90m
120m
150m
60m
Zambezi River
Surface Contours :- ----120m---
1 0 1 2 3 km

Map 2


X
Y
SCALE
metres 500
N
U
T
S
R
Q
P
400
700
600
500
700
600
500
400
300
200

Map 3


600
600
500
600
700
A
B
800
700
600
500
500
0
400
700 Topographic contours in metres
Geologic contacts
Scale in metres

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015

GGY4071- IGNEOUS PETROLOGY

PAPER I – THEORY

ANSWER: ANY **FIVE** QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS. ILLUSTRATE YOUR ANSWER WITH FIGURES, DIAGRAMS ETC. WHEREVER POSSIBLE

TIME: THREE (3) HOURS

Q1 a) Discuss how pyroclastic rocks are formed and how they are classified.

b) Buddington (1959) divided granite intrusions on basis of their depth of emplacement. Discuss the main characteristics of each type.

Q2 Several mechanisms can account for the development of a symplectitic intergrowth. What are these mechanisms and describe, in detail, the textures with each mechanism.

Q3. Briefly describe the following: (a) Anorthosites masifs (b) Lamprophyres, (c) Oceanic Island (d) Kimberlites.

Q4. Compare and contrast shallow granitic intrusions and deep granitic intrusions

Q5. Different rock types can be evolved from a single parent magma. Discuss the processes which can account for the different igneous rocks that can be produced from a single parent magma

Q6. Much can be learnt about the way magma behaves during crystallization and about its origin by studying major intrusions.

a) Discuss the main characteristics of the layered basic intrusions

b) Give three examples of such types of intrusions

Q7. Write short notes with diagrams and examples where possible, on the following:

a) congruent melting
b) porphrytic texture
c) Tholeiitic basalt
d) Ophiolite complex
e) shield volcano
f) a natectic granites

----------END OF EXAMNATION----------

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY4071- IGNEOUS PETROLOGY
PAPER II – PRACTICAL

ANSWER: ALL QUESTIONS. USE DIAGRAMS AND EQUATIONS WHEREVER NECESSARY
TIME: 1½ HOURS

Q1. The modal composition of four plutonic rocks is given below:

i) Orthoclase 48%; Plagioclase (An_{26}) 39%; Quartz 3%; Augite 4%; Biotite 4%.
ii) Quartz 30%; oligoclase 46%; Orthoclase 8%; Plagioclase (An_4) 4%; Hornblende 8%; Biotite 4%
iii) Orthoclase 35%; Quartz 33%; Plagioclase (An_4) 24%; Biotite 4%; Hornblende 4%.
iv) Orthoclase 65%; Oligoclase 11%; Quartz 15%; Biotite 6%; Hornblende 3%.

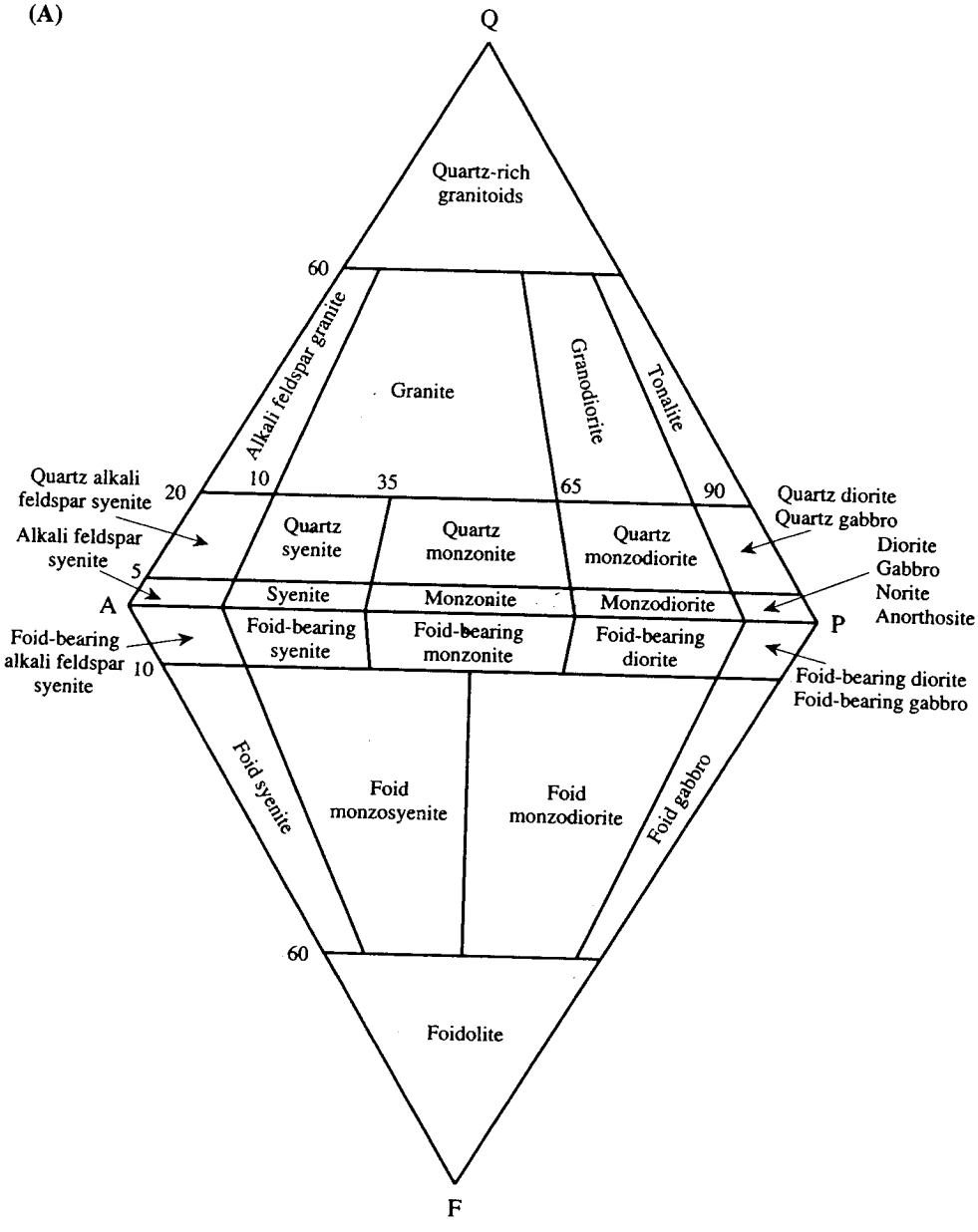
For the data above:

a) Plot the rocks on AQP diagram
b) Name the rocks
c) Name their volcanic equivalents (if any)

Q2. Give a complete petrographic description of the thin section A emphasizing on the following:
a) Mineralogy
b) Texture
c) Is this rock a volcanic or plutonic? Why?
d) Name the geotectonic setting / settings in which the rock is found.
e) Name the rock

----------END OF EXAMNATION----------

(A)


Q
Quartz-rich granitoids
60
Alkali feldspar granite
Granite
Granodiorite
Tonalite
Quartz alkali feldspar syenite
20
10
35
65
90
Quartz diorite
Quartz gabbro
Alkali feldspar syenite
Quartz syenite
Quartz monzonite
Quartz monzodiorite
Diorite
Gabbro
Norite
Anorthosite
5
A
Syenite
Monzonite
Monzodiorite
P
Foid-bearing alkali feldspar syenite
Foid-bearing syenite
Foid-bearing monzonite
Foid-bearing diorite
10
Foid-bearing diorite
Foid-bearing gabbro
Foid syenite
Foid monzosyenite
Foid monzodiorite
Foid gabbro
60
Foidolite
F

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY4091- LOW TEMPERATURE AND APPLIED GEOCHEMISTRY
PAPER I – THEORY

ANSWER: ANY **FIVE** QUESTIONS. USE DIAGRAMS AND EQUATIONS WHEREVER NECESSARY. ALL QUESTIONS CARRY EQUAL MARKS.

TIME: THREE (3) HOURS

Q1. Write brief notes on the following aspects.
(a) Geochemical province
(b) Aqueous migration coefficient
(c) Pathfinder element
(d) Geochemical barriers
(e) Geochemical contrast
(f) Geochemical associations of elements

Q2. Use the data given in table 1 to answer the following questions.
(a) Discuss the chemical differentiation of the earth
(b) compute the average composition of the whole earth
(c) Describe the methods which were used by Goldschmidt and Clarke to estimate the chemical composition of the continental crust

Table 1 Chemical composition of the three major shells of the earth (all the values are in %).

Mass proportion	**CORE**	**MANTLE**	**CRUST**
O	31.5	68.1	0.4
Fe	0.0	33.24	45.5
Si	90.78	27.24	7.06
Mg	0.0	17.10	26.8
S	0.0	14.29	3.2
Ni	0.0	1.93	0.03
Ca	8.59	1.64	0.01
Al	0.0	1.27	5.3
Na	0.0	1.6	8.4
Co	0.0	0.84	2.3
K	0.63	0.09	0.003
Data Source	0.0	0.08	0.9
	Meteorites	Meteorites	Continental rocks

Q3. Discuss the role of chemical weathering in the formation of the following natural resources.
(a) Limestone
(b) Bauxite deposits
(c) Clay deposits
(d) Spring or mineral water
(e) Sedimentary copper sulphide deposits

Q4. Discuss the major factors which control the aqueous mobility of the following elements in the secondary geochemical environment.

(a) Iron
(b) Copper
(c) Magnesium
(d) Aluminium
(e) Sulphur
(f) Sodium
(g) Tantalum
(h) Manganese

Q5. Use thermodynamic data given below to construct an Eh-pH diagram for the system Al-O-H at a pressure of 1 bar and temperature of 25^{O}C. Use this diagram to explain the role of pH and Eh in the formation and stability of bauxite deposits.

Species	Al^{3+} (aq)	$Al(oH)_3$(c)	AlO_2^-(aq)	H_2O (l)	H^+(aq)	H_2(g)	O_2(g)
ΔG_f^o (Kcal/gfw)	-115.92	-276.08	-198.59	-56.69	0.0	0.0	0.0

Q6. Discuss the surficial geochemical dispersion patterns that are likely to be associated with the following mineral deposits.

(a) Cassiterite bearing pegmatites in Choma district.
(b) Beryl – rich pegmatites in Lufwanyama district.
(c) Hydrothermal deposits of lead and zinc.
(d) Sandstone hosted uranium mineralization.
(e) Gabbro hosted Ni-Cu-Co-Pt sulphide deposits.

Q7. Discuss the physicochemical and biochemical processes that control the existence of a seawater system whose pH and chemical composition are constant.

