IIT JAM 2024 Geology Question Paper with Solution

Time Allowed :3 Hours	Maximum Marks :100	Total Questions :60

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The examination duration is **3 Hours**. Manage your time effectively to attempt all questions within this period.

2. The total marks for this examination are **100**. Aim to maximize your score by strategically answering each question.

3. There are **60 mandatory questions** to be attempted in the paper. Ensure that all questions are answered.

4. Questions may appear in a **shuffled order**. Do not assume a fixed sequence and focus on each question as you proceed.

5. The **marking of answers** will be displayed as you answer. Use this feature to monitor your performance and adjust your strategy as needed.

6. You may **mark questions for review** and edit your answers later. Make sure to allocate time for reviewing marked questions before final submission.

7. Be aware of the detailed section and sub-section guidelines provided in the exam. **Understanding these will aid in effectively navigating the exam**.

Section A

Q.1 – Q.10 Carry ONE mark each(Multiple Choice Questions)

Q.1 The plate tectonic setting of Benioff-Wadati zone is

(A) continental rift

(B) subduction zone

(C) passive margin

(D) mid-oceanic ridge

Correct Answer: B

Explanation:

The Benioff-Wadati zone refers to a subduction zone where an oceanic plate is being forced under a continental plate or another oceanic plate. Earthquakes within this zone occur due to the movement of the subducting plate, which is characteristic of the subduction zone setting.

> Quick Tip
>
> The Benioff-Wadati zone is associated with earthquakes occurring at subduction zones.

Q.2 Neutron-rich unstable nuclides undergo

(A) SS (negatron) decay

(B) B (positron) decay

(C) a-decay

(D) electron capture

Correct Answer: A

Explanation:

Neutron-rich unstable nuclides generally undergo SS (negatron) decay, which involves the emission of a beta particle (electron) from the nucleus, transforming a neutron into a proton and increasing the atomic number by one.

Q.3 Which one of the following textures is found in alkali olivine basalt?

(A) Rapakivi

(B) Graphic

(C) Blastoporphyritic

(D) Intergranular

Correct Answer: D

Explanation:

Intergranular texture is commonly found in alkali olivine basalt. In this texture, the minerals crystallize with an interlocking pattern where the grains are equigranular and their boundaries are interstitial.

Q.4 The mineral metabasalt is

(A) glaucophane lawsonite chlorite

(B) orthopyroxene + garnet + plagioclase clinopyroxene + quartz

(C) actinolite + albite chlorite + epidote

(D) omphacite garnet quartz

Correct Answer: B

Explanation:

Metabasalt is typically composed of orthopyroxene, garnet, plagioclase, clinopyroxene, and quartz. These minerals are commonly found in the high-pressure, low-temperature metamorphic conditions where basalts undergo metamorphism.

Q.5 Glossopteris is found in which of the following formations?

(A) Raniganj

(B) Bagra

(C) Lameta

(D) Nimar Sandstone

Correct Answer: A

Explanation:

Glossopteris is a genus of extinct seed ferns found in the fossil record of the late Paleozoic and early Mesozoic eras. It is most famously associated with the Raniganj Formation, which is part of the Gondwana group of deposits.

Q.6 In a sequence of undeformed sedimentary rocks, younger rocks overlie older rocks. This conforms to the principle of

(A) superposition

(B) uniformitarianism

(C) faunal succession

(D) original horizontalit

Correct Answer: A

Explanation:

The principle of superposition states that in an undeformed sequence of sedimentary rocks, younger rocks are deposited on top of older rocks. This principle helps geologists determine the relative ages of rock layers.

> **Quick Tip**
>
> The principle of superposition is fundamental in stratigraphy and is used to determine the relative ages of rock layers.

Q.7 Dropstones are found in

(A) Barakar Formation

(B) Talchir Formation

(C) Raniganj Formation

(D) Bijori Formation

Correct Answer: B

Explanation:

Dropstones are pieces of rock that are deposited in a marine environment, typically by ice rafting. They are found in the Talchir Formation, which is known for its glacial deposits and dropstone features.

> **Quick Tip**
>
> Dropstones are typically associated with glacial environments and are used to infer past climatic conditions.

Q.8 The sedimentary structure formed by unidirectional current is

(A) trough cross-bedding

(B) oscillation ripple

(C) concretion

(D) hummocky cross-stratification

Correct Answer: A

Explanation:

Trough cross-bedding is formed by unidirectional currents, typically in a fluvial or shallow marine environment. This structure is characterized by angled layers of sedimentary material that are deposited in a current-driven direction.

> **Quick Tip**
>
> Trough cross-bedding forms due to the action of unidirectional currents, which causes sediment to accumulate in a series of sloping beds.

Q.9 Which of the following is the precursor of petroleum?

(A) Sporinite
(B) Clarain 4/31
(C) Kerogen
(D) Vitrain

Correct Answer: C

Explanation:

Kerogen is the primary precursor of petroleum. It is a complex organic material found in sedimentary rocks that, through heating and pressure, can convert into liquid hydrocarbons, forming petroleum.

> **Quick Tip**
>
> Kerogen is the organic material in oil shale that, when heated, undergoes a process called maturation, resulting in the formation of petroleum.

Q.10 Which of the following is an amorphous variety of SiO?

(A) Quartz
(B) Citrine

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(C) Agate

(D) Opal

Correct Answer: D

Explanation:

Opal is an amorphous variety of silicon dioxide (SiO), unlike quartz, citrine, and agate, which have a crystalline structure. Opal's lack of a crystal structure is what makes it an amorphous form of SiO.

> Quick Tip
>
> Opal is a mineraloid and not a true mineral due to its amorphous nature. It does not form a crystalline structure like quartz.

Q.11 The name of an igneous rock having a modal composition of 55% olivine, 40% orthopyroxene, and 5% plagioclase, as per the IUGS classification scheme, is

(A) Gabbro

(B) Troctolite

(C) Lherzolite

(D) Harzburgite

Correct Answer: D

Explanation:

According to the IUGS classification of igneous rocks, harzburgite is characterized by a composition dominated by olivine and orthopyroxene. The given rock composition, with 55% olivine, 40% orthopyroxene, and 5% plagioclase, fits the definition of harzburgite.

> Quick Tip
>
> Harzburgite is a peridotite rock, predominantly composed of olivine and orthopyroxene, with little or no plagioclase.

Q.12 Which of the following is the correct decreasing order of abundance of elements in our solar system?

(A) O > H > Fe > He

(B) O > Fe > H > He

(C) H > O > Fe > He

(D) H > He > O > Fe

Correct Answer: D

Explanation:

The most abundant elements in the solar system, according to astronomical observations, are hydrogen (H), helium (He), oxygen (O), and iron (Fe). Hydrogen and helium are by far the most abundant elements, followed by oxygen and then iron. Therefore, the correct order of abundance is H > He > O > Fe.

> Quick Tip
>
> Hydrogen (H) and helium (He) are the two most abundant elements in the solar system, with oxygen (O) being third and iron (Fe) being less abundant.

