UNAM

FACULTY	Agriculture, Engineering & Natural Sciences		
DEPARTMENT	Geo-Sciences		
SUBJECT	Introduction to Hydrology & Environmental Geochemistry		
SUBJECT CODE	S3651GY		
PAPER	PAPER 1 – combined theory & practical		
DATE	June 2026		
DURATION	**180 min (3 hours)**	**MARKS**	100

FIRST OPPORTUNITY EXAMINATION (New curriculum)

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This question paper consists of 5 pages (including this one)

Instructions

- Closed-book examination.
- Answer all eight (8) questions.
- Recommendation: Read all subordinate questions first before answering them.
- Sketches are encouraged where necessary.
- Calculators are necessary.
- Hand in the question paper.

UNIVERSITY OF NAMIBIA EXAMINATIONS

Question 1: **[15 marks]**

Introduction to Hydrology students measured air characteristics at 08H00 outside their classroom at an altitude of 1019 m using their cell phones. Their measurements were as follows:
Air temperature: 11 °C
Dew point: 7 °C
Relative humidity 74 %

a) [4 marks] Differentiate between relative humidity and specific humidity.
b) [4 marks] Briefly, explain the adiabatic principle.
c) [2 marks] State how the relative humidity of the air parcel changes with increasing altitude.
d) [5 marks] If the air parcel measured by the Introduction to Hydrology students is to be cooled to its dew point, at what altitude must the air parcel be uplifted?

Question 2: **[10 marks]**

a) [4 marks] List four steps that should be followed when applying the Thiessen polygon method to determine the average precipitation over a drainage basin.
b) [6 marks] Find polygons for each station in the given drainage basin below.

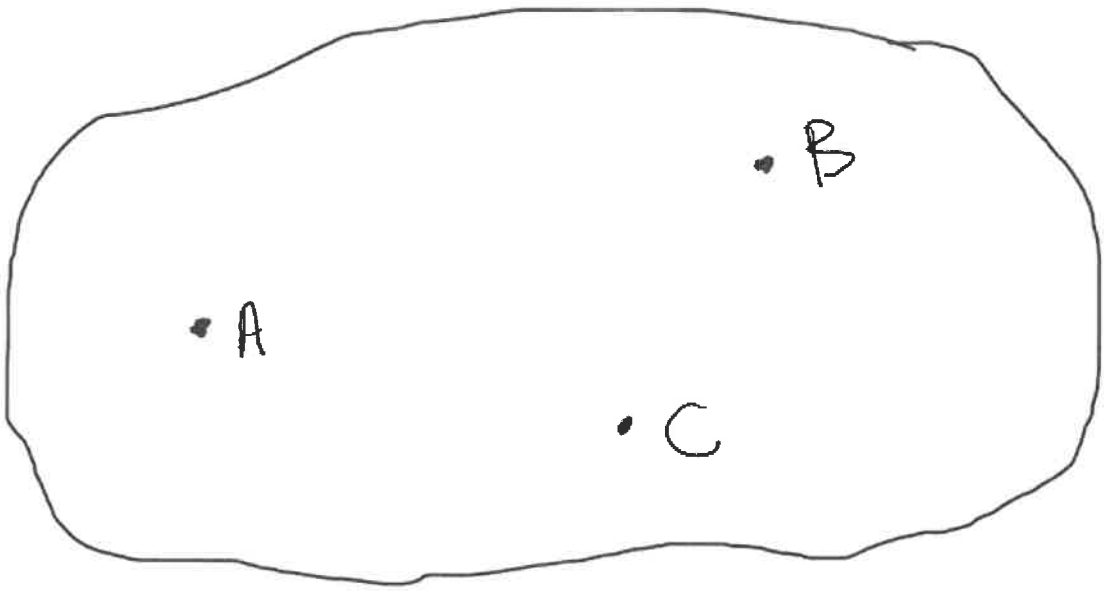


Figure 1: A drainage basin with precipitation stations for Question 2.