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

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY4091- LOW TEMPERATURE AND APPLIED GEOCHEMISTRY
PAPER II – PRACTICAL

ANSWER: **ALL** THE QUESTIONS. USE DIAGRAMS AND EQUATIONS WHEREVER NECESSARY.
TIME: THREE (3) HOURS

Q1. The contents of Cu, Pb and Zn in stream sediments of an area are given in Table 1. Use an appropriate statistical technique to determine the mineralization potential of this area and discuss the association of these elements. (60 %)

Table 1: Concentration of elements in stream sediments (in ppm)

S/N°	Cu	Pb	Zn	S/N°	Cu	Pb	Zn	S/N°	Cu	Pb	Zn
1	100	10	30	32	45	10	20	63	30	20	35
2	60	10	10	33	60	10	35	64	10	0	25
3	35	10	30	34	40	10	30	65	30	10	35
4	35	10	25	35	40	20	40	66	50	10	35
5	40	10	30	36	50	20	55	67	50	10	30
6	40	10	30	37	35	20	75	68	60	20	40
7	60	10	15	38	25	10	20	69	30	10	30
8	15	0	20	39	35	10	20	70	20	10	55
9	35	10	30	40	25	10	20	71	50	10	20
10	25	10	25	41	30	10	20	72	60	20	20
11	30	10	30	42	30	10	25	73	70	20	35
12	40	10	10	43	45	20	30	74	40	20	65
13	30	0	45	44	60	20	60	75	25	20	10
14	65	20	20	45	70	20	40	76	30	15	25
15	40	20	30	46	120	30	45	77	30	0	35
16	65	20	30	47	100	35	35	78	30	10	25
17	20	10	20	48	65	20	15	79	25	10	35
18	60	20	10	49	340	25	25	80	40	10	15
19	65	10	10	50	240	30	40	81	25	10	25
20	50	10	10	51	270	30	20	82	20	10	25
21	90	10	15	52	80	20	15	83	50	15	30
22	80	5	15	53	100	30	30	84	90	20	35
23	50	20	15	54	120	10	25	85	80	20	35
24	60	10	15	55	35	10	120	86	30	20	25
25	30	20	25	56	40	30	30	87	20	10	20
26	50	30	30	57	40	5	35	88	50	15	35
27	20	20	50	58	50	10	30	89	100	20	30
28	120	5	10	59	70	20	35	90	50	20	25
29	25	0	30	60	10	0	10	91	90	20	35
30	35	10	55	61	90	10	20	92	60	30	20
31	75	40	35	62	60	20	30				

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY4091- LOW TEMPERATURE AND APPLIED GEOCHEMISTRY
PAPER II – PRACTICAL

ANSWER: **ALL** THE QUESTIONS. USE DIAGRAMS AND EQUATIONS WHEREVER NECESSARY.
TIME: THREE (3) HOURS

Q1. The contents of Cu, Pb and Zn in stream sediments of an area are given in Table 1. Use an appropriate statistical technique to determine the mineralization potential of this area and discuss the association of these elements. (60 %)

Table 1: Concentration of elements in stream sediments (in ppm)

S/N°	Cu	Pb	Zn	S/N°	Cu	Pb	Zn	S/N°	Cu	Pb	Zn
1	100	10	30	32	45	10	20	63	30	20	35
2	60	10	10	33	60	10	35	64	10	0	25
3	35	10	30	34	40	10	30	65	30	10	35
4	35	10	25	35	40	20	40	66	50	10	35
5	40	10	30	36	50	20	55	67	50	10	30
6	40	10	30	37	35	20	75	68	60	20	40
7	60	10	15	38	25	10	20	69	30	10	30
8	15	0	20	39	35	10	20	70	20	10	55
9	35	10	30	40	25	10	20	71	50	10	20
10	25	10	25	41	30	10	20	72	60	20	20
11	30	10	30	42	30	10	25	73	70	20	35
12	40	10	10	43	45	20	30	74	40	20	65
13	30	0	45	44	60	20	60	75	25	20	10
14	65	20	20	45	70	20	40	76	30	15	25
15	40	20	30	46	120	30	45	77	30	0	35
16	65	20	30	47	100	35	35	78	30	10	25
17	20	10	20	48	65	20	15	79	25	10	35
18	60	20	10	49	340	25	25	80	40	10	15
19	65	10	10	50	240	30	40	81	25	10	25
20	50	10	10	51	270	30	20	82	20	10	25
21	90	10	15	52	80	20	15	83	50	15	30
22	80	5	15	53	100	30	30	84	90	20	35
23	50	20	15	54	120	10	25	85	80	20	35
24	60	10	15	55	35	10	120	86	30	20	25
25	30	20	25	56	40	30	30	87	20	10	20
26	50	30	30	57	40	5	35	88	50	15	35
27	20	20	50	58	50	10	30	89	100	20	30
28	120	5	10	59	70	20	35	90	50	20	25
29	25	0	30	60	10	0	10	91	90	20	35
30	35	10	55	61	90	10	20	92	60	30	20
31	75	40	35	62	60	20	30				

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY4101- GEOLOGY OF ZAMBIA

ANSWER: ANY **FOUR** QUESTIONS USING SKETCHES WHEREVER POSSIBLE. ALL QUESTIONS CARRY EQUAL MARKS.

TIME: THREE (3) HOURS

Q1. Write an account of the geological evolution of Africa from Archean to Neo-Proterozoic with special reference to southern Africa.

Q2. Write an outline of the stratigraphy of Zambia and the economic significance of each major sequence.

Q3. Compare and contrast the Mozambique and Zambezi mobile belts in terms of spatial distribution, geological and tectonic setting, age, as well as the orogenic activities that lead to their formation.

Q4. Discuss the geology and tectonic setting of the Lufilian Arc and its significance on the economies of the countries in which it is found.

Q5. Write a short essay on the geology and distribution of the Irumide Belt in Zambia.

Q6. The Ubendian Belt is believed to be the oldest mobile belt that affected parts of Zambia and subsequently hosting some of the oldest sequences of rocks in the country. Discuss.

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

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY5151 – ENGINEERING GEOLOGYAND ROCK MECHANICS

TIME: 3 HOURS

ANSWER: ALL QUESTIONS FROM SECTION A, AND**THREE** QUESTIONS FROM SECTION 2. **ALL** QUESTIONS IN SECTION B CARRY EQUAL MARKS

SECTION A: MULTIPLE CHOICE QUESTIONS

1 In stress-strain test, rocks that exhibit a significant amount of plastic response before failure are said to be: a) plastic b) ductile c) elastic d) brittle

2 A map at the scale of 1:24,000 compared to a map at the scale of 1:62,500 is: a) a smaller scale map b) a larger scale map c) larger scale or smaller scale dependent upon the units of measurement d) larger scale or smaller scale dependent upon the ground area shown.

3 According to Darcy's Law: a) the velocity of flow in clay is higher than in sand. b) the higher the gradient, the lower the velocity. c) The water table is generally flatter in an area of high transmissivity d) spring flow is independent of the hydraulic characteristics of the aquifer.

4 According to the Unified Soil Classification, a soil described as a GW is a (an): a) well-graded gravel or gravel-sand mixture, with no or little fines b) poorly graded gravel or gravel-sand mixture, with no or little fines c) coarse clayey gravel d) organic silt of low plasticity.

5 Prediction of swelling potential in soil is possible using which of the following? A) grain size b) organic content of the soil c) Atterberg limits d) colour.

6 Which of the following is NOT a common triggering mechanism of slope failure?: a) sudden increase of water, b) changes in slope c) earthquakes d) actually, all of these are common triggering mechanisms

7 POROSITY is found by dividing the volume of voids by: a) volume of solids b) volume of water c) total volume of the sample d) none of these.

8 Falling-head tests and constant-head tests are used to determine the: a) porosity of rock or soil b) safety factors of critical reservoir levels c) hydrostatic pressure on liners d) permeability of rock or soil.

9 Coherent movements that occur along curved failure surfaces are called: a) translational slides b) slumps c) earth flows d) creep

10 A site location map must include scale, orientation, title, and: a) topographic contours b) geologic units c) dip and strike symbols d) geographic reference

11 In engineering practice, rock is divided into: a) igneous, sedimentary and metamorphic rocks b) intact rock and rock mass c) loose and lithified rocks d) none of these.

12 The plastic limit and the liquid limit, together, are referred to as the: a) Atterberg limits b) Mohr-Coulomb limits c) Wegener limits d) plasticity index

13 A particle-size distribution characterized by roughly equal proportions of all particle sizes would be called: a) well sorted b) poorly graded c) poorly sorted d) ductile

14 A map at the scale of 1:24,000 compared to a map at the scale of 1:62,500 is: a) a smaller scale map b) a larger scale map c) larger scale or smaller scale dependent upon the units of measurement d) larger scale or smaller scale dependent upon the ground area shown

15 The capacity of a rock to transmit water is called: a) porosity b) void ratio c) permeability

16 In its simplest form, Darcy's law relates mean velocity to: a) cross-sectional area x hydraulic gradient b) hydraulic conductivity x head, c) hydraulic conductivity x hydraulic gradient

17 The intrinsic shear strength a material possesses, when the effective normal stress = 0 is called the: a) internal friction b) friction between particles c) cohesion d) interlocking of particles

18 Which of the following classifications in the Unified Soil Classification System has the highest strength? A) well graded gravel b) clayey gravel c) silty sand d) silt e) silty clay

19 The soil mechanics test that involves rolling moist soil into thin threads is the: a) Atterberg limit b) liquid limit c) plastic limit d) plasticity index

20 The capacity of a rock to transmit water is called: a) porosity b) void ratio c) permeability d) saturation

21 In stress-strain test, rocks that exhibit a significant amount of plastic response before failure are said to be: a) plastic b) ductile c) elastic d) brittle

22 Soil creep is produced by repeated expansion and contraction of the soil due to all but which of the following: a) freezing-thawing b) wetting-drying c) heating-cooling

23 The geological term WELL SORTED corresponds to the engineering term: a) highly plastic b) highly porous c) poorly graded d) well graded

24 In a direct-shear apparatus, when the normal force is 10kg, a shear force of 6 kg is required to cause failure. What is the angle of internal friction? A) 31^0 b) 22^0 c) 37^0 d) 53^0

25 The main effect of human activities that produces sinkhole collapse is: a) vibrations from highways, etc. b) increasing runoff by paving c) lowering the water table d) removing vegetation

SECTION B:ESSAY-TYPE QUESTIONS.

1 a) An NX-size core sample with a length to diameter ratio of 3:1 was collected from a prospective construction site and subjected to a vertical load, in the lab, of 35 kN. At failure, the sample experienced 14 mm and 2 mm changes in length and diameter, respectively. Calculate:

i) The sample's longitudinal and diametric strains
ii) The modulus of elasticity (also called Young's modulus) for the sample
iii) Poisson's ratio *(Diameter of an NX-core sample is 5.4 cm)*

b) A field refraction seismic survey carried out at the same site, where the sample tested in (a) was collected from, gave the following wave velocities:

Compressional waves = 1,200 m s^{-1}
Transverse waves = 700 m s^{-1}

If the ratio $\frac{v_p}{v_s} = \sqrt{\frac{2\times(1-\mu)}{1-(2\times\mu)}}$,

determine the Poisson's ratio (μ) for the ground, in which this survey was undertaken. Give one possible reason for the difference in the Poisson's values obtained in (a) and (b).

2. a) On the basis of their shear strength parameters, geologic materials may be classified into three main groups. Describe, with the aid of diagrams, these three groups.

b) A soil sample from one of the groups in (a) had a volume of 14.88 cm^3, a total mass of 28.81 grams, a dry mass of 24.83 grams, and a specific gravity of 2.7. For this sample, **determine** its **void ratio** and the **degree of saturation**

c) When subjected to a triaxial compression test at a confining pressure of 260 kN m^{-2}, the soil sample used in (b) failed at 950 kN m^{-2}. If the angle of shearing resistance at failure for this sample was 22.5°, **determine** the **shear and normal stresses** that acted on, and perpendicular to, the failure plane, respectively.