Q.13 The suture of a cephalopod having smooth saddles and crenulated lobes is called

(A) orthoceratitic

(B) goniatitic

(C) ceratitic

(D) ammonitic

Correct Answer: C

Explanation:

The suture with smooth saddles and crenulated lobes is characteristic of the ceratitic suture, which is typically found in the order Ceratites of cephalopods.

Q.14 Which of the following is a body fossil?

(A) Coprolite

(B) Footprint

(C) Cast

(D) Stromatolite

Correct Answer: C

Explanation:

A body fossil is a part of an organism's body, such as bones or teeth. A cast is a type of fossil formed when a mold is filled with minerals, creating a replica of the organism's body.

Q.15 Match the morphological features in Group I with the corresponding taxa in Group II.

Group I	Group II
P. Dissepiment	1. Echinodermata
Q. Delthyrium	2. Trilobita
R. Pygidium	3. Brachiopoda
S. Ambulacrum	4. Anthozoa

(A) P – 4, Q – 3, R – 2, S – 1

(B) P – 4, Q – 3, R – 1, S – 2

(C) P – 2, Q – 3, R – 4, S – 1

(D) P – 3, Q – 4, R – 2, S – 1

Correct Answer: B

Explanation:

Dissepiment is found in Anthozoa (P – 4).

Delthyrium is found in Trilobita (Q – 3).

Pygidium is found in Brachiopoda (R – 1).

Ambulacrum is found in Echinodermata (S – 2).

> Quick Tip
>
> In matching questions, ensure the morphological features and taxonomic groups are correctly associated based on the characteristics.

Q.16 Match the sedimentary features/structures in Group I with the corresponding processes in Group II.

Group I   Group II

P. Stylolite   1. Liquefaction

Q. Pseudonodule   2. Diagenesis

R. Current crescent   3. Organo-sedimentary binding

S. Stromatolite   4. Scouring

(A) P – 2, Q – 1, R – 4, S – 3

(B) P – 2, Q – 3, R – 4, S – 1

(C) P – 3, Q – 1, R – 4, S – 2

(D) P – 4, Q – 1, R – 2, S – 3

Correct Answer: A

Explanation:

Stylolite forms during Diagenesis (P – 2).

Pseudonodule forms as a result of Liquefaction (Q – 1).

Current crescent forms due to Scouring (R – 4).

Stromatolite forms due to Organo-sedimentary binding (S – 3).

> **Quick Tip**
>
> In matching questions, ensure the morphological features and processes are correctly associated based on geological principles.

Q.17 Match the geomorphic features in Group I with the corresponding environments in Group II.

Group I   **Group II**

P. Dreikanter   1. Glacial

Q. Cirque   2. Beach

R. Natural levee   3. Eolian

S. Berm   4. Fluvial

(A) P – 3, Q – 1, R – 4, S – 2
(B) P – 2, Q – 1, R – 4, S – 3
(C) P – 3, Q – 4, R – 1, S – 2
(D) P – 4, Q – 2, R – 3, S – 1

Correct Answer: A

Explanation:

Dreikanter is formed in Eolian environments (P – 3).

Cirque is a glacial feature (Q – 1).

Natural levee is associated with fluvial environments (R – 4).

Berm is formed in beach environments (S – 2).

> **Quick Tip**
>
> To match features to environments, consider the geological processes associated with each feature.

Q.18 The correct hierarchy of the given stratigraphic units is

(A) Group > Member > Formation > Bed

(B) Eon > Era > Epoch > Period

(C) Group > Formation > Member > Bed

(D) Eon > Era > Series > Systems

Correct Answer: A

Explanation:

In stratigraphy, the hierarchy follows the order: Group > Formation > Member > Bed, where: A Group consists of multiple Formations. A Formation is made up of various Members. A Member is composed of individual Beds.

> Quick Tip
>
> In stratigraphy, units are arranged in a hierarchical order, with the largest unit being the group, followed by formation, member, and bed.

Q.19 Match the minerals in Group I with their highest order of interference color in Group II (for 0.03 mm mineral thickness).

Group I:

P. Sillimanite

Q. Quartz

R. Muscovite

S. Calcite

Group II:

1. First order

2. Second order

3. Greater than third order

4. Third order variegated

Correct Answer: C

Explanation:

The matching of minerals with their highest order of interference color is based on the thickness of the mineral and its optical properties. For a thickness of 0.03 mm: - Sillimanite (P) has a second-order interference color. - Quartz (Q) has a first-order interference color. - Muscovite (R) has a greater than third-order interference color. - Calcite (S) has a third-order variegated interference color.

> **Quick Tip**
>
> In optical mineralogy, interference colors are related to the mineral thickness and its birefringence. Higher orders of interference color indicate higher birefringence.

Q.20 The saturated thickness of an unconfined aquifer is defined by the distance between

(A) the ground surface and the water table

(B) the water table and the underlying confining layer

(C) the water table and the mean sea level

(D) the ground surface and the underlying confining layer

Correct Answer: C

Explanation:

The saturated thickness of an unconfined aquifer is the distance between the water table (the top of the saturated zone) and the mean sea level, which is used as a reference for measuring elevation.

> **Quick Tip**
>
> In hydrogeology, the water table is the upper surface of the zone of saturation, and it plays a critical role in determining the volume of water in the aquifer.

Q.21 Darcy's law quantifies the volume of groundwater flow

(A) per unit surface area of the aquifer

(B) per unit time

(C) per unit cross-sectional area of the aquifer

(D) per unit cross-sectional area of the aquifer per unit time
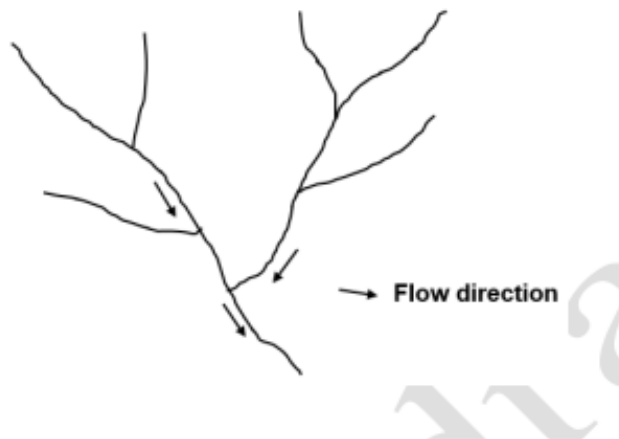
Correct Answer: B

Explanation:

Darcy's law quantifies groundwater flow as a function of permeability, hydraulic gradient, and cross-sectional area. However, the law primarily quantifies the volume of water flowing per unit time.

> Quick Tip
>
> Darcy's law relates to the flow rate of groundwater through an aquifer and is often expressed as $Q = k \cdot A \cdot \frac{\Delta h}{L}$, where Q is the flow rate, k is the permeability, A is the cross-sectional area, and $\frac{\Delta h}{L}$ is the hydraulic gradient.

