PNG UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF MINING ENGINEERING

2021 FIRST SEMESTER EXAMINATION

Fourth Year Mining and Mineral Process Engineering

MN 413: ENVIRONMENTAL ENGINEERING

DATE:	WEDNESDAY 9TH JUNE 2021
TIME ALLOWED:	THREE (3) HOURS
START:	8:20 PM

INFORMATION FOR CANDIDATES

1. Write your **NAME** and **Student Number** clearly on the **ANSWER BOOK**. Do it **NOW**.
2. You have ten (10) minutes to read this question paper. You **SHOULD NOT** write in the answer book during this period.
3. There are **THREE PARTS**: (1) Multiple Choice Questions; (2) Short-answer Questions; and (3) Short-answer Questions on Waste Management
4. Attempt to **ANSWER ALL THE QUESTONS**
5. Marks as indicated
6. **NO** other materials are allowed in the exam room. This includes Mobile Phones, MPs and other devices

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PART 1: MULTIPLE CHOICE (40 Marks) [2 Marks each]

1. Which legal framework governs the environmental impacts of the mining industry?

a) Mining Act (1992)
b) Mine Safety Act (1957)
c) Environmental Act (2000)
d) All of the above

2. The factors that encourage the water use permit (WUP) is required in the absence of a legislative framework for mine waste management are:

a) Physical drivers such as geophysical and seismology that place a restriction on building a tailings dam
b) Economic drivers such as the need for mining activities to drive economic growth forces the PNG Government use the WUP
c) Tailings dam is almost unsuitable for PNG conditions
d) *a* and *b* are correct

3. The two critical issues associated with waste rock dump design associated with surface mining are:

a) Leaving behind a healthy environment for re-use of the land after a mine closure and continuous rehabilitation
b) Revegetation and maintaining stability of the dumps
c) Safety designs to control AMD formation and stability of dumps
d) All of the above are correct

4. The purpose of mine site rehabilitation to:

a) Completely restore the mine site to its original landscape before the mine begun
b) Replicate the original land features and replace the mountain that has been mined-out
c) Restore the mine-site to a re-useable land that is safe from toxicity and other risks in the post-mine period
d) To ensure safe designs to control AMD formation and stability of dumps
e) *c* and *d* are correct

5. **The main risks that are considered in designing an underground mine are:**

a) Control water toxicity and rock stability
b) The mined-out tunnel must be back-filled to control subsurface subsidence and ground water contamination from AMD
c) Study the stability orientation of the host rock and apply stability designs and design a suitable mine ventilation system
d) All of the above risk parameters are important

6. **Controlling mine-waste at the design and process stages are important because:**

a) Controls are necessary part of the overall mine closure plan
b) Control ground water contamination from AMD
c) Control stability and mine ventilation system
d) Control the mine waste at the plant design and extraction phases because impact management and clean-up costs are excessive

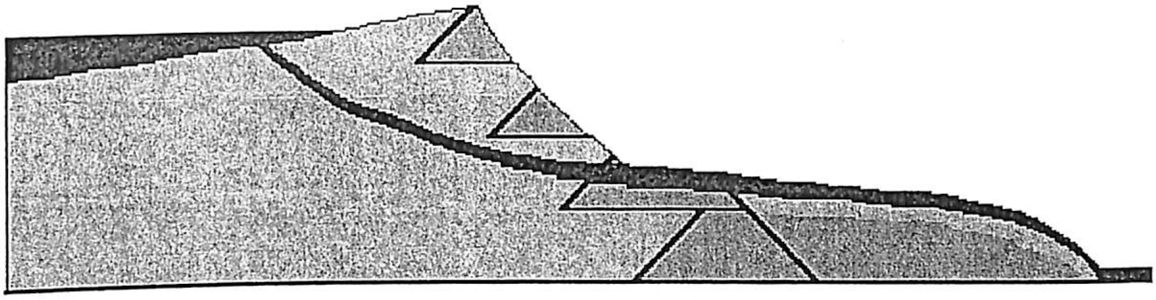
7. **Which of the following actions best describe the difference between active (1) and passive (2) treatments of mine waste?**

a) Extracting pyrite before disposal and adding limestone at the river site
b) Control ground water contamination by detoxifying yellowish out-flows
c) Add detoxifying agents and control AMD by planting acid absorption plants
d) *a* and *c* are correct
e) All of the above

8. **Which factors are important considerations in a tailings dam design?**

a) Topography and geological conditions, stability and engineering skills
b) Topography and geological conditions, design stability and costs
c) Topography and geological conditions, design stability and costs and engineering designs
d) All of the above

10. **Which is the possible design cause of the Omai gold mine tailings dam failure in the picture bellow?**



a) Loss of strength due to lack of toe foundation, thus causing internal erosion
b) Loss of strength due to lack of compaction and foundation and infill with degradable materials
c) Loss of strength due to use of degradable materials causing loss of internal integrity (cohesion) and erosion
d) All of the above

11 **Which statement is mostly correct about DSTS design?**

a) It is the safest means of mine tailing disposal
b) The effects of land-based riverine tailing disposal are highly risky as they are controlled by topography, geological and whether conditions
c) The only risks of DSTS are seismic activities, tectonic upswelling of seabed
d) There is limited understanding on how the tails undergoes the kinetic energy changes leading to acidity of the sea environment
e) All of the above
f) *b*, *c* and *d* are correct

12) **Which of the following is formed in primary oxidization in toxic metal solution formation?**

a) Iron sulfate and ferric hydroxide
b) Ferric hydroxide and ferric iron
c) Iron sulfate and ferrous iron
d) Ferrous iron and ferric hydroxide

