# GATE Geology and Geophysics – Geology

## Sample Paper – 4

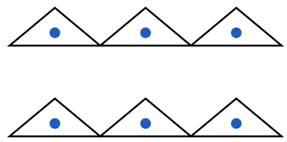
**Duration: 128 Minutes** **Maximum Marks: 72**

### Instructions

- This paper contains **46 questions** covering the core **Geology** stream of the GATE Geology and Geophysics paper conducted by the IITs and IISc (General Aptitude and the common section are provided as separate papers).
- **Q1–Q20 carry 1 mark each** and **Q21–Q46 carry 2 marks each**, for a total of **72 marks**.
- Each question carries **negative marking of one-third of its allotted marks**: a wrong 1-mark question costs **0.33** and a wrong 2-mark question costs **0.67**. Unattempted questions carry no penalty.
- Every question here is a single-correct **MCQ**. The real GATE paper also has Multiple Select (MSQ) and Numerical Answer Type (NAT) questions, and **those carry no negative marking**.
- Attempt this paper in one timed sitting of about **128 minutes**, the share this core subject earns at GATE's overall pace of 180 minutes for 65 questions. Unless stated otherwise, take the acceleration due to gravity as $g = 9.81$ m/s$^2$ and the unit weight of water as $9.81$ kN/m$^3$.

## Mineralogy and Crystallography

**Q1.** In the structural classification of the silicates, the class in which every $SiO_4$ tetrahedron shares all four of its corner oxygens with neighbouring tetrahedra to build a continuous three-dimensional framework, as sketched, is: **[1 mark]**



tetrahedra sharing all four corners

(A) Nesosilicates

(B) Inosilicates

(C) Phyllosilicates

(D) Tectosilicates

**Q2.** Olivine forms a complete range of compositions between forsterite ($Mg_2SiO_4$) and fayalite ($Fe_2SiO_4$) because $Mg^{2+}$ and $Fe^{2+}$ substitute freely for one another in the same crystal-structure site. This continuous substitution is an example of: **[1 mark]**

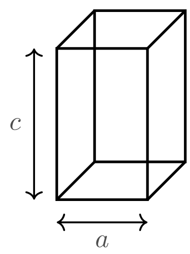
(A) Polymorphism

(B) Pseudomorphism

(C) Isomorphous solid solution

(D) Twinning

**Q3.** A crystal referred to three mutually perpendicular axes in which two axes are of equal length and the third is different ($a = b \neq c$, $\alpha = \beta = \gamma = 90°$), as shown, belongs to which crystal system? **[1 mark]**



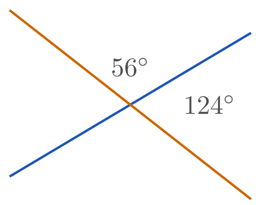

(A) Orthorhombic

(B) Tetragonal

(C) Monoclinic

(D) Triclinic

**Q4.** Amphiboles are double-chain inosilicates whose two prismatic cleavage directions intersect, as shown, at angles quite different from the near-$90^\circ$ cleavage of the single-chain pyroxenes. The characteristic pair of amphibole cleavage angles is approximately: **[1 mark]**



amphibole cleavage traces

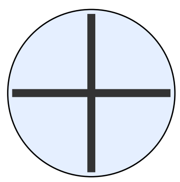
(A) $90^\circ$ and $90^\circ$

(B) $120^\circ$ and $60^\circ$ only

(C) $30^\circ$ and $150^\circ$

(D) $56^\circ$ and $124^\circ$

**Q5.** A mineral grain examined in convergent polarised light (conoscopic view) down its optic axis produces a fixed black cross of isogyres that does not break up or rotate as the stage is turned, as shown. This interference figure identifies the mineral as: **[1 mark]**


stationary black cross

(A) Optically isotropic

(B) Biaxial (acute bisectrix figure)

(C) A flash figure of a biaxial mineral

(D) Uniaxial (optic-axis figure)

**Q6.** In the plagioclase feldspar solid-solution series, the calcium-rich end member with the composition $CaAl_2Si_2O_8$ is: **[1 mark]**

(A) Albite

(B) Orthoclase

(C) Anorthite

(D) Sanidine

## Igneous and Metamorphic Petrology

**Q7.** In a metamorphosed pelite (mudrock), the successive first appearance of the index minerals chlorite $\rightarrow$ biotite $\rightarrow$ garnet $\rightarrow$ staurolite $\rightarrow$ kyanite $\rightarrow$ sillimanite records a progressive increase in: **[1 mark]**

(A) Metamorphic grade (rising temperature)

(B) Intensity of chemical weathering

(C) Silica content of the protolith

(D) Primary porosity

**Q8.** In Barrow's classic zones of Barrovian regional metamorphism, the first appearance of which index mineral defines the highest-grade zone of the sequence? **[1 mark]**

(A) Chlorite

(B) Biotite

(C) Sillimanite

(D) Garnet

**Q9.** Metamorphism that develops along a high-temperature, low-pressure gradient, marked by the appearance of andalusite and then sillimanite (the Buchan or Abukuma type), defines a metamorphic facies series described as a: **[1 mark]**

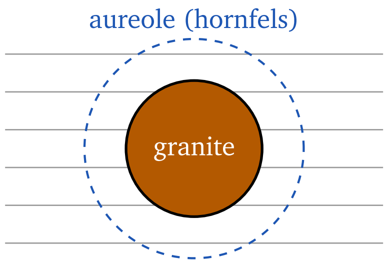
(A) Low-pressure, high-temperature (andalusite–sillimanite) series

(B) High-pressure (glaucophane–jadeite) series

(C) Very-high-pressure (coesite eclogite) series

(D) Zeolite-only burial series

**Q10.** Around the granite pluton shown, the country rock has been baked into a narrow ring of hard, non-foliated hornfels by heat alone, with little directed pressure. The metamorphism that produces this aureole is: **[1 mark]**




(A) Regional (Barrovian) metamorphism

(B) Dynamic (cataclastic) metamorphism

(C) Contact (thermal) metamorphism

(D) Burial metamorphism

**Q11.** A high-grade metamorphic rock in which light quartzo-feldspathic layers alternate with dark ferromagnesian layers to give a coarse, segregated banding is said to display: **[1 mark]**

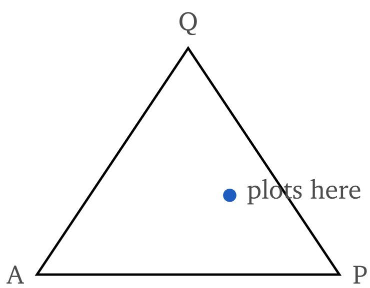
(A) Slaty cleavage

(B) Gneissose banding (gneissosity)

(C) Vesicular texture

(D) Hornfelsic (granoblastic) texture

**Q12.** On the QAPF classification triangle shown, a plutonic rock plots with quartz forming $20–60\%$ of the Q–A–P total and with plagioclase making up $65–90\%$ of the total feldspar. This rock is classified as a: **[1 mark]**



(A) Alkali-feldspar granite

(B) Syenite

(C) Gabbro

(D) Granodiorite

## Sedimentology and Stratigraphy

**Q13.** In the classification of sandstones, a texturally and mineralogically mature rock with less than about $5\%$ muddy matrix in which quartz makes up more than $95\%$ of the framework grains is a: **[1 mark]**

(A) Quartz arenite

(B) Greywacke

(C) Arkose

(D) Litharenite

**Q14.** A feldspar-rich sandstone containing more than about $25\%$ feldspar, typically produced by rapid erosion and short transport of a granitic or gneissic source terrain, is classified as an: **[1 mark]**