3. a) Construction of a new road from Lusaka to Chiawa through New Kasama, South East of Lusaka, required embankments in several places along its mountainous route. In one such embankment, a slope constructed at an angle of 45° exposed a discontinuity dipping at 35°, to **daylight** into its face. Shear box tests performed on this discontinuity gave the following results:

Normal stress (kNm^{-2})	100	200	300	400
Shear stress (kNm^{-2})	98	139	180	222

If a block weighing 1,300kN, and with a contact area of 600 m^2, lies above the discontinuity, determine:

i) The total forces that are promoting sliding of this block
ii) The factor of safety of the block against sliding
iii) Whether rock-bolting would be necessary in this slope. Justify your answer.

b) Along another road stretch crossing a dambo area, the road design involved construction of a bridge supported on piers. To test the integrity of the ground, a 20 – metre borehole was drilled at one of the proposed pier locations. The top five meters intersected soil, while the remainder of the drilling was in rock. The rock intersection gave the following drilled lengths (in centimetres):

9.9	8	1.3	3	5.3	0.8	17	3.8	2.5	10	2	7	9	5	2.7	2.8	5.3	9.6	34
8	35	36	10.8	10	59	3.3	5	19.4	2.3	95.3	3.3	7.3	11.3	6	7.8	11	110	10
63	6	4.3	8.2	53	1.5	10	11	2.5	48	10.8	10	7.5	10	12.3	6.5	7	25	97
20	12	8.9	2.8	5.8	13.8	3	3	87.9	4	16	6	117	19.5	10	7.9	1.3	116	56

Determine the following quality parameters for this rock mass:

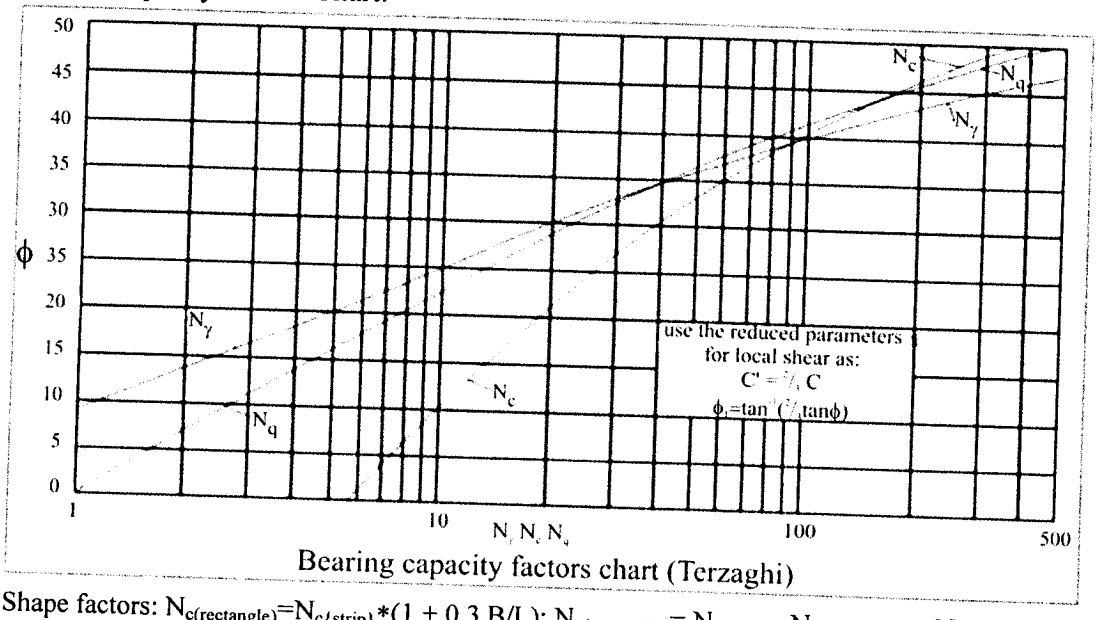
a) Its Rock Quality Designation (RQD)

b) Total core recovery

4. a) During site investigations for the UNZA East Park Mall Shopping Complex, a soil sample, 162 mm long and 54 mm in diameter, was collected from the site for permeability testing in the lab. If the diameter of the stand-pipe was 20 cm and the head decreased from 1.5 m to 1.2 m in 10.5 minutes, **calculate** the hydraulic conductivity of the sample in m/sec.

b) The foundation design of the UNZA East Mall Park shopping complex was on 2m square pad footings cast at 40 cm below ground surface. Determine the ultimate bearing capacity under each footing if laboratory tests established the unit weight of the underlying soil as 15 kN m^{-3} and an angle of shearing resistance of 35°.

➢ Bearing capacity factors Chart:



Bearing capacity factors chart (Terzaghi)

➢ Shape factors: $N_{c(rectangle)}=N_{c\{strip\}}*(1 + 0.3.B/L)$; $N_{q(rectangle)} = N_{q\{strip\}}$; $N_{\gamma(rectangle)} = N_{\gamma\{strip\}}*(1-0.2.B/L)$

5. a) A soil sample, with a mass of 315 grams, was collected from a prospective construction site. After sieving it, the following results were got:

Grain size (mm)	50	35.5	20	14	10	6.3	3.35	1.18	0.6	0.15	0.063
Mass retained (g)	0	15.5	17	10	11	33	114.5	63.6	18.2	17	10.5

According to the British Standards Institution (BSI), the soil fractions are classified as follows:

Particle Size (mm)	< 0.002	0.002 – 0.06	0.06 – 2	2 – 60	>60
Soil Fraction	Clay	Silt	Sand	Gravel	stone

For this soil, **determine** the **percentage of each fraction** contained in it, and **name** the soil.

b) Give **four** reasons for carrying out a site investigation and describe its various stages

c) Write brief notes on (i) factors that determine the specific capacity of the ground to carry load, (ii) safe bearing capacity, (iii) differential settlement.

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

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY5161 – EXPLORATION GEOPHYSICS

ANSWER: ANY **FIVE** QUESTIONS. INCLUDE DIAGRAMS, WHEREVER POSSIBLE. ALL QUESTIONS CARRY EQUAL MARKS.

TIME: THREE (3) HOURS

---

1. Explain the following terms, briefly:
   a) Target
   b) Spatial aliasing
   c) Active method
   d) Noise
   e) Nyquist frequency
   f) Larmor precession frequency (fp)
   g) Geometric (or configuration) factor for the Dipole-Dipole Array
   h) Apparent I.P. chargeability (Ma)
   i) Diffusion depth (d) of a transient electric field
   j) The Turam Large-Loop system.

   (20 marks)

2. Prepare a Table of geophysical methods, listing the following:
   a) Name of geophysical method
   b) Type of method (i.e. potential or active)
   c) Physical property measured
   d) Application
   e) One type of natural source of noise the method is susceptible to, if any. (20 marks)

3. Describe the five factors or issues that need to be considered in the planning or design of a geophysical survey. (20 marks)

4. a) Explain the principles behind the Proton Precession Magnetometer (PPM). (10 marks)
   b) What is the "Overhauser Effect"? 5 marks
   c) Suppose a PPM measures a total magnetic field of 40,000nT at one location and 5 metres down the traverse the field drops to 30,000nT. Should the data be considered as valid? Explain. (5 marks)

5. a) Describe how to conduct a two dimensional (2-D) electrical imaging or tomography for the Wenner Array with twenty (20) electrodes (15 marks)
   b) What are the limitations of one dimensional (1-D) resistivity surveys? (5 marks)

6. a) Explain three (3) Induced Polarisation systems, namely;
      i) Time domain
      ii) Frequency domain
      iii) Phase domain

      (10 marks)

   b) i) What is Spectral IP and Complex Resistivity?
      ii) List the four electrical parameters that need to be known in order to define the dispersion curve in Spectral IP? (10 marks)

7. Explain the principle of the Frequency Domain Electromagnetic Method (FDEM). (20 marks)

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

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY5171 – ECONOMIC GEOLOGY OF METALLIFEROUS MINERAL DEPOSITS
PAPER I - THEORY

ANSWER: ANY **FOUR** QUESTIONS USING SKETCHES WHEREVER POSSIBLE. ALL QUESTIONS CARRY EQUAL MARKS.

TIME: THREE (3) HOURS

Q1. a) Zambia, in its 2015 budget, has implemented changes to the mining taxes by increasing royalty tax from 6% to 8% for underground mines and 20% for open pit mines. Discuss how this factor and the decreasing price of copper on the international market would affect the availability of Zambian copper. (5 marks)

b) A rock, by epigenetically interacting with hot ore fluids, is mineralized with chalcopyrite, bornite and chalcocite. The key gangue minerals are quartz, calcite and muscovite. A microscopic study reveals that quartz, calcite and muscovite formed at the same time, but it is apparent that these minerals also occur in both chalcopyrite and bornite as remnants or islands. However, calcite is also found in microveins that cut across both chalcopyrite and bornite. Chalcopyrite, bornite and microveins are all replaced by covellite on margins. With brief explanations and a diagram propose a possible paragenetic sequence illustrating the timing for the formation of minerals. (10 marks)

c) Classify the following deposit types into either syngenetic or epigenetic and state why: IOCG, stratiform chromite, BIFs, and placer. (6 marks)

d) Why is the Kitumba deposit that is being developed by Blackthrone Resources in Mumbwa District thought to be an IOCG deposit? (4 marks)

Q2. a) A slightly acidic meteoric water has percolated downwards through a near vertical quartz and calcite vein composed of pyrite and chalcopyrite, describe the three zones which are developed stating the key minerals formed and why. A diagram would be very useful. (10 marks)

b) Describe briefly the stratiform chromite deposits in terms of tectonic setting, age, morphology, key ore minerals and gangue minerals and how they formed. (10 marks)

c) What is isotope fractionation and how do stable isotopes help in the study of mineral deposits? (5 marks)

Q3. a) Describe the product of having a limestone country rock intruded by a hot granitic body in terms of the type of mineralized skarn that develops, skarn mineralogy, ore mineralogy, hydrothermal fluids involved and the alteration that develops. (10 marks)

b) State three geophysical methods that may be employed in searching for skarn deposits and why such methods would be suitable. (6 marks)

c) What is a primary fluid inclusion and what are the four pieces of information about mineral deposits that would result from the study of such inclusions? (6 marks)

d) How are hydrothermal fluids produced through metamorphism? (3 marks)

Q4. a) Define the following terms:

i) Epithermal Vein
ii) Mesothermal Vein
iii) Hypothermal Vein

b) Describe briefly how Ni-Cu sulphide mineralisation is produced through a magmatic process called liquid immiscibility. (10 marks) (6 marks)

c) Describe briefly how metal complexation promotes solubility of metals in hydrothermal fluids. (4 marks)

d) Briefly describe how evaporites form? (5 marks)

Q5. a) Define the following terms

i) Cation exchange
ii) Laterite
iii) Oxidation
iv) Dissolution
v) Hydration

(10 marks)

b) Describe briefly how alluvial diamond deposits would form in terms of source, transport mechanism and deposition site conditions. (10 marks)

c) There is so much copper in the Katanga Supergroup of the Zambian Copperbelt and yet the Basement does not contain enough copper to have been the source. Describe briefly the new thought on the possible source of copper. (5 marks)

Q6. a) In a gold placer deposit located at Senga Hill, Mbala District zircons have been extracted and dated at 540±2Ma. Explain this age. (5 marks)

b) Particles of quartz, pyrite and gold are contained in flowing water (at room temperature and 1 atm pressure) along a straight river channel. At these conditions water, with density of 910 kg/m^3 and viscosity of 0.982×10^{-3} kg/s.m, flows at a speed of 50 m/s over a length of 200 m. Quartz, pyrite and gold have the following parameters.

PARTICLE	PARTICLE DIAMETER (mm)	PARTICLE DENSITY (kg/m^3)
Quartz	11	1500
Pyrite	7	3000
Gold	3	17000

Note that gravitational acceleration is 9.81ms^{-2} and

(i) $Re = UL\delta_f/\eta$; (ii) $V = gd^2(\delta_p - \delta_f)/18\eta$

a) Explain all the parameters in equations (i) and (ii). (4.5 marks)

b) Determine the Reynolds Number and state whether the flow is laminar, transient or turbulent and why. (5.5 marks)

c) Determine the settling velocity for each of the particles (quartz, pyrite and gold). (6 marks)

d) With results in (c) comment on the settling pattern. (4 marks)

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

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
2015 MID YEAR EXAMS
EGT 5171
26/02/15 – PM
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UNIVERSITY OF ZAMBIA
SCHOOL OF MINES

UNIVERSITY OF ZAMBIA EXAMINATIONS – FEBRUARY 2015

GGY 5171 – ECONOMIC GEOLOGY OF METALLIFEROUS MINERAL DEPOSITS – PRACTICAL EXAMINATION

LIST OF POSSIBLE ORE MINERALS

Pyrite, chalcopyrite, bornite, chalcosite, sphalerite, galena, covellite, magnetite, digenite, hematite, pyrrhotite, pentlandite, chromite, cassiterite, arsenopyrite, carrolite, ilmenite, rutile, malachite, and azurite.

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS – FEBRUARY/MARCH 2015
GGY5171 – ECONOMIC GEOLOGY OF METALLIFEROUS MINERAL DEPOSITS
PAPER II - PRACTICAL

ANSWER: **THE** QUESTION.
TIME: ONE (1) HOUR

You are provided with two polished sections (X and Y). Using the reflected light microscope identify the ore minerals present and describe the observed textures.