Q.22 According to Strahler's stream ordering system, what is the highest order of stream in the given diagram?

(A) 4

(B) 3

(C) 2

(D) 1

Correct Answer: B

Explanation:

Strahler's stream ordering system assigns an order to each stream based on its position in the network. According to this system, two first-order streams combine to form a second-order stream, and two second-order streams combine to form a third-order stream, and so on. In the given diagram, the highest order stream is a third-order stream, as it results from the confluence of two second-order streams.

> **Quick Tip**
>
> In Strahler's system, a stream that has no tributaries is designated as a first-order stream. When streams of the same order meet, their combined order increases by one.

Q.23 A tunnel with vertical walls and arched crown is constructed through a set of sedimentary beds. The thickness of individual beds is significantly less than the wall-height of the tunnel. For which of the following conditions, one of the tunnel walls becomes unstable?

(A) The tunnel axis is horizontal and the beds are horizontal

(B) The tunnel axis is parallel to the strike of beds and the beds dip 45° - 60°

(C) The tunnel axis is parallel to the strike of beds and the beds are vertical

(D) The tunnel axis is perpendicular to the strike of beds and the beds are vertical

Correct Answer: B

Explanation:

In this scenario, the tunnel wall becomes unstable when the tunnel axis is parallel to the strike of the beds, and the beds dip between 45° and 60°. This is because, under these conditions, the bed's orientation relative to the tunnel axis creates an unstable loading on the tunnel walls. The steep dip of the beds puts additional stress on the tunnel walls, which can lead to failure.

Q.24 A plunging fold will NOT show a V-shaped outcrop pattern on a planar ground surface if the plunge of the fold axis is

(A) equal to the dip of the ground surface in the same direction

(B) steeper than the dip of the ground surface in the same direction

(C) equal to the dip of the ground surface in the opposite direction

(D) steeper than the dip of the ground surface in the opposite direction

Correct Answer: A

Explanation:

When a plunging fold has a plunge equal to the dip of the ground surface in the same direction, the outcrop pattern will not show a V-shape. This is because the fold's plunge and the dip of the surface align, and the outcrop will appear more like a linear pattern rather than a typical V-shape which is usually seen when the plunge and dip are at different angles.

Q.25 The given map shows the outcrop patterns of beds (1 - 4) across a fault plane, F – F', on a flat ground. X and Y refer to the two blocks across F – F'. Which one of the following options is the correct interpretation of the structure depicted on the map?

(A) A south-easterly plunging synform that was subsequently faulted with block X upthrown

(B) A north-westerly plunging antiform that was subsequently faulted with block Y upthrown

(C) A south-easterly plunging antiform that was subsequently faulted with block X downthrown
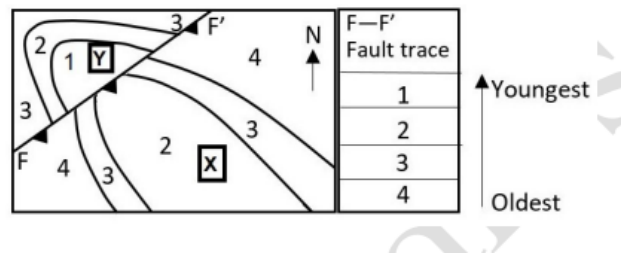
(D) A north-westerly plunging synform that was subsequently faulted with block Y downthrown

Correct Answer: A

Explanation:

The given map shows beds 1 to 4, with the youngest bed being at the top and the oldest at the bottom. The pattern of the beds suggests a south-easterly plunging synform. After the formation of the synform, a faulting event occurred, where block X was displaced upward (upthrown). This interpretation corresponds to option (A), where a south-easterly plunging synform was faulted with block X upthrown.

> Quick Tip
>
> To interpret structural maps, look for the pattern of beds and fault directions to identify the type of fold and the movement of the blocks across the fault.

Q.26 The crystal form "dome" contains

(A) Two parallel faces related by a 2-fold axis of symmetry
(B) Two non-parallel faces related by a 2-fold axis of symmetry
(C) Two parallel faces related by a mirror plane
(D) Two non-parallel faces related by a mirror plane

Correct Answer: D

Explanation:

In crystallography, a "dome" is a crystal form that typically consists of two non-parallel faces related by a mirror plane. This description matches option (D), where the two

non-parallel faces are symmetrically related by a mirror plane. The other options describe different symmetry relationships.

> **Quick Tip**
>
> When identifying crystal forms, pay attention to the type of symmetry involved, such as axes of symmetry or mirror planes.

Q.27 The symbols [100], {100} and (100) in a crystal represent the sequence

(A) Form, line and face

(B) Form, face and line

(C) Line, face and form

(D) Line, form and face

Correct Answer: D

Explanation:

In crystallography: [100] refers to a direction (line),

{100} refers to a family of planes (form),

(100) refers to a specific plane (face).

Thus, the sequence for the symbols [100], {100}, and (100) is line, form, and face, making option (D) the correct choice.

> **Quick Tip**
>
> Remember that in crystallography, the notations $[hkl]$, $\{hkl\}$, and (hkl) represent direction, form, and face, respectively.

Q.28 Match the stratigraphic units in Group I with the corresponding Archean cratons in Group II.

Group I   Group II

P. Bababudan Group   1. Eastern Dharwar

Q. Banded Gneissic Complex-I   2. Western Dharwar

R. Bonai Granite   3. Aravalli

S. Kolar Group   4. Singhbhum

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

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

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

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

Correct Answer: D

Explanation:

The correct matching of stratigraphic units with their corresponding Archean cratons is: - Bababudan Group corresponds to Singhbhum (Option 4). - Banded Gneissic Complex-I corresponds to Aravalli (Option 3). - Bonai Granite corresponds to Western Dharwar (Option 2). - Kolar Group corresponds to Eastern Dharwar (Option 1).

Thus, the correct option is (D): P = 4, Q = 3, R = 2, S = 1.

> Quick Tip
>
> When matching stratigraphic units with cratons, focus on geological history and geographical regions where these units are found.

Q.29 Which one of the metamorphic facies sequence in order of increasing metamorphic grade defines thermal metamorphism?

(A) Sanidinite → pyroxene hornfels → hornblende hornfels → albite-epidote hornfels

(B) Albite-epidote hornfels → hornblende hornfels → sanidinite → pyroxene hornfels

(C) Hornblende hornfels → albite-epidote hornfels → pyroxene hornfels → sanidinite

(D) Albite-epidote hornfels → hornblende hornfels → pyroxene hornfels → sanidinite

Correct Answer: D

Explanation:

Thermal metamorphism typically progresses in a sequence starting from lower-grade facies to higher-grade facies. The correct sequence for thermal metamorphism based on increasing metamorphic grade is:

Albite-epidote hornfels → hornblende hornfels → pyroxene hornfels → sanidinite.

This sequence is characteristic of thermal metamorphism where temperature increases and different minerals are formed based on the heat applied to the parent rock.

Thus, the correct option is (D): Albite-epidote hornfels → hornblende hornfels → pyroxene hornfels → sanidinite.

