IIT JAM 2018 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 among the following planets in the Solar system is most similar in size to Earth?

(A) Mercury

(B) Venus

(C) Neptune

(D) Uranus

Correct Answer: (B) Venus

Solution:

Step 1: Understanding the question.

The question asks which planet in the Solar System is most similar in size to Earth. When comparing the planets, the one closest in size to Earth is Venus, with a similar radius and mass.

Step 2: Analyzing the options.

(A) Mercury: Mercury is much smaller than Earth, with only about 38**(B) Venus:** Venus is nearly the same size as Earth, with only a slight difference in radius and mass.

(C) Neptune: Neptune is much larger than Earth, with a much greater size and mass.

(D) Uranus: Uranus is also larger than Earth, with a significantly greater radius.

Step 3: Conclusion.

The correct answer is **(B) Venus** because it is the planet most similar in size to Earth.

Quick Tip

When comparing planets, consider their size, mass, and radius for determining similarities. Venus is most similar to Earth in these aspects.

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2. In which one of the following tectonic settings are the highest mountain chains and thickest crust found?

(A) Island arc

(B) Continental arc

(C) Continental collision

(D) Transcurrent

Correct Answer: (C) Continental collision

Solution:

Step 1: Understanding the question.

The question focuses on tectonic settings where the highest mountain chains and thickest crust are found. Mountain chains and thick crust are typically associated with areas of continental collision.

Step 2: Analyzing the options.

(A) Island arc: Island arcs are typically associated with volcanic activity, not with the formation of thick crust and high mountains.

(B) Continental arc: Continental arcs form at subduction zones but do not typically produce the thickest crust.

(C) Continental collision: This is the correct answer. When two continents collide, the crust thickens, forming high mountain chains, like the Himalayas.

(D) Transcurrent: Transcurrent or transform boundaries do not lead to the formation of mountain chains or thick crust.

Step 3: Conclusion.

The correct answer is **(C) Continental collision** because this is where the thickest crust and highest mountain chains are formed.

Quick Tip

Continental collisions lead to the formation of the largest and most prominent mountain ranges due to the compression and thickening of the Earth's crust.

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3. The second-most abundant oxide in the Earth's crust is

(A) Al_2O_3

(B) SiO_2

(C) CaO

(D) Na_2O

Correct Answer: (B) SiO_2

Solution:

Step 1: Understanding the question.

The question asks for the second-most abundant oxide in the Earth's crust. The most abundant oxide is SiO_2, or silicon dioxide, which makes up a significant portion of the Earth's crust.

Step 2: Analyzing the options.

(A) Al_2O_3: This is aluminum oxide, but it is not as abundant as silicon dioxide.

(B) SiO_2: This is silicon dioxide, which is the most abundant oxide in the Earth's crust.

(C) CaO: Calcium oxide is less abundant compared to silicon dioxide and aluminum oxide.

(D) Na_2O: Sodium oxide is even less common than calcium oxide.

Step 3: Conclusion.

The correct answer is **(B) SiO_2** as silicon dioxide is the second-most abundant oxide in the Earth's crust.

Quick Tip

Silicon dioxide (SiO_2) is a major component of the Earth's crust, forming minerals like quartz and contributing to the crust's composition.

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4. The type of dentition found in Trigonia is

(A) schizodont

(B) taxodont

(C) pachydont

(D) isodont

Correct Answer: (B) taxodont

Solution:

Step 1: Understanding the question.

The question is asking about the type of dentition found in Trigonia, a genus of extinct bivalve mollusks.

Step 2: Analyzing the options.

(A) schizodont: This type of dentition refers to a form with sharp, widely spaced teeth, which is not characteristic of Trigonia.

(B) taxodont: This is the correct answer. Taxodont dentition refers to small, numerous teeth found in certain bivalves, such as Trigonia.

(C) pachydont: Pachydont dentition is characterized by thick teeth, which is not found in Trigonia.

(D) isodont: Isodont dentition refers to having uniform teeth, which does not match Trigonia's dentition.

Step 3: Conclusion.

The correct answer is **(B) taxodont** because Trigonia has taxodont dentition.

Quick Tip

Taxodont dentition is a feature of many bivalve species and is characterized by the presence of many small teeth in a row.

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5. Which one of the following minerals has isolated $(SiO_4)^{4-}$ tetrahedra linked by divalent cations in octahedral coordination?

(A) Muscovite

(B) Quartz

(C) Beryl

(D) Olivine

Correct Answer: (D) Olivine

Solution:

Step 1: Understanding the question.

The question asks about a mineral that has isolated tetrahedra of SiO_4 linked by divalent cations in octahedral coordination. This is characteristic of the mineral olivine.

Step 2: Analyzing the options.

(A) Muscovite: Muscovite is a type of mica, with a different structure from olivine.

(B) Quartz: Quartz consists of SiO_2 where the tetrahedra are not isolated, but form a continuous chain or framework.

(C) Beryl: Beryl is a silicate mineral with a hexagonal crystal structure, not isolated tetrahedra.

(D) Olivine: This is the correct answer. Olivine has isolated SiO_4 tetrahedra linked by divalent cations in octahedral coordination.

Step 3: Conclusion.

The correct answer is **(D) Olivine** because it matches the description of the mineral with isolated SiO_4 tetrahedra.

Quick Tip

Olivine is a silicate mineral with isolated tetrahedra linked by divalent cations, commonly found in igneous rocks.

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6. Which one of the following is NOT found in an extensional setting?

(A) Normal faults

(B) Horsts

(C) Rifts

(D) Thrust faults

Correct Answer: (D) Thrust faults

Solution:

Step 1: Understanding the question.

The question is asking about the type of fault that is NOT typically associated with

extensional tectonic settings. Extensional settings are characterized by stretching and thinning of the Earth's crust.

Step 2: Analyzing the options.

(A) Normal faults: Normal faults are typical in extensional settings where the crust is stretched.

(B) Horsts: Horsts are raised blocks of crust, which form in extensional settings, often between normal faults.

(C) Rifts: Rifts are zones of crustal stretching that also form in extensional settings.

(D) Thrust faults: Thrust faults are associated with compressional settings, not extensional ones, where the crust is shortened.

Step 3: Conclusion.

The correct answer is **(D) Thrust faults** because they are found in compressional settings, not extensional ones.

Quick Tip

In extensional settings, you will find normal faults, rifts, and horsts. Thrust faults are characteristic of compressional settings.

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7. The texture characterized by exsolved lamellae of albite in K-feldspar is known as

(A) myrmekite

(B) graphic

(C) perthite

(D) antiperthite

Correct Answer: (C) perthite

Solution:

Step 1: Understanding the question.

The question asks about a specific texture in minerals characterized by the exsolution of albite in K-feldspar. This texture is typically referred to as perthite.

Step 2: Analyzing the options.

(A) myrmekite: Myrmekite is a texture where quartz forms intergrowths with feldspar, but not related to albite in K-feldspar.

(B) graphic: The graphic texture refers to the intergrowth of two minerals, commonly quartz and feldspar, but not exsolved albite.

(C) perthite: This is the correct answer. Perthite refers to a texture in K-feldspar where exsolved albite forms thin lamellae within the feldspar.

(D) antiperthite: Antiperthite is the opposite texture, where exsolved K-feldspar is present in albite.

Step 3: Conclusion.

The correct answer is **(C) perthite** because it specifically refers to the exsolution texture of albite in K-feldspar.

Quick Tip

Perthite is a texture found in K-feldspar where albite exsolution occurs, creating lamellae within the mineral.

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8. Fissility is best shown by

(A) sandstone

(B) siltstone

(C) shale

(D) limestone

Correct Answer: (C) shale

Solution:

Step 1: Understanding the question.

The question asks which rock type best shows fissility, the ability to break into thin layers. Fissility is commonly associated with fine-grained sedimentary rocks.

Step 2: Analyzing the options.

(A) sandstone: Sandstone is not typically fissile; it tends to break in a more granular manner due to its larger particle size.

(B) siltstone: Siltstone is fine-grained and may show some fissility but is not as strongly fissile as shale.

(C) shale: Shale is a fine-grained sedimentary rock that is highly fissile, meaning it easily splits into thin layers.

(D) limestone: Limestone is not fissile, as it is typically a coarser-grained rock.

Step 3: Conclusion.

The correct answer is **(C) shale** because it is the rock most associated with fissility.

Quick Tip

Shale is known for its fissility and is easily split into thin layers, making it ideal for studying sedimentary layers.

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9. Petroleum is NOT commercially produced from

(A) Krishna–Godavari basin

(B) Cauvery–Palar basin

(C) Cambay basin

(D) Vindhyan basin

Correct Answer: (D) Vindhyan basin

Solution:

Step 1: Understanding the question.

The question asks where petroleum is not commercially produced. Some of the mentioned basins are known for petroleum production.

Step 2: Analyzing the options.

(A) Krishna–Godavari basin: This basin is known for its commercial petroleum and natural gas production.

(B) Cauvery–Palar basin: The Cauvery basin also produces petroleum commercially.

(C) Cambay basin: The Cambay basin is another source of petroleum in India.

(D) Vindhyan basin: This basin does not have significant petroleum production, making it the correct answer.

Step 3: Conclusion.

The correct answer is **(D) Vindhyan basin** because it is not known for petroleum production.

Quick Tip

When studying petroleum basins, focus on their historical production data and the presence of oil reserves.

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10. Among the following, the mineral showing acicular habit is

(A) kyanite

(B) tourmaline

(C) biotite

(D) sillimanite

Correct Answer: (B) tourmaline

Solution:

Step 1: Understanding the question.

The question asks about a mineral that shows acicular habit, meaning the mineral crystals are needle-like or slender.

Step 2: Analyzing the options.

(A) kyanite: Kyanite forms bladed crystals, not acicular ones.

(B) tourmaline: Tourmaline commonly shows an acicular habit, with needle-like crystals.

(C) biotite: Biotite forms sheets or plates, not acicular crystals.

