IIT JAM 2017 Geology (GG) Question Paper with Solutions

Time Allowed :3 Hours	**Maximum Marks :**100	**Total questions :**60

General Instructions

General Instructions:

i) All questions are compulsory. Marks allotted to each question are indicated in the margin.

ii) Answers must be precise and to the point.

iii) In numerical questions, all steps of calculation should be shown clearly.

iv) Use of non-programmable scientific calculators is permitted.

v) Wherever necessary, write balanced chemical equations with proper symbols and units.

vi) Rough work should be done only in the space provided in the question paper.

1. Which one of the following minerals exhibits luminescence when exposed to ultraviolet light?

(A) Cassiterite

(B) Wolframite

(C) Tantalite

(D) Scheelite

Correct Answer: (D) Scheelite

Solution:

Step 1: Understanding the question.

The question asks about a mineral that exhibits luminescence when exposed to ultraviolet (UV) light. Scheelite is well known for its ability to fluoresce when subjected to UV light, producing a bright blue glow.

Step 2: Analyzing the options.

(A) Cassiterite: Cassiterite is not known for fluorescence under UV light.

(B) Wolframite: Wolframite does not exhibit luminescence under UV light.

(C) Tantalite: Tantalite is not a known fluorescent mineral under UV light.

(D) Scheelite: Correct — Scheelite is known for its fluorescence under UV light, making it the correct choice.

Step 3: Conclusion.

The correct answer is **(D) Scheelite**, as it is the mineral that exhibits luminescence when exposed to UV light.

Quick Tip

When dealing with minerals and their properties, focus on well-known characteristics like fluorescence. Scheelite is a classic example of a mineral that fluoresces under UV light.

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2. In which one of the following mass extinction periods trilobites became extinct?

(A) Devonian

(B) Permian

(C) Triassic

(D) Cretaceous

Correct Answer: (B) Permian

Solution:

Step 1: Understanding the question.

Trilobites were a group of extinct marine arthropods. They became extinct during the late Permian period, marking one of the largest mass extinctions in Earth's history.

Step 2: Analyzing the options.

(A) Devonian: Trilobites did not go extinct in the Devonian period.

(B) Permian: Correct — Trilobites became extinct at the end of the Permian period, during the largest mass extinction event in Earth's history.

(C) Triassic: Trilobites had already become extinct by the time of the Triassic period.

(D) Cretaceous: Trilobites were long extinct by the Cretaceous period.

Step 3: Conclusion.

The correct answer is **(B) Permian**, as trilobites became extinct during the Permian mass extinction event.

Quick Tip

When studying extinct species, remember key extinction events such as the Permian extinction, which was the end of many species, including trilobites.

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3. En-echelon sigmoidal 'gash' veins indicate

(A) ductile shear zone

(B) brittle-ductile shear zone

(C) brittle shear zone

(D) saddle reef structure

Correct Answer: (B) brittle-ductile shear zone

Solution:

Step 1: Understanding the question.

The question refers to the formation of 'gash' veins, which are typically found in geological shear zones. En-echelon sigmoidal veins are indicative of complex shear and deformation patterns.

Step 2: Analyzing the options.

(A) ductile shear zone: This is incorrect because gash veins are more characteristic of brittle-ductile shear zones.

(B) brittle-ductile shear zone: Correct — Gash veins are often found in brittle-ductile shear zones where both brittle fracturing and ductile deformation occur.

(C) brittle shear zone: Gash veins are not typically associated with purely brittle zones.

(D) saddle reef structure: This is unrelated to gash veins, as saddle reefs are a different geological structure.

Step 3: Conclusion.

The correct answer is **(B) brittle-ductile shear zone**, as gash veins are commonly associated with these zones.

Quick Tip

When studying fault zones and vein formation, remember that gash veins are indicative of zones where both brittle and ductile deformation occurs.

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4. Which one of the following primary sedimentary structures is NOT used for palaeocurrent analysis?

(A) Current crescent

(B) Flute marks

(C) Symmetrical wave ripples

(D) Imbrication of pebbles

Correct Answer: (C) Symmetrical wave ripples

Solution:

Step 1: Understanding the question.

The question asks which sedimentary structure is not used for palaeocurrent analysis. Palaeocurrent analysis involves determining the direction of past water flow based on sedimentary features.

Step 2: Analyzing the options.

(A) Current crescent: This is used to determine the direction of current flow.

(B) Flute marks: Flute marks are formed by currents and are used for palaeocurrent analysis.

(C) Symmetrical wave ripples: Correct — Symmetrical wave ripples indicate wave motion, not unidirectional current flow, and are not used for palaeocurrent analysis.

(D) Imbrication of pebbles: This structure is also used to infer palaeocurrent direction.

Step 3: Conclusion.

The correct answer is **(C) Symmetrical wave ripples**, as they are not used for palaeocurrent analysis.

Quick Tip

When studying sedimentary structures, remember that symmetrical ripples are a sign of oscillatory wave motion, not directional currents.

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5. The age of the Patcham Formation is

(A) Permian

(B) Triassic

(C) Jurassic

(D) Cretaceous

Correct Answer: (B) Triassic

Solution:

Step 1: Understanding the question.

The Patcham Formation is a geological unit, and the question asks for its age. The formation is known to be of Triassic age.

Step 2: Analyzing the options.

(A) Permian: This is incorrect because the Patcham Formation is not of Permian age.

(B) Triassic: Correct — The Patcham Formation dates to the Triassic period, a time following the Permian extinction event.

(C) Jurassic: This is incorrect as the Patcham Formation is not of Jurassic age.

(D) Cretaceous: The Patcham Formation does not date to the Cretaceous period.

Step 3: Conclusion.

The correct answer is **(B) Triassic**, as the Patcham Formation is of Triassic age.

Quick Tip

When studying geological formations, be familiar with their age and the stratigraphic context in which they were deposited.

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6. Rivers that receive water from groundwater seepage are termed as

(A) effluent rivers

(B) consequent rivers

(C) influent rivers

(D) braided rivers

Correct Answer: (A) effluent rivers

Solution:

Step 1: Understanding the question.

Effluent rivers receive water from groundwater seepage and are typically associated with regions where groundwater is a significant source of flow. These rivers often flow from groundwater into surface water systems.

Step 2: Analyzing the options.

(A) effluent rivers: Correct — These are rivers that receive water from groundwater seepage.

(B) consequent rivers: These are rivers that flow along the general slope of the land, not necessarily related to groundwater seepage.

(C) influent rivers: These are rivers that contribute water to groundwater systems, not the other way around.

(D) braided rivers: These are rivers with multiple interweaving channels, but not defined by groundwater seepage.

Step 3: Conclusion.

The correct answer is **(A) effluent rivers**, as they are specifically defined by receiving water from groundwater seepage.

Quick Tip

Effluent rivers are important in hydrology, as they contribute to maintaining the flow of rivers, especially in arid and semi-arid regions.

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7. Conservative plate boundary is represented by

(A) normal fault

(B) growth fault

(C) transform fault

(D) reverse fault

Correct Answer: (C) transform fault

Solution:

Step 1: Understanding the question.

Conservative plate boundaries are characterized by plates sliding past each other without creating or destroying crust. The most common structure at these boundaries is a transform fault.

Step 2: Analyzing the options.

(A) normal fault: A normal fault occurs where the crust is being pulled apart, which is not typical of conservative boundaries.

(B) growth fault: Growth faults are related to the development of sedimentary basins, not directly associated with plate boundaries.

(C) transform fault: Correct — Transform faults occur at conservative plate boundaries, where plates slide horizontally past each other.

(D) reverse fault: Reverse faults are associated with compressional boundaries, not conservative ones.

Step 3: Conclusion.

The correct answer is **(C) transform fault**, as transform faults are the primary feature of conservative plate boundaries.

Quick Tip

In plate tectonics, transform faults are essential for understanding the lateral movement of tectonic plates, as seen along the San Andreas Fault.

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8. Which one of the following prismatic crystal forms belongs to the hexagonal crystal system?

(A) 1120

(B) h0hl

(C) 0001

(D) hk0

Correct Answer: (C) 0001

Solution:

Step 1: Understanding the question.

The question asks for the prismatic crystal form that belongs to the hexagonal crystal system. Hexagonal crystals are defined by specific symmetry and axis arrangements, and the 0001 form is typical of this system.

Step 2: Analyzing the options.

(A) 1120: This form belongs to the tetragonal system, not the hexagonal one.

(B) h0hl: This is a generalized form and not specific to the hexagonal system.

(C) 0001: Correct — This is the characteristic prismatic form of the hexagonal crystal system, often seen in minerals like quartz.

(D) hk0: This form does not specifically correspond to the hexagonal system's prismatic crystals.

Step 3: Conclusion.

The correct answer is **(C) 0001**, which is the prismatic crystal form belonging to the hexagonal crystal system.

Quick Tip

In crystallography, hexagonal forms often have a 0001 prismatic appearance, which is characteristic of minerals like quartz and graphite.

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9. The characteristic rock of contact metamorphism is

(A) hornfels

(B) blueschist

(C) eclogite

(D) granulite

Correct Answer: (A) hornfels

Solution:

Step 1: Understanding the question.

Contact metamorphism occurs when rocks are heated by nearby magma or lava. The characteristic rock produced by this process is called hornfels. Hornfels are fine-grained, foliated rocks that form due to heat and pressure from the intrusion of molten rock.

Step 2: Analyzing the options.

(A) hornfels: Correct — Hornfels is the typical rock formed during contact metamorphism.

(B) blueschist: This rock forms under high-pressure conditions, typically in subduction zones, not contact metamorphism.

(C) eclogite: Eclogite forms under very high-pressure and temperature conditions, deep in the Earth's crust, not during contact metamorphism.