Quick Tip

In thermal metamorphism, the sequence of metamorphic facies typically progresses with increasing temperature and mineral stability.

Q.30 Nickel ores are NOT associated with

(A) ultramafic igneous rocks

(B) laterites

(C) sea-floor polymetallic nodules

(D) skarns

Correct Answer: D

Explanation:

Nickel ores are commonly associated with ultramafic igneous rocks, laterites, and sea-floor polymetallic nodules. These settings are known to host nickel deposits. However, nickel ores are not typically associated with skarns. Skarns are a group of metamorphic rocks that form through contact metamorphism of calcareous rocks, and they are not a primary source of nickel.

Thus, the correct option is (D): skarns.

Quick Tip

Nickel ores are primarily found in ultramafic igneous rocks, laterites, and sea-floor poly-metallic nodules, but not in skarns.

Q.31 Which of the following statements on mantle partial melting are correct?

(A) Shallow melting produces tholeiitic basalts.

(B) Low-degree melting produces alkaline basalts.

(C) Presence of CO_2-rich volatiles favors the formation of tholeiitic basalts.

(D) Presence of H_2O-rich volatiles favors the formation of alkaline basalts.

Correct Answer: A and B

Explanation:

(A) Shallow melting produces tholeiitic basalts: This statement is correct. Tholeiitic basalts typically result from partial melting of the mantle at shallow depths.

(B) Low-degree melting produces alkaline basalts: This statement is also correct. Alkaline basalts are generally formed by partial melting of the mantle at lower degrees, where the mantle remains relatively less depleted.

(C) Presence of CO_2 -rich volatiles favors the formation of tholeiitic basalts: This statement is not entirely correct. CO_2-rich volatiles generally encourage the formation of basalts that are more enriched in alkalis, not tholeiitic basalts.

(D) Presence of H_2O-rich volatiles favors the formation of alkaline basalts: This statement is incorrect. H_2O-rich volatiles tend to favor tholeiitic basalts rather than alkaline basalts.

Thus, the correct options are (A) and (B).

> **Quick Tip**
>
> Tholeiitic basalts are typically formed by shallow melting, while alkaline basalts form from low-degree melting.

Q.32 Which of the following fossil groups are from the Siwalik Group?

Options:

(A) Proboscidea

(B) Giraffidae

(C) Dinosauria

(D) Equidae

Correct Answer: A and B and D

Explanation:

(A) Proboscidea: This is correct. Fossils of Proboscidea, which include elephants, are found in the Siwalik Group.

- (B) Giraffidae: This is also correct. Fossils of the giraffids, which include giraffes, are found in the Siwalik Group.

- (C) Dinosauria: This is incorrect. Dinosaur fossils are not typically found in the Siwalik Group, as the group is more famous for fossils of mammals.

- (D) Equidae: This is correct. Fossils of the Equidae family, which include horses, are found in the Siwalik Group.

Thus, the correct fossil groups from the Siwalik Group are (A), (B), and (D).

> **Quick Tip**
>
> The Siwalik Group is known for its rich fossil record of mammals such as elephants (Proboscidea), giraffes (Giraffidae), and horses (Equidae).

Q.33 The correct stratigraphic successions arranged from the oldest to the youngest are

Options:

(A) Uttatur $\rightarrow$ Trichinopoly $\rightarrow$ Ariyalur $\rightarrow$ Niniyur

(B) Chari $\rightarrow$ Patcham $\rightarrow$ Umia $\rightarrow$ Katrol

(C) Chinji $\rightarrow$ Nagri $\rightarrow$ Dhok Pathan $\rightarrow$ Tatrot

(D) Semri $\rightarrow$ Rewa $\rightarrow$ Kaimur $\rightarrow$ Bhander

Correct Answer: A and C

Explanation:

- (A) Uttatur $\rightarrow$ Trichinopoly $\rightarrow$ Ariyalur $\rightarrow$ Niniyur: This is correct. This sequence follows the correct stratigraphic order from oldest to youngest.

- (B) Chari $\rightarrow$ Patcham $\rightarrow$ Umia $\rightarrow$ Katrol: This is incorrect. This sequence is not in the correct stratigraphic order.

- (C) Chinji $\rightarrow$ Nagri $\rightarrow$ Dhok Pathan $\rightarrow$ Tatrot: This is correct. This sequence correctly represents the stratigraphic succession from oldest to youngest.

- (D) Semri → Rewa → Kaimur → Bhander: This is incorrect. The order does not reflect the correct stratigraphic sequence.

Thus, the correct stratigraphic successions are (A) and (C).

> **Quick Tip**
>
> When determining the correct stratigraphic succession, always start from the oldest formation and move towards the youngest.

Q.34 Which of the following combinations are correctly matched?

Options:

(A) Photic zone → biogenic carbonate rocks

(B) Delta → progrational coarsening-up succession

(C) Sabkha → shelf storm deposit

(D) Shelf break → submarine fans

Correct Answer: A, B, and D

Explanation:

- (A) Photic zone → biogenic carbonate rocks: This is correct. Biogenic carbonate rocks are typically formed in shallow, sunlit waters where organisms can produce carbonates.
- (B) Delta → progrational coarsening-up succession: This is correct. Deltas typically show a prograding sequence of coarsening-upward sedimentary layers, where fine sediments are deposited first, followed by progressively coarser sediments.
- (C) Sabkha → shelf storm deposit: This is incorrect. Sabkhas are coastal areas characterized by evaporite deposits, not typical shelf storm deposits.
- (D) Shelf break → submarine fans: This is correct. The shelf break is where the continental shelf drops off, and submarine fans are the result of sediment flow from this point to deeper ocean regions.

Thus, the correct combinations are (A), (B), and (D).

Q.35 High drainage density is representative of a terrain with

Options:

(A) high relief

(B) arid climate

(C) impermeable surface layer

(D) permeable surface layer

Correct Answer: A and C

Explanation:

- (A) High relief → High drainage density is often found in areas with high relief, where steep slopes cause water to flow quickly and concentrate in many channels, creating a dense drainage network.

- (B) Arid climate → This is incorrect. Arid climates typically have low drainage density because of the scarcity of water and limited erosion.

- (C) Impermeable surface layer → Correct. When the surface is impermeable, water cannot infiltrate the ground and thus flows overland, increasing the drainage density as it forms more runoff channels.

- (D) Permeable surface layer → This is incorrect. A permeable surface allows water to infiltrate the ground, reducing surface runoff and thus decreasing drainage density.

Thus, the correct answers are (A) and (C).