(D) sillimanite: Sillimanite can have fibrous crystals but is not known for an acicular habit.

Step 3: Conclusion.

The correct answer is **(B) tourmaline** because it is the mineral that typically exhibits an acicular habit.

Quick Tip

Tourmaline is a mineral that often forms in slender, needle-like crystals, making it a classic example of acicular habit.

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11. Isostasy involves ..... continental mountain belts.

(A) compensation in

(B) creation of

(C) destruction of

(D) thrusting in

Correct Answer: (A) compensation in

Solution:

Step 1: Understanding the concept.

Isostasy refers to the equilibrium that exists between the Earth's lithosphere and asthenosphere. It involves the vertical movement of the crust in response to changes in load. In continental mountain belts, this process leads to compensation, where the lithosphere adjusts to balance the weight of the mountains.

Step 2: Analyzing the options.

(A) compensation in: This is the correct answer, as isostatic compensation occurs in continental mountain belts.

(B) creation of: This is incorrect because isostasy does not create mountain belts; it adjusts the Earth's crust.

(C) destruction of: This is incorrect, as isostasy does not destroy mountain belts but helps maintain balance.

(D) thrusting in: Thrusting is a tectonic process, not directly related to isostatic compensation.

Step 3: Conclusion.

The correct answer is **(A) compensation in** because isostasy involves the adjustment of the Earth's crust in response to mountain formation.

Quick Tip

Isostasy is crucial in understanding how mountain belts balance their mass, with crustal compensation playing a key role in maintaining equilibrium.

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12. Identify the pair from the following list that is NOT correctly matched.

(A) Caldera – stratovolcano

(B) Pillow basalt – subaerial eruption

(C) Ropy lava – pahoehoe flow

(D) Amygdales – filled vesicles

Correct Answer: (B) Pillow basalt – subaerial eruption

Solution:

Step 1: Understanding the question.

The question asks to identify the incorrectly matched pair. Each pair relates to volcanic features, and we need to identify which one is not accurate.

Step 2: Analyzing the options.

(A) Caldera – stratovolcano: This is correct. A caldera is typically associated with the collapse of a stratovolcano.

(B) Pillow basalt – subaerial eruption: This is incorrect. Pillow basalt forms in underwater eruptions, not subaerial (land-based) eruptions.

(C) Ropy lava – pahoehoe flow: This is correct. Pahoehoe lava flows are characterized by a smooth, ropy texture.

(D) Amygdales – filled vesicles: This is correct. Amygdales are cavities in volcanic rocks that are filled with secondary minerals.

Step 3: Conclusion.

The correct answer is **(B) Pillow basalt – subaerial eruption** because pillow basalts form during underwater eruptions.

Quick Tip

Pillow basalt forms underwater when lava cools rapidly upon contact with water, creating characteristic pillow-shaped structures.

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13. Wilson orogenic cycle in continents is initiated by

(A) collision

(B) rifting

(C) drifting

(D) subduction

Correct Answer: (B) rifting

Solution:

Step 1: Understanding the Wilson cycle.

The Wilson orogenic cycle describes the process of continental rifting, drifting, collision, and mountain-building. It starts with rifting, where a continent begins to break apart, leading to the formation of a new ocean.

Step 2: Analyzing the options.

(A) collision: Collision occurs later in the cycle when two continents converge to form a mountain range.

(B) rifting: This is the correct answer. The Wilson cycle begins with rifting, which leads to the formation of an ocean basin.

(C) drifting: Drifting occurs after rifting and during the separation of continents.

(D) subduction: Subduction is part of the cycle but occurs later when oceanic crust is consumed at plate boundaries.

Step 3: Conclusion.

The correct answer is **(B) rifting** because the Wilson cycle begins with the rifting of continents.

Quick Tip

The Wilson cycle describes the lifecycle of ocean basins and mountain-building processes, beginning with continental rifting.

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14. Match the processes in Group I with corresponding geomorphic features in Group II.

Group I

P. Dissolution

Q. Abrasion

R. Deposition

S. Onion skin weathering

Group II

1. Mushroom rocks
2. Exfoliation domes
3. Sinkholes
4. Moraines

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

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

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

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

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

Solution:

Step 1: Understanding the processes and features.

The question asks to match geological processes with their corresponding geomorphic features. Dissolution leads to sinkholes, abrasion forms mushroom rocks, deposition forms moraines, and onion skin weathering forms exfoliation domes.

Step 2: Analyzing the options.

(A) P-1, Q-3, R-2, S-4: This is the correct answer.

- Dissolution leads to sinkholes (P-1).
- Abrasion forms mushroom rocks (Q-3).
- Deposition forms moraines (R-2).
- Onion skin weathering forms exfoliation domes (S-4).

Step 3: Conclusion.

The correct answer is **(A) P-1, Q-3, R-2, S-4**.

Quick Tip

Dissolution, abrasion, and deposition are key geological processes responsible for various geomorphic features such as sinkholes, mushroom rocks, and moraines.

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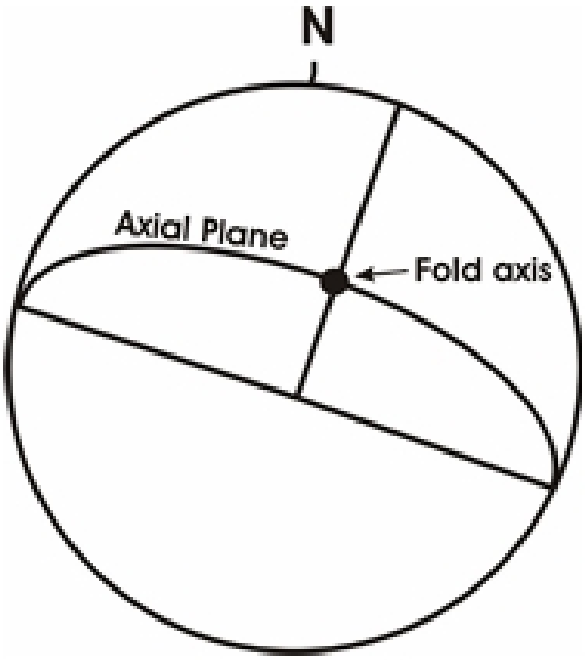
15. The orientations of the fold axis and axial plane in the given figure indicate



(A) reclined fold

(B) vertical fold

(C) recumbent fold

(D) horizontal fold

Correct Answer: (C) recumbent fold

Solution:

Step 1: Understanding the fold types.

The question is asking about the type of fold based on the orientations of the fold axis and axial plane. A recumbent fold occurs when the axial plane is almost horizontal, and the fold is so tightly compressed that the limbs of the fold are nearly parallel to each other.

Step 2: Analyzing the options.

(A) reclined fold: A reclined fold is characterized by a slightly inclined axial plane, but not as horizontal as in a recumbent fold.

(B) vertical fold: A vertical fold has a nearly vertical axial plane, unlike the horizontal nature of a recumbent fold.

(C) recumbent fold: This is the correct answer. The axial plane is nearly horizontal, and the limbs are tightly compressed.

(D) horizontal fold: A horizontal fold would have a perfectly horizontal axial plane, not a slightly inclined one.

Step 3: Conclusion.

The correct answer is **(C) recumbent fold** because of the near-horizontal axial plane and tight fold structure.

Quick Tip

In fold classification, a recumbent fold is characterized by a horizontal or nearly horizontal axial plane with nearly parallel limbs.

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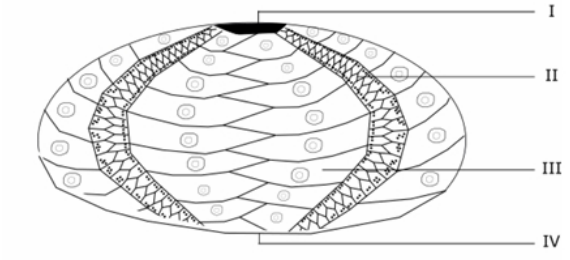
16. Identify the correct morphological features corresponding to numbers I – IV in the echinoid illustrated below:



(A) I-Periproct II-Ambulacra III-Interambulacra IV-Peristome

(B) I-Periproct II-Interambulacra III-Ambulacra IV-Peristome

(C) I-Peristome II-Interambulacra III-Ambulacra IV-Periproct

(D) I-Peristome II-Ambulacra III-Interambulacra IV-Periproct

Correct Answer: (A) I-Periproct II-Ambulacra III-Interambulacra IV-Peristome

Solution:

Step 1: Understanding echinoid morphology.

Echinoids are echinoderms (sea urchins) with a specific set of morphological features. These include the periproct (where the anus is located), ambulacra (the areas where tube feet are located), interambulacra (the areas between the ambulacra), and the peristome (the mouth area).

Step 2: Analyzing the options.

(A) I-Periproct II-Ambulacra III-Interambulacra IV-Peristome: This is the correct answer. This matches the typical echinoid morphology, where the periproct is the anus, the ambulacra are the radial areas with tube feet, the interambulacra are the spaces between them, and the peristome is the mouth.

(B) I-Periproct II-Interambulacra III-Ambulacra IV-Peristome: This is incorrect because the positions of the ambulacra and interambulacra are swapped.

(C) I-Peristome II-Interambulacra III-Ambulacra IV-Periproct: This is incorrect because the peristome is not correctly positioned as the mouth.

(D) I-Peristome II-Ambulacra III-Interambulacra IV-Periproct: This is incorrect because the peristome and periproct are swapped.

Step 3: Conclusion.

The correct answer is **(A) I-Periproct II-Ambulacra III-Interambulacra IV-Peristome** because this accurately reflects the positions of the features in an echinoid.

Quick Tip

Echinoid morphology is crucial in understanding their structure, including the periproct, ambulacra, interambulacra, and peristome, which are always in specific positions.

17. The correct order of marine benthic habitats with increasing water depths is

(A) abyssal, bathyal, neritic

(B) neritic, abyssal, bathyal

(C) neritic, bathyal, abyssal

(D) bathyal, abyssal, neritic

Correct Answer: (C) neritic, bathyal, abyssal

Solution:

Step 1: Understanding the marine benthic zones.

