2901/104
GEODYNAMICS, STRATIGRAPHY
AND SEDIMENTOLOGY
Oct./Nov. 2021
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN PETROLEUM GEOSCIENCE

MODULE I

GEODYNAMICS, STRATIGRAPHY AND SEDIMENTOLOGY

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Mathematical tables/a non-programmable scientific calculator (fx-82);
Answer booklet.
*This paper consists of **EIGHT** questions.*
*Answer any **FIVE** questions in the answer booklet provided.*
Maximum marks for each part of a question are as indicated.
Candidates should answer the questions in English.

This paper consists of 8 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

1. (a) Figure 1 shows tectonic plate boundaries labelled K, M, N, P and Q. The arrows near each plate show the direction of movement of the plate. Study the figure and use it to answer the questions that follow.

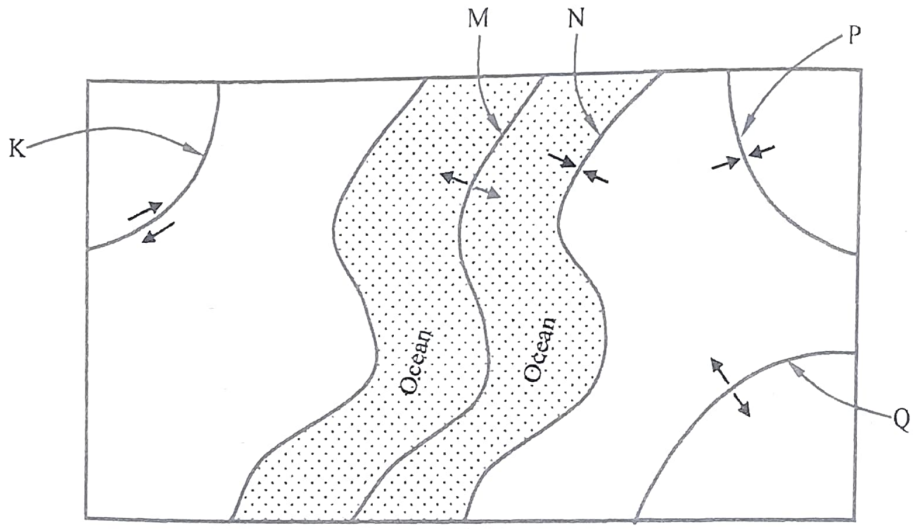


Fig. 1

(i) Identify the labelled plate boundaries. (5 marks)

(ii) Identify the plate boundary where each of the following is likely to occur:

I. ocean trench; (1 mark)

II. continental rift valley; (1 mark)

III. oceanic rift valley; (1 mark)

IV. fold mountains; (1 mark)

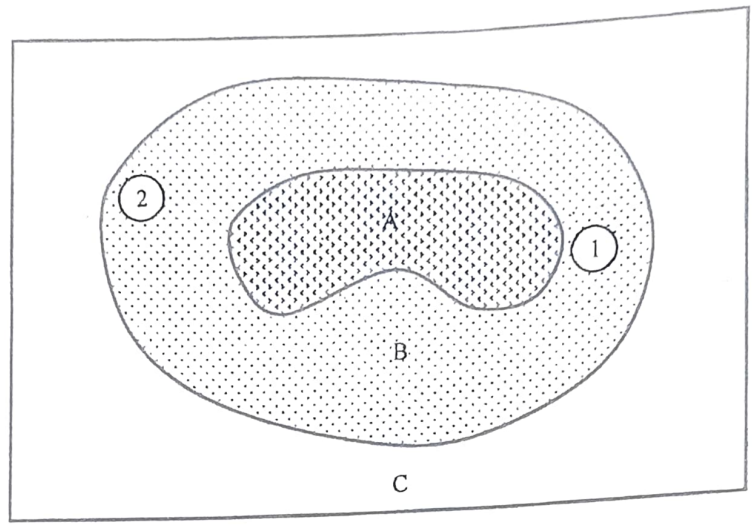
V. volcanic mountain ranges. (1 mark)

(b) Determine the lithostatic stress in Pa at the base of a continental crust of thickness 45 km and density 2800 kg/m^3. Take: g = 9.81 m/s^2. (4 marks)

(c) Determine the mean age of the oceanic floor in years whose area is 5.6×10^8 km^2 if the rate of its creation is 2.8 km^2/yr. (4 marks)

(d) Determine the weight of a rock on the earth's surface in N whose mass is 1000 kg. Take g = 9.81 m/s^2. (2 marks)

2. (a) Figure 2 shows an igneous intrusion into a shale rock. Study and use it to answer the questions that follow.