13) **Which of the following is formed in secondary oxidization in toxic metal solution formation?**

a) Iron sulfate and ferric hydroxide
b) Ferric hydroxide and ferric iron
c) Iron sulfate and ferrous iron
d) Ferrous iron and ferric hydroxide

14) **Which ironic exchange equation forms ferric hydroxide?**

(a) $FeS2^{+}(aq) + 02\ (g) + H^{+}\ (aq) \Rightarrow Fe3^{+}\ (aq) + H2(aq)$
(b) $Fe3^{+}(aq) + 3H20\ (aq) \Rightarrow Fe(OH)3\ (s) + 3H^{+}(aq)$
(c) $FeS2(s) + 302\ (g) + H20\ (aq) \Rightarrow Fe2^{+}(aq) + 2SO42^{-}(aq) + 2H^{+}\ (aq)$

15) **Which of the following statement/s is/are true?**

(a) Acidity is an aqueous solution resulting from trace metal dissolution
(b) Fresh pyrite is basic
(c) Tailings treated to pH 7 is always safe from contamination
(d) a low pH solution is acidic
e) *a*, *b* and *c*

16) **Which <u>one</u> of the following is incorrect about factors influencing sulphide oxidation?**

(a) Mineral concentration and distribution, mineralogy and physical forms of sulfides
(b) Rate of oxygen supply to the reaction medium by advection or diffusion
(c) Chemical composition of pore water in contact with reaction sites
(d) Immersion of sulphide under water
(e) Water content at the reaction site
(f) Microbial ecology of mineral surfaces

17) **Which combination of tailings dam design strategy is most suitable:**

(a) Treat tailings, construct dam with clay and silt, firm foundation and allow drainage into it to maintain salinity
(b) Dam must suit LOM tail capacity, treat tailings, use crushed granite for dam construction and slope must be steep to control overflows
(c) Treat tailings, construct dam with clay, design to suit LOM capacity and wall ad found stabilities are paramount
(d) All of the above

18) Which factor is most important underground mine:

(a) Equipment and machines produce a lot of toxic gas
(b) Man and machines need oxygen to operate
(c) Limit oxidation by water-barricading oxygen from reacting with pit-wall
(d) Underground mine environment lacks fresh air and extraction points are confined and therefore need fresh air from the surface
(e) b and d

19) Auto-oxidation in an existing AMD condition is caused by

(a) Addition of limestone carbonate
(b) Addition of zinc and lead
(c) Addition of fresh pyrite and ferric hydroxide
(d) Addition of bacteria and hydrogen peroxides
(e) *b*, *c* and *d*
(f) *c* and *d*

20) Flow of a yellow precipitate in aqueous solution is a:

a) Ferric hydroxide and sulfuric acid combination
b) Pyrite + water + other solutions of trace metals
c) Ionic solutions of trace metals and acidic bacteria
d) All of the above

PART 2: Short Answer Questions **[10 Marks each]**

1. Describe the design of most safe and competent waste rock dump with the help of a sketch. Explain the main safety parameters safely

2. Describe and compare the disadvantages and advantages of a riverine tailing disposal system and the deep-sea tailing disposal system. Defend your choice and explain why one of the methods is the most suitable tails disposal system.

PART 3 **Perform the calculations and explain the answer. 2 Marks will be deducted for not explaining the answer. [Use equations attached]** **[5 Marks each]**

1. A blasting activity is expected to generate hydrogen nitride (ammonia base) at a rate of 1.5 m^3/s. Assume the tolerance limit is for hydrogen nitride gas is 5% and initial concentration is 0.05%. What quantity of fresh air flow rate is required to dilute the toxic gas immediately after blasting?

2. With reference to Q1, if the concentration of hydrogen nitride is expected to be 0.5% right after blasting the stope, what is the required ventilation to dilute this toxicity? ***Please compare the result with Q1 and discuss what type of air quality control is needed.***

3. What is the quantity flow rate of fresh air from a drive in an underground mine if the air velocity is 30 m/s and cross-sectional of a drive is 5m and height is 6m. ***Is this flow rate suitable for the condition in Q 2?***

4. What is the friction pressure loss in a drive in an underground opening where the air volume flow rate is 30 m^3/s, the opening cross-section area of the drive is 6x6 meters, 500 meters length, and $k = 0.08\ Ns^2m^{-4}$. If the flow rate is insufficient, ***what would you recommend?***

EQUATIONS FOR PART 3

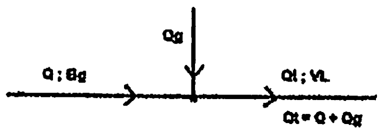
$H_f = R_f{*}Q^2 = \frac{kPL}{A^3} * Q^2$ where H_f = friction pressure loss (N/m^2);
Q = quantity flow rate (m^3/s); k= friction factor (Ns^2m^{-4}); P = perimeter of the u/g drive (opening in m); L = length (m); A = cross-sectional area (m^2)

Flow rate $Q = V \cdot A$ (m^3/s or m^3/min)

V = velocity of air flow;

A = cross-sectional area of the gallery.

$$Q = Qg\ (1 - VL)\ /\ (VL - Bg)$$



Where:

VL = maximum allowed value for the concentration of the contaminant (fraction);
Qg = contaminant flow in the mine atmosphere (m3/s);
Bg = the contaminant concentration in the Q flow (fraction);
Q = flow of air required for dilution (m3 / s).