

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED PHYSICS

BSc HONOURS IN EARTH SCIENCES PART IV

BOREHOLE LOGGING TECHNIQUES

SES 4102

Second Semester Examination Paper

December 2024

This examination paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: None

Examiner's Name: Dr. P Mandingaisa

INSTRUCTIONS

ANSWER ALL PARTS OF QUESTION 1 IN SECTION A AND ANY THREE QUESTIONS FROM SECTION B. SECTION A CARRIES 40 MARKS AND SECTION B CARRIES 60 MARKS.

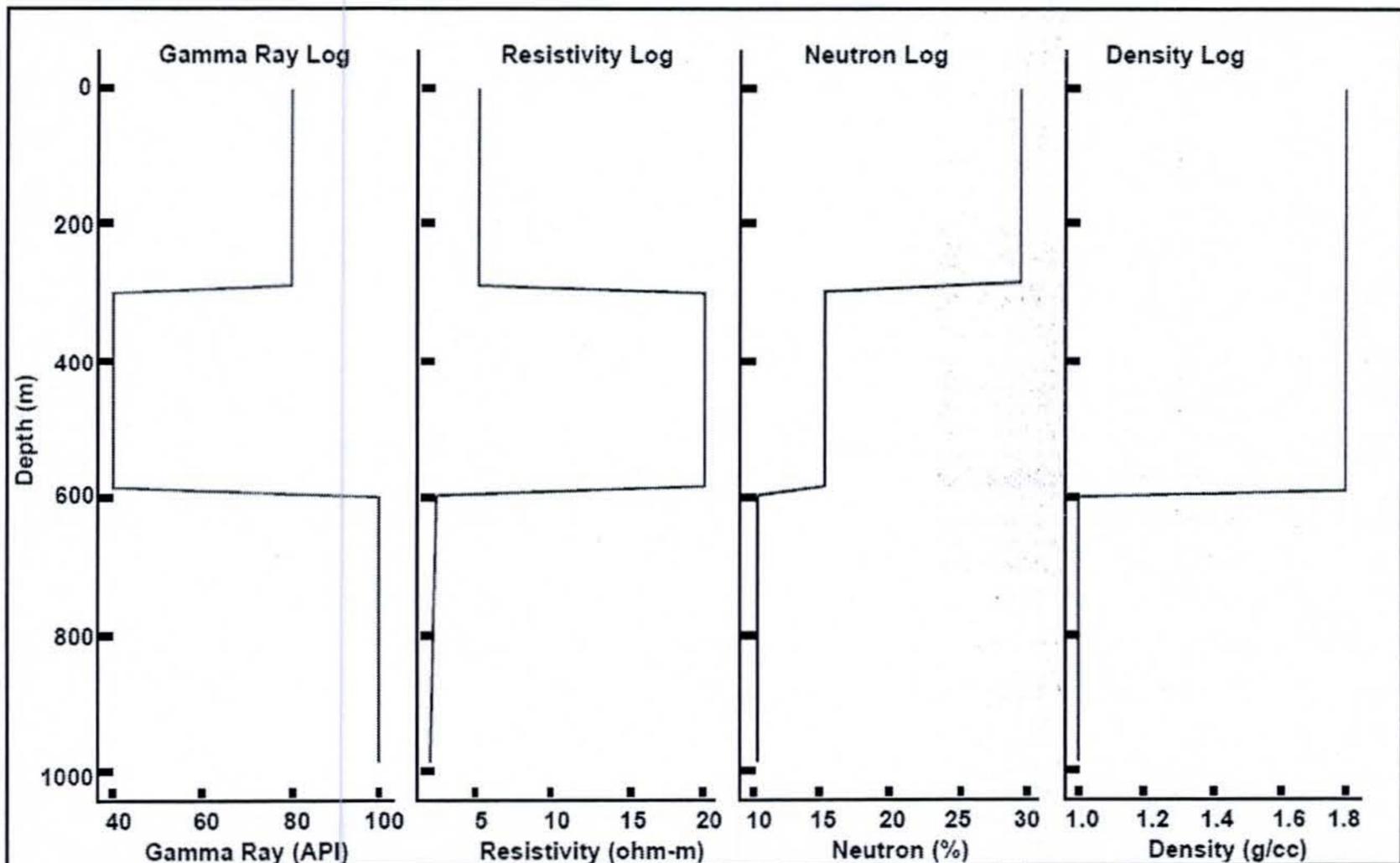
MARK ALLOCATION

QUESTION	MARKS
1	40
2	20
3	20
4	20
5	20
6	20
Maximum possible marks	100

Section A

Question 1

- a) What is borehole logging and why is it important? [4]
- b) Outline any five (5) areas of application for borehole logging techniques. [5]
- c) What does a caliper log help determine in borehole investigations. [5]
- d) Arrange the following rock types (sandstone, shale, and limestone) in their order of increasing radioactive response to gamma ray radiation. [3]
- e) Outline any five (5) rock structural features that can be identified using a dipmeter log? [5]
- f) Using the provided borehole logs (Gamma ray, Resistivity, Neutron and Density logs) in the figure below, analyse the depth intervals to identify zones that are likely;
- i. water-bearing, [3]
 - ii. oil bearing, and [3]
 - iii. gas bearing. [3]



- g) What is the significance of crossover between neutron and density logs? [4]

- h) Describe any two (2) borehole logging methods that can be used to differentiate between saline and fresh water zones. [5]

Section B

Question 2

- a) Name any two (2) chemical parameters and three (3) structural parameters that are important to record when characterizing a hydrocarbon reservoir. [5]
- b) Briefly explain how formation porosity can be estimated using nuclear logging tools. [5]
- c) What role does resistivity logging play in distinguishing hydrocarbons from water in a reservoir? [5]
- d) Discuss how borehole imaging logs can be used to characterize fractures and their impact on hydrocarbon flow. [5]

Question 3

- a) Outline any five (5) factors to consider when selecting borehole logging tools for a specific geological investigation. [5]
- b) Describe any five (5) factors that can affect the accuracy of borehole logging data. [10]
- c) How can the factors you listed in question 3 b) be mitigated? [5]

Question 4

- a) Describe the geophysical logging tools you would use to investigate the following parameters;
- i. water composition (ionic content), [5]
 - ii. water flow path or direction, [5]
 - iii. formation boundary, and [5]
 - iv. water recharge zones. [5]

Question 5

- a) Explain how sonic logs can be used to evaluate the mechanical strength of sub-surface rocks during geotechnical assessments. [6]
- b) Discuss how variations in sonic velocity can be used to differentiate between lithologies in a well-bore. [8]
- c) Outline potential limitations associated with interpreting data from sonic logs in heterogeneous or fractured formations. [6]

Question 6

Discuss the role of geophysical borehole logging techniques in the exploration and characterization of uranium deposits. Highlight the key logging methods used, the type of data they provide, and describe how this information can be integrated to assess the grade, thickness, and structural controls of a uranium ore body. [20]

END OF EXAMINATION
