UNIVERSITI KUALA LUMPUR
INSTITUTE OF MEDICAL SCIENCE TECHNOLOGY

FINAL EXAMINATION

MARCH 2025 SEMESTER

COURSE CODE	:	HGD10703
COURSE TITLE	:	INTRODUCTION TO SOIL & HYDROGEOLOGY
PROGRAMME NAME	:	DIPLOMA IN ENVIRONMENTAL HEALTH
DATE	:	01 JULY 2025
TIME	:	2:00PM - 5:00PM
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.

2. This question paper is printed on both sides of the paper.

3. This question paper consist of TWO sections.

4. Section A consist 25 MCQ or EMQ questions. Answer ALL questions.

5. Section B consist of four questions. Answer THREE (3) questions only.

6. Please write your answer on the answer booklet provided.

7. Please answer all questions in English only.

8. Please answer MCQ/EMQ questions using OMR sheet. ☐ *Tick if applicable*

9. Refer to the attached Formula/ Appendies. ☐ *Tick if applicable*

THERE ARE 13 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 25 marks)

Answer ALL questions.

Please use the objective answer sheet provided.

1. A soil with a high abundance of iron oxides displays rich brown colours. What does this indicate about its drainage status?

   A. Poorly drained, waterlogged

   B. Well drained, aerated

   C. Extremely dry, no colour change

   D. Imperfectly drained, mottled

2. Which of the following are related to gleization?
   I. Occurs in well-drained soils
   II. Causes bluish-grey soil color due to ferrous compounds
   III. Leads to low rate of organic decomposition
   IV. Happens under reducing conditions

   A. I,II and IV

   B. II, III, and IV

   C. I,III, and IV

   D. I, II and III

3. Which property of water allows insects to walk on its surface, and how does it help them?

   A. Surface tension due to cohesion; supports weight without breaking the surface

   B. Heat of vaporization; keeps water cool

   C. High specific heat; provides thermal stability

   D. Neutral pH; prevents toxicity

4. When designing a water filtration system that considers soil absorption, which process must be considered to estimate the water entering underground reservoirs?

A. Surface runoff

B. Infiltration

C. Precipitation

D. Transpiration

5. Which process moves dissolved materials from an upper horizon to a lower one?

A. Translocation

B. Leaching

C. Capillary action

D. Humification

6. Which factor of soil formation is most directly responsible for the rate of chemical weathering and humification?

A. Relief

B. Organisms

C. Parent material

D. Climate

7. You are given a hydraulic conductivity (K) of 40 m/day, a cross-sectional area (A) of 2,000 m², and a hydraulic gradient (dh/dL) of 0.01. Which of the following is the correct volumetric flow rate (Q)?

A. 400 m³/day

B. 1,200 m³/day

C. 2,000 m³/day

D. 800 m³/day

8. Which soil horizon is primarily composed of decomposed organic material such as leaf litter and humus?

   A. A horizon

   B. B horizon

   C. C horizon

   D. O horizon

9. If a soil scientist observes a distinct eluvial layer where fine particles have been leached out, which horizon are they most likely examining?

   A. E horizon

   B. B horizon

   C. C horizon

   D. A horizon

10. Which of the following processes contribute to soil profile color changes?
    i. Melanization – darkening from humus
    ii. Gleization – blue-grey due to iron compounds
    iii. Podzolization – bleaching of E horizon
    iv. Calcification – red due to oxidation

    A. II, III, and IV

    B. I, II and III

    C. III and IV

    D. I and II

11. If a farmer observes that nutrients in the topsoil are being depleted despite fertilizer use, which soil process is most likely occurring?

A. Transformation

B. Addition

C. Translocation

D. Losses

12. How does the process of melanization contribute to soil development differently from podzolization?

A. Melanization creates humus; podzolization removes all organic matter.

B. Both involve water movement, but podzolization occurs only in deserts.

C. Melanization darkens soil by adding organic matter, while podzolization leaches minerals to form distinct horizons.

D. Melanization removes minerals while podzolization adds them.

13. Why might older soils look significantly different from their parent material?

A. Translocations add nutrients from nearby sources.

B. Transformations continuously alter the composition of soil components.

C. Additions reduce the need for natural weathering.

D. Losses are minimized in older soils, preserving original traits.

14. Which of the following best distinguishes between translocation and transformation in soil formation?

A. Translocation only happens in dry climates; transformation only in humid climates.

B. Translocation involves physical movement; transformation involves chemical change.

C. Translocation is driven by organisms; transformation occurs through evaporation.

D. Translocation adds new material; transformation removes old material.

15. If the seepage velocity is 1.25 m/day, how long (in days) will it take water to travel 4000 m through the aquifer?

    A. 3500 days

    B. 3200 days

    C. 4000 days

    D. 2500 days

16. Which value of seepage velocity (Vs) would result from a Darcy velocity of 0.3 m/day and porosity of 0.2?

    A. 2.5 m/day

    B. 1.5 m/day

    C. 0.6 m/day

    D. 0.15 m/day

17. Which of the following are the outcomes of melanization in soil formation?
    i. Dark-colored A horizon
    ii. Decrease in humus content
    iii. Occurs in low humidity regions
    iv. Transformation of organic matter

    A. II,III, and IV

    B. I,II and III

    C. I, III, and IV.

    D. I,II, and III

18. Which of the following are the features of the eluviation process?
    I. Movement of water carrying materials downward
    II. Removal of clay, humus, and minerals from upper layers
    III. Accumulation of materials in lower horizons
    IV. Associated with leaching
    V. Occurs under anaerobic conditions

    A. II, III, and IV

    B. I, II, and IV

    C. I, II, and III

    D. III, IV, and V

19. Which of the following equations would you use to calculate the volumetric flow rate in a confined aquifer?

    A. $Q = M / C$

    B. $Q = KA \, (dh/dL)$

    C. $Q = V_w / t$

    D. $Q = A \times v \times n$

20. Given: $Q = 37{,}500 \ m^3/day$, area $A = 150{,}000 \ m^2$. What is the Darcy velocity?

    A. 0.75 m/day

    B. 1.25 m/day

    C. 0.25 m/day

    D. 0.15 m/day

21. A piezometric head difference of 10 ft exists between a river and a nearby channel 2000 ft apart. If the hydraulic conductivity is 0.25 ft/hr and the saturated thickness is 30 ft, what is the flow rate Q per unit length in ft^3/day?