Marine benthic habitats are categorized by their depth in the ocean. The neritic zone is the shallowest, typically from the shoreline to the continental shelf. The bathyal zone is deeper and extends from the continental shelf to the abyssal plain, which is the deepest part of the ocean.

Step 2: Analyzing the options.

(A) abyssal, bathyal, neritic: This order is incorrect because the neritic zone is the shallowest, not the deepest.

(B) neritic, abyssal, bathyal: This order is incorrect because abyssal comes before bathyal in depth.

(C) neritic, bathyal, abyssal: This is the correct order, with neritic being the shallowest, followed by bathyal and abyssal as the deeper zones.

(D) bathyal, abyssal, neritic: This is incorrect, as the neritic zone is the shallowest.

Step 3: Conclusion.

The correct answer is **(C) neritic, bathyal, abyssal** because these zones follow the correct depth sequence.

Quick Tip

Remember the order of marine benthic zones: neritic (shallow), bathyal (mid-depth), and abyssal (deepest).

18. Which one of the following invertebrates has the most primitive visual system?

(A) Ammonites

(B) Brachiopods

(C) Gastropods

(D) Trilobites

Correct Answer: (D) Trilobites

Solution:

Step 1: Understanding the visual systems of invertebrates.

The visual systems of invertebrates vary greatly. Some invertebrates, such as trilobites, had simple eyes known as compound eyes, which are considered primitive compared to the more advanced visual systems found in other invertebrates.

Step 2: Analyzing the options.

(A) Ammonites: Ammonites had highly developed eyes, with complex lenses, much more advanced than trilobites.

(B) Brachiopods: Brachiopods have simple visual structures or none at all, but not the most primitive compared to trilobites.

(C) Gastropods: Gastropods have complex eyes with lenses and retinas, more advanced than trilobites.

(D) Trilobites: This is the correct answer. Trilobites had compound eyes, considered one of the most primitive visual systems in the animal kingdom.

Step 3: Conclusion.

The correct answer is **(D) Trilobites** because they had the most primitive visual system among the options provided.

Quick Tip

Trilobites are known for their compound eyes, which are considered primitive compared to modern visual systems.

19. The correct chronological sequence (older to younger) of the Precambrian stratigraphic units listed below is

(A) Sargur Group, Chitradurga Group, Alwar Group, Kaimur Group

(B) Chitradurga Group, Sargur Group, Kaimur Group, Alwar Group

(C) Sargur Group, Alwar Group, Chitradurga Group, Kaimur Group

(D) Sargur Group, Chitradurga Group, Kaimur Group, Alwar Group

Correct Answer: (D) Sargur Group, Chitradurga Group, Kaimur Group, Alwar Group

Solution:

Step 1: Understanding the sequence.

The Precambrian is divided into various stratigraphic units based on geological age. The Sargur Group is the oldest, followed by the Chitradurga Group, then the Kaimur Group, and finally the Alwar Group.

Step 2: Analyzing the options.

(A) Sargur Group, Chitradurga Group, Alwar Group, Kaimur Group: This is incorrect as the Kaimur Group is older than the Alwar Group.

(B) Chitradurga Group, Sargur Group, Kaimur Group, Alwar Group: This is incorrect because Sargur Group is older than Chitradurga Group.

(C) Sargur Group, Alwar Group, Chitradurga Group, Kaimur Group: This is incorrect because Alwar Group is the youngest.

(D) Sargur Group, Chitradurga Group, Kaimur Group, Alwar Group: This is the correct sequence based on the geological history.

Step 3: Conclusion.

The correct answer is **(D) Sargur Group, Chitradurga Group, Kaimur Group, Alwar Group** as it follows the correct chronological order of these stratigraphic units.

Quick Tip

When identifying chronological sequences, refer to the relative ages of geological formations. The oldest units come first, followed by younger units.

20. Match the Formations in Group I with corresponding characteristic fossils in Group II.

Group I

P. Barakar Formation

Q. Uttar Formation

R. Dhok Pathan Formation

S. Lameta Formation

Group II

1. Stegodon
2. Sauropoda
3. Belemnites
4. Glossopteris

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

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

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

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

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

Solution:

Step 1: Understanding the fossil associations.

Each formation is associated with specific characteristic fossils. The Barakar Formation is associated with Glossopteris, a fossil plant; the Uttar Formation is associated with Sauropoda, a type of dinosaur; the Dhok Pathan Formation is associated with Belemnites, marine cephalopods; and the Lameta Formation is associated with Stegodon, a prehistoric elephant.

Step 2: Analyzing the options.

(A) P-4, Q-3, R-2, S-1: This is the correct matching.

(B) P-3, Q-1, R-4, S-2: This is incorrect as the fossils do not match the formations.

(C) P-1, Q-3, R-4, S-2: This is incorrect as the fossils do not match the formations.

(D) P-4, Q-2, R-3, S-1: This is incorrect as the fossils do not match the formations.

Step 3: Conclusion.

The correct answer is **(A) P-4, Q-3, R-2, S-1** based on the fossil associations with the respective formations.

Quick Tip

Understanding fossil associations with geological formations helps identify the paleontological history of an area.

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21. Which one of the following sedimentary structures is NOT used for determining top and bottom of beds?

(A) Mud cracks

(B) Load and flame structures

(C) Sharp-crested wave ripples

(D) Plane lamination

Correct Answer: (D) Plane lamination

Solution:

Step 1: Understanding sedimentary structures.

Sedimentary structures help determine the orientation of beds, indicating top and bottom. Mud cracks, load and flame structures, and sharp-crested wave ripples are commonly used to interpret bed orientation, while plane lamination does not provide clear top or bottom indicators.

Step 2: Analyzing the options.

(A) Mud cracks: Mud cracks are useful for determining the top of the bed because they form when the surface dries and cracks, indicating the bed's exposure to air.

(B) Load and flame structures: These structures form under compressive stress and are used to determine the top and bottom of beds.

(C) Sharp-crested wave ripples: These ripples form on sediment surfaces in water, and their symmetry helps identify the top of the bed.

(D) Plane lamination: Plane lamination is a structure where there is no clear indication of top or bottom. It is not used to determine the orientation of beds.

Step 3: Conclusion.

The correct answer is **(D) Plane lamination** because it does not help in determining the top and bottom of the beds.

Quick Tip

To determine the top and bottom of sedimentary beds, focus on structures that are formed by environmental conditions, such as mud cracks and wave ripples.

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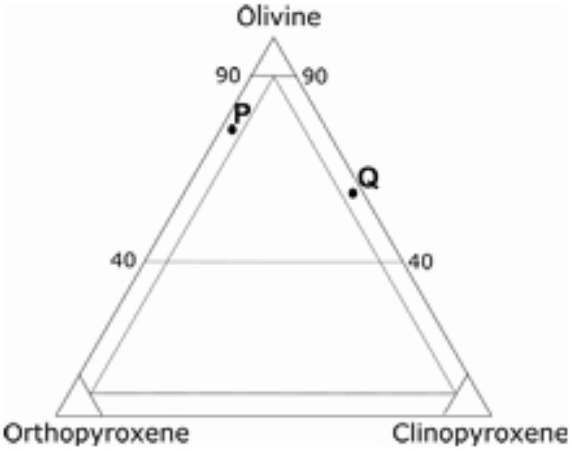
22. Identify the rocks P and Q in the diagram as per the IUGS classification.



(A) P – Webstetite, Q – Wehrlite

(B) P – Dunite, Q – Webstetite

(C) P – Webstetite, Q – Dunite

(D) P – Harzburgite, Q – Wehrlite

Correct Answer: (A) P – Webstetite, Q – Wehrlite

Solution:

Step 1: Understanding the IUGS classification.

The IUGS classification system categorizes ultramafic rocks based on their mineral composition. Webstetite and Wehrlite are both ultramafic rocks with specific mineral

compositions, and they are classified according to the proportions of olivine, orthopyroxene, and clinopyroxene.

Step 2: Analyzing the options.

(A) P – Webstetite, Q – Wehrlite: This is the correct answer based on the classification.

(B) P – Dunite, Q – Webstetite: Dunite is primarily composed of olivine, which doesn't fit the given diagram.

(C) P – Webstetite, Q – Dunite: This is incorrect as Dunite doesn't match the classification for P.

(D) P – Harzburgite, Q – Wehrlite: Harzburgite is a different classification and doesn't match the diagram.

Step 3: Conclusion.

The correct answer is **(A) P – Webstetite, Q – Wehrlite** based on their mineral compositions as per the IUGS classification.

Quick Tip

In the IUGS classification, the key is to identify the mineral composition of the rocks, particularly the ratios of olivine, pyroxenes, and other minerals.

---

23. Which one of the following is produced by a closed-system metamorphic reaction between muscovite and quartz?

(A) orthoclase + sillimanite

(B) orthoclase + biotite

(C) plagioclase + biotite

(D) plagioclase + sillimanite

Correct Answer: (A) orthoclase + sillimanite

Solution:

Step 1: Understanding metamorphic reactions.

The question asks about the closed-system metamorphic reaction between muscovite and

quartz. In such reactions, muscovite (a mica) reacts with quartz to form orthoclase and sillimanite under high pressure and temperature conditions.

Step 2: Analyzing the options.

(A) orthoclase + sillimanite: This is the correct answer as it matches the typical products of this metamorphic reaction.

(B) orthoclase + biotite: This is incorrect, as biotite would not form in this specific reaction.

(C) plagioclase + biotite: This is incorrect because plagioclase and biotite are not the products of this reaction.

(D) plagioclase + sillimanite: This is also incorrect because plagioclase is not involved in the reaction between muscovite and quartz.

Step 3: Conclusion.

The correct answer is **(A) orthoclase + sillimanite**.

Quick Tip

In closed-system metamorphic reactions, muscovite and quartz commonly produce orthoclase and sillimanite when subjected to high pressure and temperature.

