GATE Geology and Geophysics – Geology

Sample Paper – 3

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. When the permissible symmetry elements (rotation axes, mirror planes, a centre of symmetry and inversion axes) are combined in every self-consistent way, the total number of distinct crystal classes (point groups) that results is: **[1 mark]**

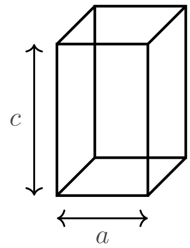
(A) 14

(B) 32

(C) 7

(D) 230

Q2. A crystal is referred to three mutually perpendicular axes in which two are equal and the third (vertical) axis is longer, that is $a = b \neq c$ and $\alpha = \beta = \gamma = 90°$, as sketched. It belongs to which crystal system? **[1 mark]**



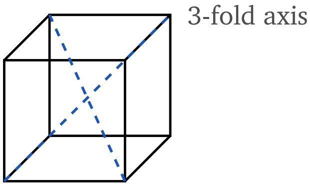
(A) Isometric (cubic)

(B) Orthorhombic

(C) Hexagonal

(D) Tetragonal

Q3. The defining diagnostic symmetry of the isometric (cubic) system is a particular set of three-fold rotation axes that run along the body diagonals of the cube, as shown. The number of such three-fold axes is: **[1 mark]**



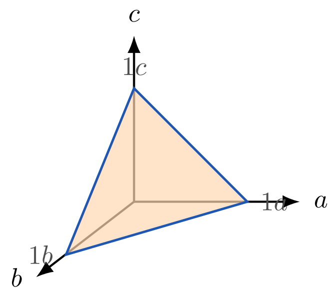
(A) Four

(B) Three

(C) Six

(D) Two

Q4. A crystal face cuts the three crystallographic axes at unit distances $1a$, $1b$ and $1c$, as sketched. Taking the reciprocals of these intercepts and clearing fractions, the Miller indices of the face are: **[1 mark]**



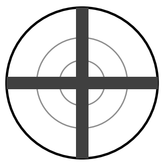
(A) (100)

(B) (110)

(C) (111)

(D) (011)

Q5. A transparent mineral grain is observed in convergent polarised light and yields a single centred "bull's-eye" interference figure with one black cross (isogyres) that does not break up on rotation, as sketched. Optically the mineral is: **[1 mark]**



single fixed cross

(A) Isotropic

(B) Biaxial

(C) Amorphous

(D) Uniaxial

Q6. The symmetry operation that relates any point of coordinates (x, y, z) to an identical point at $(-x, -y, -z)$ by inversion through a single point at the middle of the crystal is called the: **[1 mark]**

(A) Mirror plane

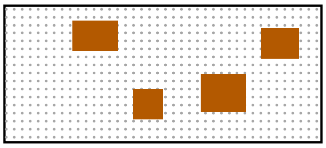
(B) Centre of symmetry (inversion centre)

(C) Rotation axis

(D) Glide plane

Igneous and Metamorphic Petrology

Q7. The igneous texture sketched below has a few large, well-formed crystals (phenocrysts) set in a much finer-grained groundmass, recording two distinct stages of cooling. This texture is described as: **[1 mark]**



phenocrysts in fine groundmass

(A) Porphyritic

(B) Aphanitic

(C) Glassy

(D) Equigranular

Q8. A silica-rich lava that cools so rapidly on eruption that no crystals nucleate, freezing into a smooth, dark natural glass with conchoidal fracture, produces the rock: **[1 mark]**

(A) Obsidian (glassy texture)

(B) Granite

(C) Gabbro

(D) Diorite

Q9. Basalt and its deep-seated plutonic equivalent share the same basic (mafic) chemistry but differ in grain size. The coarse-grained, slowly cooled plutonic equivalent of basalt is: **[1 mark]**

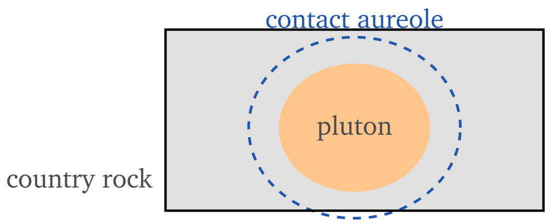
(A) Rhyolite

(B) Andesite

(C) Gabbro

(D) Granite

Q10. Around the hot margin of the intrusion shown, the country rock is baked within a narrow aureole by heat alone, at low pressure and with no directed stress, producing a hard, fine-grained, non-foliated rock. That rock is: **[1 mark]**



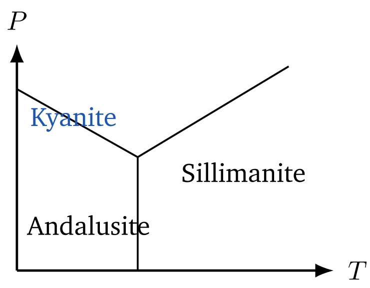
(A) Hornfels

(B) Schist

(C) Gneiss

(D) Slate

Q11. The Al_2SiO_5 phase diagram below shows three polymorphs. The polymorph whose stability field lies at high pressure (and is the classic indicator of high-pressure metamorphism) is: **[1 mark]**



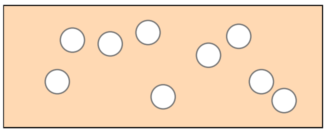
(A) Andalusite

(B) Sillimanite

(C) Kyanite

(D) Quartz

Q12. The volcanic rock shown in section is riddled with small rounded cavities that were once gas bubbles trapped as the lava solidified. A rock with this bubble-hole fabric is said to have a: **[1 mark]**



(A) Porphyritic texture

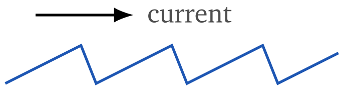
(B) Poikilitic texture

(C) Vesicular texture

(D) Ophitic texture

Sedimentology and Stratigraphy

Q13. The ripple marks preserved on the bedding surface below are distinctly asymmetric in profile, with a gentle up-current slope and a steep down-current slope. Such asymmetry indicates deposition by: **[1 mark]**



(A) Symmetrical wave oscillation

(B) A one-way (unidirectional) current

(C) No water movement at all

(D) Wind deflation only

Q14. The sandstone bed shown fines upward: coarse sand at the base grades continuously into fine sand and silt at the top within a single bed. This graded bedding is most characteristically produced by: **[1 mark]**

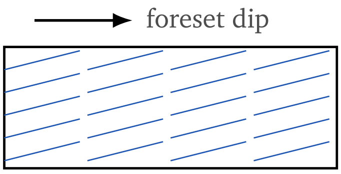
(A) Steady wind transport

(B) Glacial plucking

(C) A waning turbidity current

(D) Slow chemical precipitation

Q15. In the cross-bedded sandstone shown, the inclined foreset laminae consistently dip toward the right. The direction toward which these foresets dip records: **[1 mark]**



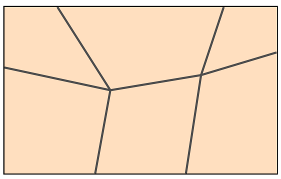
(A) The up-current direction

(B) A direction perpendicular to flow

(C) Purely vertical settling

(D) The down-current palaeoflow direction

Q16. The bedding-plane surface below is broken into a network of polygonal cracks that taper downward. These desiccation (mud) cracks indicate that the mud was, at some stage, subjected to: **[1 mark]**