(A) Quartz arenite

(B) Arkose

(C) Bedded chert

(D) Oolitic ironstone

**Q15.** In Dunham's textural classification of carbonate rocks, a mud-supported limestone that nonetheless contains more than $10\%$ grains (allochems) is termed a: **[1 mark]**

(A) Wackestone

(B) Grainstone

(C) Lime mudstone

(D) Boundstone

**Q16.** A limestone composed dominantly of very fine-grained carbonate mud (microcrystalline calcite) with few or no visible allochems is, in Folk's terminology, called: **[1 mark]**

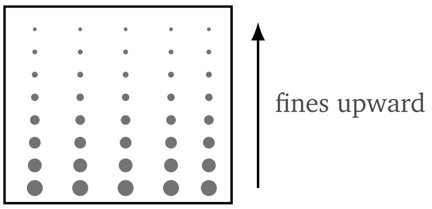
(A) Micrite

(B) Sparite

(C) Oosparite

(D) Biosparite

**Q17.** The sandstone bed shown grades from coarse sand at its base upward into fine sand and silt at its top, a structure typical of a turbidite deposited from a single waning current. This internal structure is: **[1 mark]**




(A) Herringbone cross-bedding

(B) Symmetrical ripple marks

(C) Desiccation (mud) cracks

(D) Normal graded bedding

**Q18.** Walther's Law of the correlation of facies states that a vertical succession of sedimentary facies mirrors the lateral succession of adjacent depositional environments, but only when: **[1 mark]**

(A) The strata have been tightly folded

(B) A major unconformity separates the beds

(C) The succession is conformable, with no break in sedimentation

(D) The rocks are of igneous origin

## Structural Geology and Geotectonics

**Q19.** A fracture in a rock mass along which the two sides have undergone essentially no displacement parallel to the fracture surface is called a: **[1 mark]**

(A) Joint

(B) Fault

(C) Fold

(D) Foliation

**Q20.** A penetrative planar fabric produced by the parallel alignment of platy minerals such as mica, giving a schist its ability to split along mineral surfaces, is termed: **[1 mark]**

(A) A lineation

(B) Primary bedding

(C) A cooling joint

(D) Schistosity (a foliation)

**Q21.** A penetrative linear structure defined by the parallel alignment of elongate minerals (for example hornblende needles) or by the intersection of two planar fabrics is best described as a: **[2 marks]**

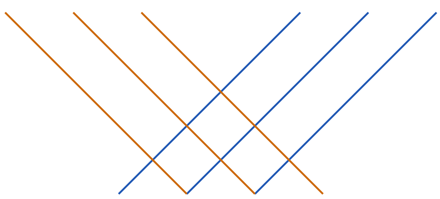
(A) Cleavage plane

(B) Lineation

(C) Foliation

(D) Bedding plane

**Q22.** In the plan (map) view shown, two sets of vertical joints are developed in a horizontal rock surface. Joint set 1 strikes $030^\circ$ and joint set 2 strikes $120^\circ$. The angle between the strikes of the two joint sets is: **[2 marks]**



set 1 ($030^\circ$) and set 2 ($120^\circ$)

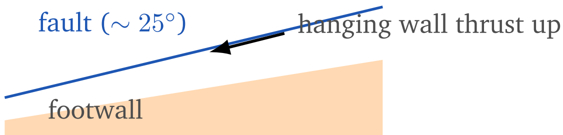
(A) 30°

(B) 60°

(C) 150°

(D) 90°

**Q23.** A reverse (contractional) fault that dips gently, at less than about 45°, and along which older rocks of the hanging wall have been pushed up and over younger rocks, as shown, is specifically named a: **[2 marks]**




(A) Thrust fault

(B) Normal fault

(C) Strike-slip fault

(D) Graben-bounding fault

**Q24.** The category of tectonic stress that acts to shorten and thicken the crust, producing folds together with reverse and thrust faults at convergent margins, is: **[2 marks]**

(A) Tensional (extensional) stress

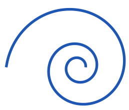
(B) Simple shear stress

(C) Compressional stress

(D) Confining (hydrostatic) stress

## Palaeontology and Historical Geology

**Q25.** Ammonoids were coiled, chambered, marine cephalopods, shown here in shell profile, that serve as classic index fossils of the Mesozoic. They belong to which invertebrate phylum? **[2 marks]**



coiled, chambered shell

(A) Mollusca

(B) Arthropoda

(C) Brachiopoda

(D) Echinodermata

**Q26.** The Siwalik Group of the sub-Himalayan foothills is world-famous among Indian fossil localities for its rich Mio–Pliocene assemblage of fossil: **[2 marks]**

(A) Trilobites

(B) Graptolites

(C) Rugose corals

(D) Land mammals (vertebrates)

**Q27.** Graptolites, colonial hemichordates that are excellent zone fossils for the Ordovician and Silurian, are most commonly preserved in black shales as: **[2 marks]**

(A) Fully silicified three-dimensional skeletons

(B) Thick calcareous shells

(C) Flattened carbonaceous impressions

(D) Permineralised woody tissue

**Q28.** The earliest known bird-like fossil, combining reptilian features (teeth and a long bony tail) with avian features (feathered wings) and recovered from the Late Jurassic Solnhofen Limestone, is: **[2 marks]**

(A) Ichthyosaurus

(B) Tyrannosaurus

(C) Archaeopteryx

(D) Dimetrodon

**Q29.** Foraminifera, single-celled protists that are indispensable microfossils for biostratigraphy and palaeoenvironmental reconstruction, most commonly build a test composed of: **[2 marks]**

(A) Calcium carbonate (calcite)

(B) Opaline silica

(C) Chitin

(D) Woody lignin

**Q30.** The Glossopteris flora, a hallmark of the Gondwana continents and a classic line of evidence for continental drift, flourished chiefly during which geological period? **[2 marks]**

(A) Cambrian

(B) Permian

(C) Neogene

(D) Quaternary

## Economic Geology and Mineral Resources

**Q31.** The bulk industrial mineral that supplies the calcium and is the principal raw material used, along with clay, to manufacture ordinary Portland cement clinker is: **[2 marks]**

(A) Gypsum

(B) Limestone

(C) Bauxite

(D) Muscovite mica

**Q32.** Among common dimension and building stones, the one that is a hard, equigranular, interlocking coarse-grained igneous rock, prized for its durability and ability to take a high polish for facing and flooring, is: **[2 marks]**

(A) Roofing slate

(B) Laterite block

(C) Granite

(D) Friable sandstone

**Q33.** A small proportion of gypsum ($CaSO_4 \cdot 2H_2O$) is interground with cement clinker mainly in order to: **[2 marks]**

(A) Retard (control) the setting time of the cement

(B) Raise the silica content of the cement

(C) Give the cement a red colour

(D) Supply iron for hydration

**Q34.** A high-alumina industrial mineral of the aluminosilicate (sillimanite) group, which on firing yields mullite and is therefore used to make refractory bricks for furnace and kiln linings, is: **[2 marks]**

(A) Talc

(B) Kyanite

(C) Barite

(D) Fluorite

**Q35.** In India, the Khetri belt of Rajasthan is a long-established and important producer of which metal? **[2 marks]**

(A) Gold

(B) Iron

(C) Copper

(D) Manganese

**Q36.** The very soft, platy, greasy-feeling industrial mineral, a magnesium sheet silicate defining hardness 1 on the Mohs scale and used widely as a filler, lubricant and cosmetic base, is: **[2 marks]**

