

GEOLOGY

PAPER—II

Time Allowed : Three Hours

Maximum Marks : 200

QUESTION PAPER SPECIFIC INSTRUCTIONS

**Please read each of the following instructions carefully
before attempting questions**

There are **ELEVEN** questions divided under **SIX** Sections.

Candidate has to attempt **SIX** questions in all.

The **ONLY** question in Section—A is **compulsory**.

Out of the remaining **TEN** questions, the candidate has to attempt **FIVE**, choosing **ONE** from each of the other Sections B, C, D, E and F.

The number of marks carried by a question/part is indicated against it.

Unless otherwise mentioned, symbols, abbreviations and notations have their usual standard meanings.

Neat sketches are to be drawn to illustrate answers, wherever required. They shall be drawn in the space provided for answering the question itself.

Wherever required, graphs/tables are to be drawn on the Question-cum-Answer (QCA) Booklet itself.

Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the Question-cum-Answer (QCA) Booklet must be clearly struck off.

Answers must be written in **ENGLISH** only.

SECTION—A

(Compulsory Section)

1. Answer the following questions in brief : 5×10=50
- State the symmetry elements of the crystal class $4/m\ 2/m\ 2/m$ and plot the crystal face (110) on its stereogram.
 - State the condition in which a biotite grain appears non-pleochroic under microscope.
 - How are the elements belonging to different categories of Goldschmidt's classification broadly distributed in the periodic table?
 - Calculate the ratio of the number of atoms of daughter isotope to the number of atoms of parent isotope after the elapse of 3 half-lives.
 - Discuss the source rocks of A-type and M-type granite.
 - What is the mineralogical composition of picritic basalt?
 - Define entropy (s) and state how it is calculated.
 - What is devolatilization reaction in metamorphism? Write with suitable examples.
 - Give the most ongoing striking changes in the Earth's magnetic field since the last few thousand years.
 - What causes drop in S-wave velocity and increase in attenuation of seismic energy at low-velocity zone?

SECTION—B

Attempt *any one* question.

2. (a) Describe the process of calculation of Miller indices of a crystal face. Determine the Miller indices of the following crystal faces :
- A crystal face which intersects a , b , c axes at 2, 3, 4 unit distances
 - A crystal face which intersects a and b axes at 1 and 5 unit distances and is parallel to c -axis
 - A crystal face which intersects b -axis at 2 unit distance and is parallel to a and c axes
- Are these three crystal faces tautozonal? 6+9=15
- (b) Why are some minerals optically isotropic and others anisotropic? Name seven crystal systems. Which minerals of these seven crystal systems are isotropic, anisotropic uniaxial and anisotropic biaxial? Write with reason and suitable examples. 4+2+9=15
3. (a) Give ternary diagram for feldspar classification and explain cationic substitution in plagioclase. 5+5=10
- (b) How do structure and composition of kaolinite and smectite groups differ from each other? 5+5=10
- (c) Give distinguishing physical properties of the following mineral groups : 5+5=10
- Pyroxene and Amphibole
 - Quartz and Feldspar

SECTION—C

Attempt *any one* question.

4. (a) Under what conditions can the variation of partial pressure (P_i) of a component i with its mole fraction (X_i) in a mixture be explained by (i) the Raoult's law and (ii) the Henry's law? 8+7=15
- (b) If a mafic crust containing $10 \mu\text{g/g}$ of element Li undergoes 10% equilibrium partial melting (batch melting), then what will be the concentration of Li in the resulting melt? Assume that the bulk distribution coefficient of Li for mafic composition is 0.25 ($D = 0.25$). 15
5. (a) How are the concentrations of rare earth elements (REEs) in a natural sample generally plotted? Why are these concentrations normalized to a reference material? 5+5=10
- (b) Define ϵ_{Nd} (epsilon-Nd). How do ϵ_{Nd} and Sr isotopic ratio $\left(\frac{^{87}\text{Sr}}{^{86}\text{Sr}}\right)$ taken together help to understand the origin of an igneous rock? 10
- (c) Results of stable isotope measurements in a natural sample are generally presented in δ (delta) notation. How is δ defined? Derive a relationship between the fractionation factor (α) and δ . 10

SECTION—D

Attempt *any one* question.