(A) Deep marine burial

(B) Subaerial exposure and drying

(C) Rapid deep-water deposition

(D) Contact with hot lava

Q17. A sandstone composed almost entirely of well-rounded, well-sorted quartz grains, with little feldspar, few rock fragments and almost no clay matrix, is best described as texturally and compositionally: **[1 mark]**

(A) Immature

(B) Volcaniclastic

(C) Poorly sorted and angular

(D) Mature (a clean quartz arenite)

Q18. Walther's Law of the correlation of facies states that facies seen in a conformable, gradational vertical succession are the same as those that were originally deposited: **[1 mark]**

(A) Only across major unconformities

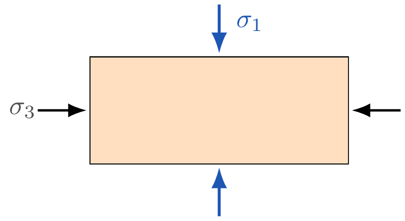
(B) Side by side (laterally adjacent) in the depositional environment

(C) In a completely random vertical order

(D) Simultaneously everywhere in the basin

Structural Geology and Geotectonics

Q19. According to Anderson's theory of faulting, the orientation of the three principal stresses controls the fault type. In a region of normal (extensional) faulting, as sketched, the maximum principal stress σ_1 is oriented: **[1 mark]**



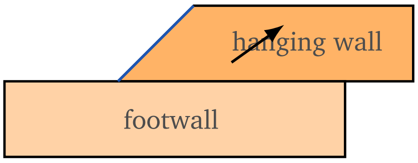
(A) Vertical

(B) Horizontal, trending north–south

(C) Horizontal, trending east–west

(D) Inclined at exactly 45°

Q20. In the fault block shown, the hanging wall has ridden up and over the footwall along a gently inclined fault plane (dip well below 45°) in response to horizontal compression. This structure is a: **[1 mark]**



(A) Normal fault

(B) Strike-slip fault

(C) Extensional graben

(D) Thrust (low-angle reverse) fault

Q21. A reverse fault dips at 60° and the beds have slipped a net distance of 20 m directly down the dip of the fault plane. The vertical throw equals net slip $\times \sin(\text{dip})$. Taking $\sin 60^\circ = 0.866$, the throw is: **[2 marks]**

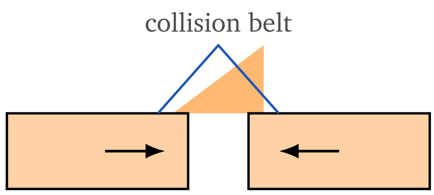
(A) 17.3 m

(B) 10.0 m

(C) 20.0 m

(D) 11.5 m

Q22. At the plate boundary shown, two thick continental plates converge, but because continental crust is too buoyant to be subducted, the crust crumples and thickens into a great mountain belt (as in the Himalaya). This boundary is a: **[2 marks]**



(A) Divergent boundary

(B) Transform boundary

(C) Ocean–ocean subduction zone

(D) Continent–continent collision boundary

Q23. A cylindrical rock specimen fails in a uniaxial compression test when an axial force of 90 kN is applied to its circular end of cross-sectional area 30 cm^2. The compressive stress at failure, $\sigma = F/A$, is: **[2 marks]**

(A) 3 MPa

(B) 300 MPa

(C) 9 MPa

(D) 30 MPa

Q24. A transform fault offsets the axis of a mid-ocean ridge. Along the active segment between the two ridge tips, the relative motion of the two plates is: **[2 marks]**

(A) Purely vertical

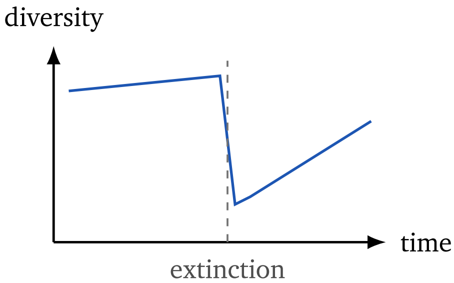
(B) Horizontal but perpendicular to the fault trace

(C) Horizontal and parallel to the fault trace

(D) Effectively zero (no relative motion)

Palaeontology and Historical Geology

Q25. The diagram schematically shows the drop in marine biodiversity across the largest mass extinction in Earth history, in which roughly 90% of marine species were wiped out. This greatest of all extinctions took place at the end of which period? **[2 marks]**



(A) End-Permian

(B) End-Cretaceous

(C) End-Ordovician

(D) End-Triassic

Q26. The base of the Phanerozoic is defined by the sudden appearance in the fossil record of abundant animals with mineralised hard parts. This "explosion" of shelly life marks the base of which period? **[2 marks]**

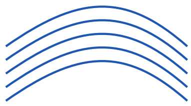
(A) Ordovician

(B) Devonian

(C) Cambrian

(D) Silurian

Q27. The finely laminated, dome-shaped structures sketched below are among the oldest evidence of life on Earth. They are built up layer by layer by the trapping and binding of sediment by mats of: [2 marks]



stromatolite laminae

(A) Cyanobacteria (microbial mats)

(B) Reef-building corals

(C) Trilobites

(D) Planktonic foraminifera

Q28. Ammonoids, the coiled, chambered cephalopods that are among the finest index fossils of the Mesozoic, flourished for over 300 million years before dying out completely. Their final extinction came at the end of the: [2 marks]

(A) Permian Period

(B) Triassic Period

(C) Jurassic Period

(D) Cretaceous Period

Q29. Eldredge and Gould proposed an evolutionary model in which species stay morphologically almost unchanged (in stasis) for long intervals, broken by geologically brief bursts of rapid change at speciation. This model is called: [2 marks]

(A) Phyletic gradualism

(B) Punctuated equilibrium

(C) Catastrophism

(D) Uniformitarianism

Q30. The characteristic tongue-shaped fossil leaf that dominates the Permian coal-bearing Gondwana sequences of peninsular India, and whose distribution helped confirm continental drift, belongs to the: **[2 marks]**

(A) *Ptilophyllum* flora

(B) *Rhaetavicula* fauna

(C) *Lepidodendron* flora

(D) *Glossopteris* flora

Economic Geology and Mineral Resources

Q31. The single most important ore mineral of copper worldwide is a brassy-yellow copper–iron sulphide with the formula $CuFeS_2$. That mineral is: **[2 marks]**

(A) Galena

(B) Chalcopyrite

(C) Sphalerite

(D) Pyrite

Q32. The principal ore mineral of zinc is a sulphide of composition ZnS, showing resinous lustre and six directions of cleavage. This mineral is: **[2 marks]**

(A) Sphalerite

(B) Galena

(C) Cassiterite

(D) Cinnabar

Q33. The chief ore mineral of lead is a lead sulphide (PbS) with very high specific gravity (about 7.5), bright metallic lustre and perfect cubic cleavage. That mineral is: **[2 marks]**