(A) Talc

(B) Corundum

(C) Quartz

(D) Orthoclase feldspar

## Hydrogeology and Engineering Geology

**Q37.** As a groundwater-quality parameter, the concentration of fluoride in drinking water above which it commonly causes dental and skeletal fluorosis, and which the Indian standard sets as the permissible upper limit, is about: **[2 marks]**

(A) $0.1$ mg/L

(B) $1.5$ mg/L

(C) $45$ mg/L

(D) $15$ mg/L

**Q38.** Severe and widespread arsenic contamination of shallow groundwater, causing serious human-health hazards, is best known from the young alluvial aquifers of which Indian region? **[2 marks]**

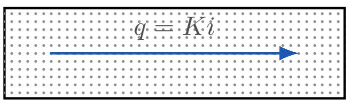
(A) The Thar Desert of Rajasthan

(B) The Ganga–Brahmaputra (Bengal) plain

(C) The Deccan basalt plateau

(D) The crest of the Western Ghats

**Q39.** Groundwater moves through a homogeneous aquifer with hydraulic conductivity $K = 15$ m/day under a hydraulic gradient $i = 0.01$, as sketched. By Darcy's law the specific discharge (Darcy velocity) $q = K\,i$ equals: **[2 marks]**




$K = 15$ m/day, $i = 0.01$

(A) 0.15 m/day

(B) 1.5 m/day

(C) 15 m/day

(D) 0.015 m/day

**Q40.** In assessing a rock mass from drill core for engineering purposes, the Rock Quality Designation (RQD) is defined and computed as the percentage given by: **[2 marks]**

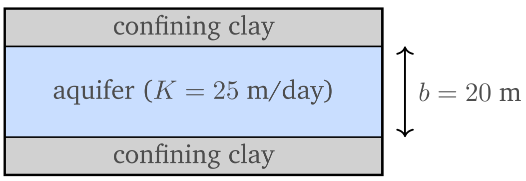
(A) Total length of all recovered core pieces divided by the core-run length

(B) Summed length of intact core pieces $\geq$ 10 cm long divided by the total core-run length

(C) Weight of recovered core divided by the theoretical weight

(D) Number of fractures counted per metre of core

**Q41.** A confined aquifer shown in section is $b = 20$ m thick and has a hydraulic conductivity $K = 25$ m/day. Its transmissivity, given by $T = K\,b$, is: **[2 marks]**




(A) 5 $m^2$/day

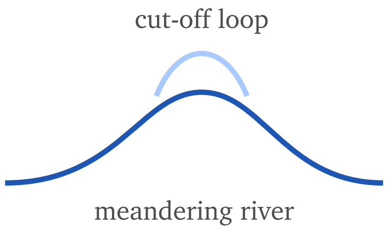
(B) 45 $m^2$/day

(C) 0.8 $m^2$/day

(D) 500 $m^2$/day

## Geochemistry, Geomorphology and Remote Sensing

**Q42.** The crescent-shaped body of standing water shown, formed when a tightly curved meander loop of a river is cut off from the active channel, is a: [2 marks]



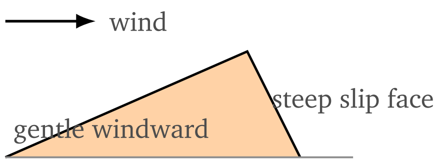

(A) Alluvial fan

(B) Oxbow lake

(C) Playa (desert salt lake)

(D) Glacial cirque

**Q43.** The asymmetrical sand dune shown in profile, with a gentle windward slope, a steep leeward slip face and a crescent plan whose horns point downwind, is a: [2 marks]




(A) Seif (longitudinal) dune

(B) Star dune

(C) Barchan dune

(D) Loess sheet

**Q44.** A streamlined, wind-sculpted ridge of resistant bedrock, elongated parallel to the prevailing wind direction and common in desert regions, is a: [2 marks]

(A) Ventifact (a wind-faceted pebble)

(B) Yardang

(C) Loess deposit

(D) Dreikanter

**Q45.** The fan-shaped body of gravel and sand laid down where a steep, sediment-laden mountain stream emerges abruptly onto a gently sloping plain and loses its transporting power is an: **[2 marks]**

(A) Delta at a lake or sea margin

(B) Natural levee

(C) Point bar on a meander

(D) Alluvial fan

**Q46.** During fractional crystallisation of a magma, incompatible trace elements become progressively concentrated in the residual melt while compatible elements are taken up by the early-formed crystals. Whether an element behaves compatibly or incompatibly is quantified by its: **[2 marks]**

(A) Atomic number

(B) Radioactive half-life

(C) Specific gravity

(D) Partition (distribution) coefficient

# Detailed Solutions

## Q1.

**Solution**

**Concept – structural classification of silicates:** Silicate minerals are grouped by the way their $SiO_4$ tetrahedra are linked, from isolated units to fully polymerised frameworks.

**Step 1 – read the degree of sharing:** The figure shows every tetrahedron sharing all four of its corner oxygens with its neighbours.

**Step 2 – match to the class:** Sharing of all four corners produces a continuous three-dimensional network, which defines the tectosilicates (framework silicates).

**Step 3 – confirm with examples:** Quartz and the feldspars are the common rock-forming tectosilicates.

**Why the other options are wrong:**

- A, nesosilicates: have isolated tetrahedra sharing no corners (e.g. olivine).
- B, inosilicates: share corners to form single or double chains (pyroxenes, amphiboles).
- C, phyllosilicates: share three corners to build sheets (micas, clays).

**Final Answer:** Tectosilicates $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q1

## Q2.

**Solution**

**Concept – substitution in a crystal structure:** When two ions of similar size and charge freely replace one another in the same structural site, a mineral forms a continuous range of compositions.

**Step 1 – read the situation:** $Mg^{2+}$ and $Fe^{2+}$ occupy the same octahedral site in olivine, giving all compositions between $Mg_2SiO_4$ and $Fe_2SiO_4$.

**Step 2 – name the phenomenon:** Substitution of similar ions in one structure, keeping the same crystal form, is isomorphous solid solution (isomorphism).

**Step 3 – note the requirement:** $Mg^{2+}$ ($\approx 0.72$ Å) and $Fe^{2+}$ ($\approx 0.78$ Å) are close in radius and equal in charge, which is exactly why the substitution is complete.

**Why the other options are wrong:**

- A, polymorphism: same composition, different structures (e.g. diamond and graphite).
- B, pseudomorphism: one mineral replaced while keeping another's outward shape.
- D, twinning: two crystal domains joined in a symmetric orientation.

**Final Answer:** Isomorphous solid solution $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q2

## Q3.

### Solution

**Concept – crystal systems from axes and angles:** The seven systems are distinguished by axial lengths and inter-axial angles.

**Step 1 – read the angles:** All three axes are mutually perpendicular ($\alpha = \beta = \gamma = 90°$).

**Step 2 – read the lengths:** Two axes are equal and the third differs, $a = b \neq c$.

**Step 3 – match to the table:** Two equal axes and one unequal axis, all at right angles, define the tetragonal system.

**Why the other options are wrong:**

- A, orthorhombic: three unequal axes at $90°$ ($a \neq b \neq c$).
- C, monoclinic: two of the angles are $90°$ but one is not.
- D, triclinic: all axes unequal and no angle is $90°$.

**Final Answer:** Tetragonal system $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q3

## Q4.

### Solution

**Concept – cleavage angles reflect chain structure:** In chain silicates the cleavage traces run parallel to the silicate chains, so their intersection angle is fixed by the chain geometry.