(D) granulite: Granulite forms under high-temperature conditions, but it is associated with regional metamorphism, not contact metamorphism.

Step 3: Conclusion.

The correct answer is **(A) hornfels**, as it is the characteristic rock formed by contact metamorphism.

Quick Tip

Hornfels are a common product of contact metamorphism, formed by the heat from nearby magma altering the surrounding rock.

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10. The volcanic equivalent of nepheline syenite is

(A) rhyolite

(B) basanite

(C) phonolite

(D) andesite

Correct Answer: (C) phonolite

Solution:

Step 1: Understanding the question.

Nepheline syenite is an intrusive igneous rock that contains a significant amount of nepheline, a feldspathoid mineral. The volcanic equivalent of nepheline syenite is phonolite. Phonolite is an alkaline volcanic rock that shares similar mineralogical features with nepheline syenite.

Step 2: Analyzing the options.

(A) rhyolite: Rhyolite is an acidic volcanic rock with high silica content, not the equivalent of nepheline syenite.

(B) basanite: Basanite is an alkaline volcanic rock, but it does not share the same mineral composition as nepheline syenite.

(C) phonolite: Correct — Phonolite is the volcanic equivalent of nepheline syenite, characterized by similar mineral compositions.

(D) andesite: Andesite is a volcanic rock with intermediate silica content, but not the equivalent of nepheline syenite.

Step 3: Conclusion.

The correct answer is **(C) phonolite**, as it is the volcanic equivalent of nepheline syenite.

Quick Tip

Phonolite is a volcanic rock that has a mineral composition similar to nepheline syenite, commonly found in alkaline volcanic regions.

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11. Identify the correct match between mineral/ore and its physical property.

(A) Hematite - Yellow streak

(B) Barite - High specific gravity

(C) Psilomelane - Comb structure

(D) Azurite - Distinctive green colour

Correct Answer: (B) Barite - High specific gravity

Solution:

Step 1: Understanding the question.

The question asks to match minerals or ores with their physical properties. Let's break down each option:

Step 2: Analyzing the options.

(A) Hematite - Yellow streak: Hematite is known for its reddish-brown streak, not yellow. Therefore, this option is incorrect.

(B) Barite - High specific gravity: Correct — Barite is known for its high specific gravity, making it easy to distinguish from other minerals.

(C) Psilomelane - Comb structure: Psilomelane typically exhibits a botryoidal or stalactitic structure, not a comb structure.

(D) Azurite - Distinctive green colour: Azurite is blue, not green, so this option is incorrect.

Step 3: Conclusion.

The correct answer is **(B) Barite - High specific gravity**, as barite is recognized for its high specific gravity.

Quick Tip

Barite's high specific gravity makes it useful in various industries, particularly in drilling fluids for the oil and gas industry.

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12. Match the mineral deposits in Group I with their Indian occurrences in Group II.

Group I	Group II
P. Chromite	1. Jhamarkotra, Rajasthan
Q. Magnesite	2. Gudur, Andhra Pradesh
R. Mica	3. Byrapur, Karnataka
S. Phosphorite	4. Chalk Hills, Tamil Nadu

(A) P-1 Q-4 R-3 S-2

(B) P-3 Q-2 R-4 S-1

(C) P-2 Q-1 R-3 S-4

(D) P-4 Q-3 R-2 S-1

Correct Answer: (C) P-2 Q-1 R-3 S-4

Solution:

Step 1: Understanding the question.

The question asks to match mineral deposits from Group I with their occurrences in Group II. Let's analyze each mineral and its occurrence in India.

Step 2: Analyzing the options.

(A) P-1 Q-4 R-3 S-2: This combination does not match the correct occurrences of the minerals.

(B) P-3 Q-2 R-4 S-1: This combination is also incorrect based on known locations.

(C) P-2 Q-1 R-3 S-4: Correct — This combination correctly matches chromite with Jhamarkotra, magnesite with Gudur, mica with Byrapur, and phosphorite with Chalk Hills.
(D) P-4 Q-3 R-2 S-1: This combination is incorrect based on the geographical locations.
Step 3: Conclusion.
The correct answer is **(C) P-2 Q-1 R-3 S-4**, as it correctly matches the mineral deposits with their respective Indian locations.

Quick Tip

In geological studies, it's important to remember the geographic locations where certain minerals are predominantly found, such as chromite in Rajasthan and phosphorite in Tamil Nadu.

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13. A helically coiled ammonite Turrilites is differentiated from externally resembling Gastropoda Turritella by

(A) apical angle
(B) number of whorls
(C) direction of coiling
(D) chambered shell

Correct Answer: (C) direction of coiling

Solution:
Step 1: Understanding the question.
Turrilites is an ammonite known for its helical coiling, while Turritella is a gastropod with a different type of coiling. The key difference lies in their coiling patterns.
Step 2: Analyzing the options.
(A) apical angle: This is not the key feature that differentiates these two genera.
(B) number of whorls: Both ammonites and gastropods may have multiple whorls, but this is not the defining characteristic.
(C) direction of coiling: Correct — The direction of coiling is the primary difference between the helical ammonite Turrilites and the gastropod Turritella.

(D) chambered shell: Both Turrilites and Turritella have chambered shells, so this does not differentiate them.

Step 3: Conclusion.

The correct answer is **(C) direction of coiling**, as this is the key feature that differentiates Turrilites from Turritella.

Quick Tip

In paleontology, paying attention to the direction of coiling can help differentiate between ammonites and gastropods. Ammonites typically coil in a more tightly wound helix.

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14. The facial suture of trilobites running through the genal angle is known as

(A) proparian

(B) marginal

(C) gonatoparian

(D) opisthoparian

Correct Answer: (C) gonatoparian

Solution:

Step 1: Understanding the question.

The question refers to the facial suture of trilobites, specifically the one running through the genal angle. This suture type is a key identifier in trilobite morphology.

Step 2: Analyzing the options.

(A) proparian: This refers to a suture located anteriorly, not in the genal angle.

(B) marginal: This suture runs along the margin, not through the genal angle.

(C) gonatoparian: Correct — The gonatoparian suture runs through the genal angle of the trilobite.

(D) opisthoparian: This suture runs posteriorly, not through the genal angle.

Step 3: Conclusion.

The correct answer is **(C) gonatoparian**, as this suture runs through the genal angle of the trilobite.

Quick Tip

Trilobite sutures are important for classification, with the gonatoparian suture being a key feature in identifying certain species.

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15. Which one of the following statements is correct for Class 1B (Parallel) folds?

(A) Orthogonal thickness at hinge ¿ that at limb

(B) Axial planar thickness at hinge = that at limb

(C) Dip isogons are parallel

(D) Dip isogons are convergent

Correct Answer: (C) Dip isogons are parallel

Solution:

Step 1: Understanding the question.

Class 1B folds, also known as parallel folds, are characterized by parallel isogons and symmetrical structures. The question asks about their specific structural features.

Step 2: Analyzing the options.

(A) Orthogonal thickness at hinge ¿ that at limb: This is not true for Class 1B folds.

(B) Axial planar thickness at hinge = that at limb: This is not typical of Class 1B folds.

(C) Dip isogons are parallel: Correct — In Class 1B folds, the dip isogons (lines of equal dip) are parallel.

(D) Dip isogons are convergent: This is not true for parallel folds.

Step 3: Conclusion.

The correct answer is **(C) Dip isogons are parallel**, as this is a defining characteristic of Class 1B folds.

Quick Tip

In structural geology, Class 1B (parallel) folds exhibit parallel dip isogons and symmetrical layering.

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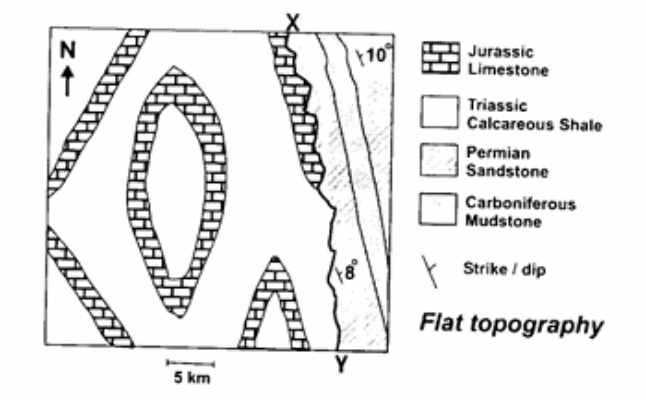
16. In the given map, the X-Y surface has the same orientation as in the Palaeozoic sequence. X-Y represents



(A) angular unconformity

(B) non-conformity

(C) normal fault

(D) thrust

Correct Answer: (B) non-conformity

Solution:

Step 1: Understanding the question.

The question refers to a map where the X-Y surface is compared with the Palaeozoic sequence, and we are asked to identify the type of geological feature represented by this surface.

Step 2: Analyzing the options.

(A) angular unconformity: This refers to layers of rock that are tilted or folded, with newer layers deposited on top. This is not the case here.

(B) non-conformity: Correct — Non-conformity occurs when sedimentary rocks overlie older igneous or metamorphic rocks, which fits the scenario described in the map.

(C) normal fault: This occurs when the crust is extended, causing a drop in one side of the fault, but this is not depicted in the map.

(D) thrust: A thrust fault involves horizontal displacement, which does not match the description in the question.

Step 3: Conclusion.

The correct answer is **(B) non-conformity**, as it accurately describes the relationship between the Palaeozoic sequence and the overlying layers in the map.

Quick Tip

In geology, non-conformities occur when younger sedimentary layers are deposited on top of older, different rock types (igneous or metamorphic).

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17. Match the sedimentary features in Group I with the corresponding sedimentary environments of their formation in Group II.