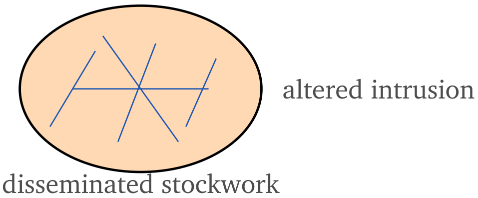
(A) Galena

(B) Sphalerite

(C) Chalcopyrite

(D) Bauxite

Q34. The deposit sketched below is a large, low-grade body of disseminated copper (with minor molybdenum) hosted in a fractured, hydrothermally altered felsic intrusion, mined in bulk by open pit. This class of deposit is called a: **[2 marks]**



(A) Placer deposit

(B) Porphyry copper deposit

(C) Evaporite deposit

(D) Banded iron formation

Q35. Many gold and silver ore shoots occur as veins in which the metals were carried in hot, chemically active aqueous fluids and precipitated as the fluids cooled and reacted along fractures in the wall rock. Such deposits are classed as: **[2 marks]**

(A) Placer deposits

(B) Residual (laterite) deposits

(C) Hydrothermal vein deposits

(D) Magmatic segregation deposits

Q36. Volcanogenic massive sulphide (VMS) deposits, rich in zinc, copper and lead, form as metal-laden fluids vent onto the sea floor and precipitate sulphides at and around the vents. They are therefore associated with: **[2 marks]**

(A) Evaporation of a desert lake

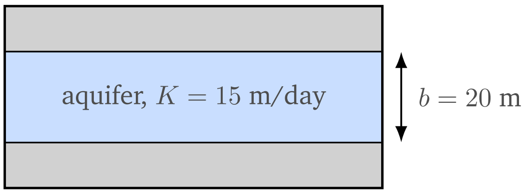
(B) Submarine volcanic exhalation (sea-floor "black smokers")

(C) Concentration in river-channel gravels

(D) Deep tropical weathering of granite

Hydrogeology and Engineering Geology

Q37. The confined aquifer shown is 20 m thick and has a hydraulic conductivity $K = 15$ m/day. Its transmissivity, defined as $T = K\,b$ where b is the saturated thickness, is: **[2 marks]**



(A) 35 m^2/day

(B) 0.75 m^2/day

(C) 150 m^2/day

(D) 300 m^2/day

Q38. In the analysis of a pumping test on a confined aquifer, the storage coefficient (storativity), which is dimensionless, characteristically falls within the range: **[2 marks]**

(A) 0.1 to 0.3

(B) 10^{-5} to 10^{-3}

(C) 1 to 10

(D) 0.5 to 0.9

Q39. Groundwater moves through a clean sand of porosity 0.25 with a Darcy (specific discharge) velocity of 0.5 m/day. The actual average velocity of the water in the pores (the seepage or linear velocity) equals the Darcy velocity divided by the porosity, and is: **[2 marks]**

(A) 0.125 m/day

(B) 2 m/day

(C) 0.5 m/day

(D) 1 m/day

Q40. For an unconfined aquifer, the property called specific yield is best defined as the: **[2 marks]**

(A) Volume of water that drains freely under gravity per unit bulk volume of aquifer

(B) Total porosity of the aquifer material

(C) Volume of water retained against gravity by surface tension

(D) Rate at which water flows under a unit gradient

Q41. During a pumping test a well is pumped at a steady rate of 600 m^3/day and the water level in the well stabilises at a drawdown of 5 m. The specific capacity of the well, defined as discharge per unit drawdown Q/s, is: **[2 marks]**

(A) 120 m^2/day

(B) 3000 m^2/day

(C) 0.0083 day

(D) 5 m

Geochemistry, Geomorphology and Remote Sensing

Q42. The deepest chemical weathering and the thickest residual (lateritic) soils on Earth develop where both temperature and rainfall are consistently high the year round. That climate is best described as: **[2 marks]**

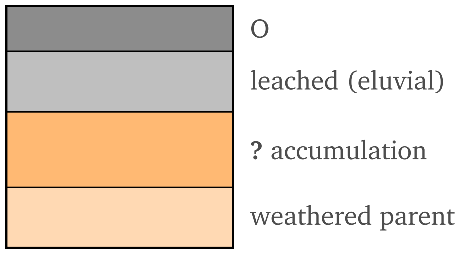
(A) Cold and dry (polar)

(B) Cool temperate

(C) Hot and humid (tropical)

(D) Hot and arid (desert)

Q43. In the idealised soil profile shown, the horizon marked in the middle is the zone of accumulation (illuviation), where clays and iron oxides washed down from above are re-deposited. In standard soil-horizon notation this is the: [2 marks]



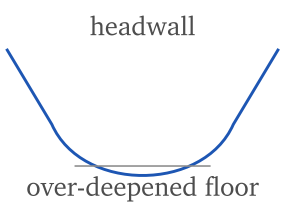
(A) A horizon

(B) B horizon

(C) C horizon

(D) O horizon

Q44. The steep-walled, amphitheatre-shaped hollow sketched below is carved into a mountainside at the head of a former glacier by frost shattering and glacial plucking. This erosional glacial landform is a: [2 marks]



(A) Delta

(B) River meander

(C) Cirque

(D) Alluvial fan

Q45. The Chemical Index of Alteration (CIA), a widely used geochemical measure of the degree of silicate weathering, increases as weathering proceeds because it tracks the progressive loss of the more soluble oxides relative to Al_2O_3. The oxides whose loss the CIA principally records are those of the: **[2 marks]**

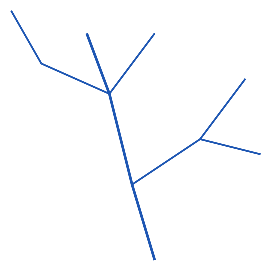
(A) Silica (SiO_2)

(B) Iron (Fe_2O_3)

(C) Mobile cations calcium, sodium and potassium

(D) Aluminium (Al_2O_3)

Q46. The drainage network shown, in which tributaries join the main channels at acute angles to form an irregular, tree-like branching pattern, develops on rocks of uniform resistance with no strong structural control. This drainage pattern is: **[2 marks]**



(A) Trellis

(B) Radial

(C) Rectangular

(D) Dendritic

Detailed Solutions

Q1.

Solution

Concept – point groups (crystal classes): A crystal class is a self-consistent combination of the point-symmetry elements that leave at least one point fixed: rotation axes, mirror planes, a centre of symmetry, and rotoinversion (inversion) axes.

Step 1 – list the allowed operations: Because of the lattice, only 1-, 2-, 3-, 4- and 6-fold rotations are permitted (a five-fold axis cannot fill space).

Step 2 – combine them consistently: When these axes are combined with mirror planes and inversion in all ways that are internally consistent, a fixed, finite number of distinct classes results.

Step 3 – state the total: That number is 32; these are the 32 crystallographic point groups (crystal classes), distributed among the 7 crystal systems.

Why the other options are wrong:

- A, 14: is the number of Bravais lattices.
- C, 7: is the number of crystal systems.
- D, 230: is the number of space groups (point symmetry plus translations).

Final Answer: 32 crystal classes $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept – crystal systems from axial ratios and angles: Each system is fixed by the relative lengths of the three crystallographic axes and the angles between them.

Step 1 – read the angle condition: All three axes are mutually perpendicular, $\alpha = \beta = \gamma = 90°$.

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

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

Why the other options are wrong:

- A, isometric: needs all three axes equal, $a = b = c$.
- B, orthorhombic: needs all three axes unequal, $a \neq b \neq c$.
- C, hexagonal: uses four axes with $120°$ between the horizontal ones.