**Step 1 – identify the mineral group:** Amphiboles are double-chain inosilicates; pyroxenes are single-chain inosilicates.

**Step 2 – recall the diagnostic angles:** Pyroxene cleavages meet at close to $90°$, whereas amphibole cleavages meet at about $56°$ and its supplement $124°$.

**Step 3 – read the figure:** The two traces shown intersect at the acute angle $56°$ (and obtuse $124°$), matching amphibole.

**Why the other options are wrong:**

- A, $90°$: is the pyroxene value, not amphibole.
- B and C: are not the standard diagnostic amphibole cleavage angles.

**Final Answer:** $56°$ and $124°$ $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q4

## Q5.

**Solution**

**Concept – interference figures in conoscopic light:** Viewed in convergent polarised light, anisotropic minerals produce interference figures whose form reveals their optical class.

**Step 1 – read the figure:** A single black cross of isogyres that stays fixed and does not split as the stage rotates.

**Step 2 – match to the optic class:** A stationary, unbroken black cross centred on the field is the optic-axis figure of a uniaxial mineral (tetragonal, hexagonal or trigonal).

**Step 3 – conclude:** Because the cross remains whole on rotation, the mineral is uniaxial.

**Why the other options are wrong:**

- A, isotropic: gives no interference figure at all (stays dark).
- B, biaxial acute bisectrix: the isogyres separate into two curved brushes on rotation.
- C, flash figure: a broad cross that leaves the field almost immediately on slight rotation.

**Final Answer:** Uniaxial optic-axis figure $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q5

## Q6.

**Solution**

**Concept – the plagioclase feldspar series:** Plagioclase is a solid solution running from albite ($NaAlSi_3O_8$) to anorthite ($CaAl_2Si_2O_8$).

**Step 1 – read the given formula:** The composition asked for is $CaAl_2Si_2O_8$, the calcium-rich end.

**Step 2 – name the end member:** The pure calcium end member of plagioclase is anorthite.

**Step 3 – contrast the two ends:** Albite (Na) is the sodic end; anorthite (Ca) is the calcic end, and $Na^+Si^{4+} \leftrightarrow Ca^{2+}Al^{3+}$ coupled substitution links them.

**Why the other options are wrong:**

- A, albite: is the sodium end member, $NaAlSi_3O_8$.
- B, orthoclase, and D, sanidine: are potassium (alkali) feldspars, not plagioclase.

**Final Answer:** Anorthite $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q6

## Q7.

**Solution**

**Concept – index minerals track metamorphic grade:** In pelitic rocks, specific new minerals appear one after another as temperature rises, and each marks a higher metamorphic grade.

**Step 1 – read the sequence:** Chlorite, then biotite, garnet, staurolite, kyanite and finally sillimanite.

**Step 2 – interpret the order:** This is the standard Barrovian order of first appearance with increasing temperature (and pressure), i.e. increasing grade.

**Step 3 – conclude:** Therefore the succession records progressively increasing metamorphic grade.

**Why the other options are wrong:**

- B, weathering: is a surface, low-temperature process unrelated to these minerals.
- C, silica content: is a property of the protolith, not what the index minerals track.

- D, porosity: falls, not rises, during metamorphic recrystallisation.

**Final Answer:** Increasing metamorphic grade $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q7

## Q8.

### Solution

**Concept – Barrow's metamorphic zones:** Barrow mapped a series of mineral zones of rising grade in the Scottish Highlands, each named for the first-appearing index mineral.

**Step 1 – list the zones in order:** Chlorite $\to$ biotite $\to$ garnet $\to$ staurolite $\to$ kyanite $\to$ sillimanite.

**Step 2 – identify the highest grade:** The last and highest-temperature zone is the sillimanite zone.

**Step 3 – conclude:** Thus sillimanite defines the highest-grade Barrovian zone.

**Why the other options are wrong:**

- A, chlorite: marks the lowest-grade zone.
- B, biotite: is a low-grade zone just above chlorite.
- D, garnet: is an intermediate-grade zone, below staurolite, kyanite and sillimanite.

**Final Answer:** Sillimanite zone $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q8

## Q9.

### Solution

**Concept – metamorphic facies series and geothermal gradient:** A facies series records the pressure–temperature path a region followed; different tectonic settings give different $P/T$ ratios.

**Step 1 – read the described gradient:** High temperature reached at relatively low pressure, with andalusite followed by sillimanite.

**Step 2 – match to a named series:** The andalusite–sillimanite association is diagnostic of the low-pressure, high-temperature (Buchan/Abukuma) series.

**Step 3 – note the setting:** Such gradients occur in contact aureoles and in regions of high heat flow.

**Why the other options are wrong:**

- B, glaucophane–jadeite: is the high-pressure, low-temperature series of subduction zones.
- C, coesite eclogite: reflects ultra-high pressure, not low pressure.
- D, zeolite-only burial series: is very low grade and does not reach sillimanite.

**Final Answer:** Low-pressure, high-temperature series $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q9

**Q10.**

**Solution**

**Concept – types of metamorphism by agent:** Metamorphism is classified by whether heat, pressure or both drive the recrystallisation, and by its geological setting.

**Step 1 – read the setting:** A narrow baked ring of hornfels immediately around an intrusive pluster of granite, formed by heat with little directed pressure.

**Step 2 – match to the type:** Heat-dominated metamorphism localised around an intrusion is contact (thermal) metamorphism, and its zone is the aureole.

**Step 3 – note the product:** The typical product, a hard, massive, non-foliated rock, is hornfels, exactly as described.

**Why the other options are wrong:**

- A, regional: affects large areas and produces foliated rocks under directed pressure.
- B, dynamic: occurs along fault zones and produces mylonite by shearing.
- D, burial: results from deep sedimentary burial over broad regions, not a local aureole.

**Final Answer:** Contact (thermal) metamorphism $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q10

## Q11.

### Solution

**Concept – foliation types by grade:** As grade rises, the planar fabric of a metamorphosed pelite changes from slaty cleavage to schistosity to a coarse compositional banding.

**Step 1 – read the description:** Coarse alternation of light quartzo-feldspathic and dark ferromagnesian layers at high grade.

**Step 2 – name the fabric:** This segregated compositional banding is gneissose banding (gneissosity), characteristic of gneiss.

**Step 3 – confirm:** It forms at higher grade than schistosity, when minerals segregate into distinct layers.

**Why the other options are wrong:**

- A, slaty cleavage: is a very fine, low-grade planar fabric in slate.
- C, vesicular texture: is an igneous (gas-bubble) texture, not metamorphic.
- D, hornfelsic texture: is a fine, non-foliated granoblastic texture of contact rocks.

**Final Answer:** Gneissose banding $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q11

## Q12.

### Solution

**Concept – the QAPF (Streckeisen) classification:** Plutonic rocks are named from their proportions of quartz (Q), alkali feldspar (A) and plagioclase (P), and from the plagioclase share of total feldspar.

**Step 1 – read the quartz content:** Q is $20–60\%$ of the Q–A–P sum, so the rock is a quartz-rich (granitoid) plutonic rock.

**Step 2 – read the feldspar ratio:** Plagioclase forms $65–90\%$ of the total feldspar, i.e. plagioclase dominates over alkali feldspar but alkali feldspar is still present.

**Step 3 – match the field:** Quartz $20–60\%$ with plagioclase-dominated feldspar $(65–90\%)$ plots in the granodiorite field of QAPF.

**Why the other options are wrong:**

- A, alkali-feldspar granite: has alkali feldspar making up almost all of the feldspar.