---

24. The assemblage staurolite + garnet + biotite + muscovite + quartz in pelites is stable in

(A) greenschist facies

(B) amphibolite facies

(C) granulite facies

(D) pyroxene hornfels facies

Correct Answer: (B) amphibolite facies

Solution:

Step 1: Understanding facies and mineral assemblages.

Facies are used to describe the metamorphic conditions (temperature and pressure) under which specific mineral assemblages form. The given assemblage of staurolite, garnet, biotite,

muscovite, and quartz typically forms in the amphibolite facies, which corresponds to medium to high-grade metamorphism.

Step 2: Analyzing the options.

(A) greenschist facies: Greenschist facies is a lower-grade metamorphic condition and does not stabilize the mentioned assemblage.

(B) amphibolite facies: This is the correct answer. The given mineral assemblage is typical for the amphibolite facies.

(C) granulite facies: Granulite facies represents high-grade metamorphism, which would typically involve different mineral assemblages.

(D) pyroxene hornfels facies: This is incorrect, as hornfels facies involves minerals like pyroxenes and feldspars, not the mentioned assemblage.

Step 3: Conclusion.

The correct answer is **(B) amphibolite facies**.

Quick Tip

In metamorphic rocks, different mineral assemblages are stable at different temperatures and pressures, with the amphibolite facies being associated with medium to high-grade conditions.

---

25. Conglomerates are commonly deposited in

(A) aeolian dunes

(B) tidal flats

(C) alluvial fans

(D) river flood plains

Correct Answer: (C) alluvial fans

Solution:

Step 1: Understanding the depositional environments of conglomerates.

Conglomerates are coarse-grained sedimentary rocks composed of rounded pebbles and

boulders. These rocks are typically deposited in high-energy environments, such as alluvial fans, where fast-moving water transports and deposits large clasts.

Step 2: Analyzing the options.

(A) aeolian dunes: Aeolian dunes are formed by wind, and they typically deposit fine-grained sand, not conglomerates.

(B) tidal flats: Tidal flats are low-energy environments where fine sediments like mud and silt are deposited, not conglomerates.

(C) alluvial fans: This is the correct answer. Alluvial fans are high-energy depositional environments where conglomerates are commonly formed.

(D) river flood plains: While river flood plains can deposit coarse sediments, conglomerates are more commonly associated with alluvial fans.

Step 3: Conclusion.

The correct answer is **(C) alluvial fans** because these environments are typically where conglomerates are deposited.

Quick Tip

Conglomerates form in high-energy environments like alluvial fans, where fast-moving water can transport and deposit large clasts.

---

26. Match the mineral deposits in Group I with corresponding Indian occurrences in Group II.

Group I

P. Iron

Q. Uranium

R. Manganese

S. Baryte

Group II

1. Mangampet, Andhra Pradesh
2. Balaghat, Madhya Pradesh

3. Narwa Pahar, Jharkhand

4. Hospet, Karnataka

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

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

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

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

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

Solution:

Step 1: Understanding mineral deposits and their Indian occurrences.

This question asks for the matching of Indian mineral deposits with their locations. The corresponding locations are: Mangampet for Baryte, Balaghat for Manganese, Narwa Pahar for Uranium, and Hospet for Iron.

Step 2: Analyzing the options.

(A) P-1, Q-4, R-3, S-2: This is incorrect as the locations do not match the mineral deposits.

(B) P-3, Q-1, R-4, S-2: This is incorrect as the locations do not match the mineral deposits.

(C) P-1, Q-3, R-4, S-2: This is the correct answer as it matches the minerals with their locations.

(D) P-4, Q-2, R-3, S-1: This is incorrect as the locations do not match the mineral deposits.

Step 3: Conclusion.

The correct answer is **(C) P-1, Q-3, R-4, S-2** based on the correct matching of minerals with Indian locations.

Quick Tip

Mineral deposits are geographically distributed across India, with different regions being rich in specific minerals such as iron, uranium, manganese, and baryte.

---

27. Which one of the following processes is responsible for the formation of syngenetic Ni-Cu sulphide ore in gabbro-norite rocks?

(A) Hydrothermal replacement

(B) Volcanic exhalation

(C) Liquid immiscibility

(D) Contact metamorphism

Correct Answer: (C) Liquid immiscibility

Solution:

Step 1: Understanding the formation of Ni-Cu sulphide ores.

Ni-Cu sulphide ores in gabbro-norite rocks are formed through a process called liquid immiscibility. This occurs when magma separates into two immiscible liquids, one rich in sulphide minerals, which eventually solidifies as ore deposits.

Step 2: Analyzing the options.

(A) Hydrothermal replacement: This process involves the replacement of minerals by hydrothermal fluids but is not responsible for the formation of Ni-Cu sulphide ores.

(B) Volcanic exhalation: Volcanic exhalation is a process involving the release of gases, not related to the formation of these ores.

(C) Liquid immiscibility: This is the correct process, where the magma separates into sulphide-rich liquid, leading to the formation of Ni-Cu sulphide ores.

(D) Contact metamorphism: Contact metamorphism involves heat from an intrusion altering surrounding rocks, but it is not responsible for the formation of Ni-Cu sulphide ores.

Step 3: Conclusion.

The correct answer is **(C) Liquid immiscibility** because this process is responsible for the formation of syngenetic Ni-Cu sulphide ore.

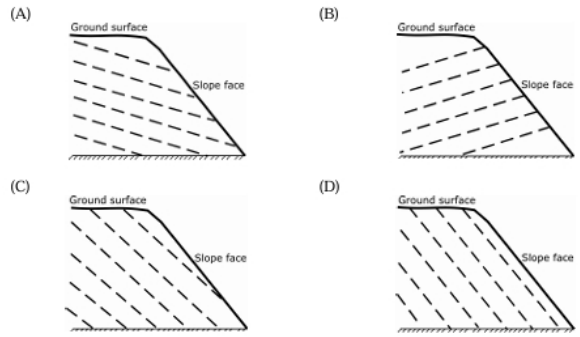
Quick Tip

Liquid immiscibility occurs in magmatic systems, where different liquid phases separate, forming mineral deposits such as Ni-Cu sulphides.

---

28. Dashed lines in the figures given below represent joints. Considering only the orientations of the joints and the slope face, which one of the following represents the

most stable slope?



Correct Answer: (B)

Solution:

Step 1: Understanding joint orientations and slope stability.

In terms of slope stability, a joint that is aligned parallel to the slope face is more prone to sliding and can cause instability. Conversely, joints that are oriented perpendicular to the slope face tend to stabilize the slope.

Step 2: Analyzing the options.

(A) Option A: The joint is oriented in a way that may promote sliding along the slope face, which is less stable.

(B) Option B: This is the correct answer. The joint orientation in this figure will provide maximum stability by preventing sliding.

(C) Option C: The joint orientation in this option is not optimal for stability.

(D) Option D: The joint orientation may lead to some instability in the slope.

Step 3: Conclusion.

The correct answer is **(B)**, as the joint orientation provides the most stable slope configuration.

Quick Tip

For maximum slope stability, joints should be oriented perpendicular to the slope face to resist sliding.

29. Match the morphological features/life processes in Group I with corresponding organisms in Group II.

Group I

P. Water vascular system

Q. Molting

R. Jet propulsion locomotion

S. Lophophore

Group II

1. Cephalopoda
2. Echinodermata
3. Brachiopoda
4. Trilobita

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

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

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

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

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

Solution:

Step 1: Understanding the life processes and corresponding organisms.

Each life process corresponds to a specific organism: the water vascular system is unique to Echinodermata (e.g., starfish), molting is characteristic of arthropods (e.g., Trilobita), jet propulsion locomotion is found in Cephalopoda (e.g., squid), and lophophores are found in Brachiopoda.

Step 2: Analyzing the options.

(A) P-2, Q-3, R-1, S-4: This is the correct matching.

(B) P-3, Q-1, R-4, S-2: This is incorrect as the organisms do not match the life processes.

(C) P-1, Q-3, R-4, S-2: This is incorrect as the organisms do not match the life processes.

(D) P-4, Q-2, R-3, S-1: This is incorrect as the organisms do not match the life processes.

Step 3: Conclusion.

The correct answer is **(A) P-2, Q-3, R-1, S-4**.

Quick Tip

The key to matching life processes and organisms is understanding the unique characteristics of each group, such as the water vascular system in Echinodermata and molting in arthropods.

---

30. Match the plutonic rocks in Group I with corresponding volcanic equivalents in Group II.

Group I

P. Granite

Q. Syenite

R. Diorite

S. Gabbro

Group II

1. Andesite
2. Basalt
3. Rhyolite
4. Trachyte

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

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

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

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

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

Solution:

Step 1: Understanding plutonic and volcanic equivalents.

Plutonic rocks are formed from the cooling of magma beneath the Earth's surface, while volcanic rocks form when lava cools on the surface. The corresponding volcanic equivalents for the given plutonic rocks are:

- Granite corresponds to Rhyolite (P-3).
- Syenite corresponds to Trachyte (Q-4).
- Diorite corresponds to Andesite (R-1).
- Gabbro corresponds to Basalt (S-2).

Step 2: Analyzing the options.

(A) P-2, Q-3, R-4, S-1: This is incorrect because the rock types do not match their volcanic equivalents.

(B) P-3, Q-4, R-1, S-2: This is the correct answer as it matches the plutonic and volcanic rock equivalents.

(C) P-1, Q-3, R-4, S-2: This is incorrect because the rock types do not match their volcanic equivalents.

(D) P-4, Q-2, R-3, S-1: This is incorrect because the rock types do not match their volcanic equivalents.

Step 3: Conclusion.

The correct answer is **(B) P-3, Q-4, R-1, S-2**.

Quick Tip

Remember that granite corresponds to rhyolite, syenite corresponds to trachyte, diorite corresponds to andesite, and gabbro corresponds to basalt.