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

Answer: (D) Go Back to Q2

Q3.

Solution

Concept – diagnostic symmetry of the cubic system: Every crystal system has a minimum, defining symmetry; for the isometric (cubic) system it is a specific set of three-fold axes, not the four-fold axes.

Step 1 – locate the three-fold axes: The three-fold axes of a cube run along its body diagonals, from one corner to the opposite corner.

Step 2 – count the body diagonals: A cube has 8 corners forming 4 pairs of opposite corners, hence 4 body diagonals.

Step 3 – conclude: Each body diagonal is a three-fold rotation axis, so the cube has four three-fold axes. Their presence is the hallmark of the cubic system.

Why the other options are wrong:

- B, three: is the number of four-fold axes (through face centres), not the three-fold axes.
- C, six: is the number of two-fold axes (through edge midpoints).
- D, two: does not correspond to any cube axis set.

Final Answer: Four three-fold axes $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept – Miller indices: Miller indices (hkl) describe a crystal face by the reciprocals of its axial intercepts, cleared of fractions.

Step 1 – write the intercepts: The face cuts the axes at $1a$, $1b$, $1c$.

Step 2 – take reciprocals: $\frac{1}{1}, \frac{1}{1}, \frac{1}{1} = 1, 1, 1.$

Step 3 – clear fractions: The values are already whole numbers, so no clearing is needed.

Step 4 – write the index: Enclosing in parentheses gives (111).

Why the other options are wrong:

- A, (100): a face parallel to b and c (intercepts $1, \infty, \infty$).
- B, (110): a face parallel to c (intercepts $1, 1, \infty$).
- D, (011): a face parallel to a (intercepts $\infty, 1, 1$).

Final Answer: $(111) \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q4

Q5.

Solution

Concept – interference figures in convergent light: An interference figure reveals whether an anisotropic mineral has one optic axis (uniaxial) or two (biaxial).

Step 1 – read the figure: A single, centred black cross (isogyres) that stays intact and does not separate into two curved brushes when the stage is rotated.

Step 2 – interpret it: A cross that does not break up is the optic-axis figure of a mineral with only one optic axis.

Step 3 – classify: A mineral with a single optic axis is uniaxial (tetragonal, trigonal or hexagonal crystals).

Why the other options are wrong:

- A and C, isotropic and amorphous: give no interference figure at all (they stay dark).
- B, biaxial: shows a cross that breaks into two curved isogyres on rotation.

Final Answer: Uniaxial mineral $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q5

Q6.

Solution

Concept – symmetry operations: Each symmetry element performs a specific geometric operation that maps the crystal onto itself.

Step 1 – read the operation: A point (x, y, z) is carried to $(-x, -y, -z)$; every coordinate simply changes sign.

Step 2 – interpret the sign change: Reversing all three coordinates is inversion through a single central point.

Step 3 – name the element: Inversion through one point is the centre of symmetry (also called the inversion centre, symbol $\bar{1}$).

Why the other options are wrong:

- A, mirror plane: reflects and changes the sign of only one coordinate.
- C, rotation axis: turns points about a line and involves no inversion.
- D, glide plane: combines a reflection with a translation, not a pure inversion.

Final Answer: Centre of symmetry $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept – igneous textures record cooling history: Grain-size relationships in an igneous rock reflect how many stages of cooling the magma passed through.

Step 1 – read the fabric: Large, well-shaped crystals (phenocrysts) sit in a distinctly finer groundmass.

Step 2 – interpret the two grain sizes: The large crystals grew slowly at depth; the fine groundmass froze quickly after the magma rose, so there were two cooling stages.

Step 3 – name the texture: Two contrasting grain sizes in one rock define a porphyritic texture.

Why the other options are wrong:

- B, aphanitic: uniformly fine, no visible phenocrysts.
- C, glassy: no crystals at all.
- D, equigranular: all crystals about the same size.

Final Answer: Porphyritic texture $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q7

Q8.

Solution

Concept – glassy (hyaline) texture: When cooling is so fast that atoms cannot organise into a crystal lattice, the melt freezes as a glass.

Step 1 – read the clues: Silica-rich lava, extremely rapid quenching, no crystals, smooth dark glass with conchoidal fracture.

Step 2 – match to a rock: A silica-rich volcanic glass with conchoidal fracture is obsidian.

Step 3 – confirm: The lack of crystals (glassy texture) rules out any coarse, crystalline plutonic rock.

Why the other options are wrong:

- B, granite: coarse, fully crystalline, slow deep cooling.
- C, gabbro: coarse, crystalline, mafic plutonic rock.
- D, diorite: coarse, crystalline, intermediate plutonic rock.

Final Answer: Obsidian (glassy texture) $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q8

Q9.

Solution

Concept – volcanic and plutonic equivalents: Rocks of identical chemistry get different names depending on grain size: fine-grained volcanic versus coarse-grained plutonic.

Step 1 – identify the chemistry: Basalt is a basic (mafic) volcanic rock.

Step 2 – find the coarse equivalent: The coarse-grained plutonic rock of the same mafic composition is gabbro.

Step 3 – confirm the pairing: Basalt (extrusive) $\leftrightarrow$ gabbro (intrusive) is the standard mafic pair, just as rhyolite $\leftrightarrow$ granite is the felsic pair.

Why the other options are wrong:

- A, rhyolite: felsic volcanic rock, not the equivalent of basalt.
- B, andesite: intermediate volcanic rock.

- D, granite: felsic plutonic rock (pairs with rhyolite).

Final Answer: Gabbro $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q9

Q10.

Solution

Concept – contact (thermal) metamorphism: Next to a hot intrusion the country rock is altered by heat alone, at low pressure and without directed stress.

Step 1 – read the conditions: Baking within a narrow aureole, heat-dominated, low pressure, no directed stress.

Step 2 – predict the fabric: With no directed stress the new minerals grow with no preferred orientation, so the rock is non-foliated and typically fine and very hard.

Step 3 – name the rock: The characteristic tough, fine, non-foliated product of contact metamorphism is hornfels.

Why the other options are wrong:

- B and C, schist and gneiss: are foliated products of regional metamorphism under directed stress.
- D, slate: is a foliated low-grade regional rock, not a contact rock.

Final Answer: Hornfels $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q10

Q11.

Solution

Concept – the Al_2SiO_5 polymorphs: Andalusite, sillimanite and kyanite share the formula Al_2SiO_5 but are stable in different pressure–temperature fields, so they are excellent index minerals.

Step 1 – read the diagram: The field lying at the top (high pressure) of the P–T grid is the one asked for.

Step 2 – assign the fields: Kyanite occupies the high-pressure field; andalusite the low-pressure, low-temperature field; sillimanite the high-temperature field.

Step 3 – conclude: The high-pressure polymorph, diagnostic of high-pressure (for example Barrovian) metamorphism, is kyanite.

Why the other options are wrong:

- A, andalusite: low-pressure polymorph (contact settings).
- B, sillimanite: high-temperature polymorph.
- D, quartz: not an Al_2SiO_5 polymorph at all.

Final Answer: Kyanite $\Rightarrow \boxed{C}$

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

Q12.

Solution

Concept – textures from trapped volcanic gas: As lava rises and pressure drops, dissolved gas comes out of solution and forms bubbles that may be frozen into the rock.