- B, syenite: is feldspar-rich but quartz-poor ($< 20\%$ Q).
- C, gabbro: is essentially quartz-free and dominated by calcic plagioclase and pyroxene.

**Final Answer:** Granodiorite $\Rightarrow \boxed{D}$

**Answer: (D)** Go Back to Q12

## Q13.

### Solution

**Concept – classifying sandstones by maturity:** Sandstones are named from the amount of muddy matrix and the proportions of quartz, feldspar and rock fragments.

**Step 1 – read the matrix:** Less than $5\%$ matrix means the rock is texturally mature (clean, well-washed).

**Step 2 – read the composition:** Quartz forms more than $95\%$ of the framework, so it is mineralogically mature as well.

**Step 3 – name the rock:** A clean, quartz-dominated sandstone with little matrix is a quartz arenite.

**Why the other options are wrong:**

- B, greywacke: is matrix-rich ($> 15\%$) and poorly sorted (immature).
- C, arkose: contains more than $25\%$ feldspar.
- D, litharenite: is rich in rock (lithic) fragments.

**Final Answer:** Quartz arenite $\Rightarrow \boxed{A}$

**Answer: (A)** Go Back to Q13

## Q14.

### Solution

**Concept – feldspathic sandstones:** A high feldspar content signals rapid erosion and short transport, so the unstable feldspar survives.

**Step 1 – read the key figure:** More than about $25\%$ feldspar in the framework.

**Step 2 – name the rock:** A sandstone with $> 25\%$ feldspar is an arkose.

**Step 3 – interpret the origin:** Arkose typically records erosion of a granitic or gneissic source under conditions of high relief or arid climate, with little time for feldspar to weather to clay.

**Why the other options are wrong:**

- A, quartz arenite: has almost no feldspar (very mature).
- C, bedded chert: is a siliceous chemical/biochemical rock, not a feldspathic sandstone.
- D, oolitic ironstone: is an iron-rich chemical sediment.

**Final Answer:** Arkose $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q14

## Q15.

**Solution**

**Concept – Dunham classification of limestones:** Dunham names carbonates by whether the fabric is mud-supported or grain-supported and by the grain content.

**Step 1 – read the support:** The rock is mud-supported (carbonate mud forms the framework).

**Step 2 – read the grain content:** It contains more than $10\%$ grains (allochems).

**Step 3 – apply the scheme:** Mud-supported with $> 10\%$ grains is a wackestone (mud-supported with $< 10\%$ grains would be a lime mudstone).

**Why the other options are wrong:**

- B, grainstone: is grain-supported with no mud.
- C, lime mudstone: is mud-supported with fewer than $10\%$ grains.
- D, boundstone: has components bound together during deposition (e.g. a reef framework).

**Final Answer:** Wackestone $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q15

## Q16.

**Solution**

**Concept – Folk classification of limestones:** Folk names carbonates from the allochems (grains) and the cement or matrix (micrite versus sparite).

**Step 1 – read the matrix:** The rock is dominated by microcrystalline calcite mud with few or no allochems.

**Step 2 – name it:** Microcrystalline carbonate mud is called micrite (from "microcrystalline calcite").

**Step 3 – contrast with sparite:** Sparite is the clear, coarse calcite cement that fills pores between grains, the opposite of muddy micrite.

**Why the other options are wrong:**

- B, sparite: is coarse, clear calcite cement, not mud.
- C, oosparite: is ooids cemented by sparite (grain-rich).
- D, biosparite: is skeletal grains cemented by sparite (grain-rich).

**Final Answer:** Micrite $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q16

## Q17.

### Solution

**Concept – graded bedding from waning currents:** When a sediment-laden current slows, coarse grains settle first and finer grains later, giving an upward decrease in grain size.

**Step 1 – read the figure:** Grain size decreases from coarse at the base to fine at the top of the single bed.

**Step 2 – name the structure:** An upward-fining bed of this kind is normal graded bedding.

**Step 3 – link to environment:** Such graded beds are the classic signature of turbidity-current deposits (turbidites) and are also useful as way-up (younging) indicators.

**Why the other options are wrong:**

- A, herringbone cross-bedding: is a tidal structure of oppositely dipping cross-sets.
- B, symmetrical ripples: are wave-formed surface bedforms, not a grading.
- C, desiccation cracks: form on drying mud, unrelated to size grading.

**Final Answer:** Normal graded bedding $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q17

## Q18.

**Solution**

**Concept – Walther's Law of facies:** Walther's Law connects the vertical stacking of facies to their lateral arrangement in the depositional system.

**Step 1 – state the law:** Facies that are found conformably stacked on top of one another were originally deposited side by side in laterally adjacent environments.

**Step 2 – read the condition:** The law holds only where sedimentation was continuous, i.e. the succession is conformable with no depositional break.

**Step 3 – conclude:** An unconformity breaks the lateral–vertical link, so the correct requirement is a conformable succession.

**Why the other options are wrong:**

- A, tightly folded: folding is a later structural event and is irrelevant to the original facies law.
- B, unconformity present: an unconformity is exactly the case where the law fails.
- D, igneous origin: Walther's Law applies to sedimentary facies.

**Final Answer:** Conformable succession $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q18

## Q19.

**Solution**

**Concept – fractures classified by displacement:** A break in rock is called a joint or a fault depending on whether the two sides have slipped past one another.

**Step 1 – read the key clause:** There has been essentially no displacement parallel to the fracture surface.

**Step 2 – name the structure:** A fracture with negligible shear displacement is a joint.

**Step 3 – contrast with a fault:** If appreciable slip parallel to the surface had occurred, the same break would instead be a fault.

**Why the other options are wrong:**

- B, fault: has measurable displacement parallel to the fracture.
- C, fold: is a bend in layering, not a fracture.
- D, foliation: is a planar mineral fabric, not a discrete fracture.

**Final Answer:** Joint ⇒ $\boxed{A}$

Answer: (A) Go Back to Q19

## Q20.

### Solution

**Concept – planar fabrics in metamorphic rocks:** Directed pressure aligns platy minerals into a planar fabric collectively called foliation, of which schistosity is one variety.

**Step 1 – read the description:** Parallel alignment of platy micas, allowing a schist to split along mineral surfaces.

**Step 2 – name the fabric:** A well-developed mica-defined foliation in a medium- to coarse-grained rock is schistosity.

**Step 3 – classify:** Schistosity is a planar (S) fabric, i.e. a foliation, distinct from any linear fabric.

**Why the other options are wrong:**

- A, lineation: is a linear, not a planar, fabric.
- B, bedding: is a primary sedimentary layering, not a metamorphic fabric.
- C, cooling joint: is an igneous fracture (e.g. columnar joints in basalt).

**Final Answer:** Schistosity (a foliation) ⇒ $\boxed{D}$

Answer: (D) Go Back to Q20

## Q21.

### Solution

**Concept – linear versus planar structures:** Structural fabrics are either planar (foliations) or linear (lineations); a lineation is any penetrative linear feature.

**Step 1 – read the description:** Parallel alignment of elongate minerals, or the intersection of two planar fabrics, giving a linear grain to the rock.

**Step 2 – name the structure:** A penetrative linear structure of this kind is a lineation (mineral lineation or intersection lineation).

**Step 3 – note its use:** Lineations record the direction of tectonic stretching or transport and are measured by their trend and plunge.

**Why the other options are wrong:**

- A, cleavage, and C, foliation: are planar fabrics, not linear ones.
- D, bedding plane: is a primary sedimentary surface, again planar.

**Final Answer:** Lineation $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q21

## Q22.

### Solution

**Concept – angle between two strike directions:** The strike of a plane is a compass azimuth; the angle between two joint sets is simply the difference of their strikes.

