THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF MINING ENGINEERING

2021 SECOND SEMESTER EXAMINATION

Third Year Mining Engineering

MN321 –MINE VENTILATION

DATE: Wednesday 03rd October 2021

TIME: 12:50 P.M.

TIME ALLOWED: 3 HOURS

INFORMATION FOR CANDIDATE:

1. You have ten minutes to read this question paper. You **SHOULD NOT** begin writing during this period.

2. There are **FIVE QUESTIONS** all together. **You are to answer all five questions**

3. Marks for each question is as indicated after question. **Total of 100 marks**

4. ALL answers must be written on the answer booklet provided. No other written materials will be accepted.

5. Write your **NAME** and **STUDENT NUMBER** clearly on the **ANSWER BOOK. DO THIS NOW.**

6. You **MUST NOT LEAVE** the room in the first hour.

7. All **MOBILE PHONES, AUDIO PLAYERS, MP3, MP 4 etc.. MUST BE SWITCHED OFF.**

Question 1 *20 marks*

(a) By your understanding discuss the general strategies when designing a ventilation system in relation to its underground atmospheric hazards and operational requirements. ..... 5 ***marks***

(b) Discuss how fresh air distributed in an underground mine and the parameters affecting the flow. ..... 5 ***marks***

(c) Identify one or more sources for one of the following air contaminants in underground mining and indicate how you would control them;

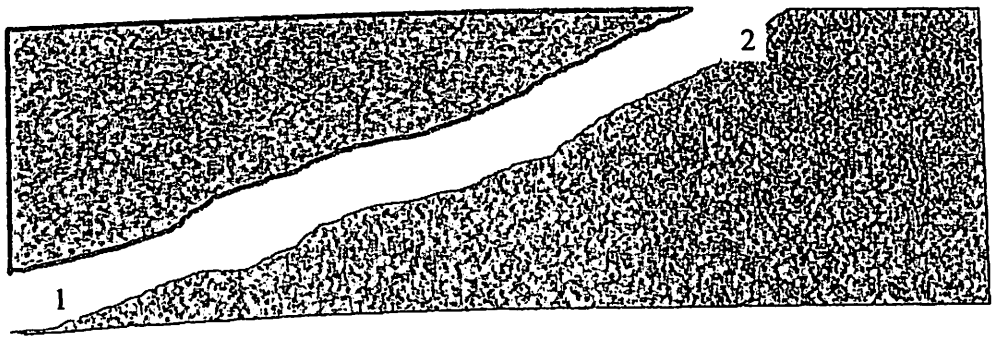
- Carbon dioxide
- Carbon monoxide
- Sulphur dioxide
- Siliceous dust
- Heat
- Nitrogen dioxide ..... 6 ***marks***

(d) Explain how thermal comfort is jointly affected by the following:

Temperature of inhaled air
Humidity
Amount of work being done
Air velocity. ..... 4 ***marks***

Question 2 *20 marks*

a) A mine access decline was surveyed as shown below. The absolute pressure measured by a barometer at points 1 and 2 are: $P_1 = 987$ mm, $P_2 = 212$ mm. (1 mm = 0.2876 kPa) Assume that the cross-sectional area of position 1 and 2 are uniform and the elevation is as indicated, what is the resistance between the two positions in terms of pressure loss and what is the direction of the air flow? (Density of air is 1.23 kg/m^3)



..... 3 ***marks***

b) In underground mines, toxic gases and fumes are produced in operations. What is toxic gas monitoring and its significance to miners health and safety. ..... ***6 marks***

c) Define the term T.L.V, T.W.A and S.T.E.L and describe how it is used to indicate the severity of the dust and toxic gas hazards to which mine workers may be exposed.
..... 5 *marks*

d) Discuss the effects of toxic dust and its effect on human respiratory system..... 6 *marks*

Question 3 *20 marks*

(a) Explain how natural ventilation pressure is maintained by underground mine heat.
..... *3 marks*

(b) Derive the three forms of energy associated with fluid flow both in terms of HEAD and PRESSURE, and make reference to law of conservation of energy according to Bernoulli's equation. .....5 *marks*

(c) How is Bernoulli's equation modified and used to represent energy balance between two positions of an airway. ..... **5 marks**

(d) Discuss, derive and relate the above energy losses and derive the Atkinsons equation and its applications to mine ventilation. ..... **7 marks**

Question 4 *20 marks*

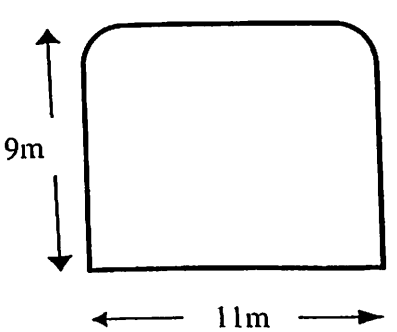
a) Sketch and describe the velocity profiles you would expect in a duct in turbulent flow and in laminar flow and describe the energy associated with each flow regime. Give Reynolds numbers number that may be appropriate to each flow regime. ..... (*8 marks*)

b) In turbulent flow the pressure drop along an airway can be assumed to be proportional to the square of the velocity of the flow. This constant of proportionality is usually expressed in terms of the frictional force, F, developed per unit area of the rubbing surface per unit (velocity squared).

i. Derive an equation giving the pressure drop along an airway in terms of the flow rate in the airway, friction factor and the airway dimensions.
..... *4 marks*

ii. Explain how variations in density affect the friction factor. ..... *5 marks*

iii. Estimate the pressure drop along a drive of the dimensions as shown below. This is at an attitude of 2786 meters above sea level. Flow rate is 9.1 m^3/s. The friction factor at sea level for drives of the same type is 0.1901 kg/m^3 ..... *3 marks*



Question 5 20 Marks

a) You are tasked to design the ventilation system for a new underground mining Outline the Ventilation design criteria and the main factors parameters you will use to design the new ventilation system for the project.

.....10 Marks

b) A 4 m by 3 m rectangular tunnel is 450 m long and contains one right-angled bend with a centre-line radius of curvature. The airway is unlined but is in good condition with major irregularities trimmed from the sides. If the tunnel is to pass 60 m3 /s of air at a mean density 1.1 kg/m3 , calculate the Atkinson and rational resistances at that density and the frictional pressure drop.

The friction factor for this airway will be k = 0.012 kg/m3 at standard density. The shock loss factor for the bend X) to be 0.75.

$R_{shock} = X \rho / (2A^2)$

..... 10 Marks