



<b><u>FACULTY</u></b>	: Science
<b><u>DEPARTMENT</u></b>	: Geology
<b><u>CAMPUS</u></b>	: APK
<b><u>MODULE</u></b>	: APG02B2 APPLIED ENGINEERING AND ENVIRONMENTAL GEOLOGY
<b><u>SEMESTER</u></b>	: Second
<b><u>EXAM</u></b>	: Nov 2021

<b><u>DATE</u></b>	: OCT 2021	<b><u>SESSION</u></b>	:
<b><u>ASSESSOR(S)</u></b>	: DR TV MAKHUBELA DR OM MOROENG		
<b><u>MODERATOR</u></b>	: DR C VORSTER		
<b><u>DURATION</u></b>	: HOURS (3 HOURS)	<b><u>MARKS</u></b>	: 180

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INSTRUCTIONS:

1. Answer ALL THE QUESTIONS
  2. READ THE QUESTIONS FULLY AND MAKE SURE YOU UNDERSTAND THEM BEFORE ATTEMPTING TO ANSWER.
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## **SECTION A: ENVIRONMENTAL GEOLOGY (90 MARKS)**

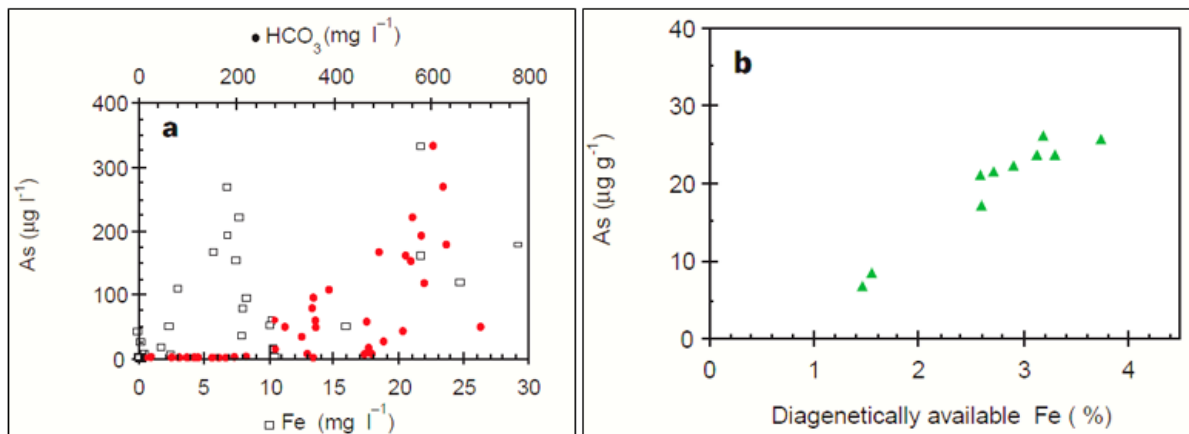
### **QUESTION 1 [10 marks]**

Provide a brief definition or description for each of the following:

- 1.1 Denudation.
- 1.2 Saprolite.
- 1.3 Bioturbation.
- 1.4 Strip-cropping.
- 1.5 Pediplanation.
- 1.6 Pedocrete.
- 1.7 Oligotrophic lake.
- 1.8 Reservoir.
- 1.9 Potentiometric surface.
- 1.10 Shale gas.

### **QUESTION 2 [10 marks]**

Study the two (2) figures below from Nickson et al. (1998, *Nature* 395, 338) and answer the following questions regarding the arsenic contamination of groundwater in Bangladesh.



2.1 What does Figure (a) tell us about the arsenic (As) content in the groundwater? [2]

2.2 What does Figure (b) tell us about the As content in the aquifer sediments? [2]

2.3 Which hypothesis is supported by the evidence presented in the two (2) figures? [2]

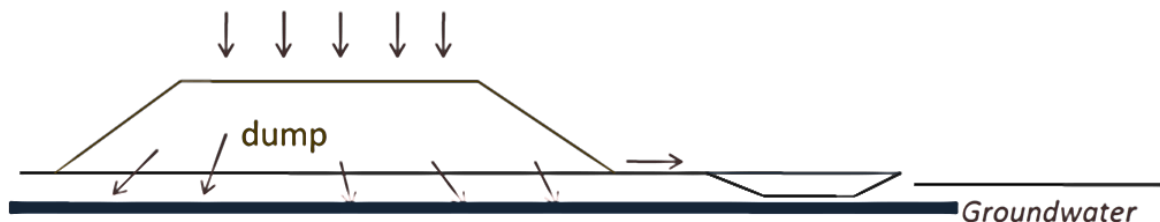
2.4 Explain how the As was released into the groundwater based on the above hypothesis. [4]

### **QUESTION 3** [10 marks]

- 3.1 Give three (3) common chemical additives for the hydraulic fracturing fluid.  
[3]
- 3.2 What are the two (2) factors that make the best shales for shale gas extraction?  
[2]
- 3.3 Name two (2) types of contaminants that pollute groundwater.  
[2]
- 3.4 Give three (3) categories of groundwater clean-up and aquifer restoration.  
[3]

### **QUESTION 4** [10 marks]

The following diagram represents the Witwatersrand gold mine tailings and slimes dam. Use it to answer the following questions.