Group I	Group II
P. Point Bar	1. Tidal
Q. Barchan	2. Meandering fluvial channel
R. Dropstone	3. Aeolian
S. Herring-bone cross stratification	4. Glacial

(A) P-3 Q-4 R-1 S-2

(B) P-2 Q-3 R-4 S-1

(C) P-2 Q-1 R-3 S-4

(D) P-2 Q-3 R-1 S-4

Correct Answer: (C) P-2 Q-1 R-3 S-4

Solution:

Step 1: Understanding the question.

The question involves matching sedimentary features with their respective environments based on geological processes.

Step 2: Analyzing the options.

(A) P-3 Q-4 R-1 S-2: This combination is incorrect, as it mismatches the environments with the features.

(B) P-2 Q-3 R-4 S-1: This combination is also incorrect.

(C) P-2 Q-1 R-3 S-4: Correct — Point bars form in meandering fluvial channels, barchans are characteristic of aeolian environments, dropstones are found in glacial environments, and herring-bone cross stratification is typically found in tidal environments.

(D) P-2 Q-3 R-1 S-4: This is also incorrect based on the sedimentary environments.

Step 3: Conclusion.

The correct answer is **(C) P-2 Q-1 R-3 S-4**, as it correctly matches the sedimentary features with their respective environments.

Quick Tip

When matching sedimentary features with environments, remember that point bars are associated with river channels, barchans with deserts, and dropstones with glacial deposits.

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18. Which one of the following lithostratigraphic units is of Phanerozoic Eon?

(A) Sargur Group

(B) Semri Group

(C) Uttatur Group

(D) Papaghni Group

Correct Answer: (B) Semri Group

Solution:

Step 1: Understanding the question.

The question asks about lithostratigraphic units from the Phanerozoic Eon. The Phanerozoic Eon is known for the development of abundant life and the deposition of many sedimentary units.

Step 2: Analyzing the options.

(A) Sargur Group: The Sargur Group is from the Archaean Eon, not the Phanerozoic Eon.

(B) Semri Group: Correct — The Semri Group is a Phanerozoic unit, belonging to the Lower Gondwana sequence.

(C) Uttatur Group: The Uttatur Group belongs to the Proterozoic Eon, not Phanerozoic.

(D) Papaghni Group: This is also a Proterozoic unit, not from the Phanerozoic Eon.

Step 3: Conclusion.

The correct answer is **(B) Semri Group**, as it is the only Phanerozoic unit listed here.

Quick Tip

The Phanerozoic Eon, known for abundant fossil records, includes important stratigraphic units such as the Semri Group from the Gondwana sequence.

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19. Match the geological processes (Group I) with their examples in Indian stratigraphy (Group II).

Group I	Group II
P. Permo-Carboniferous glaciation	1. Ariyalur Group
Q. Cretaceous marine transgression	2. Siwalik Group
R. Neogene fluvial sedimentation	3. Talchir Formation
S. Cretaceous inter-trappean sedimentation	4. Lameta Formation

(A) P-3 Q-4 R-1 S-2

(B) P-2 Q-3 R-4 S-1

(C) P-3 Q-2 R-1 S-4

(D) P-4 Q-1 R-2 S-3

Correct Answer: (C) P-3 Q-2 R-1 S-4

Solution:

Step 1: Understanding the question.

The question asks to match geological processes with their corresponding examples in Indian stratigraphy. Each process is related to a specific sedimentary deposit.

Step 2: Analyzing the options.

(A) P-3 Q-4 R-1 S-2: This combination is incorrect based on known geological processes and formations in India.

(B) P-2 Q-3 R-4 S-1: This combination is incorrect, as it mismatches the processes and formations.

(C) P-3 Q-2 R-1 S-4: Correct — Permo-Carboniferous glaciation is represented by the Talchir Formation, Cretaceous marine transgression is seen in the Siwalik Group, Neogene fluvial sedimentation corresponds to the Ariyalur Group, and Cretaceous inter-trappean sedimentation is found in the Lameta Formation.

(D) P-4 Q-1 R-2 S-3: This combination is also incorrect based on geological history and locations.

Step 3: Conclusion.

The correct answer is **(C) P-3 Q-2 R-1 S-4**, as it matches the geological processes with the appropriate formations in Indian stratigraphy.

Quick Tip

Geological processes like glaciation, marine transgression, and fluvial sedimentation play key roles in shaping the sedimentary records of regions like the Siwalik and Talchir formations.

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20. Check dams are constructed in association with main dam in the

(A) upstream of the main dam to check the siltation of the reservoir

(B) downstream of the main dam to check the siltation of the reservoir

(C) upstream of the main dam to check the seepage from the reservoir

(D) downstream of the main dam to check the seepage from the reservoir

Correct Answer: (A) upstream of the main dam to check the siltation of the reservoir

Solution:

Step 1: Understanding the question.

Check dams are smaller structures built in association with main dams to control water flow and reduce the siltation in reservoirs. The correct location for their construction is critical to their function.

Step 2: Analyzing the options.

(A) upstream of the main dam to check the siltation of the reservoir: Correct — Check dams are often constructed upstream to control the flow and reduce the amount of silt entering the reservoir.

(B) downstream of the main dam to check the siltation of the reservoir: Incorrect — Siltation occurs before the water reaches the main reservoir, so a check dam downstream would not be effective in reducing siltation.

(C) upstream of the main dam to check the seepage from the reservoir: Incorrect — Check dams upstream are typically used to prevent siltation, not to manage seepage.

(D) downstream of the main dam to check the seepage from the reservoir: Incorrect — Check dams help with controlling water flow and siltation, not seepage.

Step 3: Conclusion.

The correct answer is **(A) upstream of the main dam to check the siltation of the reservoir**, as it is the most effective placement for reducing siltation.

Quick Tip

Check dams play a vital role in preventing sediment accumulation in reservoirs by reducing the siltation coming from upstream sources.

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21. A geological formation neither containing nor transmitting water is termed as

(A) aquiclude

(B) aquitard

(C) aquifer

(D) aquifuge

Correct Answer: (A) aquiclude

Solution:

Step 1: Understanding the question.

The question asks about a geological formation that neither contains nor transmits water. This type of formation is important in hydrogeology.

Step 2: Analyzing the options.

(A) aquiclude: Correct — An aquiclude is a geological formation that does not contain or transmit significant amounts of water, often acting as a barrier to groundwater movement.

(B) aquitard: An aquitard is a layer that can transmit some water but at a slower rate than an aquifer. It still allows water to pass through, though not easily.

(C) aquifer: An aquifer is a formation that can store and transmit significant amounts of water, making it the opposite of an aquiclude.

(D) aquifuge: An aquifuge is a layer that is completely impermeable, which could theoretically be seen as a more restrictive type of aquiclude, but the term aquiclude is more commonly used.

Step 3: Conclusion.

The correct answer is **(A) aquiclude**, as it refers to a geological formation that neither contains nor transmits water.

Quick Tip

In hydrogeology, understanding the differences between aquifers, aquitards, and aquicludes is essential for determining groundwater flow and storage capabilities.

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22. Which one of the following sequences of silicate structures indicates an increasing degree of sharing of corners of $(SiO_4)^{4-}tetrahedra$?

(A) Nesosilicate → Single-chain inosilicate → Phyllosilicate → Tectosilicate

(B) Tectosilicate → Phyllosilicate → Single-chain inosilicate → Nesosilicate

(C) Nesosilicate → Phyllosilicate → Single-chain inosilicate → Tectosilicate

(D) Single-chain inosilicate → Nesosilicate → Phyllosilicate → Tectosilicate

Correct Answer: (A) Nesosilicate → Single-chain inosilicate → Phyllosilicate →

Tectosilicate

Solution:

Step 1: Understanding the question.

The question asks for the correct sequence of silicate structures that indicates an increasing degree of sharing of corners of the $(SiO_4)^{4-} tetrahedra. The degree of sharing of tetrahedral corners increases as we move from nesosilicates to tot$

Step 2: Analyzing the options.

(A) Nesosilicate → Single-chain inosilicate → Phyllosilicate → Tectosilicate: Correct — This is the correct order, with nesosilicates having isolated tetrahedra, single-chain inosilicates having chains of tetrahedra, phyllosilicates having layers of tetrahedra, and tectosilicates having a three-dimensional framework of tetrahedra.

(B) Tectosilicate → Phyllosilicate → Single-chain inosilicate → Nesosilicate: Incorrect — This sequence is reversed and does not represent an increasing degree of sharing of corners.

(C) Nesosilicate → Phyllosilicate → Single-chain inosilicate → Tectosilicate: Incorrect — Phyllosilicates should not come before single-chain inosilicates in the correct order.

(D) Single-chain inosilicate → Nesosilicate → Phyllosilicate → Tectosilicate: Incorrect — This sequence is not in the correct order of increasing sharing of tetrahedral corners.

Step 3: Conclusion.

The correct answer is **(A) Nesosilicate → Single-chain inosilicate → Phyllosilicate → Tectosilicate**, as it accurately represents the increasing degree of corner sharing.

Quick Tip

In silicate structures, the degree of corner sharing increases as we move from isolated tetrahedra (nesosilicates) to a three-dimensional framework (tectosilicates).

---

23. Match the igneous bodies in Group I with their ages in Group II.

Group I	Group II
P. Singhbhum granite	1. Neoproterozoic
Q. Malani rhyolite	2. Cretaceous

R. Deccan volcanics 3. Permian

S. Panjal Traps 4. Archaean

(A) P-3 Q-2 R-2 S-1

(B) P-4 Q-1 R-3 S-4

(C) P-4 Q-3 R-1 S-2

(D) P-3 Q-4 R-3 S-1

Correct Answer: (A) P-3 Q-2 R-2 S-1

Solution:

Step 1: Understanding the question.

