PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

MINING ENGINEERING DEPARTMENT

MN312 UNDERGROUND MINING

EXAM

(Semester #1, 2022)

TIME: 3 HOURS

Information

1. You have 5 minutes to read through the instructions and questions carefully.
2. There are seven (7) questions.
3. Answer ALL questions.
4. Total marks out of 100.
5. You MUST show all working out and express the numbers in correct units.
6. Calculators, biros and rulers ARE ALLOWED in the test. Notes, mobile phones and any other electronic devices are strictly NOT ALLOWED.
7. Formulas are provided in the last page of this document.
8. Write ALL answers on the answer sheet provided. No other materials will be accepted.
9. Write your NAME and NUMBER on the answer book. DO THIS NOW

QUESTION 1 Stope blasting **(20 Marks)**

A mine using the sublevel mining method plans to fire three (3) uphole rings. The following information is provided for the blast design.

Explosive agent	ANFO
Blow density	0.95 g/cm^3
Rock density	2.8 g/cm^3
Blasthole diameter	102 mm
Cast booster	400 g

Table 1: Ring Information

Ring	*Tonnes (t)*	*Grade (g/t)*
1	2400	5.20
2	2550	4.42
3	2350	4.30

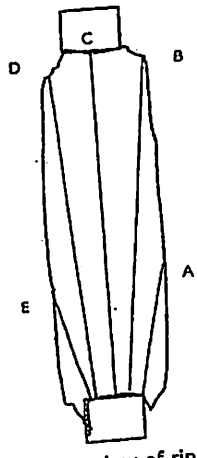


Fig1 Section view of ring
(NOTE: Assume all the 3 rings have the same profile)

Table 2: Charge length

Ring	Hole#	Length(m)	Stem Length(m)	Charge Length(m)
1	A	9	2	7
	B	20	2	18
	C	21	2	19
	D	19	2	17
	E	7	2	5
2	A	9	2	7
	B	20	2	18
	C	21	2	19
	D	19	2	17
	E	7	2	5
3	A	9	2	7
	B	20	2	18
	C	21	2	19
	D	19	2	17
	E	7	2	5

Determine the;

i) Tonnes and grade of the blast (5 marks)

ii) Powder factor (10 marks)

iii) Energy factor (5 marks)

QUESTION 2 Underground mines in PNG (10 Marks)

Porgera underground mine uses a combination of methods to extract the stopes. One of these methods is *pure avoca*. You are required to draw sketches and briefly explain the unit operations involved.

Sketch a neat;

i) Plan view that shows the main drives required in a pure avoca and briefly explain.(5 marks)

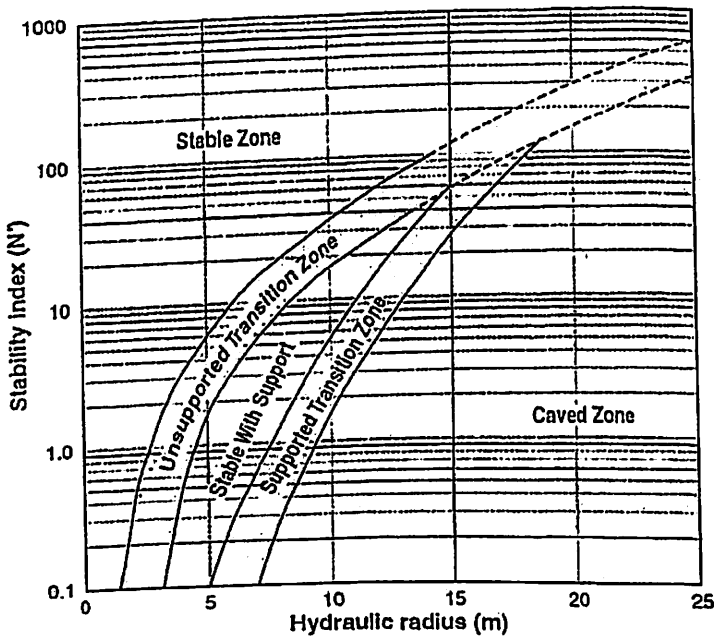
ii) Longitudinal section view that shows the unit operations and briefly explain. (5 marks)

QUESTION 3 Open stope stability (15 Marks)

You are required to assess whether a 40 m strike length proposed for a stope of fixed 20 m slanted height interval of sublevel stoping method is optimal or not.