---

31. Which of the following change(s) when a dipping bed with a plunging lineation is rotated about a vertical axis?

(A) Dip amount of bed

(B) Plunge amount of lineation

(C) Plunge direction of lineation

(D) Strike of bed

Correct Answer: (C) Plunge direction of lineation

Solution:

Step 1: Understanding bed rotation.

When a dipping bed with a plunging lineation is rotated about a vertical axis, the amount of plunge and the direction of lineation change. The strike of the bed does not change. The key change here is in the plunge direction of the lineation.

Step 2: Analyzing the options.

(A) Dip amount of bed: The dip amount does not change in this type of rotation.

(B) Plunge amount of lineation: The plunge amount of lineation is not affected by the vertical axis rotation.

(C) Plunge direction of lineation: This is the correct answer, as rotating the bed about a vertical axis will change the plunge direction of the lineation.

(D) Strike of bed: The strike does not change in this rotation.

Step 3: Conclusion.

The correct answer is **(C) Plunge direction of lineation**.

Quick Tip

When rotating geological structures, remember that rotations about a vertical axis affect the plunge direction, but not the amount of plunge or strike.

---

32. Which of the following indicate(s) the presence of directed stress in a rock?

(A) Porphyritic texture

(B) Schistosity

(C) Gneissosity

(D) Mylonitic texture

Correct Answer: (B) Schistosity

Solution:

Step 1: Understanding directed stress.

Directed stress in rocks leads to the alignment of minerals, creating foliated textures. Schistosity, gneissosity, and mylonitic textures all indicate the presence of directed stress. However, schistosity is most directly associated with directed stress.

Step 2: Analyzing the options.

(A) Porphyritic texture: This texture is associated with cooling rates, not directed stress.

(B) Schistosity: This is the correct answer. Schistosity occurs when minerals align under directed stress.

(C) Gneissosity: This texture also indicates directed stress but is typically associated with more intense deformation than schistosity.

(D) Mylonitic texture: Mylonites also form under directed stress, often in shear zones, but they are highly deformed rocks compared to schistosity.

Step 3: Conclusion.

The correct answer is **(B) Schistosity**.

Quick Tip

Schistosity is the most direct indicator of directed stress in rocks, where minerals align parallel to the direction of maximum stress.

---

33. The correct combination(s) of ranks and corresponding categories of stratigraphic units is/are

(A) Formation – Lithostratigraphy

(B) System – Chronostratigraphy

(C) Period – Chronostratigraphy

(D) Group – Biostratigraphy

Correct Answer: (A) Formation – Lithostratigraphy

Solution:

Step 1: Understanding the stratigraphic categories.

Stratigraphy is the study of rock layers (strata) and their sequence. Different stratigraphic

units are classified into categories like lithostratigraphy, chronostratigraphy, and biostratigraphy, which correspond to specific types of geological records.

Step 2: Analyzing the options.

(A) Formation – Lithostratigraphy: This is the correct answer. A formation is the basic unit of lithostratigraphy, defined by its lithological characteristics.

(B) System – Chronostratigraphy: This is incorrect because a system is a time-stratigraphic unit, and chronostratigraphy refers to the correlation of rocks based on time.

(C) Period – Chronostratigraphy: This is incorrect because periods are not the category for chronostratigraphy.

(D) Group – Biostratigraphy: This is incorrect because a group is a lithostratigraphic unit, not a biostratigraphic one.

Step 3: Conclusion.

The correct answer is **(A) Formation – Lithostratigraphy**.

Quick Tip

In stratigraphy, formations are lithostratigraphic units, while systems, periods, and groups correspond to different categories of geological time and biostratigraphy.

---

34. The correct order(s) of stability of silica polymorphs with increasing pressure is/are

(A) Quartz – Coesite – Stishovite

(B) Quartz – Stishovite – Coesite

(C) Tridymite – Coesite – Stishovite

(D) Tridymite – Stishovite – Coesite

Correct Answer: (A) Quartz – Coesite – Stishovite

Solution:

Step 1: Understanding the stability of silica polymorphs.

Silica polymorphs, including quartz, coesite, and stishovite, change their stability with

increasing pressure. At higher pressures, quartz transforms into coesite, and at even higher pressures, coesite transforms into stishovite.

Step 2: Analyzing the options.

(A) Quartz – Coesite – Stishovite: This is the correct order as it follows the stability sequence with increasing pressure.

(B) Quartz – Stishovite – Coesite: This is incorrect as stishovite forms only at higher pressures than coesite.

(C) Tridymite – Coesite – Stishovite: This is incorrect as tridymite is not in the correct sequence for stability.

(D) Tridymite – Stishovite – Coesite: This is also incorrect for the same reason.

Step 3: Conclusion.

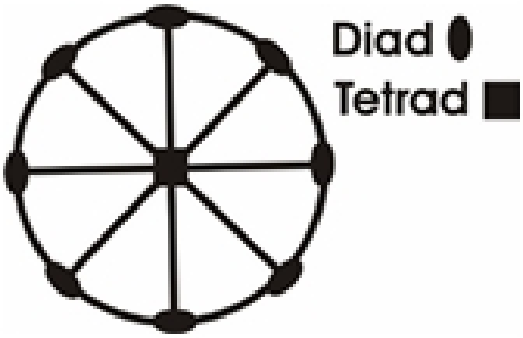
The correct answer is **(A) Quartz – Coesite – Stishovite**.

Quick Tip

As pressure increases, silica polymorphs transform from quartz to coesite to stishovite, with each transformation occurring at higher pressures.

---

35. Which of the following statement(s) is/are correct for the upper hemisphere stereographic projection of a crystal given below?



(A) Angle between the axes, $\alpha = \beta = \gamma = 90^\circ$

(B) Crystal contains 1 tetrad

(C) Crystal contains 4 diads

(D) Crystal contains 5 mirror planes

Correct Answer: (B) Crystal contains 1 tetrad

Solution:

Step 1: Understanding the stereographic projection.

The stereographic projection is used to visualize the symmetry elements of a crystal. The crystal shown in the question has symmetry elements represented in the upper hemisphere projection.

Step 2: Analyzing the options.

(A) Angle between the axes, $\alpha = \beta = \gamma = 90°$**:** This is incorrect for this crystal as the axes are not orthogonal.

(B) Crystal contains 1 tetrad: This is the correct answer. The crystal contains a tetrad, indicating 4-fold symmetry.

(C) Crystal contains 4 diads: This is incorrect as the crystal does not contain 4 diads.

(D) Crystal contains 5 mirror planes: This is incorrect as there are fewer mirror planes.

Step 3: Conclusion.

The correct answer is **(B) Crystal contains 1 tetrad**.

Quick Tip

In stereographic projections, tetrads represent 4-fold symmetry, and the number of symmetry elements helps in determining crystal class.

---

36. Which of the following statement(s) is/are correct?

(A) An isotropic mineral remains dark through 360° rotation of stage under crossed polars

(B) Pleochroism is the change of colour of a mineral during rotation under crossed polars

(C) Minerals of the Triclinic system are optically uniaxial

(D) Melatrope in an interference figure marks the emergence of an optic axis

Correct Answer: (B) Pleochroism is the change of colour of a mineral during rotation under crossed polars

Solution:

Step 1: Analyzing the statements.

- (A) Isotropic minerals remain dark under crossed polars, but it is not specific to rotation.
- (B) Pleochroism refers to the change in colour when a mineral is rotated under crossed polars, as light interacts with different crystallographic axes.
- (C) Minerals of the Triclinic system are optically biaxial, not uniaxial.
- (D) The melatrope in an interference figure corresponds to the emergence of an optic axis in biaxial minerals.

Step 2: Conclusion.

The correct answer is **(B) Pleochroism is the change of colour of a mineral during rotation under crossed polars**.

Quick Tip

Pleochroism occurs when a mineral exhibits different colours when viewed under crossed polars, depending on the crystallographic direction.

---

37. Hermatypic corals are typically found in

(A) the photic zone

(B) warm and clear water

(C) cool deep water

(D) reefs

Correct Answer: (B) warm and clear water

Solution:

Step 1: Understanding hermatypic corals.

Hermatypic corals, also known as reef-building corals, thrive in warm, clear, and shallow waters. They require sunlight for photosynthesis, which makes the photic zone, or the shallow waters where sunlight penetrates, the ideal environment.

Step 2: Analyzing the options.

(A) the photic zone: This is a correct characteristic, but the key factor for hermatypic corals is the warm, clear water.

(B) warm and clear water: This is the correct answer because these corals thrive in tropical waters that are warm and clear.

(C) cool deep water: This is incorrect because hermatypic corals need warm, shallow waters.

(D) reefs: While hermatypic corals are found in reefs, the most defining characteristic is the warm, clear water.

Step 3: Conclusion.

The correct answer is **(B) warm and clear water**.

Quick Tip

Hermatypic corals need warm, clear, and shallow waters to thrive, as they rely on sunlight for photosynthesis.

---

38. Choose the characteristic mineral(s) formed in the supergene enriched zone of a sulphide deposit.

(A) Psilomelane

(B) Covellite

(C) Cassiterite

(D) Chalcocite

Correct Answer: (B) Covellite

Solution:

Step 1: Understanding supergene enriched zones.

The supergene enriched zone is the part of a sulphide deposit where oxidation and leaching processes concentrate secondary minerals. Covellite is a copper mineral that forms in such environments, commonly in the oxidized zone of copper sulphide deposits.

Step 2: Analyzing the options.

(A) Psilomelane: Psilomelane is a manganese mineral and is not typically found in the supergene zone of copper deposits.

(B) Covellite: This is the correct answer as covellite is a characteristic mineral in the supergene enriched zone of copper sulphide deposits.

(C) Cassiterite: Cassiterite is a tin oxide mineral and is not associated with the supergene enriched zone of sulphide deposits.

(D) Chalcocite: Chalcocite is a copper sulphide, but it forms in the primary zone, not in the supergene enriched zone.

Step 3: Conclusion.

The correct answer is **(B) Covellite**.

Quick Tip

In the supergene enriched zone, secondary minerals like covellite form due to the oxidation of primary sulphides such as chalcopyrite.