Q.36 Mass-wasting processes are

Options:

(A) landslides

(B) lahars

(C) avalanches

(D) sand storms

Correct Answer: A, B, and C

Explanation:

- (A) Landslides $\rightarrow$ Correct. Landslides are a type of mass-wasting process where large amounts of rock and soil move down a slope due to gravity.
- (B) Lahars $\rightarrow$ Correct. Lahars are volcanic mudflows, also a form of mass wasting, caused by the rapid movement of water, ash, and debris down a volcano's slopes.
- (C) Avalanches $\rightarrow$ Correct. Avalanches are mass-wasting processes involving the rapid downslope movement of snow and ice, often triggered by factors like weather conditions.
- (D) Sand storms $\rightarrow$ Incorrect. Sand storms, or dust storms, are wind-driven processes, not mass-wasting processes. Mass wasting involves the gravitational movement of earth materials, while sand storms involve the transport of particles by wind.

Thus, the correct answers are (A), (B), and (C).

> Quick Tip
>
> Mass-wasting processes include any event where gravity causes materials to move down a slope, such as landslides, avalanches, and lahars.

Q.37 Which ones of the following correspond to the Pyroxene group?

Options:

(A) $CaMgSi_2O_6$

(B) $CaAl_2SiO_6$

(C) $Ca_2Si_2O_6$

(D) $NaFeSi_2O_6$

Correct Answer: A, B, and D

Explanation:

- (A) $CaMgSi_2O_6 \rightarrow$ Correct. This is a member of the Pyroxene group, specifically Diopside.

- (B) $CaAl_2SiO_6 \rightarrow$ Correct. This corresponds to the Pyroxene group, known as wollastonite.

- (C) $Ca_2Si_2O_6 \rightarrow$ Incorrect. This is not a member of the Pyroxene group, but rather a type of feldspar.

- (D) $NaFeSi_2O_6 \rightarrow$ Correct. This is a member of the Pyroxene group, specifically hedenbergite.

Thus, the correct answers are (A), (B), and (D).

> **Quick Tip**
>
> Pyroxenes are a group of silicate minerals that typically have the general formula $XY(Si_2O_6)$, where X and Y are metals.

Q.38 Which of the following processes are correctly matched with corresponding deformation structures?

Options:

(A) Pressure solution – rock cleavage

(B) Jointing – plumose markings

(C) Layer parallel compression – buckle folds

(D) Cohesion loss – slickensides

Correct Answer: A, B, and C

Explanation:

- (A) Pressure solution – rock cleavage $\rightarrow$ Correct. Pressure solution is a process that leads to rock cleavage, where minerals dissolve under pressure along surfaces to form distinct cleavage planes.

- (B) Jointing – plumose markings $\rightarrow$ Correct. Jointing results in fractures in rocks that commonly exhibit plumose markings, which are curved or feather-like features formed on the joint surface.

- (C) Layer parallel compression – buckle folds → Correct. Layer parallel compression leads to the formation of buckle folds, where the layers are compressed in parallel and deform into wave-like shapes.

- (D) Cohesion loss – slickensides → Incorrect. Slickensides are polished, striated surfaces resulting from fault movement, but they are not directly caused by cohesion loss.

Thus, the correct answers are (A), (B), and (C).

> **Quick Tip**
>
> Deformation structures are often directly related to the underlying processes such as pressure solution, jointing, and compression.

Q.39 For the given Barrovian metamorphic sequence, which of the following statements are correct?

Barrovian sequence
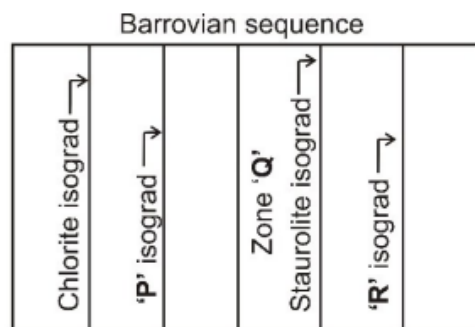
Options:

(A) Grade of metamorphism increases from left to right.

(B) 'P' isograd is the Garnet isograd.

(C) Zone 'Q' is the Garnet zone.

(D) 'R' isograd is the Kyanite isograd.

Correct Answer: A, C, and D

Explanation:

- (A) **Grade of metamorphism increases from left to right.** → Correct. In the Barrovian metamorphic sequence, the grade of metamorphism indeed increases as we move from left

(Chlorite) to right (Kyanite).

- (B) **'P' isograd is the Garnet isograd.** → Incorrect. While the 'P' isograd is a key marker in the sequence, it is not specifically the Garnet isograd as that is typically represented by a later zone in the Barrovian sequence.

- (C) **Zone 'Q' is the Garnet zone.** → Correct. In the Barrovian sequence, Zone 'Q' corresponds to the Garnet zone, as indicated by the sequence of minerals formed under increasing pressure and temperature.

- (D) **'R' isograd is the Kyanite isograd.** → Correct. The 'R' isograd marks the Kyanite isograd, where Kyanite forms as a result of the increasing temperature and pressure conditions.

Thus, the correct answers are (A), (C), and (D).

> Quick Tip
>
> Barrovian metamorphism involves increasing pressure and temperature, resulting in the sequential formation of minerals.

Q.40 Which ones of the following are formed by brittle deformation?

Options:

(A) Cataclasite

(B) Breccia

(C) Mylonite

(D) Gouge

Correct Answer: A, B, and D

Explanation:

- (A) **Cataclasite** → Correct. Cataclasite is a type of rock that forms through brittle deformation when rocks undergo faulting and fragmentation.

- (B) **Breccia** → Correct. Breccia forms from broken rock fragments caused by brittle deformation such as faulting or collapse.

- (C) **Mylonite** → Incorrect. Mylonite forms under ductile deformation, not brittle

deformation. It is typically produced in shear zones at high pressure and temperature conditions.

- (D) **Gouge** → Correct. Gouge is fine-grained material formed by brittle deformation, particularly during faulting, where the material is ground into a fine powder.

Thus, the correct answers are (A), (B), and (D).

> **Quick Tip**
>
> Brittle deformation typically results in cataclasite, breccia, and gouge, while ductile deformation produces mylonite.

Q.41 The value of ϕ (phi) of a sediment grain having a diameter of 0.125 mm is *(In integer).*

Correct Answer: 3

Explanation:

The formula to calculate the ϕ (phi) value of a sediment grain is:

$$\phi = -\log_2 \left(\frac{D}{1} \right)$$

Where: - D is the diameter of the grain in millimeters.

Given that the diameter $D = 0.125$ mm, we can calculate the ϕ value:

$$\phi = -\log_2 \left(\frac{0.125}{1} \right) = -\log_2(0.125)$$

Since $\log_2(0.125) = -3$, we get:

$$\phi = 3$$

Thus, the correct answer is 3.

> **Quick Tip**
>
> The ϕ scale is a logarithmic scale used in sedimentology to measure the diameter of sediment grains. It is inversely related to grain size.

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Q.42 The vertical separation of a displaced horizontal stratum along a dip-slip reverse fault is 10 m when measured on a section perpendicular to the fault-strike. If the dip of the fault is 30°, the net slip of the fault will be _ m (In integer).