(i) Identify the type of metamorphism caused by the intrusion. (1 mark)

(ii) Name the parts labelled A, B and C. (3 marks)

(iii) Give **two** minerals formed at each of the points 1 and 2. (4 marks)

(b) Table I shows characteristics of four mineral samples. Study and use it to answer the questions that follow.

Table I

Sample	Fracture or cleavage	Density kg/m³	Hardness (Moh's scale)	Magnetic
E	Cleavage	3700	8.5	No
F	Fracture	5200	5.5	Yes
G	Fracture	2700	7.0	No
H	Cleavage	2700	3.0	No

(i) State the:

I. most dense sample. (1 mark)

II. hardest sample. (1 mark)

III. sample likely to break along flat surfaces. (2 marks)

IV. samples that will be scratched by G. (2 marks)

V. effect of a magnet on F. (1 mark)

VI. mineral resembling an unidentified mineral of density 2900 kg/m^3 and hardness 6.8. (1 mark)

VII. minerals that have a crystal structure. (2 marks)

(ii) If sample G has a volume of 0.3 m^3, determine its mass. (2 marks)

3. (a) (i) Define the term *isostasy* as used in plate tectonics. (1 mark)

(ii) Figure **III** shows the continental crust in equilibrium with the mantle. Use it to answer the question that follows.

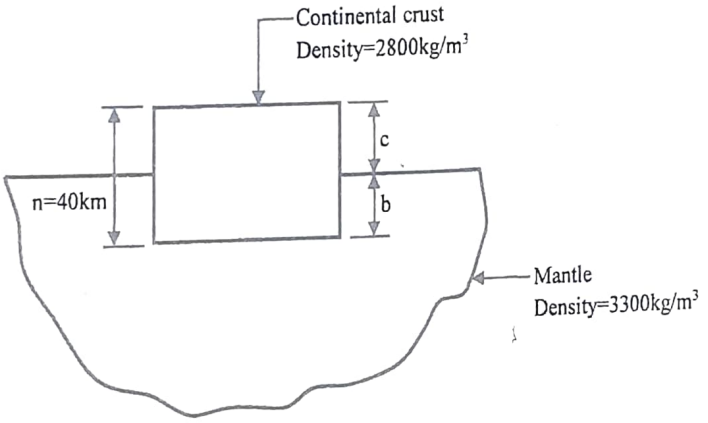


Fig. 3

Determine the depths **b** and **c**. (7 marks)

(b) State the formula and unit of measurement for each of the following:

(i) stress; (1 $\frac{1}{2}$ marks)

(ii) strain. (1 $\frac{1}{2}$ marks).

(c) (i) Give the first **six** minerals in Moh's scale of hardness in correct order. (6 marks)

(ii) Explain each of the following characteristics used for mineral identification:

I. streak; (1 mark)

II. density; (1 mark)

III. fracture. (1 mark)

4. (a) (i) Define each of the following:

I. normal stresses; (1 mark)

II. shear stresses. (1 mark)

(ii) Determine the specific gravity of a mineral whose mass in air and water is 5 gm and 3 gm respectively. (2 marks)

(b) (i) Explain the preparation of structure contour maps using seismic data. (3 marks)

(ii) State **four** uses of structure contour maps in petroleum exploration. (4 marks)

(c) Describe point bar sequences. (9 marks)

5. With the aid of a diagram, explain each of the **four** types of uncomformities. (20 marks)

6. (a) (i) Define the term basin as used in petroleum geoscience. (2 marks)

(ii) Give **four** mechanisms in which sedimentary basins are formed. (4 marks)

(b) (i) Explain the term depositional sequence as used in petroleum geoscience. (2 marks)

(ii) Figure 4 shows seismic sections illustrating sequences labelled P, Q, R and S. Study the figure and answer the questions that follow.