- 4.1 What is the most problematic mineral/group of minerals associated with the mine tailings? [1]
- 4.2 Give three (3) contaminants/contamination challenges related to these tailings in their neighbouring communities? [3]
- 4.3 What effects do each of the three (3) contaminants cause on humans or biodiversity? [3]
- 4.4 Why do mine tailings pose a more serious threat than the underground mine void? [3]

### **QUESTION 5** [10 marks]

Write a short essay about how the African surface, Post-African 1 surface and Post-African 2 surface were formed following the break-up of Gondwana.

### **QUESTION 6** [10 marks]

- 6.1 Describe two consequences of mining below the water table. [4]
- 6.2 What is the role of a mine-dewatering hydrogeologist? [2]

- 6.3 What is aquifer-pumping test? [2]  
6.4 What is a hydrograph and what is its use? [2]

**QUESTION 7 [10 marks]**

Your friend wants to buy a piece of land for residential purposes, and she has asked you to use your environmental geology knowledge to advise her on which land to buy. She has narrowed it down to two options:

Property A: sloping area underlain by granite with a wet climate.

Property B: flat area with a moist climate and underlain by limestone.

- 7.1 Which property would you choose with respect to mass movement avoidance and why? (hint: focus on what causes mass movements and soil forming factors)  
[4]  
7.2 Name two practical ways/methods you would implement to minimise/prohibit the dangers of mass movements in the property prone to have mass movements  
[4]  
7.3 What would be the dangers of property B with regards to land stability?  
[2]

**QUESTION 8 [10 marks]**

- 8.1 In which group of rocks in the Karoo Supergroup do we find the numerous coal seams mined in the eastern parts of South Africa?  
[1]  
8.2 What is the mining method commonly used for underground coal mining in SA?  
[1]  
8.3 Give three (3) challenges associated with abandoned coal mines.  
[3]  
8.4 Give three (3) AMD neutralizing agents.  
[3]  
8.5 Name two (2) methods used for mitigating the water deterioration due to coal mining in Mpumalanga.  
[2]

**QUESTION 9 [10 marks]**

9.1 Give three (3) types of spring.

[3]

9.2 What would be the effect of a heavily pumped well on nearby shallow wells and what phenomenon causes that?

[2]

9.3 How would continual groundwater withdrawal in a shallow well of an area with a humid climate differ from an area with a dry climate?

[2]

9.4 What are the dangers of excessive pumping of groundwater in coastal areas and why does it happen? What type of cone results from this phenomenon?

[3]

**END OF SECTION A**

## **SECTION B: ENGINEERING GEOLOGY (90 MARKS)**

### **Question 1 (20 marks)**

- 1.1. Discuss collapsible soils and the various factors that control their distribution in South Africa. (10 marks)
- 1.2. Differentiate between tors and corestones, including a discussion on their development (you may use illustrations). Give examples of South African lithological units associated with these. (10 marks)

### **Question 2 (20 marks)**

- 2.1. Intact rock and rock mass structure both influence the strength of a rock mass, such that: intact rock strength + strength of rock mass structure = rock mass. Explain each parameter in the above simplified mathematical equation. (10 marks)
- 2.2. The Barton-Choubey criterion is expressed as:  $T = \sigma \tan[JRC \log(\frac{JCS}{\sigma}) + \phi]$

Where  $\tau$  is the shear strength,  $\sigma$  is the normal stress, and  $\phi$  is the residual friction angles. **JRC** is the joint roughness coefficient of the discontinuity, **JCS** is the joint wall compression strength of the discontinuity.

Discuss both the JRC and the JCS and the impact thereof on the shear strength ( $\tau$ ). (10 marks)

### **Question 3 (20 marks)**

- 3.1. Schematically depict the distribution of subsurface water and explain the different zones. (10 marks)
- 3.2. Discuss the three porosity types found in rocks. Give examples of South African lithostratigraphic associated with each porosity type. (10 marks)

### **Question 4 (30 marks)**

- 4.1. You are appointed as the consulting engineering geologist on a project. However, before you are able to perform a site investigation, you are asked to provide your expert opinion on the engineering geology characteristics of the stratigraphic unit listed below using only the limited information given:

**Witwatersrand Supergroup** (comprising of a combination of conglomerates, quartzites, shales, andesites, etc). The site identified is a historic mining area and the Weinert number (N) is greater than 5.

Discuss the engineering geological properties associated with the different rock types.

How do the variations in rock properties influence the geological engineering properties of the site, and the soils produced?

What solutions would you propose to the problems identified?

**END OF SECTION B**