Information known:

Modified quality index	= 2
Stress factor	= 0.8
Joint orientation factor	= 0.7
Gravity factor	= 6



i) Determine the location of the stope on the stability chart, (5 marks)

ii) Propose a <u>minimum</u> stable strike length that requires no cable reinforcement (5 marks)

iii) Sketch a cross-section view showing the cable support on the hanging wall. (5 marks)

QUESTION 4 Room and pillar (10 Marks)

A coal mine uses the 'Room and Pillar' method of extraction. Empirical methods are used for the assessment of the stability of the square pillars. The factor of safety required to be >1.

Information provided;

Strength of cube of coal (specimen)	= 10 MPa
Depth of mining horizon from surface	= 70 m
Unit weight of the overlying rock	= 23 $kN.m^{-3}$
Pillar height	= 3 m
Pillar width	= 5 m
Room width	= 5 m

Determine the;

i) Factor of safety and comment on pillar stability. (5 Marks)

ii) Extraction ratio and comment on how the remaining ore will be extracted. (5 Marks)

QUESTION 5 Reserve (10 Marks)

An UG mine has gone through optimization process when the cost of operation has increased from $200/t to $250/t. Other information includes a mill recovery of 80 %, royalty of 2 %, inflation of 5 %, and gold price of $ 1,500 /oz.

Table of reserve physicals

Stope	Category	Tonnes (t)	Grade (g/t)
CD23-80	Proven	14,900	8.5
CA92-62	Proven	13,500	5.7
CD90-80	Proven	10,300	8.3
CD22-71	Probable	12,000	7.2
CA08-71	Probable	9,000	6.3
CD86-74	Probable	15,500	8.5

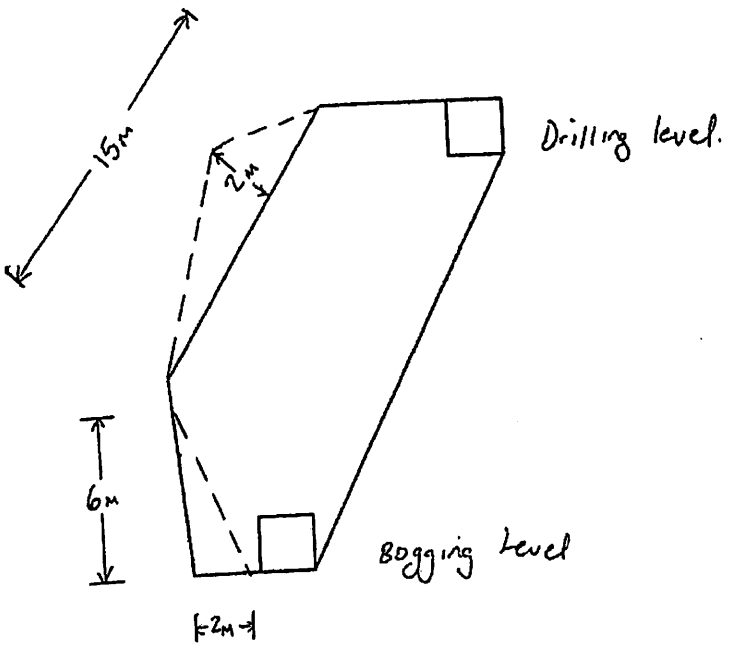
i) Determine the total reserve tonnes, grade, and ounces at the cost of $250/t, (5 marks)

ii) Determine the loss in profit ($) due to the increase in cost (5 marks)

QUESTION 6 Stope reconciliation **(20 Marks)**

A stope was mined out and cavity monitoring system (CMS) of the void was completed. A cross section is shown below for stope reconciliation.