    A. 1.2

    B. 0.9

    C. 3.6

    D. 2.4

22. What is the key factor that differentiates a perched water table from the main groundwater table?

    A. The temperature of the groundwater.

    B. The influence of rainfall.

    C. The depth of the aquifer.

    D. The presence of an impermeable layer separating the two.

23. Why does groundwater in confined aquifers rise above the top of the aquifer when tapped by a well?

    A. Due to the presence of a nearby spring.

    B. Due to evaporation at the surface.

    C. Because of the aquifer's shallow location.

    D. Because of pressure from the overlying impermeable layer.

24. A region experiences frequent rain and high temperatures, resulting in intense leaching and iron accumulation in the soil. Which soil-forming process is the most responsible for this profile?

    A. Calcification

    B. Eluviation

    C. Laterization

    D. Gleization

25. Which of the following statements about laterization are correct?
    I. Results in sesquioxide concentration.
    II. Associated with tropical climates.
    III. Enhances calcium carbonate accumulation.
    IV. Driven by intense weathering.

    A. I, III, and IV

    B. I, II and IV

    C. II, III, and IV

    D. I and II

SECTION B (Total: 75 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

Groundwater is a vital component of the Earth's hydrological system, stored beneath the surface in the pores and fractures of rocks and sediments. Although it represents only 0.6% of the total water on Earth, groundwater is an essential resource for drinking water, agriculture, and industry. .

(a)   Point out the most appropriate term to complete this sentence:

   i.   Groundwater in a _____ aquifer is under pressure and may rise above the top of the aquifer when tapped by a well.

(1 marks)

   ii.   Velocity is significantly affected by the _____ of pore spaces within the material.

(1 marks)

   iii.   An _____ acts as a barrier to groundwater flow and helps protect aquifers from surface contamination.

(1 marks)

   iv.   To determine the long-term sustainability of a groundwater source, both quantity and _____ of the water must be assessed.

(1 marks)

   v.   When siting a new well, hydrogeologists evaluate the _____ gradient to predict the direction and rate of groundwater movement.

(1 marks)

(b) A town must choose between two sites for a new public water supply well in an unconfined aquifer:

Site A has very high recharge but is 1 km down-gradient from a small industrial park.

Site B has moderate recharge but is 5 km from any known contamination sources.

Evaluate the better location for long-term drinking water safety.

(Your answer should include evaluation of both site, conclusion and justification)

(6 marks)

(c) Explain THREE (3) major sources of groundwater contamination.

(9 marks)

(d) Illustrate a diagram showing the water table, zone of aeration, zone of saturation, and capillary fringe.

(5 marks)

Question 2

Soils are complex, dynamic systems that form over time through a range of physical, chemical, and biological processes. Understanding soil formation, classification, and properties is essential in both environmental and agricultural contexts.

(a) Explain the importance of studying soil **pedology**.

(5 marks)

(b) Explain FIVE (5) main soil-forming factors, giving one example of how each influences soil development

(10 marks)

(c) Discuss a typical soil profile and the characteristics of its major horizons (with the help of a labelled diagram).

(10 marks)

Question 3

A proposed landfill site is located near a stream. As an environmental health officer, you are asked to evaluate the risk of contaminant transport from the landfill to the stream via the underlying confined aquifer. You are provided with the following data:

Hydraulic conductivity (K) = 45 m/day
Thickness of aquifer = 25 m
Width of aquifer = 3000 m
Distance from landfill to stream (flow path) = 2000 m
Hydraulic head near the landfill = 120 m
Hydraulic head near the stream = 110 m
Effective porosity (n) = 0.25
Concentration of contaminant in groundwater at landfill = 100 mg/L

(a)   Calculate the **volumetric flow rate (Q)** through the aquifer.

(5 marks)

(b)   Determine the **Darcy velocity (v)**.

(3 marks)

(c)   Determine the **seepage velocity (Vs)**

(4 marks)

(d)   Predict the **travel time** (in years) for the contaminant to reach the stream.

(4 marks)

(e)   Measure the **mass flux (M)** of contaminant entering the stream per day.

(5 marks)

(f)   Based on your results, **evaluate** whether the landfill location poses a **significant risk** to the stream over a 5-year period. Justify your reasoning.

(4 marks)

Question 4

Soil degradation is one of the most pressing environmental challenges facing global agriculture and land management today. It refers to the decline in soil quality and productivity due to natural processes and, more significantly, human activities. Healthy soil is vital for sustaining ecosystems, ensuring food security, maintaining water quality, and supporting biodiversity. However, the misuse of land, unsustainable farming practices, and increasing urbanisation have accelerated the degradation of soil in many regions, particularly in arid and semi-arid areas

(a)   Explain THREE (3) key indicators used to assess the soil health.

(12 marks)

(b)   Explain THREE (3) major human activities that contribute to soil degradation and their effects on soil quality.

(9 marks)

(c)   Explain TWO (2) major human activities that contribute to soil degradation.

(4 marks)

END OF EXAMINATION PAPER