Step 1 – read the fabric: Numerous small rounded cavities that were once gas bubbles.

Step 2 – name the texture: A rock preserving these empty bubble holes has a vesicular texture (the holes are vesicles).

Step 3 – note the sequel: If later minerals fill the vesicles, they become amygdales and the texture is called amygdaloidal.

Why the other options are wrong:

- A, porphyritic: two crystal sizes, not gas holes.
- B, poikilitic: small crystals enclosed within a larger host crystal.
- D, ophitic: laths of plagioclase enclosed in pyroxene, a crystalline intergrowth, not cavities.

Final Answer: Vesicular texture $\Rightarrow \boxed{C}$

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

Q13.

Solution

Concept – ripple symmetry records the flow regime: The profile shape of a ripple tells whether the water moved back and forth or in one direction.

Step 1 – read the profile: The ripples are asymmetric: a gentle slope on the up-current side and a steep slope on the down-current side.

Step 2 – interpret the asymmetry: Asymmetry develops when flow is stronger in one direction, pushing sediment up the gentle side and dumping it on the steep lee side.

Step 3 – conclude: Asymmetric (current) ripples therefore record a one-way, unidirectional current, such as a river or tidal-dominated flow.

Why the other options are wrong:

- A, wave oscillation: produces symmetrical ripples with sharp crests.
- C, no movement: would leave a flat, unrippled bed.
- D, wind deflation: is an erosional process, not the cause of these depositional ripples.

Final Answer: A one-way current $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q13

Q14.

Solution

Concept – graded bedding: A single bed that grades from coarse at the base to fine at the top records a flow whose carrying power fell steadily during deposition.

Step 1 – read the bed: Coarse sand at the base passes upward continuously into fine sand and silt at the top.

Step 2 – interpret the fining-up: As a sediment-laden flow slows, the largest grains settle first and progressively finer grains settle later, giving an upward decrease in grain size.

Step 3 – identify the agent: A waning turbidity current (a submarine density flow) is the classic producer of graded beds, forming Bouma sequences in turbidites.

Why the other options are wrong:

- A, steady wind: gives well-sorted dune cross-beds, not a single graded bed.

- B, glacial plucking: yields unsorted till, not graded bedding.
- D, chemical precipitation: builds crystalline or laminated chemical rocks, not size-graded clastic beds.

Final Answer: A waning turbidity current $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q14

Q15.

Solution

Concept – cross-bedding as a palaeocurrent indicator: The inclined foreset laminae of a cross-bed are deposited on the downstream (lee) face of a migrating dune or ripple.

Step 1 – read the geometry: The foresets dip consistently toward the right.

Step 2 – link dip to flow: Because sediment avalanches down the lee face in the direction the current is moving, the foresets dip in the down-current direction.

Step 3 – conclude: The direction of foreset dip therefore records the down-current (palaeoflow) direction of the ancient current.

Why the other options are wrong:

- A, up-current: is the opposite of the true sense.
- B, perpendicular: describes the crest orientation, not the flow.
- C, vertical settling: would leave flat laminae, not inclined foresets.

Final Answer: The down-current palaeoflow direction $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q15

Q16.

Solution

Concept – desiccation (mud) cracks: Polygonal cracks that taper downward form when wet, clay-rich mud loses water and shrinks.

Step 1 – read the structure: A network of polygons bounded by cracks that narrow downward into the bed.

Step 2 – interpret the shrinkage: Drying removes pore water, the mud contracts, and tension opens the cracks at the surface.

Step 3 – infer the setting: Drying requires the mud to be exposed to the air, so the environment saw subaerial exposure (for example a mudflat, floodplain or drying lake margin).

Why the other options are wrong:

- A, deep marine burial: keeps sediment permanently wet, so no drying cracks form.
- C, rapid deep-water deposition: gives no chance for subaerial drying.
- D, contact with hot lava: bakes and hardens sediment but does not make shrinkage polygons of this kind.

Final Answer: Subaerial exposure and drying $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q16

Q17.

Solution

Concept – textural and compositional maturity: Maturity measures how far transport and reworking have driven a sediment toward well-rounded, well-sorted, chemically stable grains.

Step 1 – read the texture: Grains are well rounded and well sorted, with almost no clay matrix; this is textural maturity.

Step 2 – read the composition: The rock is almost pure quartz, with little feldspar or lithic material; unstable grains have been eliminated, so it is compositionally mature.

Step 3 – classify: A clean, well-sorted, rounded, quartz-dominated sandstone is a mature quartz arenite.

Why the other options are wrong:

- A, immature: would be poorly sorted, angular and clay-rich.
- B, volcaniclastic: implies abundant volcanic fragments, not pure quartz.
- C, poorly sorted and angular: is the opposite of the described texture.

Final Answer: Mature quartz arenite $\Rightarrow \boxed{\text{D}}$

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 original lateral arrangement.

Step 1 – state the law: Only facies that were deposited beside one another (in laterally adjacent environments) can be found superimposed in a conformable vertical succession.

Step 2 – explain the mechanism: As depositional environments migrate laterally over time, their deposits come to lie one above the other, so a vertical section reproduces the original side-by-side belts.

Step 3 – apply the condition: The law holds only where the succession is conformable, that is, with no depositional break; an unconformity breaks the relationship.

Why the other options are wrong:

- A, only across unconformities: is the exact situation where Walther's Law does not apply.
- C, random order: contradicts the ordered lateral-to-vertical link.
- D, simultaneous everywhere: describes a single time plane, not a facies succession.

Final Answer: Laterally adjacent in the depositional environment $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept – Anderson's theory of faulting: Because the Earth's surface is a free surface, one principal stress must be vertical; which one determines the fault type.

Step 1 – read the regime: The setting is extensional, producing normal faults.

Step 2 – assign the stresses: For normal faulting the greatest principal stress σ_1 is vertical, while the least stress σ_3 is horizontal (the direction of stretching).

Step 3 – conclude: Therefore σ_1 is oriented vertically, and slip occurs on planes dipping about $60°$.

Why the other options are wrong:

- B and C, horizontal σ_1: correspond to thrust (σ_1 horizontal, σ_3 vertical) or

strike-slip regimes, not normal faulting.
- D, inclined $45°$: principal stresses are not fixed at that angle here; σ_1 is vertical.

Final Answer: σ_1 is vertical $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q19

Q20.

Solution

Concept – classifying dip-slip faults: The sense of hanging-wall movement and the dip of the fault plane define whether a fault is normal, reverse or thrust.

Step 1 – read the movement: The hanging wall has moved up relative to the footwall, which is reverse motion.

Step 2 – read the dip: The fault plane is gently inclined, with a dip well below $45°$.

Step 3 – read the stress: The driving stress is horizontal compression (shortening).

Step 4 – classify: A low-angle reverse fault produced by compression is a thrust fault.

Why the other options are wrong:

- A, normal fault: hanging wall moves down, under extension.
- B, strike-slip fault: horizontal movement, no up/down separation.
- C, extensional graben: a down-dropped block between normal faults, again extensional.

Final Answer: Thrust (low-angle reverse) fault $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept – relating net slip to throw: For dip-slip movement, the vertical throw is the vertical component of the net slip along the fault plane.

Step 1 – write the relation: $\text{throw} = \text{net slip} \times \sin(\text{dip})$.