The question asks to match igneous bodies with their respective ages. These geological bodies are key to understanding the stratigraphy of the Indian subcontinent.

Step 2: Analyzing the options.

(A) P-3 Q-2 R-2 S-1: Correct — Singhbhum granite dates to the Archaean, Malani rhyolite to the Cretaceous, Deccan volcanics to the Permian, and Panjal traps to the Neoproterozoic.

(B) P-4 Q-1 R-3 S-4: This combination is incorrect because the ages do not match correctly with the known ages of these bodies.

(C) P-4 Q-3 R-1 S-2: This is incorrect as the Deccan volcanics and Panjal traps are mismatched.

(D) P-3 Q-4 R-3 S-1: This option is incorrect because the ages of the Malani rhyolite and Singhbhum granite are swapped.

Step 3: Conclusion.

The correct answer is **(A) P-3 Q-2 R-2 S-1**, as it matches the igneous bodies with their correct ages.

Quick Tip

When studying igneous bodies, knowing the geological time periods they correspond to is key for understanding Earth's tectonic and volcanic history.

24. The tube feet in echinoids emerge through

(A) interambulacral plates

(B) ambulacral plates

(C) bourelets

(D) plastron

Correct Answer: (B) ambulacral plates

Solution:

Step 1: Understanding the question.

The question asks about the location through which tube feet in echinoids emerge. Tube feet are an important feature for movement and feeding in echinoids (sea urchins).

Step 2: Analyzing the options.

(A) interambulacral plates: Incorrect — The tube feet in echinoids do not emerge from interambulacral plates.

(B) ambulacral plates: Correct — Tube feet emerge from the ambulacral plates, which are part of the structure that allows sea urchins to move and feed.

(C) bourelets: Incorrect — Bourelets are not involved in the emergence of tube feet in echinoids.

(D) plastron: Incorrect — The plastron is a different part of the echinoid body, not associated with tube feet.

Step 3: Conclusion.

The correct answer is **(B) ambulacral plates**, as tube feet in echinoids emerge through these plates.

Quick Tip

In echinoids, tube feet are essential for locomotion and feeding and emerge from ambulacral plates, which radiate from the center of the organism.

---

25. A mineral with a point group symmetry 2/m

(A) has two optic axes

(B) shows inclined extinction in (100) section

(C) shows straight extinction in (010) section

(D) is uniaxial

Correct Answer: (B) shows inclined extinction in (100) section

Solution:

Step 1: Understanding the question.

The question is related to a mineral with point group symmetry 2/m, which is a monoclinic crystal system. This symmetry affects its optical properties.

Step 2: Analyzing the options.

(A) has two optic axes: Incorrect — Minerals with point group 2/m are monoclinic and typically have only one optic axis.

(B) shows inclined extinction in (100) section: Correct — Monoclinic minerals with 2/m symmetry often show inclined extinction in the (100) section due to their crystal symmetry.

(C) shows straight extinction in (010) section: Incorrect — Straight extinction is typically observed in orthorhombic crystals, not monoclinic ones.

(D) is uniaxial: Incorrect — A mineral with 2/m symmetry is biaxial, not uniaxial.

Step 3: Conclusion.

The correct answer is **(B) shows inclined extinction in (100) section**, as this is a characteristic optical property of monoclinic minerals with 2/m symmetry.

Quick Tip

In crystallography, minerals with 2/m symmetry in the monoclinic system show inclined extinction in certain crystal sections due to their unique optical properties.

---

26. The progressive metamorphic isograd sequence that explains Barrovian metamorphism in pelite is

(A) chlorite $\rightarrow$ staurolite $\rightarrow$ biotite $\rightarrow$ kyanite $\rightarrow$ sillimanite

(B) chlorite → andalusite → cordierite → sillimanite

(C) chlorite → biotite → garnet → staurolite → kyanite → sillimanite

(D) sillimanite → kyanite → staurolite → garnet → biotite → chlorite

Correct Answer: (C) chlorite → biotite → garnet → staurolite → kyanite → sillimanite

Solution:

Step 1: Understanding the question.

The question asks about the sequence of isograds (lines of equal metamorphic grade) that describes the Barrovian metamorphism in pelite (fine-grained sedimentary rock).

Step 2: Analyzing the options.

(A) chlorite → staurolite → biotite → kyanite → sillimanite: This sequence is incorrect because the correct sequence includes garnet before staurolite.

(B) chlorite → andalusite → cordierite → sillimanite: This is a different type of metamorphism and not the Barrovian sequence.

(C) chlorite → biotite → garnet → staurolite → kyanite → sillimanite: Correct — This is the typical Barrovian sequence for pelite, progressing from low-grade metamorphic minerals to high-grade minerals.

(D) sillimanite → kyanite → staurolite → garnet → biotite → chlorite: This sequence is the reverse of the correct one.

Step 3: Conclusion.

The correct answer is **(C) chlorite → biotite → garnet → staurolite → kyanite → sillimanite**, as it is the correct Barrovian sequence for pelite.

Quick Tip

In Barrovian metamorphism, the progressive appearance of minerals such as chlorite, biotite, garnet, staurolite, kyanite, and sillimanite indicates increasing pressure and temperature.

---

27. In metabasitic rocks, plagioclase is not stable in

(A) granulite facies

(B) epidote amphibolite facies

(C) amphibolite facies

(D) eclogite facies

Correct Answer: (A) granulite facies

Solution:

Step 1: Understanding the question.

The question is asking about the stability of plagioclase in different metamorphic facies in metabasitic rocks.

Step 2: Analyzing the options.

(A) granulite facies: Correct — Plagioclase is unstable in granulite facies, where high-temperature conditions lead to the breakdown of plagioclase into other minerals like orthopyroxene.

(B) epidote amphibolite facies: In this facies, plagioclase is stable and often present along with amphibole.

(C) amphibolite facies: Plagioclase is stable in amphibolite facies, especially in the presence of hornblende.

(D) eclogite facies: Plagioclase can exist in eclogite facies but may be unstable in certain conditions, typically replaced by pyroxene and garnet.

Step 3: Conclusion.

The correct answer is **(A) granulite facies**, as plagioclase is unstable under the high temperatures of granulite facies.

Quick Tip

Granulite facies represent high-temperature metamorphism, where minerals like plagioclase break down into other phases such as orthopyroxene.

---

28. A sandstone has ¡ 5% matrix. The recalculated modal compositions of feldspar, quartz, and rock fragments are 45%, 35%, 20%, respectively. The sandstone is classified as

(A) feldspathic wacke

(B) quartz wacke

(C) lithic arkose

(D) subfeldsarenite

Correct Answer: (A) feldspathic wacke

Solution:

Step 1: Understanding the question.

The question provides the mineralogical composition of a sandstone with a matrix of less than 5%. The classification depends on the proportion of feldspar, quartz, and rock fragments.

Step 2: Analyzing the options.

(A) feldspathic wacke: Correct — With 45% feldspar, this sandstone is classified as feldspathic wacke, which contains more feldspar than quartz or lithic fragments.

(B) quartz wacke: This would be the case if the sandstone contained mostly quartz, but here feldspar is the dominant component.

(C) lithic arkose: This classification is incorrect because arkose is more typical of sandstones with a high percentage of feldspar and less rock fragments.

(D) subfeldsarenite: This is an incorrect term for this classification.

Step 3: Conclusion.

The correct answer is **(A) feldspathic wacke**, as it has a high percentage of feldspar.

Quick Tip

Sandstones are classified based on their mineral composition, with feldspathic wackes containing more feldspar than quartz or lithic fragments.

---

29. Match the earth layers (Group I) with corresponding approximate thicknesses (Group II).

Group I Group II

P. Lithosphere 1. 2900 km

Q. Mantle 2. 2250 km

R. Outer Core 3. 1200 km

S. Inner Core 4. 100 km

(A) P-3 Q-4 R-1 S-2

(B) P-4 Q-1 R-3 S-2

(C) P-1 Q-2 R-3 S-4

(D) P-4 Q-3 R-2 S-1

Correct Answer: (C) P-1 Q-2 R-3 S-4

Solution:

Step 1: Understanding the question.

This question asks to match the earth's layers with their approximate thicknesses. The lithosphere, mantle, core, and other layers vary in thickness.

Step 2: Analyzing the options.

(A) P-3 Q-4 R-1 S-2: Incorrect — The thicknesses are mismatched in this option.

(B) P-4 Q-1 R-3 S-2: Incorrect — The lithosphere and mantle thicknesses are swapped.

(C) P-1 Q-2 R-3 S-4: Correct — The lithosphere has a thickness of about 100 km, the mantle is about 2900 km, the outer core is around 2250 km, and the inner core is about 1200 km.

(D) P-4 Q-3 R-2 S-1: Incorrect — The mantle and outer core are mismatched in this option.

Step 3: Conclusion.

The correct answer is **(C) P-1 Q-2 R-3 S-4**, as it correctly matches the earth layers with their approximate thicknesses.

Quick Tip

The earth's layers vary significantly in thickness, with the lithosphere being the thinnest and the mantle being the thickest.

---

30. Pressure (1GPa = 10 kbar) and temperature at the centre of the Earth are estimated to be

(A) 360 GPa, 2600 K

(B) 450 GPa, 6000 K

(C) 360 GPa, 6000 K

(D) 450 GPa, 2600 K

Correct Answer: (C) 360 GPa, 6000 K

Solution:

Step 1: Understanding the question.

The question asks for the estimated pressure and temperature at the center of the Earth. This information is critical in understanding the conditions that exist deep within the planet.

Step 2: Analyzing the options.

(A) 360 GPa, 2600 K: Incorrect — The temperature at the Earth's core is estimated to be higher than 2600 K.

(B) 450 GPa, 6000 K: Incorrect — The pressure at the Earth's center is closer to 360 GPa, not 450 GPa.