Question 3: **[20 marks]**

a) [2 marks] State whether the river represented in Figure 2 is an effluent or influent.
b) [2 marks] What does the arrows in Figure 2 represent?
c) [5 marks] Sketch a hydrograph of the given river for one year, from January to December.
d) [3 marks] List the components of the hydrograph in your sketch (Question 3: c).
e) [4 marks] Describe how one can estimate the discharge rate of a river.
f) [4 marks] Give four examples of such rivers in Namibia

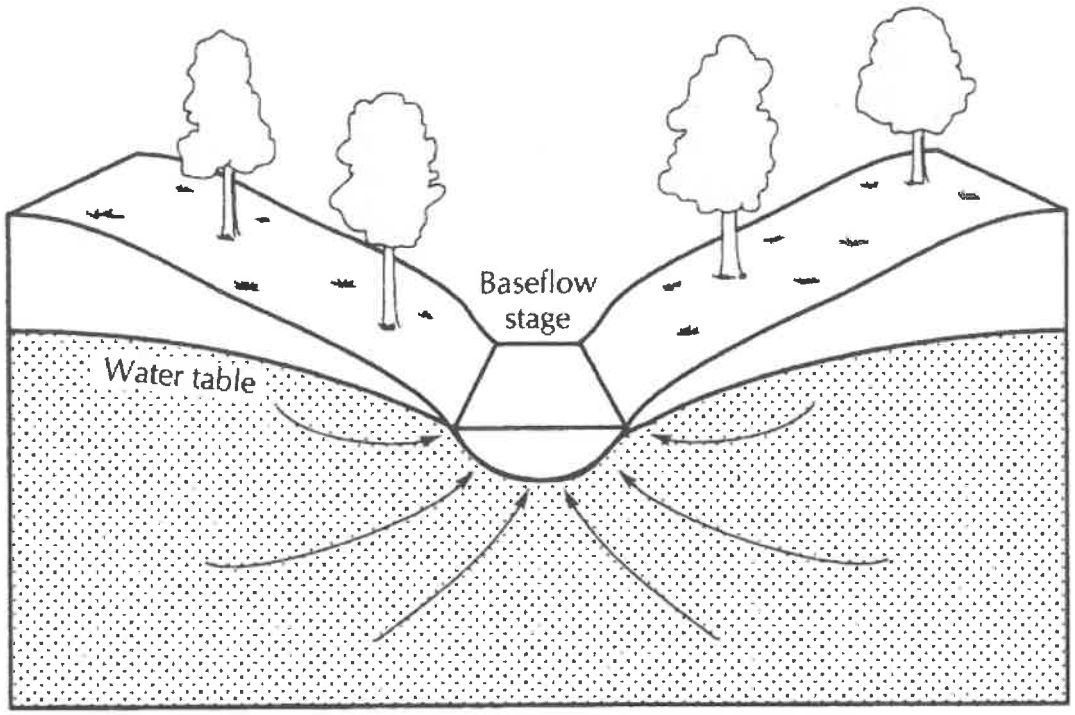


Figure 2: A cross-sectional view of the river for Question 3.

Question 4: **[15 marks]**

Figure 2 is a cross-section showing several wells that have been completed at various levels. The two aquifers are separated by a confining layer; some wells are completed in the upper aquifer (Aquifer 1), and others are completed in the lower aquifer (Aquifer 2). The symbol with the upside-down triangle next to a well indicates the water level in that well. The water levels in wells A and B have not yet been measured.