Information known:		
Rock density	= 2.8 t/m^3	
Stope cross section area	= 250 m^2	(assume the same profile for the entire stope)
Ring burden	= 3 m	
Slanted height	= 30 m	
Total rings in the stope	= 6	
Stope design grade	= 7.5 g/t	
Over break grade	= 1.5 g/t	
Under break grade	= 7.5 g/t	(use stope grade)



Determine the;

i) Dilution (%) and mine recovery (%), (5 marks)

ii) Mined tonnes and grade, (5 marks)

iii) ELOS and (5 marks)

iv) Importance of stope reconciliation (5 marks)

QUESTION 7 Block caving **(15 Marks)**

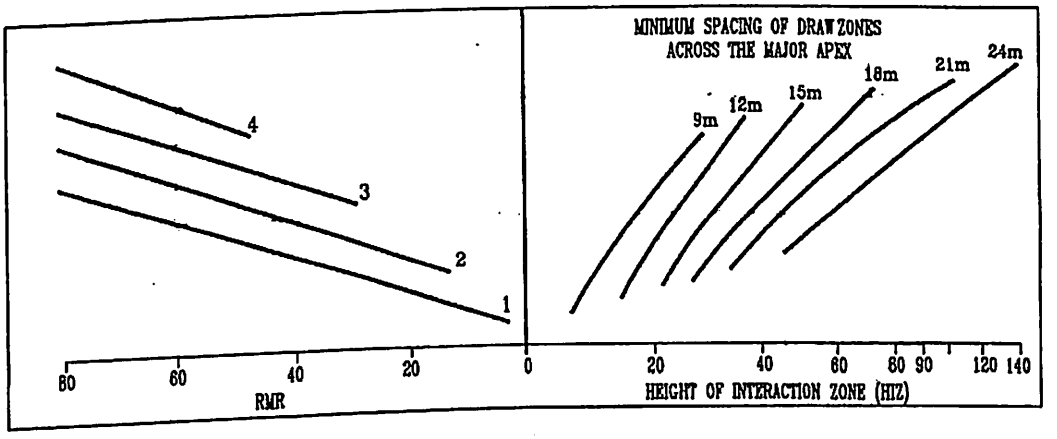
Block caving is a mining method of high production and is applied on massive ore bodies.

i) Neatly sketch a section view of the main developments, name and explain the purpose of each of the developments. (7.5 marks)

ii) Determine the dilution entry from the information provided below; (7.5 marks)

Typical swell factors used are;

Fine fragmentation = 1.16,
Medium fragmentation = 1.12, and
Coarse fragmentation = 1.08



RMR Range	Curves
0 - 14	NO.1
15 - 29	NO.2
30 - 49	No.3
+50	No.4

Information provided:

Draw column height	= 150 m
Blocky coarse ore	
Rockmass rating	= 40 to 60
Draw zone spacing	= 12 m
Draw control factor	= 0.85

USEFUL FORMULAS

$$\text{Dilution Entry} = (A-B)/A \times C \times 100$$

$$\text{Pillar Stress} = \lambda H \left(\frac{A_T}{A_p}\right)$$

$$\text{Pillar Strength} = C_s\left(0.78 + 0.22\frac{W_p}{H_p}\right)$$

$$\text{BECOG} = \frac{(\text{Total unit cost} \times \text{Inflation})}{(\text{Price} \times \text{royalty} \times \text{Mill recovery})}$$

$$\text{Stability number} = Q' \times A \times B \times C$$

$$\text{ELOS} = \frac{(\text{volume of slough})}{(\text{stope height} \times \text{strike length})}$$

$$Q = \frac{RQD}{J_n} \times \frac{J_r}{J_a} \times \frac{J_w}{SRF}$$

Note: All symbols and initials accorded the usual meaning