**Step 1 – write the two strikes:** Set 1 strikes $030^\circ$ and set 2 strikes $120^\circ$.

**Step 2 – subtract:** $120^\circ - 030^\circ = 90^\circ$.

**Step 3 – check the acute value:** Because $90^\circ$ is already the smaller (non-reflex) angle between the two lines, the two joint sets are mutually perpendicular.

**Step 4 – interpret:** Two joint sets meeting at right angles form an orthogonal joint system, common in flat-lying strata.

**Final Answer:** $90^\circ \Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q22

## Q23.

### Solution

**Concept – classifying reverse faults by dip:** Contractional faults place older rock over younger; those with gentle dips are given a special name.

**Step 1 – read the sense of slip:** The hanging wall has moved up relative to the footwall, so it is a reverse (contractional) fault.

**Step 2 – read the dip:** The fault dips gently, at less than about $45^\circ$.

**Step 3 – apply the definition:** A low-angle reverse fault (dip $< 45^\circ$) is specifically a thrust fault.

**Why the other options are wrong:**

- B, normal fault: the hanging wall moves down, under extension.
- C, strike-slip fault: displacement is horizontal, along the strike.
- D, graben-bounding fault: bounds a down-dropped block and is of normal (extensional) type.

**Final Answer:** Thrust fault ⇒ $\boxed{A}$

**Answer: (A)** Go Back to Q23

## Q24.

### Solution

**Concept – stress regimes and the structures they make:** The three principal stress regimes (compression, tension and shear) each generate characteristic structures.

**Step 1 – read the structures produced:** Folds together with reverse and thrust faults, which shorten and thicken the crust.

**Step 2 – match to the stress:** Crustal shortening and thickening are the response to compressional stress at convergent margins.

**Step 3 – conclude:** Therefore the stress responsible is compressional stress.

**Why the other options are wrong:**

- A, tensional stress: stretches and thins the crust, giving normal faults and grabens.
- B, shear stress: produces strike-slip faults, not crustal thickening.
- D, confining (hydrostatic) stress: is equal in all directions and produces no folds or faults.

**Final Answer:** Compressional stress ⇒ $\boxed{C}$

**Answer: (C)** Go Back to Q24

## Q25.

### Solution

**Concept – classifying ammonoids:** Ammonoids are one of the great index-fossil groups; placing them in the correct phylum rests on their soft- and hard-part anatomy.

**Step 1 – read the description:** Coiled, chambered marine shells built by cephalopod animals.

**Step 2 – assign the phylum:** Cephalopods (ammonoids, nautiloids, squid) are a class within the phylum Mollusca.

**Step 3 – confirm:** The chambered, septate shell divided by a siphuncle is the classic molluscan cephalopod plan.

**Why the other options are wrong:**

- B, Arthropoda: includes trilobites and crustaceans, which are jointed-limbed animals, not cephalopods.
- C, Brachiopoda: are bivalved lophophorates, not coiled cephalopods.
- D, Echinodermata: are spiny-skinned animals such as crinoids and echinoids.

**Final Answer:** Mollusca $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q25

## Q26.

### Solution

**Concept – famous Indian fossil localities:** Different Indian rock units are known for different fossil groups; the Siwaliks are a benchmark for vertebrate palaeontology.

**Step 1 – identify the unit:** The Siwalik Group is a thick Mio–Pliocene molasse deposited in front of the rising Himalaya.

**Step 2 – recall its fossils:** It is celebrated for an abundant assemblage of fossil land mammals (elephants, giraffids, primates, rodents and many others), i.e. vertebrates.

**Step 3 – conclude:** The Siwaliks are therefore famous for fossil mammals (vertebrates).

**Why the other options are wrong:**

- A, trilobites, and B, graptolites: are extinct Palaeozoic marine invertebrates, far older than the Siwaliks.
- C, rugose corals: are Palaeozoic marine invertebrates, not the Siwalik fauna.

**Final Answer:** Land mammals (vertebrates) $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q26

## Q27.

**Solution**

**Concept – preservation of graptolites:** The mode of fossil preservation depends on the original skeletal material and the depositional setting.

**Step 1 – recall graptolite hard parts:** Graptolites built a colonial skeleton (rhabdosome) of a tough organic (collagen-like) material.

**Step 2 – recall the setting:** They are typically found in dark, oxygen-poor shales where organic matter is preserved.

**Step 3 – deduce the preservation:** Compaction of the shale flattens the organic skeleton into a thin carbonaceous film or impression on the bedding plane.

**Why the other options are wrong:**

- A, silicified skeletons: graptolites are not typically silicified in three dimensions.
- B, thick calcareous shells: graptolites were organic, not calcareous.
- D, permineralised wood: applies to plant fossils, not graptolites.

**Final Answer:** Flattened carbonaceous impressions $\Rightarrow \boxed{C}$

$\boxed{\text{Answer: (C)}}$ Go Back to Q27

## Q28.

**Solution**

**Concept – transitional fossils in vertebrate evolution:** Certain fossils bridge major groups by combining features of both; the bird–reptile link is a textbook case.

**Step 1 – read the features:** Teeth and a long bony tail (reptilian) together with feathered wings (avian), from the Late Jurassic Solnhofen Limestone of Germany.

**Step 2 – name the fossil:** This classic feathered transitional fossil is Archaeopteryx.

**Step 3 – note its significance:** Archaeopteryx is the earliest widely accepted bird-like animal and key evidence for the dinosaur ancestry of birds.

**Why the other options are wrong:**

- A, Ichthyosaurus: a fully marine reptile, not feathered.
- B, Tyrannosaurus: a large Cretaceous theropod dinosaur, not a transitional bird.

- D, Dimetrodon: a Permian synapsid ("sail-back"), not a bird ancestor.

**Final Answer:** Archaeopteryx $\Rightarrow$ $\boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q28**

## Q29.

### Solution

**Concept – test composition of foraminifera:** Microfossils are grouped partly by the material of their skeleton, which controls how and where they fossilise.

**Step 1 – recall foraminiferal skeletons:** Most foraminifera secrete a chambered test of calcium carbonate (calcite); some are agglutinated from sediment grains.

**Step 2 – select the dominant material:** The common, calcareous (hyaline and porcelaneous) forms build tests of calcium carbonate.

**Step 3 – note the use:** Their calcareous tests, together with narrow time ranges, make them prime index and palaeoenvironmental microfossils.

**Why the other options are wrong:**

- B, opaline silica: is the skeletal material of radiolaria and diatoms, not most foraminifera.
- C, chitin: builds arthropod cuticle, not foraminiferal tests.
- D, woody lignin: is plant material, irrelevant to foraminifera.

**Final Answer:** Calcium carbonate $\Rightarrow$ $\boxed{\text{A}}$

$\boxed{\textbf{Answer: (A)}}$ **Go Back to Q29**

## Q30.

### Solution

**Concept – the Glossopteris flora and Gondwana:** The distribution of the Glossopteris flora across the southern continents is a cornerstone of the continental-drift argument.

**Step 1 – recall the flora:** Glossopteris was a seed-fern (pteridosperm) that dominated the Gondwana landmasses.

**Step 2 – date its heyday:** It flourished mainly during the Permian (Late Palaeozoic), with the coal-bearing Gondwana sequences of India recording its abundance.

**Step 3 – conclude:** Therefore the Glossopteris flora is characteristically Permian.

**Why the other options are wrong:**

- A, Cambrian: predates land plants of this kind entirely.
- C, Neogene, and D, Quaternary: are far younger Cenozoic times, long after Glossopteris went extinct.