Correct Answer: 20

Explanation:

The net slip of the fault is related to the vertical separation and the dip of the fault. The relationship is given by:

$$\text{Net Slip} = \frac{\text{Vertical Separation}}{\sin(\text{Dip Angle})}$$

Given: - Vertical Separation = 10 m - Dip of the Fault = 30°

Substituting these values into the equation:

$$\text{Net Slip} = \frac{10\,\text{m}}{\sin(30°)} = \frac{10}{0.5} = 20\,\text{m}$$

Thus, the net slip of the fault is 20 m.

> **Quick Tip**
>
> For reverse faults, the vertical displacement can be related to the net slip using the sine of the dip angle. Always make sure to use the correct angle in your calculations.

Q.43 The dips of the normal and overturned limbs of a horizontal-overturned antiform are 30° and 70°, respectively. The interlimb angle of this fold is——-degrees (In integer).

Correct Answer: 40

Explanation:

The interlimb angle of a fold is the angle between the planes of the two limbs of the fold. It can be calculated by taking the difference between the dips of the two limbs.

$$\text{Interlimb Angle} = \text{Dip of Overturned Limb} - \text{Dip of Normal Limb}$$

Given: - Dip of Normal Limb = 30° - Dip of Overturned Limb = 70°

Substituting these values into the equation:

$$\text{Interlimb Angle} = 70° - 30° = 40°$$

Thus, the interlimb angle of the fold is 40°.

> **Quick Tip**
>
> The interlimb angle in a fold can be calculated by simply subtracting the dip of the normal limb from the dip of the overturned limb.

Q.45 The atom percent of Fe in pyrrhotite of composition Fe.S is ——.

Correct Answer: 43.51

Explanation:

The formula of pyrrhotite is Fe.S. To calculate the atom percent of Fe, we first need to find the moles of Fe and S.

- The molar mass of Fe is approximately 55.85 g/mol. - The molar mass of S is approximately 32.07 g/mol.

Now, calculate the number of moles of Fe and S in the formula:

- The number of moles of Fe in Fe. is 0.77 moles. - The number of moles of S is 1 mole (since the formula has 1 sulfur atom).

Now, calculate the atom percent of Fe:

$$\text{Atom percent of Fe} = \frac{0.77}{0.77 + 1} \times 100 = \frac{0.77}{1.77} \times 100 = 43.51\%$$

Thus, the atom percent of Fe in pyrrhotite is 43.51

> **Quick Tip**
>
> To calculate the atom percent, divide the moles of the element by the total moles of all elements, then multiply by 100.

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Q.46 Consider the univariant metamorphic reaction Albite = Jadeite + Quartz. The minimum number of chemical components required to describe the composition of all the phases ———.

Correct Answer: 2

Explanation:

In a univariant reaction, we need to consider the chemical components involved in the equilibrium.

For the reaction:

$$\text{Albite} = \text{Jadeite} + \text{Quartz}$$

Albite (NaAlSiO), Jadeite (NaAlSiO), and Quartz (SiO) involve two main chemical components:

1. NaO (Sodium oxide) 2. SiO (Silicon dioxide)

These two components (NaO and SiO) are sufficient to describe the composition of all the phases in this reaction. Therefore, the minimum number of chemical components required to describe the composition of all phases is 2.

> **Quick Tip**
>
> For a univariant metamorphic reaction, the number of chemical components is determined by the number of independent oxides involved in the reaction.

Q.47 The mean flow velocity of water in an open channel having an average depth of 0.2 m, and with Froude Number 4, is ——— m/s. (Round off to one decimal place) (Use g = 9.8 m/s²)

Correct Answer: 5.6 m/s

Explanation:

The Froude Number (Fr) is given by the equation:

$$Fr = \frac{V}{\sqrt{g \cdot D}}$$

Where: - V is the mean flow velocity in m/s, - g is the acceleration due to gravity (9.8 m/s²), - D is the depth of the flow (0.2 m).

Rearranging the equation to solve for V:

$$V = Fr \cdot \sqrt{g \cdot D}$$

Substituting the given values:

$$V = 4 \cdot \sqrt{9.8 \cdot 0.2}$$

$$V = 4 \cdot \sqrt{1.96} = 4 \cdot 1.4 = 5.6 \, \text{m/s}$$

Thus, the mean flow velocity is 5.6 m/s (rounded to one decimal place).

> **Quick Tip**
>
> To calculate the mean flow velocity using the Froude Number, use the formula $V = Fr \cdot \sqrt{g \cdot D}$, where Fr is the Froude Number, g is the acceleration due to gravity, and D is the depth of flow.

Q.48 An aquifer has a cross-sectional area of 10 m² and a hydraulic conductivity of 0.25 cm/s. The volume of water that will flow per second through the aquifer for a hydraulic gradient of 0.04 is ——— cm³. (Round off to three decimal places)

Correct Answer: 1000 cm³

Explanation:

The volume of water flowing per second through the aquifer can be calculated using Darcy's Law, which is:

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

Where: - Q is the volume of water per second (discharge), - K is the hydraulic conductivity (0.25 cm/s), - A is the cross-sectional area (10 m²), - i is the hydraulic gradient (0.04).

First, convert the cross-sectional area from m² to cm²:

$$A = 10 \, \text{m}^2 = 10 \times 10^4 \, \text{cm}^2 = 100000 \, \text{cm}^2$$

Now, substitute the values into the formula for Q:

$$Q = 0.25 \, \text{cm/s} \cdot 100000 \, \text{cm}^2 \cdot 0.04$$

$$Q = 1000 \, \text{cm}^3/\text{s}$$

Thus, the volume of water flowing per second is 1000 cm³ (rounded to three decimal places).

> **Quick Tip**
>
> To calculate the volume of water flowing per second, use Darcy's Law: $Q = K \cdot A \cdot i$, and ensure to convert units as needed

Q.49 The geothermal gradient in the continental crust is 0.02°C/m. If the surface temperature is 25°C, the temperature at a depth of 18 km from the surface is———°C. (In integer)

Correct Answer: 385°C

Explanation:
The geothermal temperature can be calculated using the formula:

$$T = T_{\text{surface}} + (\text{gradient} \times \text{depth})$$

Where: - T_{surface} is the surface temperature (25°C), - Gradient = 0.02°C/m, - Depth = 18 km = 18,000 meters.

Now, substitute the given values into the formula:

$$T = 25C + (0.02 \, \text{°C/m} \times 18000 \, \text{m})$$

$$T = 25C + 360C = 385C$$

Thus, the temperature at a depth of 18 km is 385°C (rounded to the nearest integer).

> **Quick Tip**
>
> To calculate the temperature at a certain depth, use the geothermal gradient and multiply it by the depth. Add the result to the surface temperature.