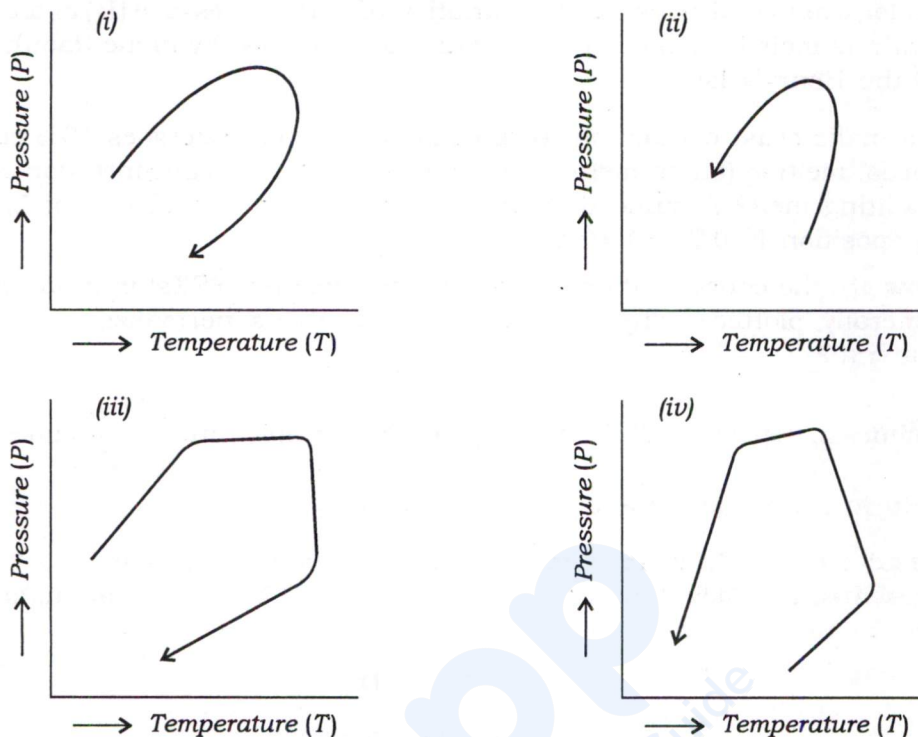
6. (a) How is viscosity of a silicate magma related to its temperature (T), silica (SiO_2) content and H_2O content? Write with reason and suitable examples. 15
- (b) Discuss the magmatic differentiation due to sequential fractionation of minerals from a basaltic magma. Define co-magmatic suite of rocks with suitable examples. 12+3=15
7. (a) Define alkaline rocks. Discuss the various causes of alkali enrichment in these rocks. How does one explain the origin of alkaline rocks in continental rift zone? 2+8+5=15
- (b) What are the differences of layered and massive anorthosite? Discuss the different ideas put forward to account for the origin of massive anorthosite. 7+8=15

SECTION—E

Attempt *any one* question.

8. (a) State the different factors of metamorphism and briefly discuss the types of metamorphism caused by these factors. 3+12=15
- (b) Define Gibbs free energy (G) and state how it is related to chemical potential (μ). Deduce the relationship of G with temperature (T) and pressure (P). 5+10=15
9. (a) What are the components used in AFM projection of metamorphic rocks? How does one calculate 'A', 'F', 'M' values? Discuss the procedure of plotting mineral assemblages of metapelitic rocks on AFM diagram with reason. 15

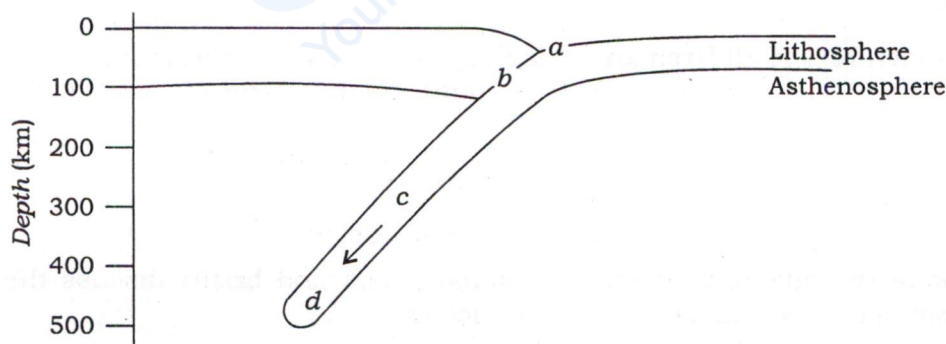
- (b) What is P - T path in metamorphism? How is P - T path determined? What is the importance of time (t) in metamorphic process? Interpret the given P - T - t paths and comment on their probable tectonic implication. 6+1+8=15



SECTION—F

Attempt any **one** question.

10. (a) Explain and illustrate with figures the physiographic features and fault styles that occur along multiple segments of continental transform. 15
(b) Explain the flow mechanism in ductile rocks. 15
11. (a) Explain the nature of deformation along the regions A, B, C and D in the figure of Benioff zone : 10



- (b) Give reasons and illustrate with figures for heterogeneity in heat flow along the mid-oceanic ridges. 10
(c) Explain and illustrate with figures the motion of particles within a material on the passage of body and surface waves. 10

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