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

UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
UNIVERSITY MID-YEAR EXAMINATION/ FEBRUARY 2015

MET 3145 – MINERAL PROCESSING

Answer: Five Questions
Time : Three Hours

Question 1:

State briefly but clearly what you understand by the following terms used in mineral processing:

- 80% passing reduction ratio
- work index
- terminal velocity of a particle
- set of a crusher
- liberation
- middlings fraction
- angle of nip
- differential flotation
- ~~work index~~ Crushing
- reverse flotation

[20 Marks]

Question 2:

a) Describe the crushing action of a jaw crusher with the aid of a clearly labelled diagram. Why do most modern jaw crushers use curved swing-jaw plates? **[5 marks]**

b) Describe the crushing action of a gyratory crusher with the aid of a clearly labelled diagram. **[5 marks]**

c) Describe with a simple sketch the operation of the Symons standard cone crusher. What is the purpose of the parallel zone? **[5 marks]**

d) Describe the protection mechanisms of these three crushers when an uncrushable material enters the crushing cavity. **[5 marks]**

Question 3:

a) State three factors, which increases the efficiency of screening and three factors, which decreases the efficiency of screening. **[6 marks]**

b) Particles that are nearly the same size as the screen apertures are called "near-mesh" particles. What are the problems caused by such particles and how could this be overcome in a normal plant operation if the plant is sufficiently large? **[4 marks]**

c) Very often the new feed to a crusher is screened to remove the material, which is already sufficiently fine to pass on to the next stage, and only the screen oversize passes through the crusher. State three advantages that this "scalping" of new feed gives. **[3 marks]**

d) Give four reasons why industrial sizing of broken rock may be carried out. **[4 marks]**

e) What do you understand by the 'free settling ratio' of two minerals and what do you understand by their 'hindered settling ratio'? **[3 marks]**

[20%]

Question 4:

a) Figure 1 below shows a conventional grinding circuit operation consisting of a rod mill and a ball mill in closed circuit with a hydrocyclone. From the following given data:

Feed to rod mill = 55 tonnes of dry ore per hour
Rod mill discharge = 62 % solids
Cyclone feed = 48 % solids
Cyclone overflow = 31 % solids
Cyclone underflow = 74 % solids

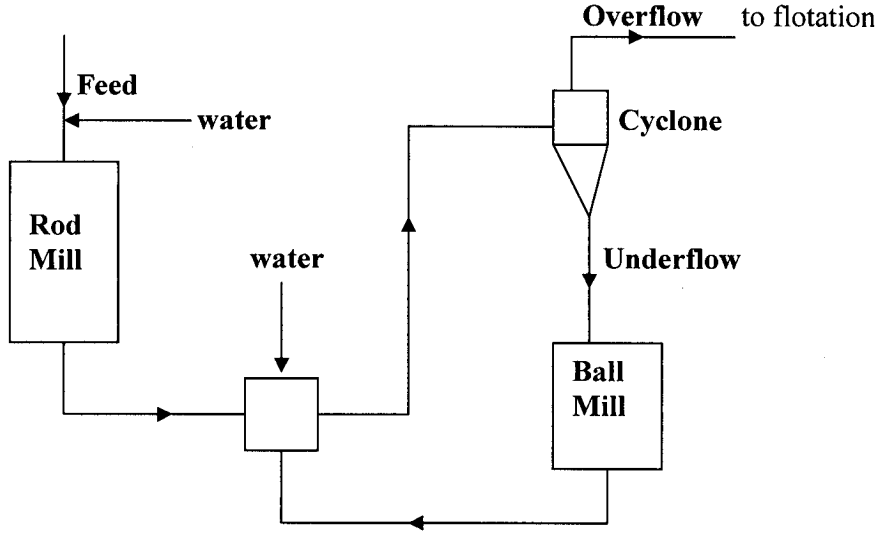


Figure 1: Rod mill – Ball mill – Cyclone circuit

Calculate:

i. the circulating load **[5 Marks]**
ii. the amount of water added to the rod mill and **[2 Marks]**
iii. the amount of water added to the cyclone feed. **[4 Marks]**

b) Discuss the classification mechanism of a hydrocyclone with the aid of a clearly labelled diagram. What do you understand by the separating size of the hydrocyclone? **[6 Marks]**

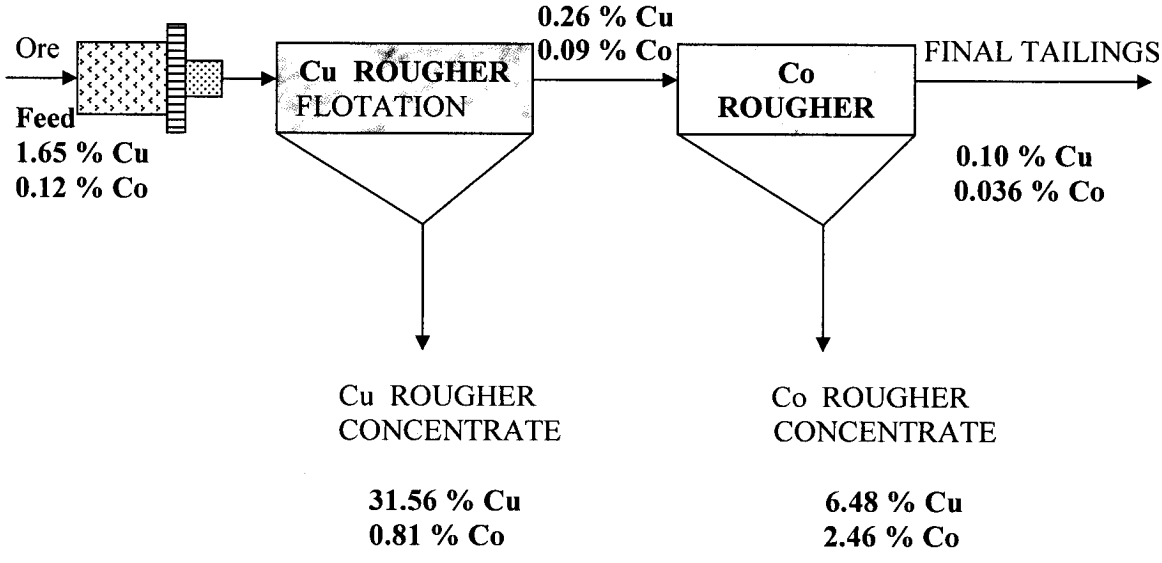
c) Hydrocyclones have replaced mechanical classifiers in most modern grinding plants. What are the advantages of hydrocyclones over mechanical classifiers? **[3 Marks]**

Question 5:

a) What is froth flotation? Describe the role of the following chemical reagents in mineral flotation:

i. Collectors
ii. Frothers
iii. Depressants and activators **[10 Marks]**

b) A copper / cobalt sulphide ore is treated in a differential flotation circuit to produce a copper concentrate and a cobalt concentrate in two stages, as shown in the diagram below. The average grades of the feed and products of this circuit are as indicated.



(i) Calculate the average recoveries of copper and of cobalt from the feed to the copper rougher concentrate. **[5 marks]**

(ii) What is the ratio of concentration into the copper rougher concentrate? **[2 Marks]**

(iii) If the feed tonnage (F) is 18 000 tonnes (dry) per day, how much copper is recovered (t/day) in the copper rougher concentrate? **[3 Marks]**

Question 6:

a) The average feed to a SAG Mill shows a calculated P80 size of 4.33 inches (11 cm). The SAG mill discharge passes over a vibrating screen deck that discharges an undersize product that measures a P80 size of 1.55 mm. The oversize from the screen is recycled back into the mill on conveyors while the undersize advances to the ball mill circuit through a pump/pipeline system. If the average power draw is 80% of the installed hp of 6,000, what is the operating SAG Mill Work Index of the ore, if the average feed tonnage is 1,000 tph. (1 hp = 0.746 kW). **[9 Marks]**

b) What are the two major function liners of tumbling mill perform? Give the three main groups into which mill liners can be classified. **[4 marks]**

c) Give and discuss three factors that affect the grinding of ores. **[3 marks]**

d) What are the essential differences between the grinding action of the rod mill and the ball mill? What is the effect of these differences in the grinding action on the size distribution in the respective mill products? **[4 marks]**

Question 7:

a) What are the main methods of dewatering? Briefly describe each of them. **[5 marks]**

b) Describe briefly the construction of tailing dams by the upstream, downstream and centre-line methods. What are the advantages of each method? Illustrate with sketches. **[15 marks]**

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END OF MET 3145 EXAMINATION
GOOD LUCK!!

THE UNIVERSITY OF ZAMBIA
School of Mines
Department of Metallurgy & Mineral Processing

COMPUTER TECHNIQUES
MET3429

2014/2015 FINAL EXAM

Date: Monday 23rd February 2015
Venue: 23A
Time: 14hrs
Duration: 3 Hours

Instructions

1. This exam has two sections A and B.
2. Answer any **two (2)** questions from **Section A.**
3. Answer any **two (2)** questions from **Section B.**
4. **Total number of questions answered should be 4.**
5. Write your answers on a separate answer sheet.

SECTION A – ANSWER ANY TWO(2) QUESTIONS

QUESTION A1 [25 marks]

a) Give two examples of Word processing programs **[2 marks]**

b) What common features are found on Word processors? List 3 **[3 marks]**

c) Write pseudo code that performs the following: Ask a user to enter a number. If the number is between 0 and 10, write the word blue. If the number is between 10 and 20, write the word red. If the number is between 20 and 30, write the word green. If it is any other number, write that it is not a correct color option. Write an algorithm and draw a flowchart to represent the pseudo code. **[20 marks]**

QUESTION A2 [25 marks]

a) Give two examples of Spreadsheet applications **[2 marks]**

b) What common features are found on Spreadsheet applications? List 3 **[3 marks]**

c) What is a comment in Java? Specify 3 types of comments and explain how they are used **[5 marks]**

d) What is a compile-time error? **[1 mark]**

```
public class Addition
{
  //-----------------------------------------------------------
  // Concatenates and adds two numbers and prints the results.
  //-----------------------------------------------------------
  public static void main (String[] args)
  {
    System.out.println ("24 and 45 concatenated: " + 24 + 45);

    System.out.println ("24 and 45 added: " + (24 + 45));
  }
}
```

e) What is the output of the program above? **[4 marks]**

f) Write a program that prints out the formatted text below; **[10 marks]**

Roses are red,
Violets are blue,
Sugar is sweet,
But I have "commitment issues",
So I'd rather just be friends
At this point in our relationship.

QUESTION A3 [25 marks]

a) What is a database management system? **[1 mark]**

b) Give 2 examples of databases. **[2 marks]**

c) What are some of the features of database management system? List 3 **[3 marks]**

d) Give 2 examples of Presentation graphics applications software? **[2 marks]**

e) What are some of the features of Presentation graphics software? List 3 **[3 marks]**

f) Write an algorithm to determine a student's final grade and indicate whether it is passing or failing. The final grade is calculated as the average of four marks. Draw a flow chart for the same. **[10 marks]**

g) Identify and correct the errors in each of the following statements: **[4 marks]**

i.
```
if (c< 7 );
System.out.println( "c is less than 7" );
```

ii.
```
if (c => 7 )
System.out.println( "c is equal to or greater than 7" );
```

SECTION B – ANSWER ANY TWO(2) QUESTIONS

QUESTION B1 [25 marks]

1. Describe briefly each of the following: Motherboard, CPU, Cooling system, ROM and RAM, Adapter card, Storage drive, Internal cable, Input/Output device. **[8 marks]**
2. State one example of a specialized computer and describe it. **[5 marks]**
3. Convert the following hexadecimal numbers to their binary equivalents: **[6 marks]**
   a. D52 b. 239
4. Convert the following binary numbers to their hexadecimal equivalents: **[6 marks]**
   a. 001001 b. 10100111

QUESTION B2 [25 marks]

1. It is generally considered that computers have existed in 5 generations. Discuss each of these five generations giving examples of computers existing in each of these where appropriate. **(Please do not just list points - discuss)**

QUESTION B3 [25 marks]

1. The operating system (OS) controls almost all functions on a computer, however, the OS may have potentially conflicting goals. Give an example of two goals of an OS that may be conflicting; **[2 marks]**
2. An operating system has four main roles, list them. **[2 marks]**
3. Generally it is considered that there are about 7 types of modern operating systems. Describe 2 of them and give an example for each. **[5 marks]**
4. **Discuss** the differences between Desktop Operating System and Network Operating System. Give an example for each. **[8 marks]**
5. Operating systems have the following characteristics multi-user, multitasking, multiprocessing and multithreading, describe each of these characteristics. **[8 marks]**

- END -

UNIVERSITY OF ZAMBIA

SCHOOL OF MINES

UNIVERSITY MID-YEAR EXAMINATON / FEBRUARY 2015

MET 4111 – COMMINUTION AND CLASSIFICATION

ANSWER FIVE QUESTIONS **Time: 3 hours**

Question 1:

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

- Work index
- Sphericity of a particle
- Middlings
- Bulk density
- Angle of nip
- Classification
- Terminal velocity of a particle
- Graded crushing
- Fall diameter
- Comminution

[20 Marks]

Question 2:

(a) (i) Describe the crushing action of a jaw crusher with the aid of a clearly labelled diagram. **[5 Marks]**

(ii) Why do modern jaw crushers use curved swing-jaw plates? **[2 Marks]**

(iii) How could the reduction ratio of a jaw crusher be altered for small adjustments, and for large adjustments? **[2 Marks]**

(b) (i) Describe the crushing action of a gyratory crusher with the aid of a clearly labelled diagram. **[5 Marks]**

(ii) What do you understand by the set of the gyratory crusher and how could this be adjusted? **[3 Marks]**

(iii) Describe the protection mechanisms of jaw crushers and gyratory crushers when an uncrushable material (e.g. tramp metal) enters the crushing cavity. **[3 Marks]**

Question 3:

a. In a conventional closed circuit grinding operation (Figure 1), the cyclone overflow line is instrumented with a magnetic flowmeter and nuclear density gauge, and the mass of dry ore fed to flotation is 20 t/h. The feed from the ore bin is sampled, and is found to contain 7 % moisture. The cyclone feed contains 35 % solids, the cyclone underflow 60 % solids, and the overflow 15 % solids.