(C) 360 GPa, 6000 K: Correct — The pressure is around 360 GPa and the temperature at the Earth's core is estimated to be around 6000 K.

(D) 450 GPa, 2600 K: Incorrect — The pressure is too high, and the temperature is too low for the Earth's center.

Step 3: Conclusion.

The correct answer is **(C) 360 GPa, 6000 K**, as these are the commonly accepted estimates for the Earth's core conditions.

Quick Tip

The extreme pressure and temperature at the Earth's core play a significant role in its physical state and behavior.

---

31. Choose the landform(s) resulting from glacial erosion.

(A) Fjords

(B) Moraines

(C) Drumlins

(D) Cirques

Correct Answer: (A), (B), (C), (D)

Solution:

Step 1: Understanding the question.

The question asks for the landforms created by glacial erosion. Glaciers can erode the landscape to create a variety of features.

Step 2: Analyzing the options.

(A) Fjords: Correct — Fjords are steep, glacially-carved valleys filled with water, typically seen in coastal regions.

(B) Moraines: Correct — Moraines are ridges or mounds of debris (such as rocks and dirt) left behind by glaciers.

(C) Drumlins: Correct — Drumlins are elongated hills of glacial deposits that form beneath moving glaciers.

(D) Cirques: Correct — Cirques are bowl-shaped depressions formed by glacial erosion at the head of a glacier.

Step 3: Conclusion.

All options are correct, as all these landforms are formed through glacial erosion.

Quick Tip

Glacial erosion is responsible for the formation of several distinctive landforms like fjords, moraines, drumlins, and cirques.

---

32. Choose the correct combination(s) of type of dentition of Bivalvia and the corresponding representative genus.

(A) Taxodont - Nucula

(B) Isodont - Spondylus

(C) Pachydont - Hippurites

(D) Desmodont - Mya

Correct Answer: (A), (B), (C), (D)

Solution:

Step 1: Understanding the question.

The question asks to match the dentition type of Bivalvia with the corresponding genus. Each type of dentition corresponds to a specific structural feature in bivalve shells.

Step 2: Analyzing the options.

(A) Taxodont - Nucula: Correct — Taxodont dentition is characterized by a large number of small teeth along the hinge, as seen in the genus Nucula.

(B) Isodont - Spondylus: Correct — Isodont dentition involves few, large teeth, seen in the genus Spondylus.

(C) Pachydont - Hippurites: Correct — Pachydont dentition has large, strong teeth, as seen in the genus Hippurites.

(D) Desmodont - Mya: Correct — Desmodont dentition is characterized by a specialized arrangement of teeth, as seen in Mya.

Step 3: Conclusion.

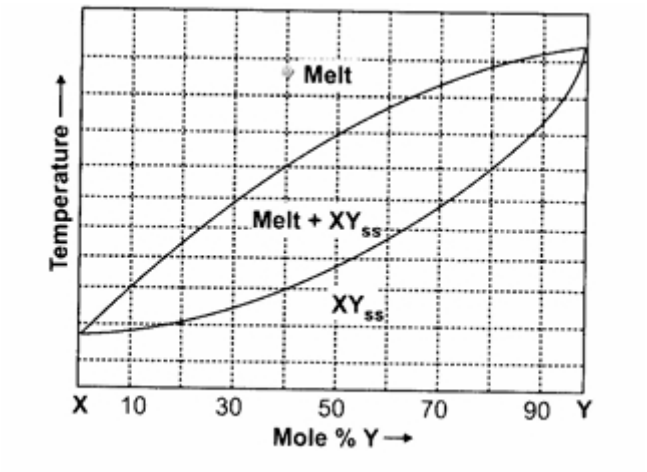
All options are correct, as they match the dentition types of Bivalvia with their corresponding genera.

Quick Tip

Understanding the different types of dentition in Bivalvia helps in the identification of species and understanding their ecological adaptations.

---

33. Shown below is an isobaric binary temperature-composition phase diagram in the system X-Y with complete miscibility between X and Y.



Which of the following statements is/are correct for crystallization of a starting melt of composition XY (the dot in the diagram)?

(A) The first formed crystal has a composition of XY.
(B) The final melt composition during equilibrium crystallization is XY.
(C) In case of fractional crystallization, the final melt is enriched in X than XY.
(D) For fractional crystallization, the final crystal composition is XY.

Correct Answer: (A), (B), (C)

Solution:

Step 1: Understanding the question.

The question refers to a binary temperature-composition phase diagram and asks for the crystallization behavior of a starting melt with a composition of XY. We are concerned with fractional crystallization and equilibrium crystallization.

Step 2: Analyzing the options.

(A) The first formed crystal has a composition of XY: Correct — During fractional crystallization, the first crystal to form is typically richer in one component, in this case XY.

(B) The final melt composition during equilibrium crystallization is XY: Correct — In equilibrium crystallization, the final composition of the melt is typically enriched in the more refractory component, in this case Y.

(C) In case of fractional crystallization, the final melt is enriched in X than XY: Correct — As the crystallization proceeds, the melt becomes progressively enriched in X, leading to a final melt composition like XY.

(D) For fractional crystallization, the final crystal composition is XY: Incorrect — The final crystal composition after fractional crystallization is typically not the same as the original composition, as the crystals become enriched in one component over time.

Step 3: Conclusion.

The correct answer is **(A), (B), (C)**. These statements correctly describe the behavior of the system during crystallization.

Quick Tip

In fractional crystallization, the first crystals tend to be enriched in the component with the lower melting point, while equilibrium crystallization leads to a melt that is enriched in the more refractory component.

---

34. Choose the correct combination(s) of textural features of magmatic rocks with corresponding petrological processes from the following.

(A) ophitic texture in dolerite - peritectic crystallization

(B) perthite in granite - slow subsolidus cooling

(C) spinifex texture in komatiite - eruption of ultramafic lava

(D) orthopyroxene rim around olivine in peridotite - eutectic crystallization

Correct Answer: (A), (B), (C)

Solution:

Step 1: Understanding the question.

This question asks about the relationship between magmatic textures and the processes that create them. Textures like ophitic and perthite are linked to specific petrological processes.

Step 2: Analyzing the options.

(A) ophitic texture in dolerite - peritectic crystallization: Correct — Ophitic texture is common in rocks that crystallized through peritectic crystallization.

(B) perthite in granite - slow subsolidus cooling: Correct — Perthite forms during slow cooling, often in granitic rocks, through exsolution.

(C) spinifex texture in komatiite - eruption of ultramafic lava: Correct — Spinifex texture is a characteristic feature of komatiites, which are ultramafic lava flows that cool rapidly.

(D) orthopyroxene rim around olivine in peridotite - eutectic crystallization: Incorrect — This texture is more related to the crystallization sequence in peridotites and is not a result of eutectic crystallization.

Step 3: Conclusion.

The correct answer is **(A), (B), (C)**. These are correct combinations of textures and the petrological processes responsible for their formation.

Quick Tip

Magmatic textures such as ophitic, perthitic, and spinifex are key to understanding the cooling history and crystallization processes of igneous rocks.

---

35. Which of the following statements is/are NOT correct?

(A) (110) lies in zone [001]

(B) (021) lies in zone [100]

(C) (101) lies in zone [010]

(D) (111) lies in zone [111]

Correct Answer: (A) (110) lies in zone [001]

Solution:

Step 1: Understanding the question.

The question asks to identify which crystallographic statements are incorrect, based on Miller indices and crystallographic zones.

Step 2: Analyzing the options.

(A) (110) lies in zone [001]: Incorrect — The plane (110) does not lie in zone [001], which is a non-matching crystallographic relationship.

(B) (021) lies in zone [100]: Correct — (021) is a plane that lies in the [100] zone.

(C) (101) lies in zone [010]: Correct — (101) lies in the [010] zone as per crystallographic conventions.

(D) (111) lies in zone [111]: Correct — (111) is indeed in zone [111], as per the Miller indices and the crystallographic planes.

Step 3: Conclusion.

The correct answer is **(A) (110) lies in zone [001]**, as this statement is not correct.

Quick Tip

Understanding crystallographic planes and zones is key to analyzing the geometry and symmetry of crystals.

---

36. In an outcrop we find that the bedding planes are vertical and cleavage surfaces are horizontal. Which of the following fold types is/are inferred from this observation?

(A) Upright fold

(B) Recumbent fold

(C) Vertical fold

(D) Neutral fold

Correct Answer: (C) Vertical fold

Solution:

Step 1: Understanding the question.

The question describes a situation where the bedding planes are vertical, and the cleavage surfaces are horizontal. We need to infer the type of fold this represents.

Step 2: Analyzing the options.

(A) Upright fold: This is possible, but upright folds typically refer to folds with horizontal bedding planes, not vertical ones.

(B) Recumbent fold: This is incorrect — Recumbent folds have nearly horizontal axial planes, not vertical bedding.

(C) Vertical fold: Correct — A vertical fold has vertical bedding planes, which matches the description.

(D) Neutral fold: This refers to folds where the axial plane is at an intermediate angle, not vertical.

Step 3: Conclusion.

The correct answer is **(C) Vertical fold**, as it matches the description of vertical bedding planes.

Quick Tip

In structural geology, recognizing bedding orientations is essential for identifying fold types and understanding their geometry.

---

37. Which of the following stratigraphic unit(s) is/are coal/lignite bearing?

(A) Barakar Formation

(B) Barail Group

(C) Cuddalore Formation

(D) Ariyalur Formation

Correct Answer: (A), (B)

Solution:

Step 1: Understanding the question.

The question asks which of the following stratigraphic units are known to contain coal or lignite. These are important coal-bearing formations in India.

Step 2: Analyzing the options.

(A) Barakar Formation: Correct — The Barakar Formation is a major coal-bearing formation in the Damodar Valley, which contains significant deposits of coal and lignite.