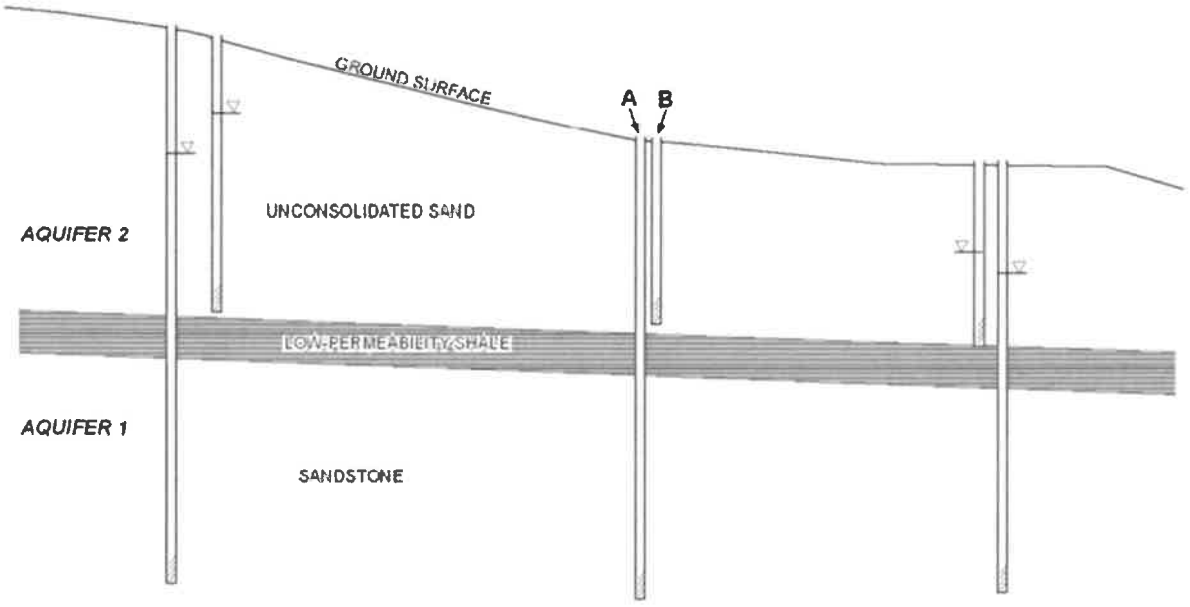


Figure 3: A cross-section showing several wells at various levels for Question 4.

a) [2 marks] What is an unconfined aquifer?

b) [2 marks] Which aquifer is unconfined in Figure 3?

c) [4 marks] Use the upside-down triangle symbol to show where you think the water levels in wells A and B would be.

d)

e) [2 marks] Which direction is groundwater flowing in each aquifer? Draw two arrows on the cross-section to indicate the direction of flow in each aquifer.

f) [1 mark] State Darcy's law.

g) [4 marks] Explain how Darcy's law was derived.

Question 5: **[10 marks]**

Important concepts in hydrochemistry include identifying major dissolved constituents and classifying water types by hydrochemical facies.

a) [6 marks] Mention the major chemical constituents commonly found in groundwater.

b) [2 marks] Define the term hydrochemical facies.

c) [2 marks] What is the importance of calculating the charge balance error in groundwater chemical analysis?

Question 6: **[10 marks]**

A town is experiencing declining groundwater quality. Possible sources include a leaking fuel tank at a service station, runoff from surrounding crop fields, household waste dumped in open areas, and wastewater from a small industrial workshop.

a) [4 marks] Differentiate between point source pollution and non-point source pollution. In your answer, provide at least one example of each type of pollution.

b) [4 mark] Classify each of the following as either a point source or a non-point source:

   i) Leaking fuel tank
   ii) Agricultural runoff
   iii) Industrial wastewater discharge from a pipe
   iv) Urban runoff after rainfall

c) [2 marks] Which type of pollution is generally easier to control or mitigate? Explain your answer.

Question 7: **[10 marks]**

A contaminant is released into a sandy aquifer. The groundwater flows from Point A toward Point B. However, monitoring shows that the contaminant does not arrive at all monitoring wells at the same time. Some parts of the plume arrive earlier than expected.

a) [2 marks] Define advection in groundwater contaminant transport.

b) [3 marks] Explain why groundwater particles may take different travel times to move from Point A to Point B in a porous medium.

c) [3 marks] Give three reasons why some contaminants or particles may move faster or slower than the average groundwater velocity.

d) [2 marks] When using advection to estimate contaminant movement, why is it usually assumed that the contaminant does not significantly change the groundwater flow pattern?

Question 8: **[10 marks]**

A soil survey was carried out around an abandoned mine tailings site. Soil samples were collected at different distances from the tailings. The results for Pb and Zn are shown below.

Sample point	Distance from tailings (m)	Pb concentration (mg/kg)	Zn concentration (mg/kg)
S1	50	850	1200
S2	100	620	950
S3	200	410	700
S4	400	180	320
S5	800	95	160
S6	1200	60	110

The local background values are:
Pb = 50 mg/kg
Zn = 100 mg/kg

a) [2 marks] Identify the samples that may be considered geochemical anomalies for Pb and Zn. Explain your answer.
b) [2 marks] Describe the spatial trend shown by Pb and Zn concentrations with increasing distance from the tailings.
c) [2 marks] Based on the pattern, suggest the most likely source of Pb and Zn.
d) [4 marks] Explain two environmental processes that may have caused the observed spatial pattern.

END OF EXAM