Calculate:

(i) The circulating load on the circuit. **[5 Marks]**
(ii) The amount of water required to dilute the ball mill discharge. **[5 Marks]**

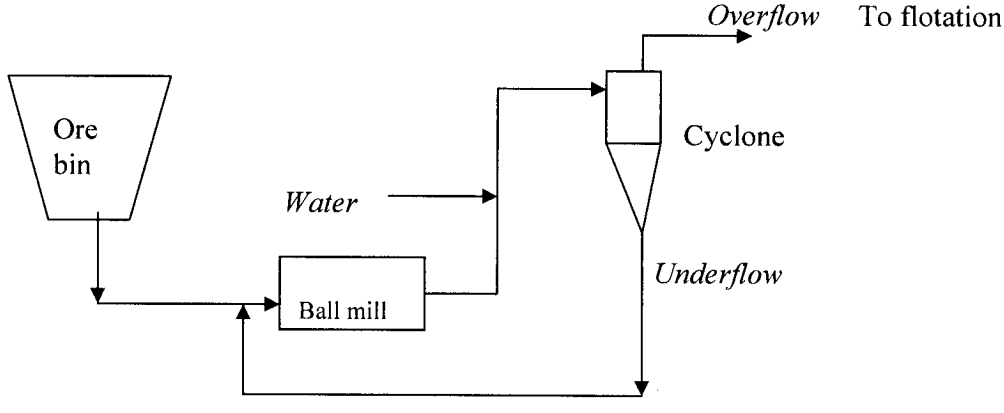


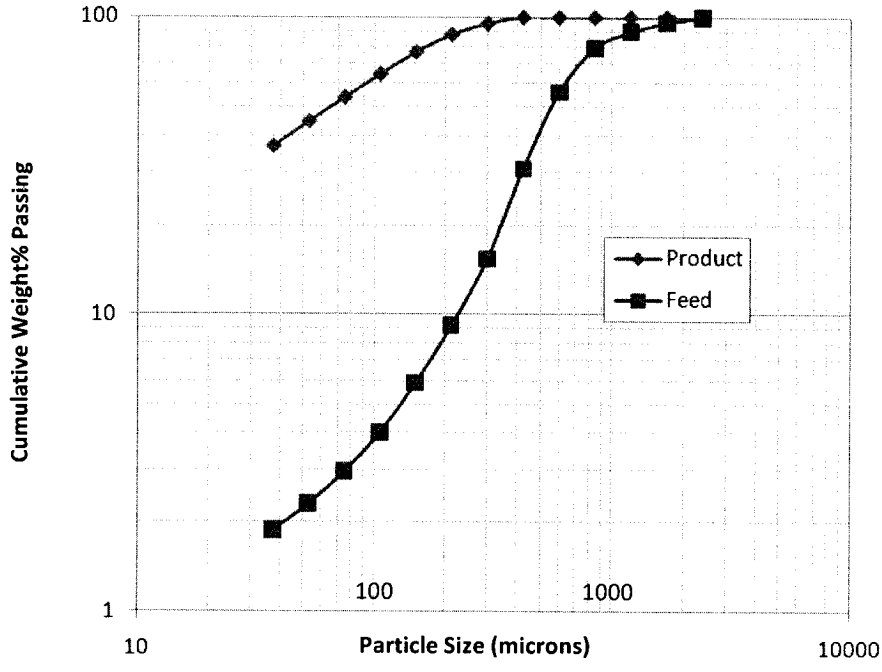
Figure 1: Closed circuit grinding flowsheet

b. Describe with a simple sketch the operation of the Symons standard cone crusher. What is the purpose of the parallel zone and what do you understand by the set of the cone crusher? **[7 Marks]**

c. What are the advantages of autogenous mills on suitable ores over conventional circuits? **[3 Marks]**

Question 4:

a. An ore has been tested for comminution using a lab-scale rod mill. Screen analyses of the feed to the mill and the product after grinding for 10 minutes shows the following particle size analyses:



Previous studies with the same lab rod mill with identical conditions on an ore of known Work Index gave the following results:

Feed 80% Passing Size = 1,148 microns
Product 80% Passing Size = 116 microns
Work Index = 14.63 kWh/t

Calculate the Work Index of the unknown ore sample. **[10 Marks]**

b. What are the two major function liners of tumbling mill perform? **[2 Marks]**

c. What are the essential differences between the grinding action of the rod mill and the ball mill? What is the effect of these differences in the grinding action on the size distribution in the respective mill products? **[4 Marks]**

d. Describe the grinding action of a ball mill indicating the various zones that can be distinguished. **[4 Marks]**

UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATION – FEBRUARY 2015

MIN 4025 - GEOSTATISTICS

INSTRUCTIONS: **ANSWER ALL QUESTIONS** TOTAL MARK: **100**
TIME: **3 HOURS** CLOSED BOOK

Question 1

1. A) Define the following terms
   i. Geostatistics
   ii. Variogram
   iii. Range
   iv. Nugget effect
   v. Collerogram and co variance **10 Marks**

   B) Quantify the characteristics of four common variograms mathematically **5 Marks**

   C) Discuss the relationships between collerogram and variogram **5 Marks**

Question 2

Interpret the following geostastical terms

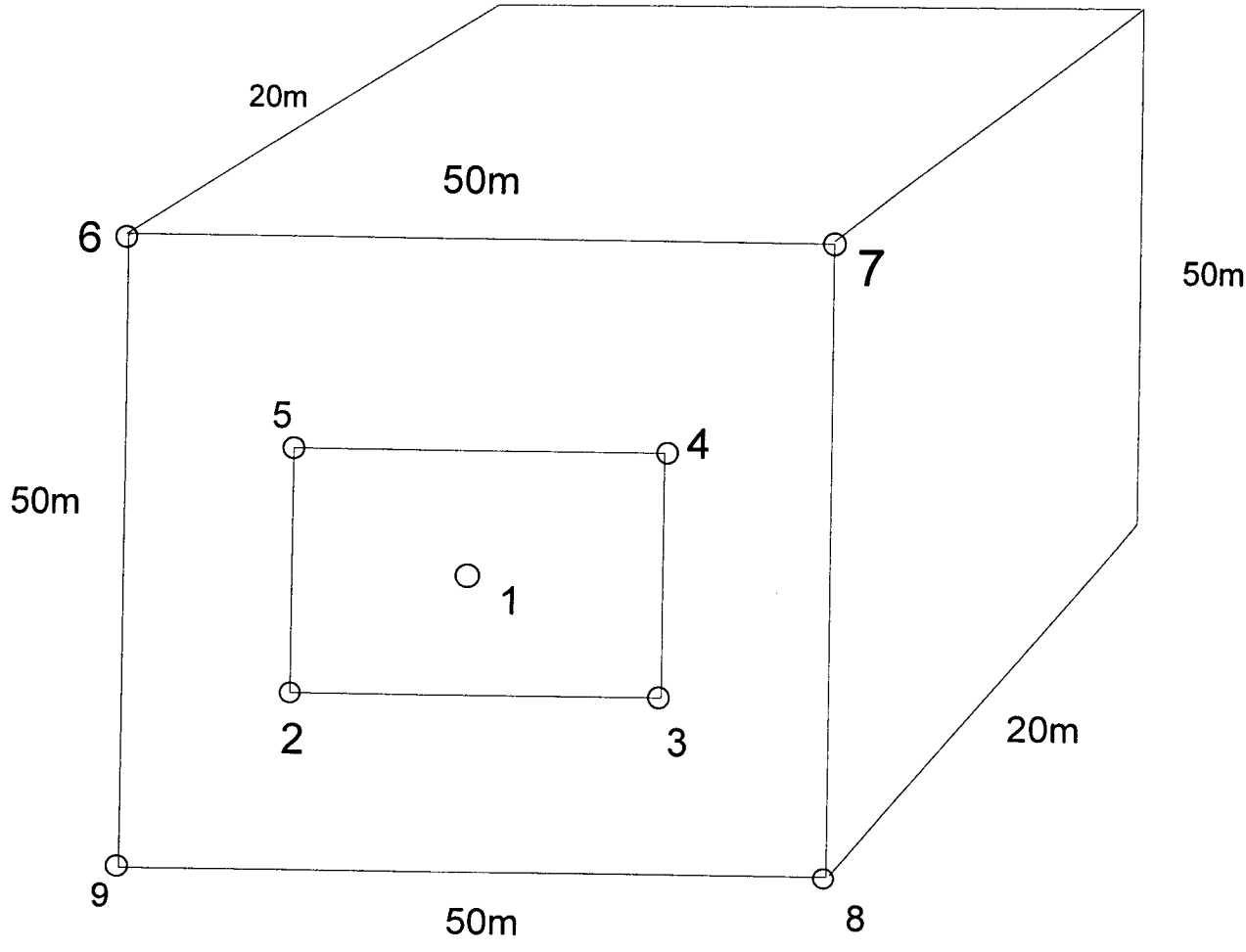
(i.) First order moments **2 Marks**
(ii.) Second order moments **2 Marks**
(iii.) Strict stationasity **2 Marks**
(iv.) Stationarity of order one **2 Marks**
(v.) Intrinsic hypotheses **4 Marks**
(vi.) Quasi stationarity **4 Marks**
(vii.) Positive definite conditions **4 Marks**

Question 3

Given the data configuration as shown in the figure A.