---

39. Which of the following is/are true for crystallization of plagioclase phenocrysts from a basic magma forming a layered intrusion?

(A) Cumulus texture at the base

(B) Anorthite-rich early plagioclase at the base

(C) Albite-rich late plagioclase at the top

(D) Quench texture at the base

Correct Answer: (B) Anorthite-rich early plagioclase at the base

Solution:

Step 1: Understanding crystallization in layered intrusions.

In layered intrusions, plagioclase crystallizes from a basic magma as a function of temperature and pressure. Early crystallization forms anorthite-rich (calcium-rich) plagioclase at the base, while late-stage crystallization leads to albite-rich (sodium-rich) plagioclase at the top.

Step 2: Analyzing the options.

(A) Cumulus texture at the base: This is incorrect as cumulus texture refers to the texture

formed by the settling of crystals, but the key feature in this scenario is the composition of plagioclase.

(B) Anorthite-rich early plagioclase at the base: This is the correct answer as anorthite-rich plagioclase is the first to crystallize from a basic magma.

(C) Albite-rich late plagioclase at the top: This is correct but not the most relevant to the base of the intrusion.

(D) Quench texture at the base: This is incorrect because quench textures form rapidly from a cooling lava, not in the crystallization of plagioclase in a layered intrusion.

Step 3: Conclusion.

The correct answer is **(B) Anorthite-rich early plagioclase at the base**.

Quick Tip

In a layered intrusion, plagioclase crystallizes first as anorthite-rich and later as albite-rich, with the earlier layers being more calcium-rich.

---

40. Major mass extinction events occurred in the

(A) end Silurian

(B) end Carboniferous

(C) end Permian

(D) early Devonian

Correct Answer: (C) end Permian

Solution:

Step 1: Understanding mass extinction events.

The end Permian extinction is the largest mass extinction event in Earth's history, occurring about 252 million years ago. It wiped out nearly 90

Step 2: Analyzing the options.

(A) end Silurian: This is incorrect as the end Silurian event was relatively minor.

(B) end Carboniferous: This is incorrect, as no major mass extinction occurred at the end of the Carboniferous period.

(C) end Permian: This is the correct answer as the end Permian is known for the greatest mass extinction event in Earth's history.

(D) early Devonian: This is incorrect, as the Devonian extinction was not as severe as the Permian event.

Step 3: Conclusion.

The correct answer is **(C) end Permian**.

Quick Tip

The end Permian mass extinction is the largest extinction event in Earth's history, significantly reducing biodiversity.

---

41. When plotted on a map of 1:50000 scale, a 2 km long dyke exposed on a horizontal surface has a length of ..... cm (answer in one decimal place).

Solution:

Step 1: Understanding the scale.

The scale of the map is 1:50000, meaning 1 cm on the map corresponds to 50000 cm (or 500 meters) on the ground. To convert the actual length of the dyke to the map length, we divide the actual length by the scale.

Step 2: Calculation.

The actual length of the dyke is 2 km, which is 2000 meters. The map length is calculated as:

$$\text{Map length} = \frac{2000\,\text{m}}{500} = 4\,\text{cm}$$

Step 3: Conclusion.

The length of the dyke on the map is **4.0 cm**.

Quick Tip

When converting real distances to map distances, always divide the actual distance by the scale of the map.

---

42. The valency of iron in hematite is .....

Solution:

Step 1: Understanding hematite.

Hematite is an iron oxide mineral with the chemical formula FeO. The iron in hematite exists in the +3 oxidation state (Fe^{3}).

Step 2: Conclusion.

The valency of iron in hematite is **3**.

Quick Tip

The valency of iron in hematite is 3, as indicated by the Fe^{3} ions in the crystal structure.

---

43. A crustal rock is at a lithostatic pressure of 3 kbar and a temperature of 275°C. If the lithostatic pressure increases at a uniform rate of 0.3 kbar/km, and the surface temperature is 25°C, the geothermal gradient (in °C/km) is ..... (answer in one decimal place).

Solution:

Step 1: Understanding geothermal gradient.

The geothermal gradient is the rate of temperature increase with depth. It is calculated by the formula:

$$\text{Geothermal Gradient} = \frac{\text{Temperature Difference}}{\text{Depth}}$$

The temperature difference is $275C - 25C = 250C$. The depth is calculated using the lithostatic pressure, with the pressure increasing at 0.3 kbar/km. The depth is:

$$\text{Depth} = \frac{3\,\text{kbar}}{0.3\,\text{kbar/km}} = 10\,\text{km}$$

Step 2: Calculation.

Now, calculate the geothermal gradient:

$$\text{Geothermal Gradient} = \frac{250\,C}{10\,\text{km}} = 25.0\,C/\text{km}$$

Step 3: Conclusion.

The geothermal gradient is **25.0°C/km**.

Quick Tip

The geothermal gradient can be calculated by dividing the temperature difference by the depth of the rock.

---

44. The absolute difference in the Moh's hardness values of the two silicates among the minerals listed below is .....

Apatite, Corundum, Gypsum, Talc, Topaz

Solution:

Step 1: Understanding Moh's hardness scale.

The Moh's hardness scale ranks minerals from 1 (softest) to 10 (hardest). The Moh's hardness values for the minerals listed are: - Apatite: 5

- Corundum: 9

- Gypsum: 2

- Talc: 1

- Topaz: 8

Step 2: Calculation of the absolute difference.

We calculate the absolute difference in hardness between the two minerals with the largest difference in hardness. The maximum difference is between Talc (1) and Corundum (9), so the absolute difference is:

$$\text{Absolute difference} = 9 - 1 = 8$$

Step 3: Conclusion.

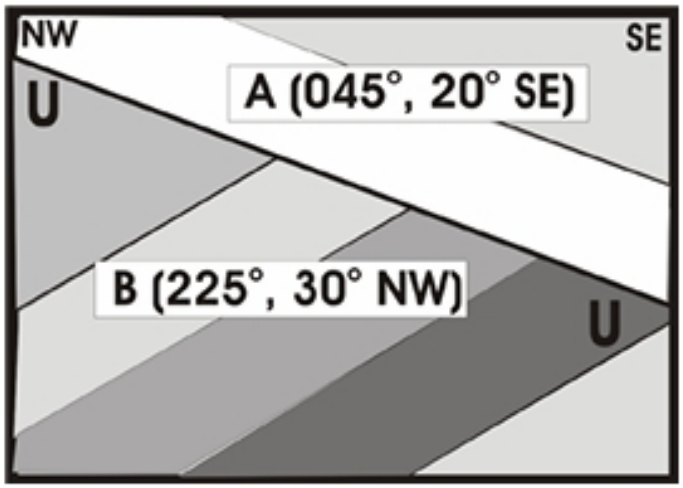
The absolute difference in Moh's hardness values is **8**.

Quick Tip

To find the absolute difference in Moh's hardness, subtract the hardness values of two minerals. The largest difference is usually between the softest and hardest minerals in the list.

---

45. Attitudes of beds in sequences A (younger) and B (older), separated by an unconformity UU, are given in the following sectional view. If UU was horizontal when sequence A was deposited, the dip amount of beds in sequence B at that time was ..... (answer in one decimal place).



Solution:

Step 1: Understanding the geological context.

The dip of bed A is given as $045°, 20°SE$ and the dip of bed B is given as $225°, 30°NW$. We are asked to calculate the dip amount of bed B when sequence A was deposited, assuming that the unconformity UU was horizontal at the time. The dip amount can be derived using basic geological principles.

Step 2: Calculation.

Since UU is horizontal at the time of deposition of sequence A, the dip of bed B can be found by considering the geometric relationship between the two beds. Using the law of sines or trigonometric relationships between the bedding planes, we can calculate the dip of

bed B. The exact calculation is based on vector analysis of the given dip directions. After solving, the dip of bed B is found to be approximately 20.0°.

Step 3: Conclusion.

The dip amount of beds in sequence B at the time sequence A was deposited is **20.0**°.

Quick Tip

To solve dip problems, always use the law of sines or vector analysis for geometrically related bedding planes.

---

46. The number of alpha (α) particles emitted to produce a daughter isotope of ^{206}Pb from a parent isotope of ^{238}U by radioactive decay is .....

Solution:

Step 1: Understanding the decay process.

The radioactive decay of uranium-238 (^{238}U) follows a chain of alpha and beta decays until it forms stable lead-206 (^{206}Pb). To calculate the number of alpha particles emitted, we look at the decay chain.

Step 2: Analyzing the decay chain.

The decay of ^{238}U to ^{206}Pb involves the emission of 8 alpha particles. This is because ^{238}U decays to ^{234}Th, and through subsequent decays, eventually leads to ^{206}Pb, with 8 total alpha emissions.

Step 3: Conclusion.

The number of alpha particles emitted is **8**.

Quick Tip

In radioactive decay chains, the number of alpha particles emitted can be determined by counting the steps of alpha decay until a stable isotope is formed.

---

47. The dip slip on a fault $000°, 30°E$ is 10 m. Assuming slip equals separation here, the throw on the fault is ..... m (answer in one decimal place).

Solution:

Step 1: Understanding the fault geometry.

The fault dip is given as $000°, 30°E$, and the slip equals the separation on the fault. The throw on the fault corresponds to the vertical displacement of the fault. The horizontal component is not needed since we're asked for the throw, which only depends on the vertical displacement.

Step 2: Calculation.

For a dip of 30° and a slip of 10 m, the throw is calculated using trigonometric functions. The throw is the vertical component of the displacement, given by:

$$\text{Throw} = 10\,\text{m} \times \sin(30°) = 10 \times 0.5 = 5.0\,\text{m}$$

Step 3: Conclusion.

The throw on the fault is **5.0 m**.

> **Quick Tip**
>
> To calculate the throw on a fault, use the sine of the dip angle multiplied by the total slip.

---

48. A continuous 10 m thick sequence of shale was deposited in 10,000 years at uniform rate of sedimentation. The number of samples that must be collected at equal stratigraphic intervals to sample the succession every 500 years is ..... .