**Final Answer:** Permian $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q30

## Q31.

### Solution

**Concept – raw materials of Portland cement:** Portland cement clinker is made by burning a calcium source with a source of silica, alumina and iron.

**Step 1 – identify the calcium source:** The bulk raw material supplying calcium is limestone (calcium carbonate), which makes up the majority of the raw mix.

**Step 2 – add the other ingredient:** Clay or shale supplies the silica, alumina and iron; the two are burned together to form clinker.

**Step 3 – conclude:** The principal raw material is therefore limestone.

**Why the other options are wrong:**

- A, gypsum: is added later, in small amount, to control setting, not as the bulk raw material.
- C, bauxite: may be a minor corrective for alumina but is not the main raw material.
- D, muscovite mica: is not a cement raw material at all.

**Final Answer:** Limestone $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q31

## Q32.

### Solution

**Concept – properties that make a good building stone:** A dimension stone is valued for hardness, durability, low porosity and its ability to take a polish.

**Step 1 – read the description:** A hard, equigranular, interlocking coarse-grained igneous rock that takes a high polish.

**Step 2 – identify the rock:** An interlocking, coarse-grained (phaneritic) felsic plutonic rock is granite.

**Step 3 – justify its use:** Its interlocking crystals give strength and very low porosity, so it is widely used for facing, flooring and monuments.

**Why the other options are wrong:**

- A, roofing slate: is a fine-grained metamorphic rock used for its cleavage, not for polish.
- B, laterite block: is a soft, porous residual material, low in strength.
- D, friable sandstone: crumbles easily and does not take a durable polish.

**Final Answer:** Granite $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q32

## Q33.

**Solution**

**Concept – the role of gypsum in cement:** A small addition to clinker can change the hydration behaviour of cement dramatically.

**Step 1 – recall the flash-set problem:** Without an additive, the tricalcium aluminate in clinker reacts with water almost instantly, causing a "flash set" that ruins workability.

**Step 2 – state gypsum's function:** Interground gypsum reacts with tricalcium aluminate to form ettringite, slowing the reaction and so retarding (controlling) the setting time.

**Step 3 – conclude:** Gypsum is therefore added chiefly to retard the setting time of the cement.

**Why the other options are wrong:**

- B, raise silica: gypsum ($CaSO_4 \cdot 2H_2O$) contributes no silica.
- C, give colour: cement colour is governed mainly by its iron content, not gypsum.
- D, supply iron: gypsum contains no iron.

**Final Answer:** Retard the setting time $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q33

## Q34.

**Solution**

**Concept – refractory aluminosilicate minerals:** Minerals of the $Al_2SiO_5$ (sillimanite) group are prized as refractories because on heating they convert to mullite.

**Step 1 – read the clues:** A high-alumina aluminosilicate that, on firing, yields mullite and is used for furnace-lining bricks.

**Step 2 – identify the mineral:** Kyanite (one of the three $Al_2SiO_5$ polymorphs, with sillimanite and andalusite) is the standard high-alumina refractory raw material.

**Step 3 – confirm:** On heating, kyanite breaks down to mullite plus siliceous glass, giving the high-temperature stability required in refractories.

**Why the other options are wrong:**

- A, talc: is a low-temperature sheet silicate used as a filler, not a high-alumina refractory.
- C, barite: is barium sulphate, used chiefly as a weighting agent in drilling mud.
- D, fluorite: is calcium fluoride, used as a flux in metallurgy, not as a refractory.

**Final Answer:** Kyanite $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q34

## Q35.

**Solution**

**Concept – Indian metallogenic belts:** Particular Indian districts are long associated with particular metals.

**Step 1 – locate the belt:** The Khetri belt lies in the Aravalli terrain of Rajasthan.

**Step 2 – recall its metal:** Khetri is a historic and important source of copper, hosted in metasedimentary rocks and worked by Hindustan Copper.

**Step 3 – conclude:** The Khetri belt is therefore a copper producer.

**Why the other options are wrong:**

- A, gold: is chiefly associated with the Kolar and Hutti belts of Karnataka.
- B, iron: comes mainly from the Bailadila, Bellary–Hospet and Singhbhum belts.

- D, manganese: is centred on the Balaghat–Nagpur and Srikakulam belts, not Khetri.

**Final Answer:** Copper $\Rightarrow$ $\boxed{\text{C}}$

**Answer: (C)** Go Back to Q35

## Q36.

### Solution

**Concept – identifying industrial minerals by properties:** Distinctive physical properties (hardness, feel, habit) point directly to particular industrial minerals.

**Step 1 – read the properties:** Very soft, platy, greasy to the touch, a magnesium sheet silicate, hardness $1$ on the Mohs scale.

**Step 2 – name the mineral:** Hardness $1$ with a greasy, soapy feel identifies talc, $Mg_3Si_4O_{10}(OH)_2$.

**Step 3 – recall its uses:** Talc is used as a filler in paper and paint, as a lubricant, and as a cosmetic (talcum) base.

**Why the other options are wrong:**

- B, corundum: is extremely hard (Mohs $9$), the opposite of talc.
- C, quartz: has hardness $7$ and no greasy feel.
- D, orthoclase feldspar: has hardness $6$ and is not a soft platy mineral.

**Final Answer:** Talc $\Rightarrow$ $\boxed{\text{A}}$

**Answer: (A)** Go Back to Q36

## Q37.

### Solution

**Concept – fluoride as a groundwater-quality parameter:** Some dissolved ions are beneficial at low concentration but harmful above a threshold; fluoride is the classic example.

**Step 1 – recall the health effect:** Excess fluoride in drinking water causes dental and, at higher levels, skeletal fluorosis.

**Step 2 – recall the standard:** The Indian drinking-water standard (BIS) sets the permissible upper limit for fluoride at about $1.5$ mg/L.

**Step 3 – conclude:** The threshold asked for is therefore $1.5$ mg/L.

**Why the other options are wrong:**

- A, 0.1 mg/L: far below the fluorosis threshold; such water may even be too low in fluoride.
- C, 45 mg/L: is the limit for nitrate, not fluoride.
- D, 15 mg/L: is an order of magnitude too high for a fluoride limit.

**Final Answer:** 1.5 mg/L $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q37

## Q38.

### Solution

**Concept – arsenic in shallow alluvial aquifers:** Naturally occurring arsenic is released to groundwater from young, organic-rich alluvium under reducing conditions.

**Step 1 – recall the affected setting:** The problem is concentrated in the young, fine-grained alluvium of the Ganga–Brahmaputra plain.

**Step 2 – name the region:** West Bengal and the wider Bengal basin (extending into Bangladesh) is the best-known Indian arsenic-affected region.

**Step 3 – conclude:** The correct region is the Ganga–Brahmaputra (Bengal) plain.

**Why the other options are wrong:**

- A, Thar Desert: is arid and is associated with fluoride and salinity, not widespread arsenic.
- C, Deccan Plateau: is hard basaltic terrain, not young arsenic-bearing alluvium.
- D, Western Ghats: are high-rainfall crystalline highlands, not an arsenic problem area.

**Final Answer:** Ganga–Brahmaputra (Bengal) plain $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q38

## Q39.

**Solution**

**Concept – Darcy's law and specific discharge:** The specific discharge (Darcy velocity) is the product of hydraulic conductivity and hydraulic gradient.

**Step 1 – write the law:** $q = K\,i$, where $q$ is the Darcy velocity, $K$ the hydraulic conductivity and $i$ the hydraulic gradient.