Determine stope characteristics:

(i)	Grade value	**5 Marks**
(ii)	Bank Cubic metres	**5 Marks**
(iii)	Tonnage	**10 Marks**

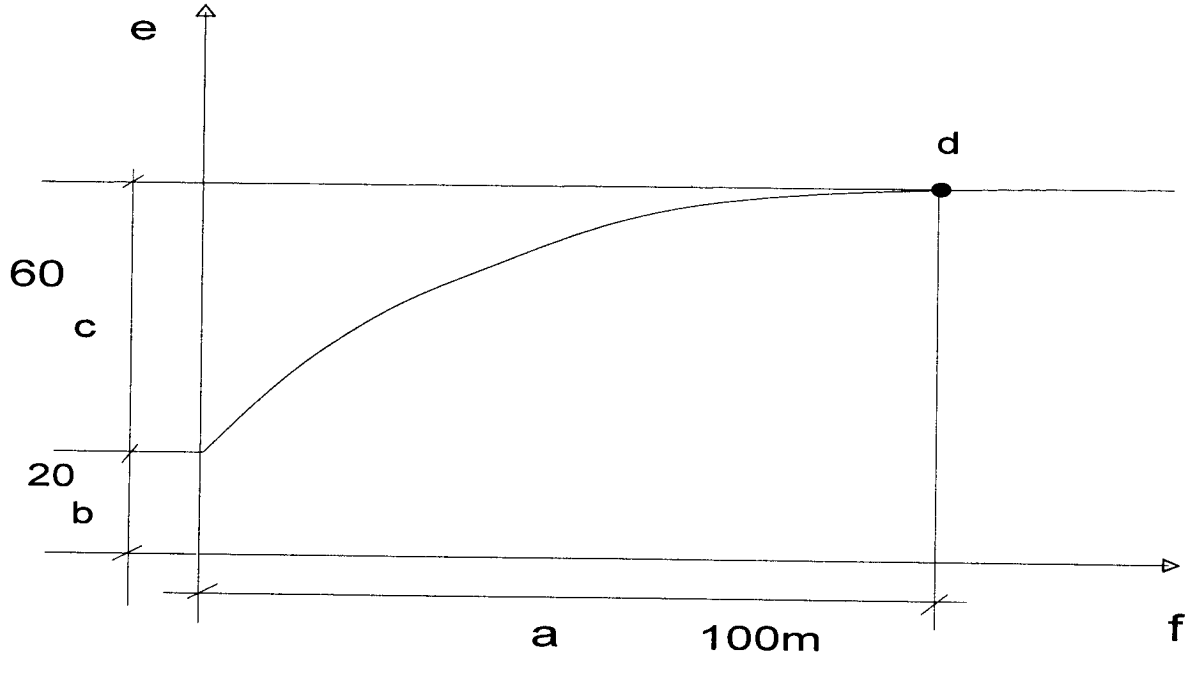


Point	Grade	Weight
1	2.0	20%
2	3.0	15
3	2.5	15
4	2.2	15
5	2.3	15
6	1.9	5%
7	1.8	5%
8	1.6	5%
9	2.0	5%

Tonnage factor 20 tonnes per m^3

Question 4

(a) From the Experimental variogram below what is the Sill value, Nugget effect and the range of the experimental variogram.



NB. Do not consider the shape and properties of the variogram developed.

(b) Give a formula of the variogram mathematically given that the supply interval was 10m

(c) What type of variogram is this **10 Marks**

Question 5

Given samples of grades of copper along a haulage at 10 meters intervals as follows: 2.1, 2.9, 3.1, 1.9, 1.8, 2.6, 2.8, 3.2, 1.7, 2.5

I. Estimate and plot a variogram of grades **10 Marks**

II. How would you validate the variogram parameters estimated **5 Marks**

III. Discuss kriging as an estimation procedure **5Marks**

UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – FEBRUARY 2015

MIN 4035 OPERATIONS RESEARCH

TIME: THREE (3) HOURS **TOTAL MARKS: 100**
INSTRUCTIONS: ANSWER ANY FIVE (5) QUESTIONS

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1. Consider a project which has 8 events (event 1 = project start and event 8 = project finish). The three PERT time estimates (in days) are given in the following table:

Activity	a	m	b
1,2	3	4	6
1,3	1	2	3
2,4	3	5	6
2,5	3	4	6
3,7	5	6	7
4,6	1	3	4
5,6	1	3	5
5,7	1	2	3
6,7	3	5	7
6,8	1	2	4
7,8	2	3	4

i) Construct an arrow diagram for the project **[2 marks]**
ii) Using PERT assumptions, find the mean and variance of times of each activity. **[5 marks]**
iii) Find the critical path using the mean times in (ii) above **[8 marks]**
iv) Assume the completion time for the total project can be approximated by a normal distribution. Determine the project's completion time and its corresponding standard deviation. **[5 marks]**

2. An exploration company buys drill bits used in its exploration programs directly from Atlas Copco Sweden. The company uses drills at a constant rate and requires 1,000 bits per month throughout the year (12,000 per year). If ordering costs are US$25 per order, unit cost is US$250 per bit, and annual inventory holding costs are charged at 20%, determine the following:

i) Define the term 'Economic order quantity' **[2 marks]**
ii) The economic order quantity (EOQ)? **[8 marks]**
iii) Length of cycle time in months between orders? **[5 marks]**
iv) The total annual inventory holding and ordering costs? **[5 marks]**

3. A new mining investor (Xhiao China) would like to invest in Zambia. Earlier attempts aimed at acquiring controlling shares in Chambeshi Mining Limited were unsuccessful. The company has now decided to look elsewhere. It has two options to consider:

Option 1:

Buy a recently revived gold mine prospect in Mumbwa at an advertised price of US$5 million. Preliminary available geological information indicates the prospect maybe fairy priced. The company expects to spend US$100,000 on feasibility studies so that it can decide whether to develop the mine or not. Development and other costs to bring the mine into production are expected to be US$500,000 and annual operating costs to be US$200,000. Gold recovery by a recently developed recovery method is expected to be 420 ounces with a probability of 0.5 and 390 ounces with a probability of 0.3. Gold price by contract with Ashanti Gold Marketing has been agreed at US$1,200 per ounce.

Option 2:

Approach the Ministry of Mines for a mining right to develop a new emerald mine in Ndola rural. Once developed, the company hopes to sell cut stones at international markets. Expected investment costs will be US$950,000. Operating costs are expected to be US$450,000 annually. 10,000 carats of cut stones will be produced annually. Emerald prices are extremely volatile. Three price scenarios with their corresponding probabilities have been established as follows:

Price (US$/carat)	**Probability of price**
US$2,000	0.1
1,900	0.4
1,500	0.5

i) Construct the decision tree for the above problem **[10 marks]**

ii) If the company's objective is to maximize the expected value of contribution (i.e., profit), what is the company's best strategy? **[10 marks]**

4. Given the discrete probability distribution in the table below, of revenue/tonne and cost/tonne for a mining company and a set of random numbers, determine the following:

Revenue/tonne	Probability of revenue per tonne P(R/t)	Cost /tonne	Probability of cost per tonne P(C/t)
20.5	0.05	7.5	0.15
21.5	0.10	8.5	0.40
22.5	0.25	9.5	0.30
23.5	0.40	10.5	0.15
24.5	0.15	**Total**	**1.00**
25.5	0.05		
Total	**1.00**		

Table of Random numbers for revenue per tonne and cost per tonne

Sample no.	Random numbers for Revenue/tonne	Random numbers for Cost per tonne
1	0.488	0.140
2	0.322	0.097
3	0.274	0.674
4	0.557	0.783
5	0.931	0.679
6	0.986	0.767
7	0.682	0.031
8	0.179	0.613
9	0.881	0.867
10	0.834	0.227
11	0.913	0.209
12	0.327	0.530
13	0.077	0.704
14	0.552	0.165
15	0.890	0.299
16	0.518	0.145
17	0.597	0.421
18	0.802	0.815
19	0.829	0.949
20	0.770	0.278

i) The expected value of profit per tonne. **[5 marks]**

ii) From the twenty random numbers (20 simulations) presented in above table, determine the expected value using Monte Carlo simulation. **[10 marks]**

iii) Comment on why there is a difference in expected values derived in (i) and (ii) above. **[5 marks]**

5. Mansa Manganese Resources (Plc) produces two manganese alloys Mg1 and Mg2 from its Kabwe furnance. The products passes through two treatment processes (TR1 and TR2). It takes 7 hours on process TR1 and 4 hours on process TR2 to manufacture 100 tonnes of Mg1. It requires 6 hours on process TR1 and 2 hours on process TR2 to manufacture 100 tonnes of product Mg2.

   It is possible for process TR1 to take 42 hours and process TR2 16 hours of this work. The profit that can be realized per 100 tonnes of product Mg1 is K5.50m and K2.00m per 100 tonnes of product Mg2.

   i) If the objective is maximize profit, develop a mathematical model that shows the objective function and the corresponding constraints. **[10 marks]**

   ii) To obtain maximum profit, graphically determine how much of product Mg1 and product Mg2 must be produced. **[10 marks]**

6. A summary of a mine transportation problem is presented to management as outlined in the following table below.

Origin	P1	P2	P3	P4	**Total units available**
W1	10	10	30	8	**20**
W2	16	9	5	15	**14**
W3	22	12	7	15	**30**
Total units required	**16**	**16**	**24**	**8**	**64**

The origins are warehouses W1, W2, and W3. Destinations are plants P1, P2, P3 and P4. Supply from W1=20 units, W2=14 units, and W3=30 units. Total plant requirements at P1=16 units, P2=16 units, P3=24 units and P4=8 units

i) From the given details, establish the initial feasible solution using:

   a) The least cost method **[5 marks**

   b) Northwest corner **[5 marks]**

   c) The total cost of transportation using the Stepping-stone- method. **[10 marks]**

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

SECOND TERM UNIVERSITY EXAMINATION FEBRUARY, 2015

MIN 4045 –UNDERGROUND MINING

INSTRUCTIONS: Answer Question one and any four Questions **FULL MARKS**: 100

TIME: 3 hours

Question 1

i) With the help of clearly labelled diagram and equations explain the gravity flow concept of ore in sublevel and block caving methods based on *Janelid* and *Kvapil* concept. How does this concept relate to flow of ore in narrow dips and restricted planes? **[10 Marks]**

ii) Explain the effects of the following factors on ore draw:

- Moisture content **[2 Marks]**
- Angle of repose **[2 Marks]**
- Discharge width **[2 Marks]**
- Caved ore mass height **[2 Marks]**
- Granulometric composition of caved ore and waste **[2 Marks]**

Question 2

A horizontal slice of ore measuring 40m x 50 m x 2.5 m is to be extracted by using vertical crater retreat method (VCR). Given the following parameters below in table 1:

Table 1 VCR parameters

No	Parameter	Unit
1	Depth Ratio of charge, Δ	0.2
2	Amount of Spherical charge per crater, Q	28.5 kg
3	Density of ore, ρ	3.6 t/m^3
4	Ore Dilution, D	5%
5	Stope Recovery, R	95 %

6 E 0.45

i) Determine the amount of broken ore per crater **[5 Marks]**

ii) Amount of ore broken in the entire slice **[5 Marks]**

iii) Construct spherical charge using "Nonel" charging method and briefly explain the charging and blasting process in the stope. **[10 Marks]**

Question 3

A vertical slot measuring 5m wide by 15 m long and 60 m high is to be formed at the centre of the block in sublevel stoping. Given the following: height of sublevel, h= 20 m; area of sublevel drift, A=6.25 m^2; diameter of blast hole, d= 80 mm; rock strength coefficient, f=10; linear charge, U=6.5 kg/m, area of slot raise, A_s=2.2 m^2 ; ore density, γ =3.6 t/m^3; dilution coefficient, D= 0.1; slot recovery coefficient, R_s= 0.98 %. Determine:

i) Burden and spacing and use the same to determine graphically total number of holes per fan lay out. **[8 Marks]**

ii) Amount of ore broken per metre of blast hole **[2 Marks]**

iii) Total tonnage of ore extracted from the slot excluding that from development works **[5 Marks]**

iv) Total number of rounds/blasts required for complete formation of the slot. **[5 Marks]**

Question 4

i) Given the following parameters of mine Y:

V= 15 m , vertical depression of deposit
S = 30m x 1500 m , surface area of deposit
γ= 2.5 t/m^3, density of ore
K_{ex}= 0.95 , mineral extraction coefficient or recovery
D= 0.1, dilution coefficient

Calculate the production output based on the value of annual lowering of deposit extraction level. **[10 Marks]**

ii) Explain briefly how qualitative and quantitative losses of ore occur in the mine and how they are accounted for. **[10 Marks]**

Question 5

Explain the basis of geo-mechanical classification of mining methods and illustrate your answer by drawing and clearly labelling a variant of one mining method in each class **[20 Marks]**

Question 6

A horizontal stratiform ore-body at **150 m** below ground surface is planned for extraction using **6.0** m room spans, pillars **7.0** m square in plan. The full stratigraphic thickness of **3.0** m is mined. The unit weight of overburdern rock is 22.5 kNm^{-3}. Analysis of pillar failures in the ore- body indicates that pillar strength is defined by:

$$S=10.44h^{-0.7}W_p^{0.5}$$

Where **S** is in Mpa , **h**- pillar height and W_p- pillar width

Determine the factor of safety against compressive failure of pillars in planned layout. If the factor of safety is inadequate, propose a mining lay out which will achieve a maximum volume extraction ratio, for a selected factor of **1.6.** State the assumption made in this calculation. **[20 Marks]**

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

UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATION – FEBRUARY 2015

MIN 4065 - INVERSTMENT ANALYSIS

INSTRUCTIONS:	**ANSWER ALL QUESTIONS**	TOTAL MARK:	**100**
TIME:	**3 HOURS**	CLOSED BOOK	

Question 1

Engineer Zulu was given an award of K10000 by his employer.

