PNG UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF MINING ENGINEERING

2020 FIRST SEMESTER EXAMINATION

Fourth Year Mining and Mineral Process Engineering

MN 413: ENVIRONMENTAL ENGINEERING

DATE: WEDNESDAY 24TH JUNE 2020
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

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

1. **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

2. **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

3. **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) $FeS2(s) + 302\ (g) + H20\ (aq) \Rightarrow Fe2^{+}(aq) + 2SO42^{-}(aq) + 2H^{+}\ (aq)$

4. **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*

5. **Which of the following combination is are environmental impacts in a surface mine?**

(a) Sub-surface disturbances, sedimentation and pollution of rivers
(b) Sub-surface disturbances, slope instability and acid rock drainage
(c) Sub-surface disturbances, slope instability and desertification
(d) Talings dam failures, Sub-surface disturbances, slope instability and desertification

6. Which one 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

7. 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

8. 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

9. Which combination of air toxicity can be expected in an underground mine in PNG?

(a) carbon dioxide, carbon monoxide, nitrogen dioxide and sulfure dioxide
(b) carbon dioxide, carbon monoxide, nitrogen dioxide and methane
(c) carbon monoxide, nitrogen dioxide, methane and hydrogen sulphide
(d) nitrogen dioxide, methane, hydrogen sulphide and nitrogen nitrite
(e) all of the above

10. Which one (s) of the following is/are a passive treatment/s?

(a) planting special plants that absorb metal rich solution
(b) calcium carbonate treatment at the plant site
(c) dredging river bed and mixing of tailings with limestone
(d) *a* and *c* are correct
(e) all of the above

11. 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*

12. The auxiliary ventilation involves:

(a) directing air to return airways to the exhaust system
(b) barricading toxic air using shields across openings
(c) directing the supply of fresh air in poorly ventilated areas using booster fans
(d) directing fresh air to be mixed with bad air using booster fans
(e) mechanised treatment techniques are often expensive

13. 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

14. What is the major concern regarding deep sea tailings system (DSTS)?

(a) ARD formation
(b) destroying tuna/fish breeding grounds, which could lead to tuna stock depletion
(c) lack of knowledge on the kinetics of ionic exchanges occurring in a deep oceanic environment

(d) lack of knowledge on seismic activities on oceanography environment can expose tailings to the surface over time
(e) *c* and *d* are correct

15. What condition is best described as an acid mine drainage

(a) when acidic tailings are released from the mine into the environment
(b) when mud and slurry flow for long distance and in contact with water and oxygen
(c) when fish and other organisms are dead and food chain is affected through bioaccumulation
(d) toxicity emerges when trace metals dissolve into solution through ion transfers
(f) *a* and *d*

16. Which statement/s is/are correct about calcium carbonate?

(a) universally used to treat mill or heap leach tailings
(b) adding HIGH pH >10.8 calcium carbonate make trace metals precipitate out of solution
(c) calcium carbonate reacts with weak acid, thus forming water, carbon dioxide and calcium salts
(d) all of the above

17. Which statement/s is/are correct?

(a) placing tailings and waste rock in limestone topography entirely reduce formation of AMD
(b) rock waste dump must be engineered to allow small scale miners to do artisanal mining after a mine closes
(c) mercury pollution is always caused by its use in alluvial mining by small scale miners
(d) stability of competent waste rock dump is crucial for long-term management
(e) *b* and *d*

18. Which statement (s) are correct?

(a) concentration of hydrogen ion forms acidic solution
(b) fresh pyrite is acidic
(c) presence of oxygen and rain water accelerate the ion transfer to form ferric hydroxide
(d) all of the above

19. Which of the following statement/s is true?

(a) coal and silica dust are toxic in mine air
(b) environmental rehabilitation must replace the mountain being mined
(c) mining causes green-house effects, deforestation and desertification
(d) long-term effects may occur if tailings are not controlled at process stage
(e) all of the above
(f) *a* and *d* are correct