Step 2 – substitute the values: $\text{throw} = 20 \text{ m} \times \sin 60°$.

Step 3 – insert $\sin 60°$: $\sin 60° = 0.866$, so throw $= 20 \times 0.866$.

Step 4 – compute: $20 \times 0.866 = 17.32$ m ≈ 17.3 m.

Why the other options are wrong:

- B, 10.0 m: would use $\sin 30° = 0.5$, the wrong angle.
- C, 20.0 m: is the full net slip, ignoring the sine factor.
- D, 11.5 m: does not follow from the given numbers.

Final Answer: 17.3 m $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept – convergent plate boundaries: Convergence can be ocean–ocean, ocean–continent (both give subduction) or continent–continent (collision).

Step 1 – read the crust involved: Two thick continental plates are converging.

Step 2 – apply buoyancy: Continental crust is too buoyant (low density) to sink into the mantle, so neither plate subducts fully.

Step 3 – read the result: Instead the crust crumples and thickens into a high mountain belt, as in the Himalaya from the India–Asia collision.

Step 4 – name the boundary: This is a continent–continent collision boundary.

Why the other options are wrong:

- A, divergent: plates move apart and create new crust, the opposite of collision.
- B, transform: plates slide past horizontally, building no mountain belt.
- C, ocean–ocean subduction: involves dense oceanic crust sinking, forming island arcs, not a continental collision belt.

Final Answer: Continent–continent collision boundary $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q22

Q23.

Solution

Concept – compressive stress: Stress is force per unit area, $\sigma = F/A$, and must be evaluated in consistent SI units.

Step 1 – list the data: $F = 90$ kN $= 90{,}000$ N and $A = 30$ cm^2.

Step 2 – convert the area: 1 cm$^2 = 10^{-4}$ m^2, so $A = 30 \times 10^{-4}$ m$^2 = 3 \times 10^{-3}$ m^2.

Step 3 – apply the formula: $\sigma = \dfrac{F}{A} = \dfrac{90{,}000}{3 \times 10^{-3}}$.

Step 4 – compute: $\sigma = 3 \times 10^7$ Pa.

Step 5 – convert to MPa: 1 MPa $= 10^6$ Pa, so $\sigma = 30$ MPa.

Why the other options are wrong:

- A, 3 MPa: mishandles the area conversion by a factor of ten.
- B, 300 MPa: overestimates by a factor of ten.
- C, 9 MPa: does not follow from F/A.

Final Answer: 30 MPa $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q23

Q24.

Solution

Concept – transform faults: A transform fault is a conservative plate boundary where plates slide past each other and crust is neither created nor destroyed.

Step 1 – read the setting: The fault links two offset ridge segments; the active part lies between the two ridge tips.

Step 2 – determine the motion: Because the ridges on either side are spreading, the two plates move in opposite directions along the fault, so the motion is horizontal and directed along the fault trace.

Step 3 – conclude: The relative plate motion on the active segment is horizontal and parallel to the fault.

Why the other options are wrong:

- A, purely vertical: describes dip-slip faults, not a transform.
- B, perpendicular to the fault: would open or close the boundary, which a transform does not do.
- D, zero motion: contradicts the active shearing that defines the boundary.

Final Answer: Horizontal and parallel to the fault $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q24

Q25.

Solution

Concept – the "Big Five" mass extinctions: Earth's Phanerozoic record shows five great extinction events, of which one was by far the most severe.

Step 1 – read the severity: About 90% of marine species vanished; this is the largest known biodiversity crash.

Step 2 – match to an event: The most severe extinction, sometimes called "the Great Dying," occurred at the Permian–Triassic boundary, that is, the end of the Permian.

Step 3 – confirm: It closed the Palaeozoic Era and reset marine ecosystems, ushering in the Mesozoic.

Why the other options are wrong:

- B, end-Cretaceous: killed the non-avian dinosaurs but was less severe for marine species overall.
- C, end-Ordovician: was a major event but smaller than the end-Permian.
- D, end-Triassic: cleared niches for dinosaurs but was again less severe.

Final Answer: End-Permian $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept – the base of the Phanerozoic: The Phanerozoic Eon ("visible life") begins with the first widespread appearance of animals with hard, preservable skeletons.

Step 1 – read the marker: A sudden radiation of abundant shelly, skeletonised animals in the fossil record.

Step 2 – name the event: This rapid diversification is the Cambrian explosion.

Step 3 – place the boundary: It defines the base of the Cambrian, the first period of the Palaeozoic Era.

Why the other options are wrong:

- A, Ordovician: follows the Cambrian and hosts a later radiation, not the base of the Phanerozoic.
- B, Devonian: much younger (the "Age of Fishes").
- D, Silurian: younger still, after the Ordovician.

Final Answer: Cambrian $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q26

Q27.

Solution

Concept – stromatolites and early life: Stromatolites are laminated, often domed structures built where microbial mats trap and bind sediment layer upon layer.

Step 1 – read the description: Finely laminated, dome-shaped, built up by trapping and binding of sediment by mats.

Step 2 – identify the mat-builders: The mats are made chiefly of photosynthetic cyanobacteria (blue-green bacteria).

Step 3 – note the significance: Such structures are among the oldest evidence of life, dating back over 3 billion years, and their oxygen-producing metabolism helped oxygenate the early atmosphere.

Why the other options are wrong:

- B, corals: are much younger reef metazoans, not the builders of ancient stromatolites.
- C, trilobites: are Palaeozoic arthropods, not mat-forming microbes.
- D, foraminifera: are single-celled protists, not the layered-mat builders here.

Final Answer: Cyanobacteria (microbial mats) $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q27

Q28.

Solution

Concept – range of the ammonoids: Ammonoids are coiled cephalopods that evolved rapidly and so make superb zone (index) fossils.

Step 1 – recall their history: Ammonoids first appeared in the Devonian and diversified through the Mesozoic.

Step 2 – locate their extinction: They were finally wiped out in the end-Cretaceous mass extinction, the same event that ended the non-avian dinosaurs.

Step 3 – conclude: Their final extinction came at the end of the Cretaceous Period.

Why the other options are wrong:

- A, Permian: ammonoids were sharply reduced then but survived into the Mesozoic.
- B, Triassic: another crisis they passed through, not their final end.
- C, Jurassic: ammonoids flourished, so this is not their extinction.

Final Answer: Cretaceous Period $\Rightarrow \boxed{\text{D}}$

$\boxed{\text{Answer: (D)}}$ Go Back to Q28

Q29.

Solution

Concept – modes of evolutionary change: Two contrasting tempos of evolution are debated: slow continuous change and long stasis broken by rapid bursts.

Step 1 – read the model: Species stay nearly unchanged (in stasis) for long periods, interrupted by short, rapid episodes of change at speciation.

Step 2 – name it: This "stasis plus rapid bursts" model, proposed by Eldredge and Gould, is punctuated equilibrium.

Step 3 – contrast: It is the alternative to phyletic gradualism, which envisages slow, steady, continuous change.

Why the other options are wrong:

- A, phyletic gradualism: the opposite model, of slow continuous change.
- C, catastrophism: a view of Earth history dominated by sudden catastrophes, not a speciation model.
- D, uniformitarianism: the principle that present processes explain the past, not an evolutionary tempo.