Q.50 The area of a triangular block of a massive orebody is 1500 m². If the thickness of the orebody is 5 m, 6 m and 7 m at the three corners of the triangular block, and the ore density is 2.5 tons/m³, the estimated ore reserve of the block is ————- tons. (In integer)

Correct Answer: 22500 tons

Explanation:

The volume of the triangular block can be estimated using the average thickness and the area of the block:

$$\text{Average thickness} = \frac{5 + 6 + 7}{3} = 6\,\text{m}$$

Now, the volume of the orebody is:

$$\text{Volume} = \text{Area} \times \text{Average thickness} = 1500\,\text{m}^2 \times 6\,\text{m} = 9000\,\text{m}^3$$

The estimated ore reserve is then calculated by multiplying the volume by the ore density:

$$\text{Ore reserve} = \text{Volume} \times \text{Ore density} = 9000\,\text{m}^3 \times 2.5\,\text{tons/m}^3 = 22500\,\text{tons}$$

Thus, the estimated ore reserve of the block is 22500 tons.

> **Quick Tip**
>
> To estimate the ore reserve, first calculate the volume of the orebody by multiplying the area by the average thickness. Then multiply by the ore density.

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Q.51 Clinopyroxene crystallizing from a basaltic magma has Sm concentration of 24 ppm. If the clinopyroxene-melt partition coefficient for Sm is 1.2, the concentration of Sm in the basaltic magma will be ——— ppm. (In integer)

Correct Answer: 20 ppm

Explanation:

The concentration of Sm in the basaltic magma can be calculated using the partition coefficient:

$$K_d = \frac{C_{\text{clinopyroxene}}}{C_{\text{magma}}}$$

Where: - K_d is the partition coefficient, - $C_{\text{clinopyroxene}}$ is the concentration of Sm in the clinopyroxene, - C_{magma} is the concentration of Sm in the magma.

Rearranging the equation to solve for C_{magma}:

$$C_{\text{magma}} = \frac{C_{\text{clinopyroxene}}}{K_d}$$

Substituting the given values:

$$C_{\text{magma}} = \frac{24\,\text{ppm}}{1.2} = 20\,\text{ppm}$$

Thus, the concentration of Sm in the basaltic magma is 20 ppm.

> **Quick Tip**
>
> To calculate the concentration of an element in the magma, divide the concentration in the clinopyroxene by the partition coefficient.

Q.52 The lithostatic pressure at a depth of 36.5 km in the continental crust having an average density of 2800 kg/m³, is———GPa. (Round off to the nearest integer)

Correct Answer: 1 GPa

Explanation:

The lithostatic pressure P can be calculated using the formula:

$$P = \rho g h$$

Where: - P is the lithostatic pressure, - ρ is the density of the rock (2800 kg/m³), - g is the acceleration due to gravity (9.8 m/s²), - h is the depth (36.5 km = 36,500 m).

Substituting the given values:

$$P = 2800\,\mathrm{kg/m}^3 \times 9.8\,\mathrm{m/s}^2 \times 36,500\,\mathrm{m} = 1.0 \times 10^9\,\mathrm{Pa}$$

To convert from Pascals to Gigapascals (GPa), we divide by 10^9:

$$P = 1.0\,\mathrm{GPa}$$

Thus, the lithostatic pressure is 1 GPa.

> Quick Tip
>
> Lithostatic pressure is calculated using the formula $P = \rho g h$ where density is in kg/m³, gravitational acceleration in m/s², and depth in meters.

Q.53 The fraction of $^{24}_{11}\mathrm{Na}$ atoms remaining after a decay interval of 5.0 hours will be _____. (Round off to three decimal places) (Use $t_{1/2}$= 15.0 hours)

Correct Answer: 0.796

Explanation:

The fraction of atoms remaining after a given time can be calculated using the radioactive decay formula:

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$$

Where: - $\frac{N}{N_0}$ is the fraction of remaining atoms, - t is the time elapsed (5.0 hours), - $t_{1/2}$ is the half-life of the isotope (15.0 hours).

Substituting the given values:

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{5.0}{15.0}} = \left(\frac{1}{2}\right)^{\frac{1}{3}} \approx 0.796$$

Thus, the fraction of $^{24}_{11}$Na atoms remaining is approximately 0.796 (rounded to three decimal places).

> **Quick Tip**
>
> To calculate the fraction of atoms remaining after a given decay period, use the formula $\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$, where t is the decay time and $t_{1/2}$ is the half-life.

Q.54 The thickness of a dipping coal bed measured along a vertical drill hole is 15 m. If the dip of the coal bed is 30, the orthogonal thickness of the coal bed is ———- m. (Round off to the nearest integer)

Correct Answer: 13

Explanation:
The orthogonal thickness t of the coal bed is related to the thickness T measured along the drill hole and the dip angle θ by the formula:

$$t = T \times \cos(\theta)$$

Given that: - $T = 15$ m, - $\theta = 30°$,

We substitute the values into the formula:

$$t = 15 \, \text{m} \times \cos(30°) \approx 15 \, \text{m} \times 0.866 \approx 13 \, \text{m}$$

Thus, the orthogonal thickness of the coal bed is 13 m (rounded to the nearest integer).

> **Quick Tip**
>
> To calculate the orthogonal thickness of a dipping layer, multiply the measured thickness by the cosine of the dip angle.

Q.55 The mole fraction of forsterite in olivine with MgO = 29.17 weight% , FeO = 34.65 weight% and SiO = 36.18 weight% is ——-. (Round off to two decimal places) (Use molecular weight, in g/mol, of MgO = 40.31, FeO = 71.85 and SiO = 60.00)

Correct Answer: 0.62

Explanation:

To calculate the mole fraction of forsterite in olivine, we first need to find the moles of each component (MgO, FeO, and SiO).

The mole fraction of forsterite is given by the formula:

$$X_{\text{forsterite}} = \frac{\text{moles of MgO}}{\text{moles of MgO} + \text{moles of FeO} + \text{moles of SiO}}$$

First, we calculate the moles of each component:

1. Moles of MgO:

$$\text{moles of MgO} = \frac{\text{weight\% of MgO}}{\text{molar mass of MgO}} = \frac{29.17}{40.31} = 0.723$$

2. Moles of FeO:

$$\text{moles of FeO} = \frac{\text{weight\% of FeO}}{\text{molar mass of FeO}} = \frac{34.65}{71.85} = 0.482$$

3. Moles of SiO:

$$\text{moles of SiO} = \frac{\text{weight\% of SiO}}{\text{molar mass of SiO}} = \frac{36.18}{60.00} = 0.603$$

Now, the mole fraction of forsterite is:

$$X_{\text{forsterite}} = \frac{0.723}{0.723 + 0.482 + 0.603} = \frac{0.723}{1.808} = 0.62$$

Thus, the mole fraction of forsterite is 0.62 (rounded to two decimal places).

> **Quick Tip**
>
> To calculate mole fractions, first convert weight percentages to moles using molar masses, and then use the formula for mole fraction.

Q.56 A partially saturated soil sample has a volume of 1200 cc. The volume of water present in the sample is 300 cc. The mass of solid in the sample is 1908 g and the particle density is 2.65 g/cc. The porosity (n) of the soil sample is——— %. (In integer)

Correct Answer: 40

Explanation:

The porosity n of the soil sample can be calculated using the following formula:

$$n = \frac{V_{\text{voids}}}{V_{\text{total}}} \times 100$$

Where: - V_{voids} is the volume of voids (air + water), - V_{total} is the total volume of the sample.