**Step 2 – insert the values:** $q = 15$ m/day $\times 0.01$.

**Step 3 – multiply:** $15 \times 0.01 = 0.15$.

**Step 4 – attach the unit:** $q = 0.15$ m/day.

**Note:** The Darcy velocity is a bulk (apparent) velocity; the true pore velocity would be higher, obtained by dividing $q$ by the effective porosity.

**Final Answer:** $q = 0.15$ m/day $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q39

## Q40.

**Solution**

**Concept – Rock Quality Designation (RQD):** RQD is a simple, widely used index of rock-mass quality obtained from drill core.

**Step 1 – state the definition:** RQD is the summed length of all intact (sound) core pieces $\geq 10$ cm long, divided by the total length of the core run, expressed as a percentage.

**Step 2 – note the key restriction:** Only pieces at least $10$ cm long and of sound rock are counted; broken or weathered fragments are excluded.

**Step 3 – interpret:** Higher RQD means fewer fractures and better rock quality (e.g. RQD $> 90\%$ is "excellent").

**Why the other options are wrong:**

- A: counts core of any length, which is core recovery, not RQD.
- C: a weight ratio is not how RQD is defined.
- D: fracture frequency per metre is a related but different index.

**Final Answer:** Summed intact pieces $\geq 10$ cm / total core-run length $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q40

## Q41.

### Solution

**Concept – transmissivity of a confined aquifer:** Transmissivity measures how much water an aquifer of a given thickness can transmit, and equals conductivity times thickness.

**Step 1 – write the relation:** $T = K\,b$, where $K$ is hydraulic conductivity and $b$ is the saturated aquifer thickness.

**Step 2 – insert the values:** $T = 25$ m/day $\times$ $20$ m.

**Step 3 – multiply:** $25 \times 20 = 500$.

**Step 4 – attach the unit:** $T = 500$ m$^2$/day.

**Check on the units:** (m/day) $\times$ (m) $=$ m$^2$/day, the correct unit for transmissivity.

**Final Answer:** $T = 500$ m$^2$/day $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q41

## Q42.

### Solution

**Concept – fluvial landforms of meandering rivers:** As a river meanders it cuts off tight loops, leaving distinctive abandoned-channel landforms.

**Step 1 – read the description:** A crescent-shaped body of water formed when a meander loop is cut off from the main channel.

**Step 2 – name the landform:** An abandoned, water-filled meander loop is an oxbow lake.

**Step 3 – note its formation:** During a flood the river takes a shorter path (a chute or neck cut-off); the isolated loop is dammed by sediment and becomes an oxbow lake.

**Why the other options are wrong:**

- A, alluvial fan: is a depositional cone at a mountain front, not a cut-off loop.
- C, playa: is a flat ephemeral lake bed of an arid closed basin.
- D, glacial cirque: is an armchair-shaped hollow eroded by a mountain glacier.

**Final Answer:** Oxbow lake $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q42

## Q43.

### Solution

**Concept – classifying sand dunes:** Dune shape reflects sand supply and wind regime; the barchan is the classic crescentic dune of limited sand and one wind direction.

**Step 1 – read the profile:** A gentle windward slope, a steep leeward slip face, and a crescent plan with horns pointing downwind.

**Step 2 – name the dune:** A crescent-shaped dune with downwind-pointing horns and this asymmetry is a barchan.

**Step 3 – link to conditions:** Barchans form where sand supply is limited and the wind blows steadily from one direction across a firm surface.

**Why the other options are wrong:**

- A, seif (longitudinal) dune: is a long ridge parallel to the wind, not a crescent.
- B, star dune: is a pyramidal, multi-armed dune formed by multidirectional winds.
- D, loess sheet: is wind-blown silt, not a dune at all.

**Final Answer:** Barchan dune $\Rightarrow \boxed{\text{C}}$

$\boxed{\text{Answer: (C)}}$ Go Back to Q43

## Q44.

### Solution

**Concept – aeolian erosional landforms:** Wind erosion (deflation and abrasion) carves resistant rock into streamlined shapes aligned with the wind.

**Step 1 – read the description:** A streamlined ridge of resistant bedrock, elongated parallel to the prevailing wind.

**Step 2 – name the landform:** A wind-sculpted, streamlined rock ridge of this kind is a yardang.

**Step 3 – note the process:** Sand-blasting near the ground undercuts the ridge, while its long axis is aligned parallel to the dominant wind.

**Why the other options are wrong:**

- A, ventifact, and D, dreikanter: are individual wind-faceted pebbles, not large bedrock ridges.

- C, loess: is a wind-blown silt *deposit*, an aeolian depositional (not erosional) feature.

**Final Answer:** Yardang $\Rightarrow$ $\boxed{\text{B}}$

**Answer: (B)** Go Back to Q44

## Q45.

### Solution

**Concept – depositional landforms at a slope break:** Where a stream loses gradient it drops its load, building a distinctive depositional form.

**Step 1 – read the setting:** A steep, sediment-laden mountain stream emerges abruptly onto a gently sloping plain and loses velocity.

**Step 2 – deduce the deposit:** The sudden loss of transporting power forces rapid deposition, spreading sediment into a fan shape.

**Step 3 – name the landform:** This fan of gravel and sand at a mountain front is an alluvial fan.

**Why the other options are wrong:**

- A, delta: forms where a river enters a standing body of water (lake or sea), not at a dry slope break.
- B, natural levee: is a low ridge built along a channel bank during floods.
- C, point bar: is a crescent of sediment on the inner bank of a meander bend.

**Final Answer:** Alluvial fan $\Rightarrow$ $\boxed{\text{D}}$

**Answer: (D)** Go Back to Q45

## Q46.

### Solution

**Concept – partitioning of trace elements during crystallisation:** The tendency of a trace element to enter a crystal or stay in the melt is described by a single quantitative parameter.

**Step 1 – define the parameter:** The partition (distribution) coefficient $K_D$ is the ratio of an element's concentration in the crystal to that in the coexisting melt.

**Step 2 – interpret the values:** $K_D > 1$ means the element is compatible (prefers the crystal); $K_D < 1$ means it is incompatible (stays in the melt and is enriched in the residual liquid).

**Step 3 – conclude:** Whether an element behaves compatibly or incompatibly is therefore governed by its partition (distribution) coefficient.

**Why the other options are wrong:**

- A, atomic number: does not by itself fix compatibility; ionic size and charge matter within a given structure.
- B, half-life: is a property of radioactive decay, used in dating, not in crystal–melt partitioning.
- C, specific gravity: relates to crystal settling, not to chemical partitioning between crystal and melt.

**Final Answer:** Partition (distribution) coefficient $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q46

## Answer Key

| Q | Ans | Q | Ans | Q | Ans | Q | Ans | Q | Ans |
|---|---|---|---|---|---|---|---|---|---|
| 1 | D | 2 | C | 3 | B | 4 | D | 5 | D |
| 6 | C | 7 | A | 8 | C | 9 | A | 10 | C |
| 11 | B | 12 | D | 13 | A | 14 | B | 15 | A |
| 16 | A | 17 | D | 18 | C | 19 | A | 20 | D |
| 21 | B | 22 | D | 23 | A | 24 | C | 25 | A |
| 26 | D | 27 | C | 28 | C | 29 | A | 30 | B |
| 31 | B | 32 | C | 33 | A | 34 | B | 35 | C |
| 36 | A | 37 | B | 38 | B | 39 | A | 40 | B |
| 41 | D | 42 | B | 43 | C | 44 | B | 45 | D |
| 46 | D | | | | | | | | |