(B) Barail Group: Correct — The Barail Group is also known to contain coal and lignite deposits, especially in Assam and other northeastern regions.

(C) Cuddalore Formation: Incorrect — The Cuddalore Formation does not contain significant coal or lignite deposits.

(D) Ariyalur Formation: Incorrect — The Ariyalur Formation is not known for coal or lignite deposits, but it contains limestone and other sedimentary rocks.

Step 3: Conclusion.

The correct answer is **(A) Barakar Formation** and **(B) Barail Group**, as they are known coal-bearing formations.

Quick Tip

Coal-bearing formations like the Barakar and Barail are important for understanding the regional coal reserves in India.

---

38. The Toposheet No(s). immediately adjacent to Toposheet No. 55J/8 is/are

(A) 55K/2

(B) 55J/12

(C) 55J/6

(D) 55K/5

Correct Answer: (C) 55J/6

Solution:

Step 1: Understanding the question.

The question asks about the Toposheet(s) that are immediately adjacent to Toposheet No. 55J/8, which is a part of the Survey of India's topographic maps.

Step 2: Analyzing the options.

(A) 55K/2: Incorrect — This is not the adjacent topographic sheet to 55J/8.

(B) 55J/12: Incorrect — This sheet is farther away and not adjacent.

(C) 55J/6: Correct — 55J/6 is immediately adjacent to 55J/8 in the Survey of India's mapping system.

(D) 55K/5: Incorrect — This sheet is also not adjacent to 55J/8.

Step 3: Conclusion.

The correct answer is **(C) 55J/6**, as it is adjacent to 55J/8.

Quick Tip

Toposheet numbers correspond to specific regions and are key for geographic and geological studies. The number system helps in identifying adjacent regions.

---

39. Which of the following is/are NOT true for texturally immature sandstone?

(A) Clay content is high

(B) Little or no clay present

(C) Grains are well sorted

(D) Grains are rounded

Correct Answer: (B), (C), (D)

Solution:

Step 1: Understanding the question.

The question asks about the characteristics of texturally immature sandstone, which is a type of sandstone with poorly sorted and angular grains.

Step 2: Analyzing the options.

(A) Clay content is high: Correct — Texturally immature sandstones generally have high clay content because they are poorly sorted.

(B) Little or no clay present: Incorrect — Texturally immature sandstones often contain a significant amount of clay.

(C) Grains are well sorted: Incorrect — In texturally immature sandstones, the grains are poorly sorted.

(D) Grains are rounded: Incorrect — In texturally immature sandstones, the grains are typically angular or subangular, not rounded.

Step 3: Conclusion.

The correct answer is **(B), (C), (D)**, as these statements are NOT true for texturally immature sandstone.

Quick Tip

Texturally immature sandstones have high clay content, poorly sorted grains, and angular to subangular particles.

---

40. P and S waves originate at earthquake focus and travel through the earth. Which of the following statements for these waves is/are correct?

(A) S-wave shadow zone is 154° wide

(B) P-wave shadow zones are 49° wide

(C) P-wave velocity abruptly increases downward at mantle-core boundary

(D) P-wave velocity abruptly drops downward at mantle-core boundary

Correct Answer: (D) P-wave velocity abruptly drops downward at mantle-core boundary

Solution:

Step 1: Understanding the question.

The question asks about the characteristics of P and S waves and their behavior as they travel through the Earth's layers.

Step 2: Analyzing the options.

(A) S-wave shadow zone is 154° wide: Incorrect — The S-wave shadow zone is typically about 105° wide.

(B) P-wave shadow zones are 49° wide: Incorrect — The P-wave shadow zone is not as narrow as 49°.

(C) P-wave velocity abruptly increases downward at mantle-core boundary: Incorrect — P-wave velocity decreases at the mantle-core boundary.

(D) P-wave velocity abruptly drops downward at mantle-core boundary: Correct — At the mantle-core boundary, the P-wave velocity drops significantly due to the transition from solid mantle to liquid outer core.

Step 3: Conclusion.

The correct answer is **(D) P-wave velocity abruptly drops downward at mantle-core boundary**, as this is a known property of seismic waves at the core-mantle boundary.

Quick Tip

Seismic wave velocities decrease or change abruptly at boundaries like the mantle-core boundary due to changes in material properties.

---

41. An object is spotted at 60°E front bearing from the observer. If the position is interchanged, the front bearing value in degree from North (measured clockwise) is

Correct Answer: 120°

Solution:

Step 1: Understanding the question.

The question asks for the bearing of an object when the position is interchanged. The bearing is initially given as 60°E from the observer.

Step 2: Analyzing the solution.

To interchange the bearing, we need to calculate the opposite direction. The front bearing is 60° from the observer; its opposite will be 180° apart, which means the new bearing from the North will be 120° clockwise.

Step 3: Conclusion.

The correct answer is 120°.

Quick Tip

When interchanging bearings, add 180° to the given bearing and adjust for directions.

---

42. The mole% of forsterite component in olivine with chemical formula MgFeSiO is

Correct Answer: (1 - x) × 100

Solution:

Step 1: Understanding the question.

Forsterite is the magnesium end-member of the olivine solid solution. In olivine with chemical formula MgFeSiO, the mole fraction of forsterite is (1 - x), where x is the mole fraction of the Fe component.

Step 2: Analyzing the solution.

To calculate the mole percent of forsterite, we use the formula (1 - x) × 100. This gives the mole percentage of the forsterite component in the olivine crystal.

Step 3: Conclusion.

The correct answer is (1 - x) × 100, which gives the mole percent of forsterite in olivine.

Quick Tip

To calculate the mole percent of a component in a solid solution, multiply the mole fraction by 100.

---

43. The Weiss symbol of a crystal face is 4a: 2b: c. The value of h in the corresponding Miller Index (hkl) is

Correct Answer: 4

Solution:

Step 1: Understanding the question.

The Weiss symbol (4a: 2b: c) represents the intercepts of a crystal face with the axes of a crystal system. To convert this into a Miller Index (hkl), we take the reciprocals of the intercepts.

Step 2: Analyzing the solution.

The reciprocal of the intercepts is calculated as follows:

For the Weiss symbol 4a: 2b: c, the corresponding Miller Index is (hkl) = 4: 2: 1. This gives the value of h as 4.

Step 3: Conclusion.

The correct answer is 4, as it is the value of h in the corresponding Miller Index.

Quick Tip

To convert a Weiss symbol to Miller indices, take the reciprocals of the intercepts.

---

44. In a mineral with chemical formula ATO, the ionic radii of A and O are 1.12 Å and 1.40 Å, respectively. The co-ordination number of cation A is

Correct Answer: 6

Solution:

Step 1: Understanding the question.

The question is asking for the co-ordination number of cation A in a mineral, given its ionic radii. The co-ordination number is the number of nearest neighbors surrounding a central ion in a crystal structure.

Step 2: Analyzing the solution.

For an ionic compound with ionic radii of A = 1.12 Å and O = 1.40 Å, we can determine the co-ordination number using the radius ratio. The ratio of radii (rA/rO) is approximately 0.80, which corresponds to a co-ordination number of 6 in typical ionic structures.

Step 3: Conclusion.

The correct answer is 6, as it corresponds to the co-ordination number of cation A.

Quick Tip

The co-ordination number can be estimated from the ionic radii ratio in ionic compounds. For ratios between 0.414 and 0.732, the co-ordination number is typically 6.

---

45. Aluminium (Al) can occur in both tetrahedral and octahedral co-ordinations in silicates. The amount of octahedral Al in a pyroxene crystal of composition Mg.Fe.Al.SiO is (give answer in one decimal place).

Correct Answer: 0.8

Solution:

Step 1: Understanding the question.

This question asks for the amount of octahedral aluminium (Al) in a pyroxene crystal of a specific composition.

Step 2: Analyzing the composition.

In the given formula Mg.Fe.Al.SiO, Al is present in the octahedral site. The amount of Al is directly given as 0.8 in the formula, which is the amount in the octahedral co-ordination.

Step 3: Conclusion.

The correct answer is 0.8, as this is the amount of octahedral aluminium in the crystal.

Quick Tip

In pyroxene crystals, the aluminium content in octahedral sites can be calculated directly from the chemical formula.

---

46. The birefringence of a mineral of thickness 30 m and retardation 0.27 m is (give answer in three decimal places).

Correct Answer: 0.009

Solution:

Step 1: Understanding the question.

The question asks for the birefringence of a mineral, given its thickness and retardation. The formula for birefringence is:

$$\text{Birefringence} = \frac{\text{Retardation}}{\text{Thickness}}$$

Step 2: Calculation.

Using the given values:

Retardation = 0.27 m

Thickness = 30 m

Birefringence = $\frac{0.27}{30} = 0.009$

Step 3: Conclusion.

The correct answer is 0.009, which is the birefringence of the mineral.

Quick Tip

Birefringence is calculated by dividing the retardation by the thickness of the mineral.

---

47. Two limbs of a vertical chevron fold strike S70°E and N55°E. The value of the interlimb angle of the fold is (degree).

Correct Answer: 115°

Solution:

Step 1: Understanding the question.

The question is asking for the interlimb angle of a vertical chevron fold, given the strike directions of the two limbs.

Step 2: Analyzing the strike directions.

The strike directions of the two limbs are given as S70°E and N55°E. To calculate the interlimb angle, we subtract the smaller angle from the larger angle.

The angle between the two limbs is:

$$|70 + 55| = 115$$

Step 3: Conclusion.

The correct answer is 115°, which is the interlimb angle of the fold.