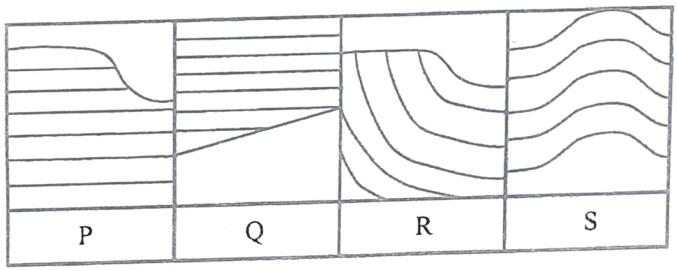


Fig. 4

Identify the labelled seismic sections. (4 marks)

(c) Explain the **four** system tracts in sequency stratigraphy. (8 marks)

7. (a) Distinguish between relative time and numerical age as used in geochronology.

(2 marks)

(b) Figure **5** shows geologic events labelled A, B, C, D, E, F, G and H. Study and use it to answer the questions that follow.

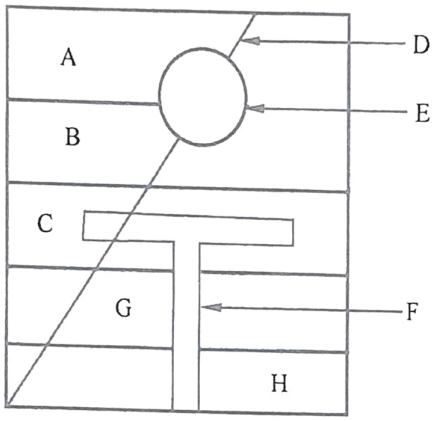


Fig. 5

Arrange the events in the order in which they occurred. (8 marks)

(c) (i) The relationship between time and radioactive decay of an isotope is given by equation (A).

$$N = N_0 e^{-\lambda t} \text{ ..... (A)}$$

Explain the terms in equation (A). (5 marks)

(ii) Relate λ and half life. (2 marks)

(d) Determine the radiometric age of a mineral from the following information.

Half life of radioactive element	= 6,000 years
Number of atoms of radioactive element present	= 300,000
Atoms of radioactive element originally	= 900,000

(3 marks)

8. (a) (i) Define the term biochronology as used in stratigraphy. (1 mark)

(ii) Write in full the acronyms FAD and LAD as used in stratigraphy. (2 marks)

(iii) State what each of the acronyms in (ii) stands for. (2 marks)

(b) Figure **6** shows a stratigraphic section. Study and use it to answer the questions that follow.

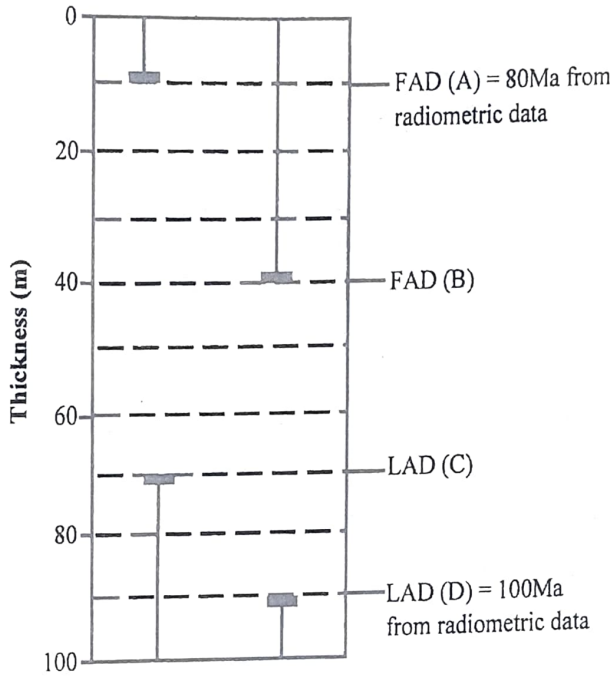


Fig. 6

Determine the age difference between:

(i) FAD (**A**) and FAD (**B**).

(ii) LAD (**C**) and LAD (**D**). (11 marks)

(c) Figure 7 shows remanent magnetism direction for rocks **A** and **B** alongside the direction of their magnetic north pole and south pole respectively. Study the figure and answer the question that follows.

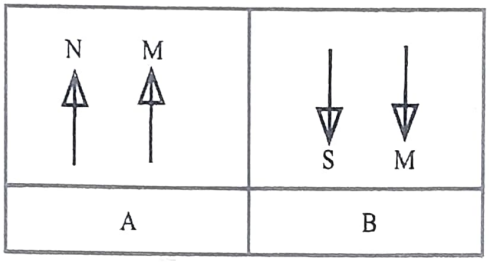


Fig. 7

Determine the polarity for each rock, giving a reason for each answer.

(4 marks)

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