1. If he inverted this award in a bank paying 9% interest per year for 15 years and inflation is at 6% what will be the value of his investment? **[10 Marks]**
2. Suppose Zulus tax rate is charged at 32% and inflation continues to be at 6% what will be the value of his interest. **[10 Marks]**

Question 2

Engineer Zulu wants to plan for retirement for 15 years. He wants to withdraw K5000 at the end of the first year and increase withdraws at K1000 per year. How much money should Mr Zulu have at the start of his retirement if money earns 6% per year compounded monthly annually? **[20 Marks]**

Question 3

If a bank pays interest at 10% per year compounded quantity what is the effective interest rate?

a. If you save K1000 a month for 20 years at 10% per year compounded monthly how much will you have at the end of 20 years? **[10 Marks]**

b. How much money must be deposited in an account per month to accumulate K10000 at the end of 5 years if the bank pays interest at the rate of 60% per year compounded quarterly? **[10 Marks]**

Question 4

A new leach plant is expected to have an initial cost of K20 million. The plant will need to be refurbished every five years at a cost of K1 million. The annual inspection and operating cost are K50000. Determine the present worth of the cost of the plant using the capitalized equivalent approach. The interest rate is 10% per compounded annually. **[20 Marks]**

Question 5

a. Find the rate or return for cash flow of –K50000 in year 0 and +K16719 each year for 1-5 years. **[2 Marks]**

b. Find NPV for a machine costing K60000, operating cost is K2675.40 the life of the machine is 7 years and revenue is K15000 per year. If the interest rate is 10%. **[3 Marks]**

c. Calculate the payback period of a project of K50000 in year 0 and +K16,719 for 5 years **[2 Marks]**

d. A company has a MARR of 30% and is looking at three new proposals.

a) Investment of – K50000, revenue K15000 for five years

b) Investment of – K25000, revenue K30000 for five years

c) Investment of – K100000, revenue of K350000 for five years, which proposal should be chosen. **[8 Marks]**

UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATION – FEBRUARY 2015

MIN 4075 – MATERIALS HANDLING

INSTRUCTIONS: **ANSWER QUESTION 1 AND ANY 5 QUESTIONS**
TOTAL MARK: **100**
TIME: **3 HOURS** CLOSED BOOK

Q 1 (a) Write the parameters needed to be considered in the design of a hoisting system. **[8 marks]**

(b) Give three differences between the drum winder and friction (kopje) winder and the situation in which they are recommended. **[6 marks]**

(c) Calculate the power in kW of the winding drum system 4.0m in diameter, torque need to be developed to turn the drum in 110kN.m. The winding rope should achieve a minimum speed of 6.0m/s. **[6 marks]**

Q2 (a) Name the principal types of conveyors used in mines and write the situations in which they are recommended. **[5 marks]**

(b) Write the main components of belt conveyor which makes it to work. **[5 marks]**

(c) What should be the speed of a belt conveyor if the bulk density of the material to be transported i.e. 1.2m, width of the conveyor belt is 1.4m and the amount of material to be transported per hour i.e. 400 t/hour? **[6 marks]**

Q3 (a) The manager of the mine where you are employed to determine the suitability of a section of road way, 1500m in length. Write the parameters you will consider for this purpose. **[10 marks]**

(b) Calculate the power of the motor of a locomotive to transport 1000 tonnes of mineral in shift of 6 hours, an uphill road 1 in 20. The length of the roadway is 1.6km; other values are given below; **[6 marks]**

- Weight of mine cars = 1t and each carry 2 tonne of coal.
- Rolling resistance between the wheel and the railway track = 50N/tone
- Rope friction = $\frac{1}{10}$
- Rope weight = 20 N/m
- Speed of locomotive = 5m/s

- Allow 4 minutes allowance for changing time
- Assume the efficiency of the engine 85%

Q4 (a) What are the main types of winding ropes and their purpose in which they are most suited. **[4 marks]**

(b) Calculate the length of the winding rope for a 40m high headgear for a hoist mineral from 800m deep shaft. The rope subtends an angle of 45° from the rope drum to the top of the pulley. While calculating the length of the winding rope you must bear in mind the statutory provision of mine regulation of Zambia. Diameter of the windy drum = 1.5m. The distance between the shaft's centre and the rope drum = 25.0m. **[12 marks]**

Q 5 (a) Write five most essentials of a haulage roadway to avoid derailment of mine locomotives mine cars. The road is wet and having mild curves at few places. **[8 marks]**

(b) Calculate the super elevation of the outer rail for a locomotive train weighing 20 tonnes moving round a curve of 100m with the speed of 35Km per hour. The gauge (width between the two rails) i.e. equal to 1.0m. Take value of $g=10m/s^2$ **[8 marks]**

Q6 (a) In a drum winder hoisting system two most serious causes of rope damage is wear and abrasion. How these are caused and explain briefly the control measures for these damages. **[8 marks]**

(b) Find the mass and the breaking strength of the strand rope if the diameter of the rope is 50mm and the values of k and s are 0.48 and 56 respectively.

[8 marks]

Q7 (a) What are the objectives of a proper design layout for both at the pit top and pit bottom? **[5 marks]**

(b) Show with the help of a line diagram for a centrifugal pump

(i) The 'suction head'; (ii) The 'delivery head'; and (iii) The other fittings provided for its efficient working of the pump. **[5 marks]**

(d) How much suction head for water, (theoretically), you expect? Show by calculation. **[6 marks]**

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

MID TERM UNIVERSITY EXAMINATIONS - 2015

MIN 4085 – MINE VENTILATION

TIME: 3HRS **FULL MARKS: 100**

INSTRUCTIONS: *Answer only* **FIVE QUESTIONS**. ***QUESTION ONE IS COMPULSORY***. *Graph paper is provided*

Question 1

i) Determine the speed at which a 1.8m diameter fan should operate to deliver 42 m^3/s at 498 Pa and density 1.36 kg/m^3. The fan performance for characteristic curve for a similar fan of 1.20 diameter operating at 1500 rpm and 1.20 kg/m^3 is given in table 1. Using fan laws, plot fan characteristics curves for 1.8 m operating at 1000 rpm.

ii) Find speed necessary for the 1.8 fan to deliver 42 m^3 at 500 Pa.

Table 1: Fan parameters

Fan Head, H (Pa)	Fan Quantity, Q (m^3)
1000	0
800	10
600	20
250	30

[20 Marks]

Question 2

Two sections of a mine are depicted in figure 1.

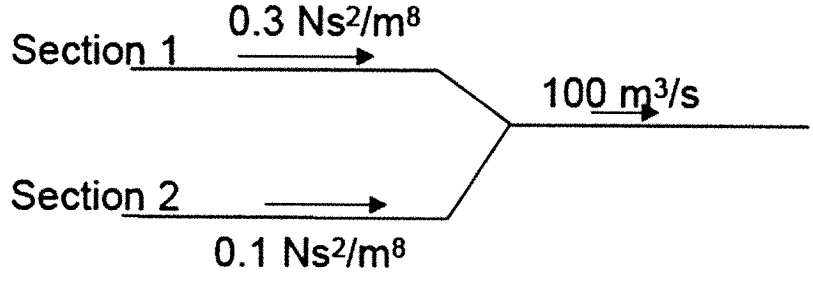


Figure. 1 Mine ventilation circuit for a section of a mine

i) Determine the airflow through each section of the mine **[10 Marks]**

ii) Calculate the pressure drop necessary to achieve 100 m^3/s **[10 Marks]**

Question 3

Figure 2 shows an ore body opened initially by use of Adit **BC** and Shaft **AB**. It is decided to drive a lower level **DE** and deepen the shaft to **BD**. Adits are 3.5 x 4.0 m and the shaft has a diameter of 5 m^2 . The friction factor for adits and shaft are 0.02 and 0.01 kg/m^3 respectively. If the fan is installed to exhaust 28 m^3 at the collar of shaft A, determine the quantity that will flow on each level and the mine heads. Solve algebraically or graphically.

[20 Marks]

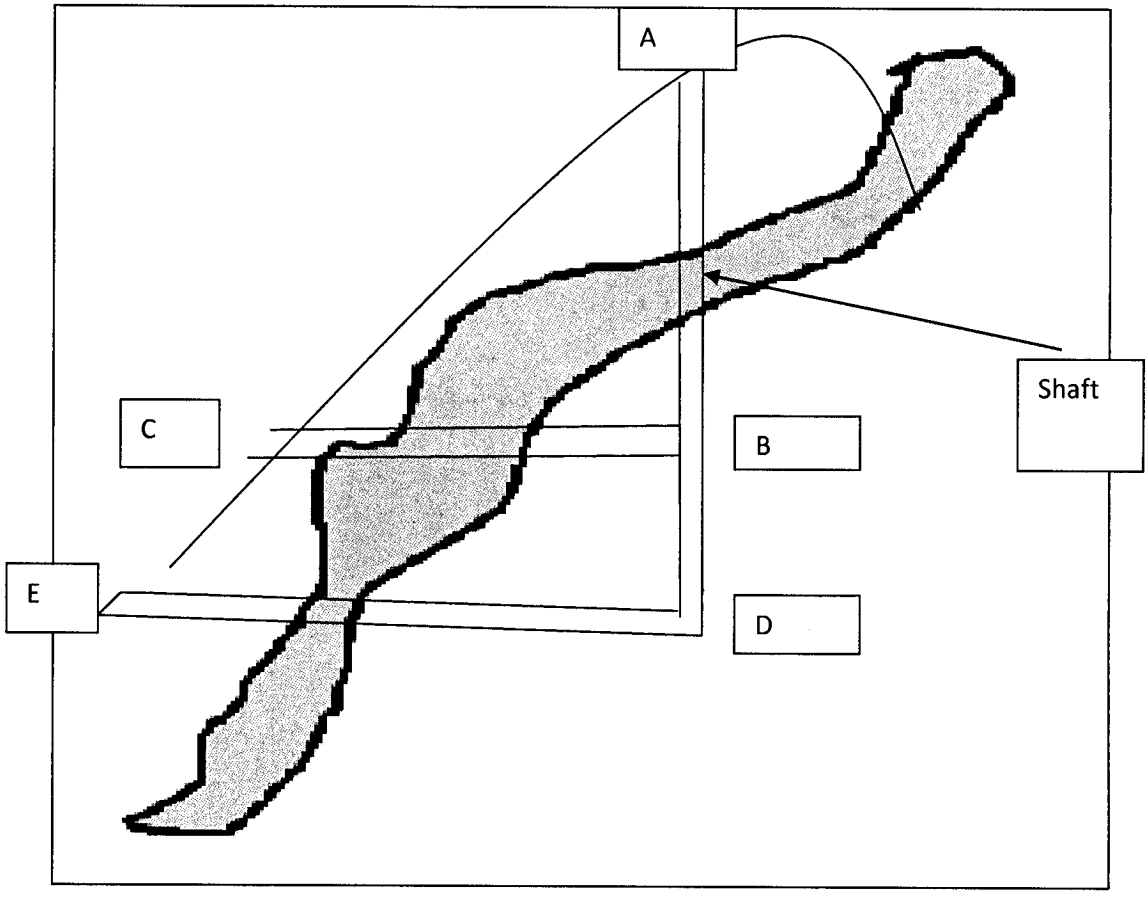


Figure 2. Ore-body opened up by adits and shaft

Question 4

a) Given mine schematic diagram in figure 3, calculate the natural ventilation pressure **(NVP)** of the system.