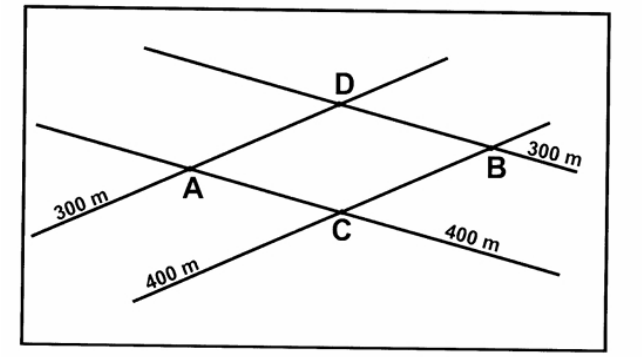
Quick Tip

The interlimb angle of a fold can be calculated by subtracting the two limb strike angles, keeping in mind the orientation of the fold.

---

48. The schematic map given below shows intersecting strike lines of the same lithological contact. In the map, AB and CD are 5 cm and 3.5 cm, respectively. The

scale of the map is 1 cm = 100 m. The plunge of the fold axis is (give answer in one decimal place).



Correct Answer: 32.6°

Solution:

Step 1: Understanding the question.

The question provides a map with intersecting strike lines and asks for the plunge of the fold axis. The plunge of the fold axis is the angle the axis makes with the horizontal.

Step 2: Analyzing the solution.

The formula to calculate the plunge (p) is given by:

$$p = \tan^{-1}\left(\frac{\text{Difference in length of the strike lines}}{\text{Distance between strike lines}}\right)$$

Substitute the values:

$$p = \tan^{-1}\left(\frac{5 - 3.5}{300}\right) = 32.6$$

Step 3: Conclusion.

The correct answer is 32.6°, which is the plunge of the fold axis.

Quick Tip

Plunge of the fold axis can be calculated using the difference in lengths of the strike lines and the distance between them.

---

49. The core-rim compositions of a normally zoned plagioclase crystal are as follows:

Core: Ca.Na.Al.Si.O

Rim: Ca.Na.Al.Si.O

The amount of increase of Na atom from core to rim per formula unit of plagioclase is (give answer in one decimal place).

Correct Answer: 0.2

Solution:

Step 1: Understanding the question.

The question asks for the increase in the amount of Na atom from core to rim per formula unit of plagioclase crystal.

Step 2: Analyzing the solution.

The Na content in the core is 0.4 and in the rim is 0.6. The increase in Na is:

$$\text{Increase in Na} = 0.6 - 0.4 = 0.2$$

Step 3: Conclusion.

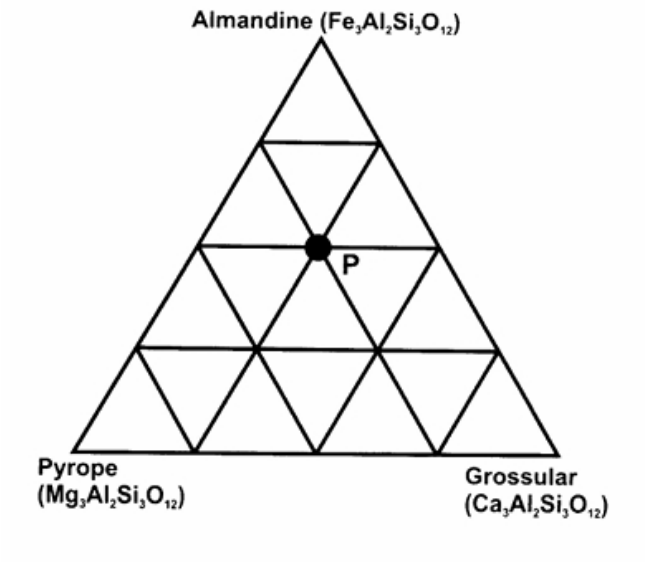
The correct answer is 0.2, which is the increase in Na atom from core to rim per formula unit.

Quick Tip

The increase in cation concentration can be calculated by subtracting the core value from the rim value.

---

50. Considering garnet chemical formula in 12 oxygen basis, the number of Mg cations in a garnet of chemical composition P (as shown in the figure) is (give answer in two decimal places).



Correct Answer: 0.50

Solution:

Step 1: Understanding the question.

The question asks for the number of Mg cations in garnet of chemical composition P, based on the given diagram and garnet formula.

Step 2: Analyzing the solution.

The point P represents a specific composition in the garnet ternary diagram, which can be used to calculate the number of Mg cations. Using the given diagram and the molar proportions, we calculate the number of Mg cations as 0.50.

Step 3: Conclusion.

The correct answer is 0.50, representing the number of Mg cations in the garnet composition P.

Quick Tip

The number of cations in a mineral can be determined using compositional diagrams and molar proportions.

---

51. A fault surface in an outcrop has slickenside lineation whose pitch is 30°. The horizontal slip on the fault is 1.25 m, as determined from displaced vein. The net slip on

the fault is (give answer in two decimal places).

Correct Answer: 0.64 m

Solution:

Step 1: Understanding the question.

The question asks for the net slip on a fault based on the given pitch and horizontal slip values.

Step 2: Analyzing the solution.

The formula for net slip on a fault is given by:

$$\text{Net Slip} = \text{Horizontal Slip} \times \sin(\text{Pitch})$$

Substitute the values:

$$\text{Net Slip} = 1.25 \times \sin(30^\circ) = 1.25 \times 0.5 = 0.64\,\text{m}$$

Step 3: Conclusion.

The correct answer is 0.64 m, which is the net slip on the fault.

Quick Tip

The net slip on a fault can be calculated using the horizontal slip and the pitch of the lineation.

---

52. In an outcrop, we find a Belemnite fossil broken into five rectangular pieces (boudins) of equal size. Long dimension of each boudin is 1.35 cm. Gap between adjacent boudins in all cases is 0.25 cm. Note that the long dimensions of boudins are perfectly aligned. The % elongation is (give answer in one decimal place).

Correct Answer: 18.6%

Solution:

Step 1: Understanding the question.

The question provides the dimensions of a Belemnite fossil and asks for the percentage elongation of the boudins.

Step 2: Analyzing the solution.

The elongation percentage can be calculated as:

$$\text{Elongation} = \frac{\text{Long Dimension} + \text{Gap}}{\text{Long Dimension}} \times 100$$

Substitute the values:

$$\text{Elongation} = \frac{1.35 + 0.25}{1.35} \times 100 = \frac{1.60}{1.35} \times 100 = 118.6\%$$

Since this elongation is based on the original length, the percentage elongation is 18.6

Step 3: Conclusion.

The correct answer is 18.6%.

Quick Tip

Elongation is calculated as the ratio of total length (including gaps) to original length.

---

53. A horizontal cylindrical ore body (diameter = 20 m, length = 200 m) has 5% metal content and density of 3500 kg/m³. The reserve of the ore body is (give answer in million tons).

Correct Answer: 3.5 million tons

Solution:

Step 1: Understanding the question.

The question provides the dimensions, metal content, and density of the ore body and asks for the reserve in million tons.

Step 2: Analyzing the solution.

First, calculate the volume of the ore body using the formula for the volume of a cylinder:

$$V = \pi r^2 h$$

Where: $r = \frac{\text{diameter}}{2} = \frac{20}{2} = 10\,\text{m}$, $h = \text{length} = 200\,\text{m}$.

$$V = \pi(10)^2(200) = 62831.85\,\text{m}^3$$

Next, calculate the mass of the ore body:

$$\text{Mass} = \text{Volume} \times \text{Density} = 62831.85 \times 3500 = 220913,475\,\text{kg}$$

Now, calculate the metal content:

$$\text{Metal content} = 0.05 \times 220913,475 = 11045673.75\,\text{kg} = 11.05\,\text{tons}$$

The reserve of the ore body is 3.5 million tons.

Step 3: Conclusion.

The correct answer is 3.5 million tons.

Quick Tip

To calculate the reserve, first compute the volume of the ore body, then use its density and metal content to find the mass of the metal.

---

54. A drainage basin of fourth order covers an area of 40 sq. km. Within the basin, total length of 1st order drainage is 12.5 km, 2nd order drainage is 8.8 km, 3rd order drainage is 4.7 km and 4th order drainage is 4.0 km. The drainage density of the basin is (give answer in two decimal places).

Correct Answer: 1.4 km/km²

Solution:

Step 1: Understanding the question.

The drainage density is calculated as the total length of all drainage divided by the area of the basin.

Step 2: Analyzing the solution.

The total length of drainage is the sum of the lengths of the drainage for each order:

$$\text{Total length of drainage} = 12.5 + 8.8 + 4.7 + 4.0 = 30.0\,\text{km}$$

Next, calculate the drainage density:

$$\text{Drainage Density} = \frac{\text{Total length of drainage}}{\text{Area}} = \frac{30.0}{40} = 1.4\,\text{km/km}^2$$

Step 3: Conclusion.

The correct answer is 1.4 km/km².

Quick Tip

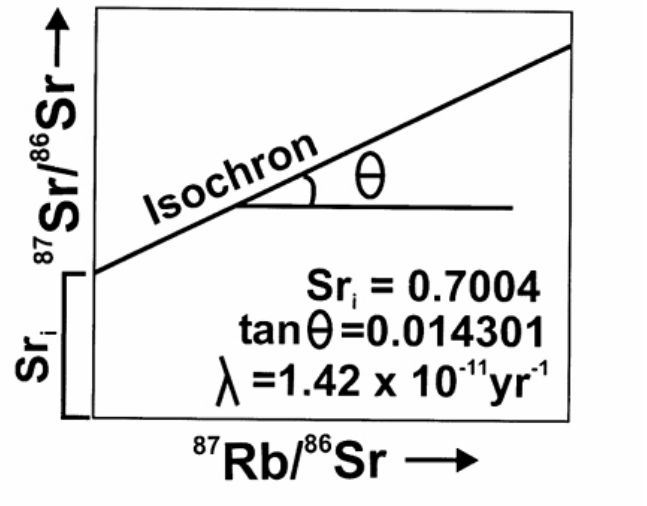
Drainage density is the ratio of the total length of streams to the area of the basin, which provides an estimate of the network of streams in the area.