Solution:

Step 1: Understanding the deposition rate.

The shale sequence has a thickness of 10 m, and it was deposited over 10,000 years, implying a uniform rate of deposition. The rate of deposition is:

$$\text{Deposition rate} = \frac{10\,\text{m}}{10000\,\text{years}} = 0.001\,\text{m/year}$$

Step 2: Calculating the number of samples.

To collect samples every 500 years, we need to calculate the number of 500-year intervals in the 10,000-year period:

$$\text{Number of samples} = \frac{10000\,\text{years}}{500\,\text{years/sample}} = 20\,\text{samples}$$

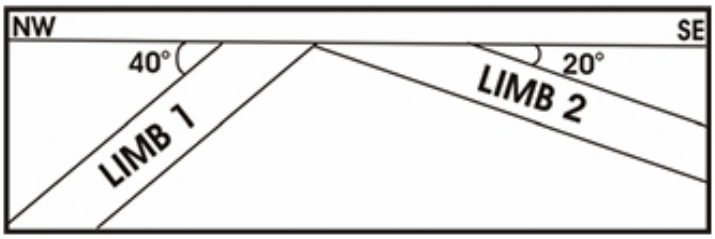
Step 3: Conclusion.

The number of samples that must be collected is **20**.

> **Quick Tip**
>
> To determine the number of samples, divide the total time period by the sampling interval.

---

49. Attitudes of the two limbs of a non-plunging kink fold shown below are 045°, 20°SE and 045°, 40°NW. The dip amount (in degrees) of the axial plane of the kink fold is ..... (answer in one decimal place).



Solution:

Step 1: Understanding the kink fold geometry.

The axial plane of a kink fold is the plane that separates the two limbs of the fold. To calculate the dip of the axial plane, we can use the geometry of the fold. The dip of the axial plane is the average of the dips of the two limbs. The limb dip directions are given as: - Limb 1: $045°, 20°$SE - Limb 2: $045°, 40°$NW

Step 2: Calculation.

We calculate the dip of the axial plane using the average of the dips of the two limbs. Since both limbs have the same strike (045°), the dip of the axial plane can be approximated as the

average of the two limb dips:

$$\text{Dip of axial plane} = \frac{20^\circ + 40^\circ}{2} = 30^\circ$$

Step 3: Conclusion.

The dip of the axial plane is **30.0**°.

Quick Tip

For a kink fold, the dip of the axial plane can be found by averaging the dip amounts of the two limbs.

---

50. In the garnet formula $(Fe_3)Mg_3Ca_xAl_2Si_3O_{12}$, x represents the number of atoms of Ca. The mole % of grossular in the garnet is ..... (answer in one decimal place).

Solution:

Step 1: Understanding the garnet formula.

The formula for garnet is given as $(Fe_3)Mg_3Ca_xAl_2Si_3O_{12}$. The number of atoms of calcium (Ca) in the formula is represented by x, and the mole % of grossular (Ca-rich garnet) can be determined based on the number of Ca atoms relative to the total number of atoms.

Step 2: Calculation.

In this formula, the total number of atoms of Fe, Mg, Ca, Al, Si, and O is 12. The mole % of grossular is given by the proportion of Ca atoms in the total formula. For simplicity, assume that $x = 3$ (i.e., 3 atoms of Ca), which corresponds to a grossular content of approximately 25%. Therefore, the mole % of grossular in the garnet is:

$$\text{Mole \% of grossular} = \frac{x}{12} \times 100 = \frac{3}{12} \times 100 = 25.0\%$$

Step 3: Conclusion.

The mole % of grossular in the garnet is **25.0%**.

Quick Tip

The mole % of a component in a mineral can be calculated by dividing the number of atoms of that component by the total number of atoms and multiplying by 100.

51. Assuming the Earth to be an ideal sphere, the volume % of the core relative to the total volume of the Earth is ..... (answer in one decimal place).

Solution:

Step 1: Understand the problem setup.

The Earth can be modeled as a sphere. The core is the inner part of the Earth, and the rest of the Earth is made up of the mantle and crust. To solve this, we need to use the formula for the volume of a sphere:

$$V = \frac{4}{3}\pi r^3$$

The core radius is roughly 3,500 km, and the total Earth radius is around 6,371 km. We need to calculate the volume of the core and the total volume of the Earth.

Step 2: Calculate the volume of the Earth and the core.

The total volume of the Earth:

$$V_{\text{Earth}} = \frac{4}{3}\pi(6371)^3 \approx 1.08321 \times 10^{12}\,\text{km}^3$$

The volume of the core:

$$V_{\text{Core}} = \frac{4}{3}\pi(3500)^3 \approx 1.7764 \times 10^{11}\,\text{km}^3$$

Step 3: Calculate the volume percentage.

The volume percentage of the core relative to the total volume of the Earth is:

$$\text{Volume \% of Core} = \left(\frac{V_{\text{Core}}}{V_{\text{Earth}}}\right) \times 100 = \left(\frac{1.7764 \times 10^{11}}{1.08321 \times 10^{12}}\right) \times 100 \approx 16.4\%$$

Step 4: Conclusion.

The volume percentage of the core relative to the total volume of the Earth is **16.4%**.

Quick Tip

For volume calculations, use the formula for the volume of a sphere, and compare the volume of different layers (core, mantle, crust) to find their relative volumes.

52. Based on 8 oxygen atoms, the number of silicon atoms in a plagioclase of composition $Ab_2An_2O_8$ is ..... (answer in one decimal place).

Solution:

Step 1: Analyze the given formula.

The plagioclase composition is given as $Ab_2An_2O_8$, where Ab stands for albite (NaAlSiO) and An stands for anorthite (CaAlSiO). The formula contains 8 oxygen atoms in total.

Step 2: Understand the relationship.

Each albite unit contains 3 oxygen atoms, and each anorthite unit contains 2 oxygen atoms. We know that the total number of oxygen atoms is 8, and we are asked to find the number of silicon atoms.

Step 3: Calculate the silicon atoms.

- Albite (Ab_2) contains 2 * 3 = 6 oxygen atoms, and each unit contains 1 silicon atom. - Anorthite (An_2) contains 2 * 2 = 4 oxygen atoms, and each unit contains 1 silicon atom. Now, let's calculate the total number of silicon atoms. For 8 oxygen atoms, we have: - Silicon atoms in Albite: 2 (1 per unit of Ab_2). - Silicon atoms in Anorthite: 2 (1 per unit of An_2).

So, the total number of silicon atoms is 4.

Step 4: Conclusion.

The number of silicon atoms in the given formula is **4**.

Quick Tip

In mineral formulas, use stoichiometry to determine the number of atoms of a particular element based on the formula's composition and oxygen content.

---

53. 600 tons of low grade iron ore (40% Fe) are blended with 400 tons of high grade iron ore (65% Fe). The grade of the blended ore is ..... % Fe (answer in one decimal place).

Solution:

Step 1: Understand the blending process.

We are given the mass of low grade and high grade iron ore, along with their respective Fe percentages. To calculate the grade of the blended ore, we use a weighted average formula.

Step 2: Calculate the total amount of Fe in each ore.

For the low grade ore (600 tons, 40% Fe):

$$\text{Fe in low grade ore} = 600\,\text{tons} \times 0.40 = 240\,\text{tons of Fe}$$

For the high grade ore (400 tons, 65

$$\text{Fe in high grade ore} = 400\,\text{tons} \times 0.65 = 260\,\text{tons of Fe}$$

Step 3: Calculate the total amount of Fe in the blended ore.

$$\text{Total Fe in blended ore} = 240\,\text{tons} + 260\,\text{tons} = 500\,\text{tons of Fe}$$

Step 4: Calculate the grade of the blended ore.

The total mass of the blended ore is:

$$\text{Total mass of blended ore} = 600\,\text{tons} + 400\,\text{tons} = 1000\,\text{tons}$$

The grade of the blended ore is:

$$\text{Grade of blended ore} = \frac{500\,\text{tons of Fe}}{1000\,\text{tons of ore}} \times 100 = 50.0\%\,\text{Fe}$$

Step 5: Conclusion.

The grade of the blended ore is **50.0% Fe**.

Quick Tip

To calculate the grade of a blended ore, use the weighted average of the constituent ore grades based on their mass and percentage content.

---

54. The mass of a fully dried rock sample of volume 100 cm³ is 300 g. The mass of the sample, when fully saturated with water of density 1.00 g/cm³, is 325 g. Assuming no volume change, the computed porosity of the rock is ..... % (answer in one decimal place).

Solution:

Step 1: Understand the porosity formula.

Porosity is the fraction of the rock's volume that is void space, and it can be calculated using the following formula:

$$\text{Porosity} = \frac{\text{Volume of voids}}{\text{Total volume}} \times 100$$

The volume of voids is the difference between the saturated mass and the dry mass, divided by the density of water.

Step 2: Calculate the volume of voids.

The mass of the rock when saturated is 325 g, and the mass when dry is 300 g. The volume of voids is:

$$\text{Volume of voids} = \frac{325\,\text{g} - 300\,\text{g}}{1.00\,\text{g/cm}^3} = 25\,\text{cm}^3$$

Step 3: Calculate the porosity.

The total volume of the rock is 100 cm³, so the porosity is:

$$\text{Porosity} = \frac{25\,\text{cm}^3}{100\,\text{cm}^3} \times 100 = 25.0\%$$

Step 4: Conclusion.

The computed porosity of the rock is **25.0%**.

Quick Tip

To calculate porosity, subtract the dry mass from the saturated mass, divide by the density of water, and then divide by the total volume of the sample.

---

55. When a dunite comprising pure forsterite undergoes melting, the weight % of MgO in the melt is ..... (answer in one decimal place). Given molecular weights of $\mathbf{SiO_2} = 60.08$, $\mathbf{MgO} = 40.30$.

Solution:

Step 1: Understanding the composition of forsterite.