[10 Marks]

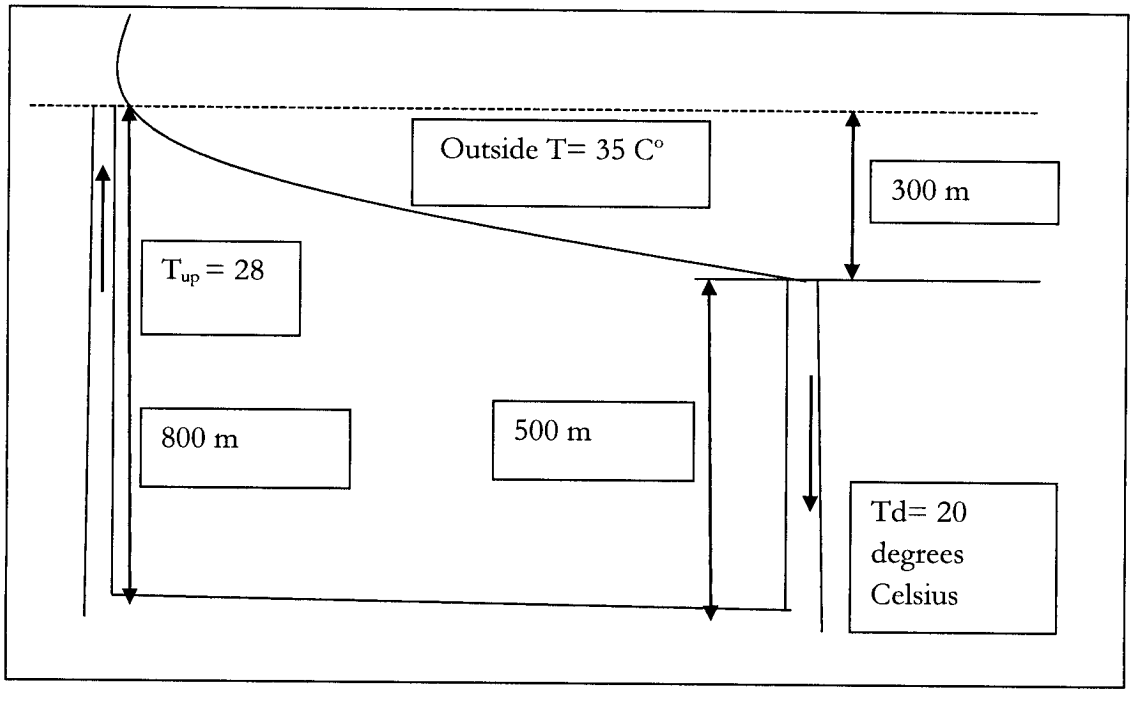


Figure 3: Mine schematic diagram

b) With the help of clear diagrams briefly explain basic mine refrigeration cycle for cooling air and what is normally done improve it.

[10 Marks]

Question 5

Figure 4 represents the mine workings of an underground mine. It is proposed to develop a new shaft (FE) and increase the mine airflow from 125m^3/s up to 240 m^3/s. What diameter should the new shaft be? Assume the new shaft can be raisebored.

[20 Marks]

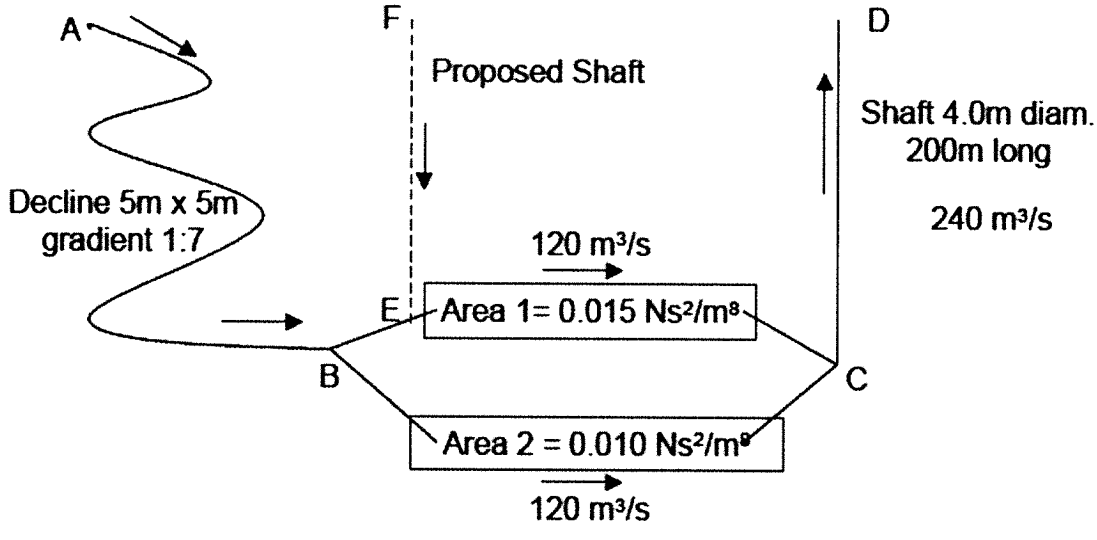


Figure 4. Underground mine workings

Question 6

a) 200 m^3/s of dry air at a temperature of 30 degrees Celsius and barometric pressure of 95 kPa flows down an intake shaft into a mine. At the bottom of the shaft, the air temperature is measured as 37 degrees Celsius and the barometric pressure is 102 kPa. What is the flow rate at the base of the shaft if there is no moisture pick- up in the shaft?

[10 Marks]

b) Three identical airways are developed in parallel. Each airway has a resistance of 0.15 (Ns^2/m^8). Calculate the pressure required to cause a flow of 50 m^3/s through each airway.

[10 Marks]

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

UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATION – FEBRUARY 2015

MIN 4095 – SURFACE MINING

INSTRUCTIONS:	**ANSWER ANY FIVE (5) QUESTIONS**	TOTAL MARK:	**100**
TIME:	**3 HOURS**	CLOSED BOOK	

Question 1

(a) Derive the recursive formula for open pit mine design. Define all symbols and parameters used in your derivation. **[5 marks]**

(b) The following sketch shows a vertical section of a small block model with the block economic values written on the blocks.

Table 1: Vertical section of a small block model with the block economic values

i \ j	1	2	3	4	5	6	7	8
1	-1	-2	-1	-2	-1	-1	-1	-1
2	x	-2	-2	-2	-1	-2	-1	x
3	x	x	+12	-2	-4	+9	x	x

Given that the pit can be mined to a maximum slope angle of 1 block: 1 block (45^0), determine the pit outline with the maximum sum of block economic values on the section using;

(i). The positive moving cone method. **[4 marks]**
(ii). A dynamic Programming Formulation. **[9 marks]**
(iii). Comment on the results obtained in (i) and (ii). **[2 marks]**

Question 2

The copper grades for a particular vertical section taken through an open pit are shown in below Figure 1. Also given is a Net Value versus % Copper curve (Figure 2). The blocks have dimensions 15m x 15m x15m. The ore density is 2.55 t/m^3. The cost to take waste material from the pit and place on the dump is $1.00 per tonne.

Table 2: Vertical section showing block grades (% copper)

0.0	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.0
0.0	0.2	0.5	0.7	0.7	0.7	0.2	0.1	0.0
0.0	0.2	0.5	0.8	0.8	0.8	0.2	0.1	0.0
0.0	0.2	0.5	0.6	0.8	0.5	0.2	0.1	0.0
0.0	0.2	0.5	0.6	0.7	0.5	0.2	0.1	0.0

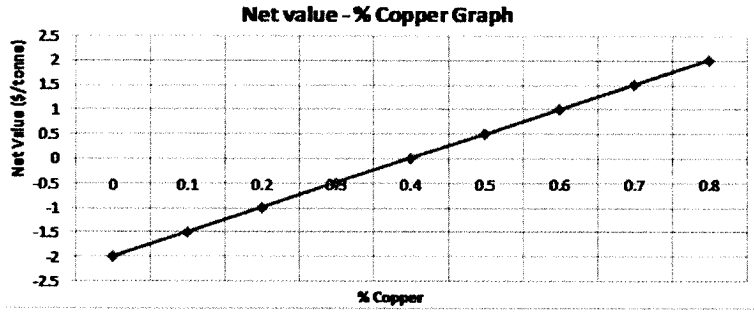


Figure 1: Net Value - % copper graph

a) Develop the Block Value ($) versus grade (%Cu) curve from the given information. Carefully label your curve and supply the axis expressed in '000's of dollars. **[5 marks]**

b) On the vertical section supply Block Economic Values and use the Floating Cone technique with 45^0 (1:1) slope to determine the final pit limits for the section. **[10 marks]**

c) What is the net value of the optimal pit for this cross-section? **[3 marks]**

d) What is the overall strip ratio? **[2 marks]**

Question 3

(a) Explain the following;

(i) Dead heading **[2 marks]**
(ii) Buffer Blasting **[3 marks]**

(b) Discuss methods of reinforcing and supporting pit slopes in open pit mining. **[5 marks]**

(c) Discuss the importance of having correct "Pit wall Slope" in open pit mine. **[5 marks]**

(d) Answer the following questions;

(i) What determines haul roads width in an open pit mine? **[2 marks]**
(ii) What controls the pit limits? **[3 marks]**

Question 4

(a) What are the main objectives of scheduling in open pit mining? **[2 marks]**
(b) Discuss the main inputs for the open mine schedule. **[4 marks]**
(c) Explain what is meant by the following, as they relate to open pit scheduling;
(i) Production Schedules; **[2 marks]**
(ii) Development Schedule; **[2 marks]**
(iii) Production drilling schedule; **[2 marks]**
(iv) Equipment Schedule; **[2 marks]**
(d) Mention five open pit equipment and explain the functions of each equipment in open pit mining. **[6 marks]**

Question 5

(a) Shown in the figure below is one of a series of parallel vertical section taken through an open pit. The sections are spaced at 60m. There are 7 million tonnes of ore within the pit limits between two sections.

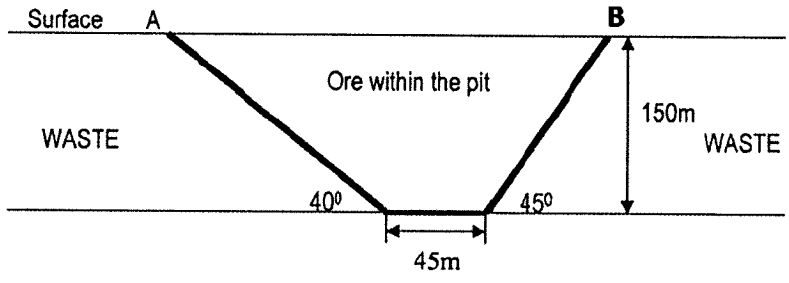


Figure 2: One of a series of parallel vertical section taken through an open pit

(i). What is the distance across the pit from A and B? **[4 marks]**
(ii). What is the volume of material contained between two sections? **[4 marks]**
(iii). What is the average density of the ore in the pit? **[4 marks]**

(b) Write short notes on the following;

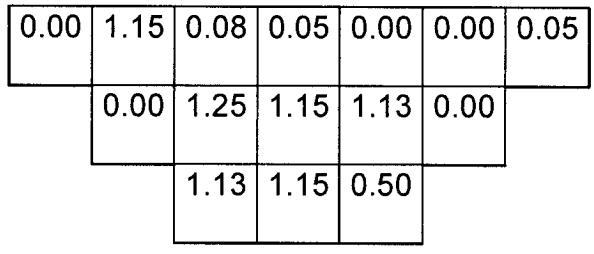
(iii) What determines haul roads width in an open pit mine? **[2 marks]**
(iv) What controls the pit limits? **[2 marks]**

(c) What are some of the advantages and disadvantages of strip mining? **[4 marks]**

Question 6

Given the following information of the block model, answer the questions below;

- % Recovery through mill and smelter = 90 %
- Value of recovered copper = $4000/ton
- Stripping and haulage to dump (level 1) =$2.5/ton
- Mining and transportation to plant level =$3/ton
- Haulage costs increase $0.50/ton per bench.
- Processing, smelting, and refining =$5/ton
- General overhead, administration, etc., (chargeable only to ore block) =$2/ton
- Assume mill will not process material containing less than 1 % Cu.
- Ultimate pit slope = 1:1
- Round all the values to nearest $.



(i) Calculate the net profit or loss of each block. **[14 marks]**

(ii) If each block contains 10,000 tonnes, give the mineable tonnage of ore and waste by bench. **[4 marks]**

(iii) Determine the Overall Stripping ratio. **[2 marks]**

END OF EXAMINATION