Final Answer: Punctuated equilibrium ⇒ $\boxed{\text{B}}$

Answer: (B) Go Back to Q29

Q30.

Solution

Concept – the Gondwana flora of India: The Permian Gondwana sequences of peninsular India carry a distinctive fossil flora that also provided key evidence for continental drift.

Step 1 – read the clues: Tongue-shaped fossil leaves dominating Permian coal-bearing beds, with a distribution spanning the southern continents.

Step 2 – name the flora: These are the leaves of *Glossopteris*, the index plant of the Gondwana coal measures.

Step 3 – note the significance: Finding the same *Glossopteris* flora across India, Africa, South America, Antarctica and Australia supported the reconstruction of Gondwanaland.

Why the other options are wrong:

- A, *Ptilophyllum*: a Jurassic (Mesozoic) plant, younger than the Permian Gondwana coals.
- B, *Rhaetavicula*: a bivalve, not a plant.
- C, *Lepidodendron*: a giant clubmoss typical of the Northern Hemisphere Carboniferous coal forests, not the Gondwana index flora.

Final Answer: *Glossopteris* flora ⇒ $\boxed{\text{D}}$

Answer: (D) Go Back to Q30

Q31.

Solution

Concept – ore minerals of copper: Copper is won mainly from sulphide minerals, of which one is by far the most important globally.

Step 1 – read the clues: Brassy-yellow colour, copper–iron sulphide, formula $CuFeS_2$.

Step 2 – identify the mineral: $CuFeS_2$ is chalcopyrite, the principal ore of copper.

Step 3 – confirm: Chalcopyrite is the dominant copper mineral in porphyry and many vein and massive-sulphide deposits.

Why the other options are wrong:

- A, galena: is PbS, the ore of lead.
- C, sphalerite: is ZnS, the ore of zinc.
- D, pyrite: is FeS_2 ("fool's gold"), an iron sulphide, not a copper ore.

Final Answer: Chalcopyrite $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q31

Q32.

Solution

Concept – ore minerals of zinc: Zinc is extracted chiefly from a single sulphide mineral.

Step 1 – read the clues: Zinc sulphide, formula ZnS, resinous lustre, six cleavage directions.

Step 2 – identify the mineral: ZnS with six-directional (dodecahedral) cleavage is sphalerite, the chief ore of zinc.

Step 3 – confirm: Sphalerite commonly occurs with galena in hydrothermal and sedimentary-exhalative Pb–Zn deposits.

Why the other options are wrong:

- B, galena: is PbS, the lead ore.
- C, cassiterite: is SnO_2, the ore of tin.
- D, cinnabar: is HgS, the ore of mercury.

Final Answer: Sphalerite $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q32

Q33.

Solution

Concept – ore minerals of lead: Lead is obtained mainly from one heavy sulphide mineral with distinctive cleavage.

Step 1 – read the clues: Lead sulphide PbS, very high specific gravity (≈ 7.5), metallic lustre, perfect cubic cleavage.

Step 2 – identify the mineral: PbS with cubic cleavage and high density is galena, the principal ore of lead.

Step 3 – confirm: Galena's silvery cubes and heaviness make it easy to recognise; it often carries silver as a valuable by-product.

Why the other options are wrong:

- B, sphalerite: is ZnS, the zinc ore.
- C, chalcopyrite: is $CuFeS_2$, the copper ore.
- D, bauxite: is a hydrated aluminium oxide ore, not a lead sulphide.

Final Answer: Galena $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q33

Q34.

Solution

Concept – porphyry deposits: Porphyry deposits are huge, low-grade bodies of disseminated sulphides formed in and around shallow felsic-to-intermediate intrusions.

Step 1 – read the description: Large, low-grade, disseminated copper (with minor molybdenum), hosted in a fractured, hydrothermally altered felsic intrusion, mined in bulk by open pit.

Step 2 – match the deposit type: These features define a porphyry copper deposit, in which copper is spread through a stockwork of tiny veinlets.

Step 3 – confirm: Porphyry systems are the world's leading source of copper and molybdenum precisely because their vast tonnage offsets low grades.

Why the other options are wrong:

- A, placer: forms by mechanical concentration in sediments, not disseminated in an intrusion.
- C, evaporite: forms by evaporation of saline water, unrelated to copper sulphides.
- D, banded iron formation: is a chemically precipitated iron ore, not a copper stockwork.

Final Answer: Porphyry copper deposit $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q34

Q35.

Solution

Concept – hydrothermal ore deposits: Many metal deposits form where hot, aqueous fluids carry dissolved metals and precipitate them in fractures.

Step 1 – read the process: Gold and silver carried in hot aqueous fluids and precipitated as the fluids cooled and reacted along fractures in the wall rock.

Step 2 – classify: Ore emplaced from hot water along fractures forms hydrothermal vein deposits.

Step 3 – confirm: Classic lode-gold and epithermal silver ore shoots are hydrothermal veins of exactly this kind.

Why the other options are wrong:

- A, placer: mechanical concentration of heavy grains in sediment, not fluid precipitation in veins.
- B, residual (laterite): concentration by intense weathering, for example of aluminium or nickel.
- D, magmatic segregation: separation of ore minerals within a cooling magma, not from aqueous fluids in fractures.

Final Answer: Hydrothermal vein deposits $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q35

Q36.

Solution

Concept – volcanogenic massive sulphide (VMS) deposits: VMS deposits are stratabound sulphide bodies formed on or just below the sea floor at submarine volcanic centres.

Step 1 – read the setting: Metal-laden fluids vent onto the sea floor and precipitate zinc–copper–lead sulphides at and around the vents.

Step 2 – identify the mechanism: Hot, metal-rich fluids discharging at sea-floor hydrothermal vents ("black smokers") precipitate sulphides on contact with cold seawater.

Step 3 – conclude: VMS deposits are therefore associated with submarine volcanic exhalation.

Why the other options are wrong:

- A, desert evaporation: forms evaporite salts, not sea-floor sulphides.
- C, river-channel gravels: form placers, not massive sulphides.
- D, deep tropical weathering: forms residual (laterite) deposits, not vent-related sulphides.

Final Answer: Submarine volcanic exhalation (black smokers) $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q36

Q37.

Solution

Concept – transmissivity of an aquifer: Transmissivity T measures how much water an aquifer of full saturated thickness can transmit, and equals conductivity times thickness.

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

Step 2 – list the values: $K = 15$ m/day and $b = 20$ m.

Step 3 – substitute: $T = 15$ m/day $\times$ 20 m.

Step 4 – compute: $T = 300$ m^2/day.

Why the other options are wrong:

- A, 35 m^2/day: adds K and b instead of multiplying.
- B, 0.75 m^2/day: divides K by b, which is dimensionally wrong.
- C, 150 m^2/day: is only half the correct product.

Final Answer: 300 m^2/day $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q37

Q38.

Solution

Concept – storativity of a confined aquifer: The storage coefficient (storativity) S is the volume of water released from storage per unit surface area per unit head decline; it is dimensionless.

Step 1 – recall the mechanism: In a confined aquifer water is released only by slight expansion of water and compression of the aquifer skeleton, not by dewatering pores.

Step 2 – estimate the magnitude: Because these elastic effects are tiny, S is very small, typically between 10^{-5} and 10^{-3}.