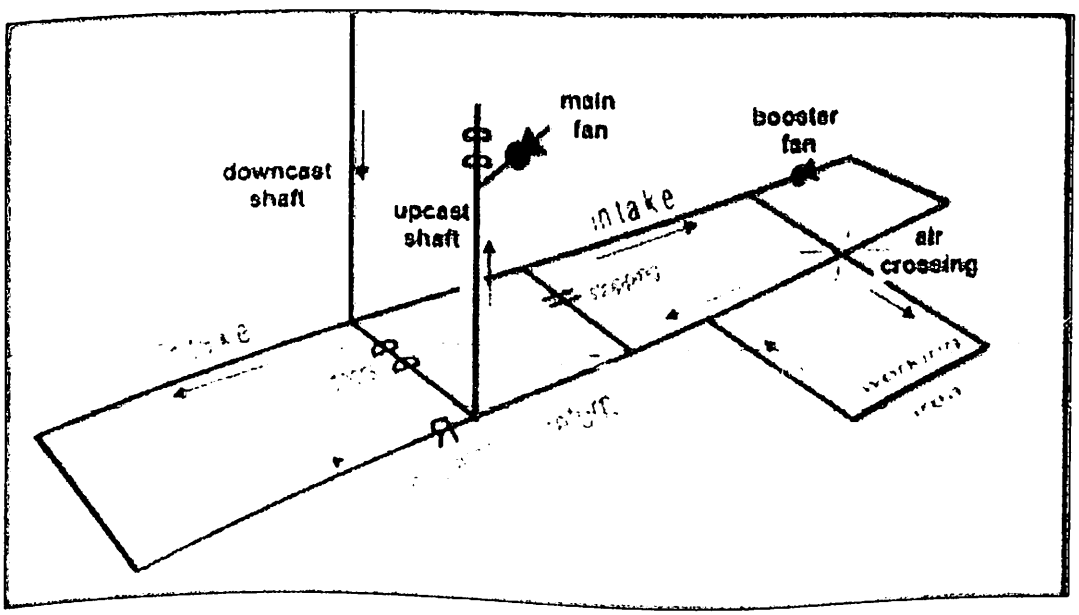
20. Which of the following statement/s is true:

(a) PNG's environmental policy is most efficient in controlling environmental impacts of mining
(b) PNG's mining and environmental laws provide the guidelines for maintaining water and air quality in line with global standards
(c) PNG's water and sea use permits provide mining firms to dispose mine waste as they are safe to do so
(d) PNG allows waste disposals into seas and rivers using permits because its economy relies on mining.

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

1. Describe how you could design a most suitable competent waste rock dump with the help of a sketch.

2. Describe the core functions of a mine ventilation system in an underground mine as given in the sketch below.



PART 3 (30 marks) [Use equations attached] **[10 Marks each]**

1. A blasting activity is expected to generate hydrogen nitride (ammonia base) at a rate of 1.5 m^3/s. Assuming the tolerance limit is for hydrogen nitride gas is 1% and initial concentration is 0.01%, what is the fresh air flow rate required to dilute the toxic gas immediately after blasting?

2. With reference to Q1, if the concentration of hydrogen nitride is expected to be 0.3% right after blasting the stope, what is the required ventilation to dilute this toxicity? Please compare the result with Q1 and discuss on the air quality control

3. What is the quantity flow rate of fresh air from a drive in an underground mine if the air velocity is 10 m/s and cross-sectional of a drive is 5m and height is 6m.

4. What is the friction pressure loss in a drive in an underground opening where the air volume flow rate is 25 m^3/s, the opening cross-section area of the drive is 5x6 meters, 500 meters length, and k = 0.05 Ns^2m^{-4} . If the flow rate is insufficient, what do you recommend?

$H_f = R_f * Q^2 = \frac{kPL}{A^3} * Q^2$ where H_f = friction pressure loss (N/m^2);

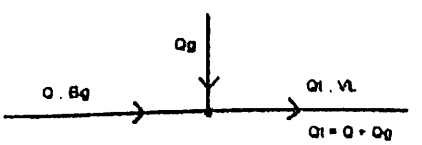
Q = quantity flow rate (m^3/s); k= friction factor (Ns^2m^{-4}); P = perimeter of the u/g drive (opening in m); L = length (m); A = cross-sectional area (m^2)

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).