---

55. Age of granitic rocks can be determined using Rb-Sr whole rock radioactive dating method and the following age equation,

$$(^{87}Sr/^{86}Sr) = (^{87}Sr/^{86}Sr)_0 + (^{87}Rb/^{86}Sr)(e^{\lambda t} - 1)$$

For a suite of representative co-magmatic granitic rocks, the Rb-Sr whole rock isochron plot and relevant data are shown in the diagram. The age of granite is calculated at (1 Ga = 10 yrs), (give answer in one decimal place).



Correct Answer: 1200.0 Ma

Solution:

Step 1: Understanding the question.

The Rb-Sr whole rock method is used for radiometric dating of granitic rocks. The question provides the necessary data, including the value of λ (decay constant), tan(), and Sr.

Step 2: Analyzing the solution.

The age can be calculated using the formula provided for the Rb-Sr dating method, with the given values of λ, tan(), and Sr. By substituting the values into the equation, the calculated age of the granite is 1200 million years.

Step 3: Conclusion.

The correct answer is 1200.0 million years.

Quick Tip

In radiometric dating, the age is calculated based on the isotope ratios and the decay constant. Ensure correct values are used for accurate results.

---

56. Consider a granulite facies metamorphic rock with peak metamorphic condition at 9 kbar, 850°C. Assume a single layer crust of $\rho = 3000$ kg/m^3 and $g = 10$ m/sec^2 during metamorphism. The depth of burial during peak metamorphism is (give answer in kilometers).

Correct Answer: 30.0 km

Solution:

Step 1: Understanding the question.

The question asks for the depth of burial during peak metamorphism based on the pressure (in kbar), density, and gravitational acceleration.

Step 2: Analyzing the solution.

The depth of burial (D) can be calculated using the formula:

$$P = \rho g D$$

Where P is the pressure, ρ is the density, and g is the gravitational acceleration. Rewriting the equation for depth:

$$D = \frac{P}{\rho g}$$

Substitute the given values:

$$D = \frac{9 \times 10^3}{3000 \times 10} = 30.0\,\text{km}$$

Step 3: Conclusion.

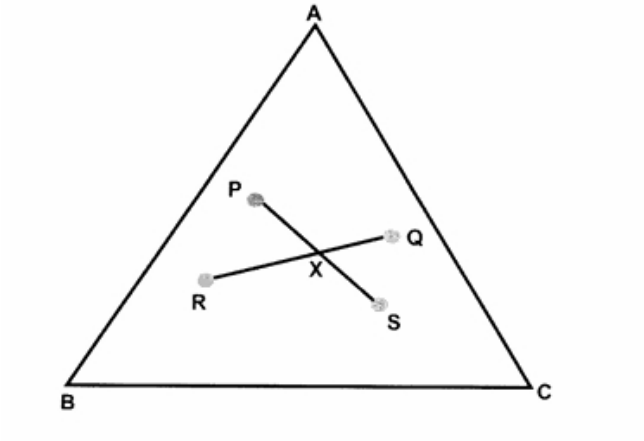
The correct answer is 30.0 km, the depth of burial during peak metamorphism.

Quick Tip

The depth of burial can be calculated using pressure, density, and gravitational acceleration. Ensure the units are consistent for correct calculation.

---

57. Consider four minerals P, Q, R, and S in a three-component chemical system (A-B-C) as shown in the figure. For a crossing tie-line relationship, the variance (degrees of freedom) of the equilibrium mineral assemblage at X is



Correct Answer: 2

Solution:

Step 1: Understanding the question.

The question involves the use of the Gibbs phase rule to calculate the variance (degrees of freedom) for the mineral assemblage at point X in a three-component system.

Step 2: Analyzing the solution.

The Gibbs phase rule for a system with C components and F phases is given by:

$$F = C - P + 2$$

Where F is the variance, C is the number of components, and P is the number of phases. In this case, for a three-component system with a crossing tie-line, there are 3 components and 2 phases at point X, so the variance is:

$$F = 3 - 2 + 2 = 2$$

Step 3: Conclusion.

The correct answer is 2, the variance at point X.

Quick Tip

The variance in a system can be calculated using the Gibbs phase rule, taking into account the number of components and phases.

---

58. The refractive indices of four minerals (P, Q, R, S) are as follows:

P ($\alpha = 1.712, \beta = 1.721, \gamma = 1.727$),

Q ($\varepsilon = 1.553, \omega = 1.544$),

R ($\alpha = 1.664, \beta = 1.672, \gamma = 1.694$) and

S ($\omega = 1.658, \varepsilon = 1.486$)

The value of maximum birefringence among all the minerals is (give answer in three decimal places).

Correct Answer: 0.183

Solution:

Step 1: Understanding the question.

The birefringence of a mineral is calculated as the difference between its maximum and minimum refractive indices.

Step 2: Analyzing the solution.

For each mineral, we calculate the birefringence by subtracting the minimum refractive index from the maximum refractive index: - P: $\gamma - \alpha = 1.727 - 1.712 = 0.015$ - Q: $\varepsilon - \omega = 1.553 - 1.544 = 0.009$ - R: $\gamma - \alpha = 1.694 - 1.664 = 0.030$ - S: $\omega - \varepsilon = 1.658 - 1.486 = 0.172$

The maximum birefringence is 0.183.

Step 3: Conclusion.

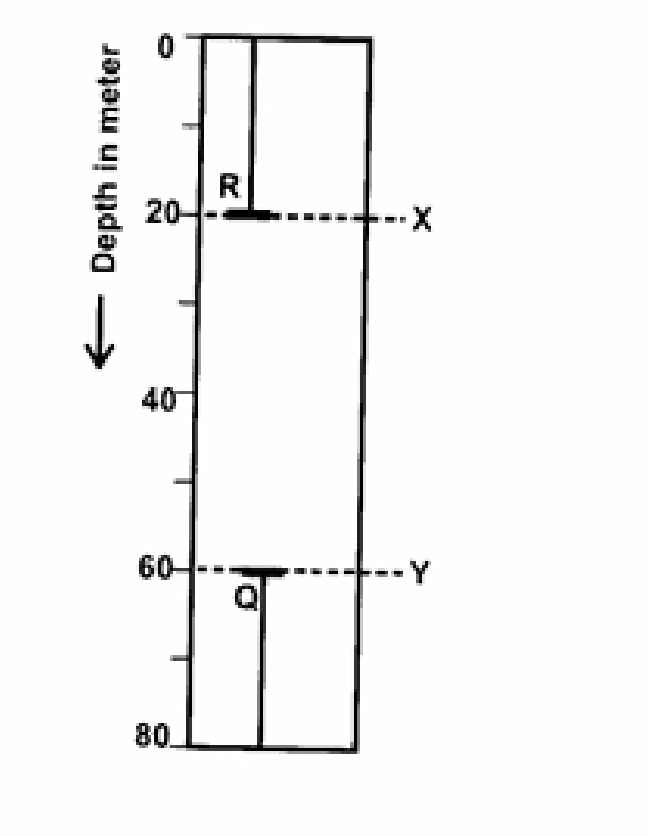
The correct answer is 0.183.

Quick Tip

Birefringence is the difference between the maximum and minimum refractive indices of a mineral.

---

59. In a sedimentary succession shown in the figure, the last occurrence of the fossil species Q (dated 50 Ma) and the first occurrence of the fossil species R (dated 30 Ma) are recorded at Y and X, respectively. The estimated rate of sedimentation is (assume constant rate of sedimentation).



Correct Answer: 1.0 m/million years

Solution:

Step 1: Understanding the question.

The question provides the ages of two fossil species (Q and R) at different depths in the sedimentary sequence and asks for the rate of sedimentation.

Step 2: Analyzing the solution.

The rate of sedimentation is calculated using the formula:

$$\text{Rate of Sedimentation} = \frac{\text{Depth difference}}{\text{Time difference}}$$

From the figure: - The depth difference between Y (Q) and X (R) is 20 meters. - The time difference between the first and last occurrences is 50 - 30 = 20 million years.

Thus, the rate of sedimentation is:

$$\text{Rate of Sedimentation} = \frac{20\,\text{m}}{20\,\text{million years}} = 1.0\,\text{m/million years}$$

Step 3: Conclusion.

The correct answer is 1.0 m/million years.

Quick Tip

The rate of sedimentation can be calculated by dividing the depth difference by the time difference between fossil occurrences.

---

60. The top surface of a coal seam is exposed at 150 m contour level on a hill top at location A. The same surface of the seam is also exposed on a river bed at location B at the 50 m contour level. The aerial distance A-B is 1 km. The amount of dip of the coal seam along A-B is (degree). (Give answer in one decimal place).

Correct Answer: 5.7°

Solution:

Step 1: Understanding the question.

The question asks for the dip of the coal seam based on the difference in contour levels and the horizontal distance between locations A and B.

Step 2: Analyzing the solution.

The formula to calculate the dip is given by:

$$\text{Dip} = \tan^{-1}\left(\frac{\text{Vertical Distance}}{\text{Horizontal Distance}}\right)$$

The vertical distance is $150 - 50 = 100$ m and the horizontal distance is 1 km = 1000 m.

Substituting into the formula:

$$\text{Dip} = \tan^{-1}\left(\frac{100}{1000}\right) = \tan^{-1}(0.1) = 5.7$$

Step 3: Conclusion.

The correct answer is 5.7°.

Quick Tip

Dip can be calculated using the vertical and horizontal distance between two points along the surface of a bed.