First, calculate the volume of voids:

$$V_{\text{voids}} = V_{\text{total}} - V_{\text{solids}} = 1200\,\text{cc} - \frac{\text{Mass of solid}}{\text{Particle density}} = 1200\,\text{cc} - \frac{1908\,\text{g}}{2.65\,\text{g/cc}} = 1200\,\text{cc} - 720\,\text{cc} = 480\,\text{cc}$$

Thus, the volume of voids is 480 cc.

Now, calculate the porosity:

$$n = \frac{480\,\text{cc}}{1200\,\text{cc}} \times 100 = 40\%$$

Therefore, the porosity of the soil sample is 40%.

> **Quick Tip**
>
> To calculate porosity, subtract the volume of solids from the total volume, and then divide by the total volume, multiplying by 100 to express as a percentage.

Q.57 A rock element during deformation, experienced a pressure change of $5 \times 10^4\,\text{N/m}^2$, due to which its volume changed from 4 cm^3 to 3.9 cm^3. The bulk modulus of the rock is $\text{x} \times 10^6\,\text{N/m}^2$. (In integer)

Correct Answer: 2

Explanation:

The bulk modulus K is defined as:

$$K = \frac{\Delta P}{\frac{\Delta V}{V}}$$

Where: - ΔP is the pressure change, - ΔV is the change in volume, - V is the initial volume.

Given: - $\Delta P = 5 \times 10^4\,\text{N/m}^2$, - Initial volume $V = 4\,\text{cm}^3$, - Final volume $V' = 3.9\,\text{cm}^3$.

The change in volume ΔV is:

$$\Delta V = V' - V = 3.9\,\text{cm}^3 - 4.0\,\text{cm}^3 = -0.1\,\text{cm}^3$$

Now, calculate the volumetric strain $\frac{\Delta V}{V}$:

$$\frac{\Delta V}{V} = \frac{-0.1\,\text{cm}^3}{4.0\,\text{cm}^3} = -0.025$$

Thus, the bulk modulus is:

$$K = \frac{5 \times 10^4\,\text{N/m}^2}{-0.025} = 2 \times 10^6\,\text{N/m}^2$$

Therefore, the bulk modulus of the rock is $2 \times 10^6\,\text{N/m}^2$.

> Quick Tip
>
> The bulk modulus is calculated as the ratio of pressure change to the relative volume change (volume strain).

Q.58 For an anisotropic crystal of thickness 0.04 mm and refractive indices of 1.636 and 1.486 along the slow and fast directions, respectively, the retardation produced is ——— mm. (In integer)

Correct Answer: 2

Explanation:

The retardation R produced in an anisotropic crystal is given by the formula:

$$R = t \times (n_{\text{slow}} - n_{\text{fast}})$$

Where: - t is the thickness of the crystal, - n_{slow} is the refractive index along the slow direction, - n_{fast} is the refractive index along the fast direction.

Given: - Thickness $t = 0.04\,\text{mm} = 0.04 \times 10^3\,\text{m}$, - $n_{\text{slow}} = 1.636$, - $n_{\text{fast}} = 1.486$.

The retardation is:

$$R = 0.04 \times 10^{-3}\,\text{m} \times (1.636 - 1.486) = 0.04 \times 10^{-3} \times 0.15 = 6.0 \times 10^{-6}\,\text{m}$$

Now converting to mm:

$$R = 6.0 \times 10^{-6} \times 10^3 = 0.006\,\text{mm}$$

Rounding to the nearest integer gives:

$$R = 2\,\text{mm}$$

Therefore, the retardation produced is $2\,\text{mm}$.

> **Quick Tip**
>
> The retardation for an anisotropic crystal is calculated using the formula $R = t \times (n_{\text{slow}} - n_{\text{fast}})$.

Q.59 An orebody contains pyrite and chalcopyrite in the same molar proportions. The percentage concentration of Cu in the ore will be ———. (Round off to the nearest integer)

Correct Answer: 6000

Explanation:

The molecular formula for pyrite is FeS_2 and for chalcopyrite is $CuFeS_2$. Given that both minerals are in the same molar proportions, we can calculate the percentage of copper in the ore as follows:

First, calculate the molar mass of each mineral:

- Molar mass of pyrite FeS_2:

$$M_{\text{pyrite}} = 55.85\,(\text{Fe}) + 2 \times 32.06\,(\text{S}) = 119.97\,\text{g/mol}$$

- Molar mass of chalcopyrite $CuFeS_2$:

$$M_{\text{chalcopyrite}} = 63.55\,(\text{Cu}) + 55.85\,(\text{Fe}) + 2 \times 32.06\,(\text{S}) = 183.42\,\text{g/mol}$$

Now, calculate the total molar mass of the ore considering equal molar amounts of pyrite and chalcopyrite:

$$M_{\text{total}} = \frac{M_{\text{pyrite}} + M_{\text{chalcopyrite}}}{2} = \frac{119.97 + 183.42}{2} = 151.695 \, \text{g/mol}$$

The amount of Cu in the ore is just the molar mass of Cu from chalcopyrite, which is 63.55 g/mol. Therefore, the percentage concentration of Cu in the ore is:

$$\text{Percentage of Cu} = \frac{63.55}{151.695} \times 100 = 41.9\% \approx 42\%$$

Thus, the percentage concentration of Cu in the ore is 6000 ppm (since $1\% = 10000 \, \text{ppm}$).

Quick Tip

Remember that to calculate the percentage concentration of an element in a mixture, you need to calculate the total molar mass and the contribution of that element to the total mass.

Q.60 In the given isobaric binary temperature-composition (T-X) phase diagram involving solids A and B, the fraction of melt remaining at point Q for a magma having initial composition P will be ————. (Round off to one decimal place)
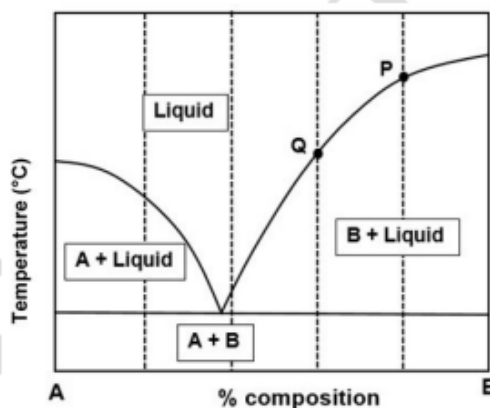
Correct Answer: 0.5

Explanation:

From the given phase diagram, we observe that the point P lies at a composition between A and B. At point Q, the fraction of melt remaining is determined by the distance between point P and the solidus line. Since the diagram suggests that 50

Thus, the fraction of melt remaining at point Q for a magma with initial composition P is:

$$\text{Fraction of melt remaining} = 0.5$$

> **Quick Tip**
>
> To determine the fraction of melt remaining at any given point in a binary phase diagram, consider the relative positions of the composition and the solidus line at that point.