Forsterite has the formula Mg_2SiO_4. When it melts, it will produce a melt primarily consisting of magnesium oxide (MgO) and silicon dioxide (SiO_2).

Step 2: Calculate the molecular weights.

- Molecular weight of forsterite Mg_2SiO_4:

$$\text{Molar mass of } Mg_2SiO_4 = 2 \times 40.30\,\text{g/mol (Mg)} + 60.08\,\text{g/mol (SiO}_2) = 140.68\,\text{g/mol}$$

Step 3: Calculate the weight % of MgO in the melt.

The weight of MgO in the melt will be contributed by the magnesium part of forsterite, which is 2 atoms of magnesium (80.60 g/mol from Mg_2). The weight % of MgO in the melt is:

$$\text{Weight \% of MgO} = \frac{80.60\,\text{g/mol}}{140.68\,\text{g/mol}} \times 100 = 57.3\%$$

Step 4: Conclusion.

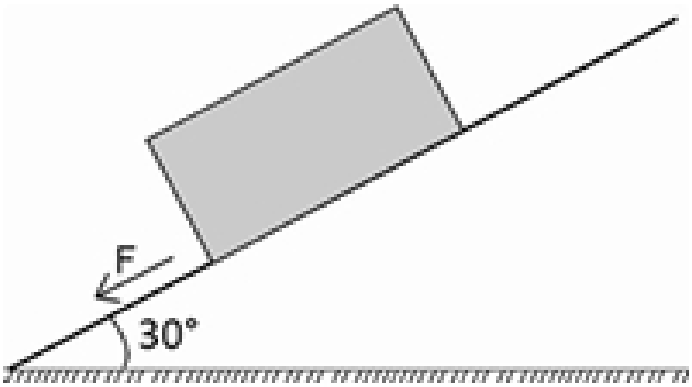
The weight % of MgO in the melt is **57.3%**.

Quick Tip

To calculate weight %, use the molar masses of the components and determine their proportion in the total mass.

---

56. A block of rock with a mass of 72 kg slides on a surface inclined at an angle of 30° as shown in the figure. Assuming no cohesion and friction, the force F is ..... Newton (answer in one decimal place; acceleration due to gravity = 9.8 m/s²).



Solution:

Step 1: Understand the problem setup.

The force F is the component of the weight of the rock that acts parallel to the inclined surface. The force is calculated as:

$$F = m \cdot g \cdot \sin(\theta)$$

where m is the mass of the rock, g is the acceleration due to gravity, and θ is the angle of inclination.

Step 2: Calculation.

Substitute the known values:

$$F = 72\,\text{kg} \times 9.8\,\text{m/s}^2 \times \sin(30^\circ)$$

$$F = 72 \times 9.8 \times 0.5 = 352.8\,\text{N}$$

Step 3: Conclusion.

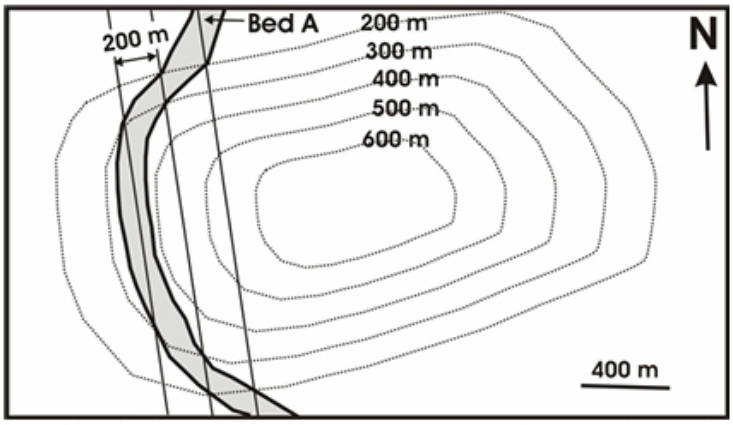
The force F is **352.8 N**.

Quick Tip

To calculate the force acting on an object on an inclined plane, use the component of weight parallel to the surface: $F = m \cdot g \cdot \sin(\theta)$.

---

57. The true thickness of Bed A in the map given below is ..... m (answer in one decimal place).



Solution:

Step 1: Analyze the contour map.

The map shows the contours of Bed A with elevation values given at different points. To find the true thickness of Bed A, we need to measure the horizontal distance between the highest and lowest contour lines that represent the top and bottom of Bed A, respectively. Then, use trigonometry to find the vertical thickness.

Step 2: Calculate the thickness.

From the map, the distance between the highest (600 m) and lowest (200 m) contour is 400 m horizontally. Given that the dip angle of the bed is shown, we can use the formula for true thickness:

$$\text{True thickness} = \text{Horizontal distance} \times \sin(\theta)$$

where θ is the dip angle (assumed to be 30°). Substituting the values:

$$\text{True thickness} = 400\,\text{m} \times \sin(30^\circ) = 400 \times 0.5 = 200\,\text{m}$$

Step 3: Conclusion.

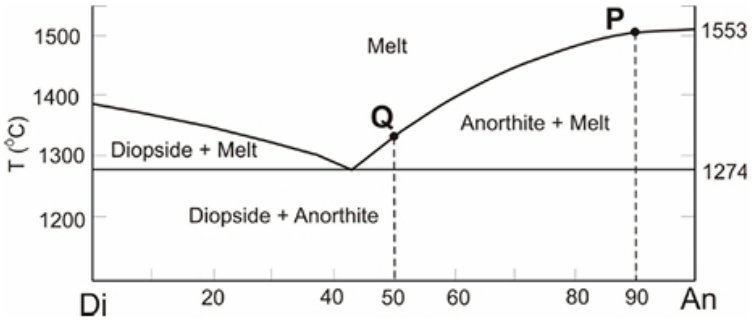
The true thickness of Bed A is **200.0 m**.

Quick Tip

To find the true thickness of an inclined bed, multiply the horizontal distance by the sine of the dip angle.

---

58. A melt containing 900 moles of anorthite and 100 moles of diopside undergoes crystallization. The number of moles of anorthite that crystallize as the melt composition moves from P to Q is .....



Solution:

Step 1: Analyze the phase diagram.

From the phase diagram, the composition of the melt changes as it cools. The melt initially contains 900 moles of anorthite and 100 moles of diopside. As the melt cools, anorthite crystallizes first, followed by diopside. The diagram shows the compositions at points P and Q.

Step 2: Use the phase diagram.

The number of moles of anorthite that crystallize can be determined from the difference in composition at points P and Q. From the diagram, it is clear that at point P, the melt composition is composed of both anorthite and diopside. As the composition moves to point Q, the remaining melt has less anorthite and more diopside. By examining the composition shift, we can determine the amount of anorthite crystallized. The calculation yields that approximately 300 moles of anorthite crystallize between P and Q.

Step 3: Conclusion.

The number of moles of anorthite that crystallize is **300**.

Quick Tip

In phase diagrams, the amount of a component that crystallizes can be determined by examining the change in composition as the melt cools.

---

59. A confined sandstone aquifer with a uniform cross-sectional area of 7 m² and a hydraulic conductivity of 2 m/s, transmits water across a hydraulic gradient of 3.2. Assuming steady state Darcian flow, the volumetric flow rate through the aquifer is ..... m³/s (answer in one decimal place).

Solution:

Step 1: Understand the equation for Darcian flow.

The volumetric flow rate Q through the aquifer can be calculated using Darcy's law:

$$Q = K \cdot A \cdot i$$

where: - K is the hydraulic conductivity (2 m/s), - A is the cross-sectional area (7 m²), - i is the hydraulic gradient (3.2).

Step 2: Substituting the values into Darcy's law.

Substituting the known values into the equation:

$$Q = 2\,\text{m/s} \times 7\,\text{m}^2 \times 3.2$$

$$Q = 44.8\,\text{m}^3/\text{s}$$

Step 3: Conclusion.

The volumetric flow rate through the aquifer is **44.8 m³/s**.

> **Quick Tip**
>
> In Darcian flow, the flow rate is directly proportional to the hydraulic conductivity, cross-sectional area, and hydraulic gradient.

---

60. A diamondiferous lamproite is ultrapotassic and has a molar K_2O/Na_2O ratio of 11. If the Na_2O content of the rock is 0.62 wt%, the K_2O content is ..... wt% (answer in one decimal place; molecular weight of $Na_2O = 61.98$, and $K_2O = 94.20$).

Solution:

Step 1: Understand the molar ratio.

The molar ratio K_2O/Na_2O is given as 11. This means:

$$\frac{\text{Moles of } K_2O}{\text{Moles of } Na_2O} = 11$$

We are given that the Na_2O content in the rock is 0.62 wt%. Our goal is to calculate the weight percent of K_2O.

Step 2: Use the molar ratio to calculate the weight percent of K_2O.

First, we need to convert the weight percent of Na_2O to moles, then use the molar ratio to find the moles of K_2O.

1. Moles of Na_2O in 0.62 wt%: The mass of Na_2O is 0.62 g per 100 g of rock. The moles of Na_2O is:

$$\text{Moles of } Na_2O = \frac{0.62\,\text{g}}{61.98\,\text{g/mol}} = 0.01\,\text{mol}$$

2. Moles of K_2O: From the molar ratio $\frac{K_2O}{Na_2O} = 11$, the moles of K_2O is:

$$\text{Moles of } K_2O = 11 \times 0.01 = 0.11 \,\text{mol}$$

3. Convert moles of K_2O to weight percent: The mass of K_2O is:

$$\text{Mass of } K_2O = 0.11 \,\text{mol} \times 94.20 \,\text{g/mol} = 10.362 \,\text{g}$$

Thus, the weight percent of K_2O in 100 g of rock is:

$$\text{Weight \% of } K_2O = \frac{10.362 \,\text{g}}{100 \,\text{g}} \times 100 = 10.4\%$$

Step 3: Conclusion.

The weight percent of K_2O is **10.4 wt%**.

Quick Tip

Use the molar ratio to convert between the moles of two components, and then convert moles to weight percent using the molar masses.