Step 3 – conclude: The characteristic confined-aquifer storativity range is 10^{-5} to 10^{-3}.

Why the other options are wrong:

- A, 0.1 to 0.3: is the range of specific yield for unconfined aquifers, which drain their pores.
- C, 1 to 10: exceeds unity, impossible for a storage coefficient.
- D, 0.5 to 0.9: far too large for a confined aquifer.

Final Answer: 10^{-5} to 10^{-3} $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q38

Q39.

Solution

Concept – Darcy velocity versus seepage velocity: The Darcy (specific discharge) velocity is spread over the whole cross-section, but water actually moves only through the pores, so the true pore velocity is higher.

Step 1 – write the relation: $v_{\text{seepage}} = \dfrac{v_{\text{Darcy}}}{n}$, where n is porosity.

Step 2 – list the values: $v_{\text{Darcy}} = 0.5$ m/day and $n = 0.25$.

Step 3 – substitute: $v_{\text{seepage}} = \dfrac{0.5}{0.25}$.

Step 4 – compute: $v_{\text{seepage}} = 2$ m/day.

Why the other options are wrong:

- A, 0.125 m/day: multiplies by porosity instead of dividing.
- C, 0.5 m/day: is the Darcy velocity, not corrected for porosity.
- D, 1 m/day: does not follow from dividing 0.5 by 0.25.

Final Answer: 2 m/day $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q39

Q40.

Solution

Concept – specific yield and specific retention: Total porosity splits into water that drains freely (specific yield) and water held back by surface tension (specific retention).

Step 1 – read what is asked: The definition of specific yield for an unconfined aquifer.

Step 2 – state it: Specific yield is the volume of water that drains out under gravity per unit bulk volume of the aquifer.

Step 3 – relate to porosity: Porosity $=$ specific yield $+$ specific retention, so specific yield is always less than the total porosity.

Why the other options are wrong:

- B, total porosity: includes water that will not drain, so it overstates the yield.
- C, water retained against gravity: is specific retention, the complement of specific yield.
- D, flow under a unit gradient: describes hydraulic conductivity, not a storage term.

Final Answer: Volume drained by gravity per unit aquifer volume $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q40

Q41.

Solution

Concept – specific capacity of a well: Specific capacity rates a well's productivity as the pumping rate it sustains for each metre of drawdown.

Step 1 – write the formula: specific capacity $= \dfrac{Q}{s}$, with Q the discharge and s the drawdown.

Step 2 – list the values: $Q = 600\ \text{m}^3/\text{day}$ and $s = 5$ m.

Step 3 – substitute: $\dfrac{Q}{s} = \dfrac{600\ \text{m}^3/\text{day}}{5\ \text{m}}$.

Step 4 – compute: $= 120\ \text{m}^2/\text{day}$.

Why the other options are wrong:

- B, $3000\ \text{m}^2/\text{day}$: multiplies Q by s instead of dividing.
- C, 0.0083 day: inverts the ratio (s/Q).

- D, 5 m: is just the drawdown, not a capacity.

Final Answer: 120 m^2/day $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q41

Q42.

Solution

Concept – climate control on chemical weathering: Chemical weathering runs fastest where reactions are both warm (high temperature) and wet (abundant water).

Step 1 – read the clues: Deepest weathering, thick lateritic soils, high temperature and high rainfall year round.

Step 2 – match the climate: These conditions describe a hot and humid (tropical) climate.

Step 3 – confirm with the product: Intense leaching under such climates removes silica and bases, leaving iron- and aluminium-rich laterite, exactly the residual soil described.

Why the other options are wrong:

- A, cold and dry: little liquid water and slow reactions, so weak chemical weathering.
- B, cool temperate: moderate rates, not the deepest weathering.
- D, hot and arid: hot but water-starved, so chemical weathering is limited and physical weathering dominates.

Final Answer: Hot and humid (tropical) $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q42

Q43.

Solution

Concept – soil horizons: A mature soil profile is layered into horizons labelled O, A, E, B and C from top to bottom, each defined by gains or losses of material.

Step 1 – read the horizon described: The middle zone of accumulation (illuviation), where clays and iron oxides carried down from above are re-deposited.

Step 2 – match the label: The horizon of illuvial accumulation is the B horizon.

Step 3 – contrast with the layer above: The overlying leached zone (from which those materials were removed) is the eluvial A/E horizon, confirming the middle accumulation zone is B.

Why the other options are wrong:

- A, A horizon: is the upper, leached (eluvial) zone, losing material downward.
- C, C horizon: is little-altered weathered parent material below the B.
- D, O horizon: is the surface organic layer of litter and humus.

Final Answer: B horizon $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q43

Q44.

Solution

Concept – glacial erosional landforms: Alpine glaciers sculpt distinctive erosional forms, of which the hollow at a glacier's source is the most characteristic.

Step 1 – read the description: A steep-walled, amphitheatre-shaped hollow at the head of a former glacier, made by frost shattering and plucking.

Step 2 – name the landform: This bowl-shaped erosional hollow is a cirque (also called a corrie or cwm).

Step 3 – confirm: Where three or more cirques cut back to back they leave a sharp peak (a horn), which supports the glacial-erosion interpretation.

Why the other options are wrong:

- A, delta: a depositional fan where a river enters standing water.
- B, river meander: a looping channel bend of a lowland river.
- D, alluvial fan: a depositional cone where a stream leaves a mountain front.

Final Answer: Cirque $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q44

Q45.

Solution

Concept – the Chemical Index of Alteration (CIA): The CIA quantifies weathering by comparing immobile alumina with the mobile oxides that are stripped out during weathering.

Step 1 – recall the formula: $\text{CIA} = \dfrac{Al_2O_3}{Al_2O_3 + CaO^* + Na_2O + K_2O} \times 100$ (in molar proportions, CaO^* being silicate-bound calcium).

Step 2 – see what changes with weathering: As feldspars break down to clays, calcium, sodium and potassium are leached away while Al_2O_3 stays behind.

Step 3 – interpret the index: Loss of these mobile cations makes the denominator shrink toward Al_2O_3, so the CIA rises toward 100.

Step 4 – conclude: The CIA principally records the loss of the mobile cations calcium, sodium and potassium.

Why the other options are wrong:

- A, silica: not part of the standard CIA formula.
- B, iron: excluded from the CIA (used in other indices).
- D, aluminium: is the immobile reference oxide, whose retention (not loss) the index is measured against.

Final Answer: Mobile cations Ca, Na and K $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q45

Q46.

Solution

Concept – drainage patterns and geological control: The plan-view pattern of a river network mirrors the underlying rock type and structure.

Step 1 – read the pattern: Tributaries join the trunk streams at acute angles in an irregular, tree-like branching network.

Step 2 – infer the control: Such random, branching geometry develops where the bedrock is uniformly resistant (or horizontally layered) with no strong structural grain to steer the streams.

Step 3 – name the pattern: This tree-like network is the dendritic drainage pattern.

Why the other options are wrong:

- A, trellis: rectangular network controlled by alternating hard and soft folded strata.
- B, radial: streams flowing outward from a central high such as a volcano or dome.
- C, rectangular: streams meeting at right angles along joints and faults.

Final Answer: Dendritic $\Rightarrow \boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ **Go Back to Q46**

Answer Key

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