TS POLYCET 2026

Question Paper (Memory-Based) with Solutions

Conducted by SBTET, Telangana

General Instructions

(i) **Duration:** The total duration of the examination is 150 minutes.

(ii) **Total Marks:** The complete paper carries a maximum of 150 marks.

(iii) Each question has four options. Only **one** option is correct.

(iv) **Right Answer:** +1 mark for each correct answer.

(v) **Incorrect Answer:** (No Negative marking).

1. Which of the following mirror is used by a dentist to examine a patient's teeth?

(A) Plane mirror

(B) Convex mirror

(C) Concave mirror

(D) None of the above

Correct Answer: (C) Concave mirror

Solution:

Concept:

Different types of mirrors form different kinds of images depending upon their shape and the position of the object. Mirrors are mainly classified into:

- Plane mirror
- Convex mirror
- Concave mirror

A dentist needs a mirror that can:

- Produce a magnified image of the teeth
- Show the teeth clearly
- Help observe small cavities or defects properly

A concave mirror has the special property of forming a magnified, erect, and clear image when the object is placed close to the mirror, that is, between the pole and the focus of the mirror. Because of this magnification property, concave mirrors are widely used by dentists for examining teeth.

Step 1: Understanding the function of a dentist's mirror.
A dentist examines very small parts inside the mouth such as:

- Cavities
- Cracks in teeth
- Gum conditions
- Tooth surfaces

For proper examination, the image should appear:

- Larger than the actual object
- Bright and clear
- Upright for easy viewing

Thus, a mirror capable of magnifying the image is required.

Step 2: Analyzing each option carefully.
Option (A): Plane mirror
A plane mirror forms:

- Virtual image
- Erect image
- Same size image

Since it does not magnify the image, it is not suitable for detailed examination of teeth.
Therefore, this option is incorrect.

Option (B): Convex mirror

A convex mirror forms:

- Virtual image
- Erect image
- Diminished image

The image formed is smaller than the actual object. Dentists require enlarged images, not diminished ones.
Hence, this option is also incorrect.

Option (C): Concave mirror

A concave mirror, when the object is placed between the pole and focus, forms:

- Virtual image
- Erect image
- Magnified image

This enlarged image helps dentists examine teeth properly and detect even tiny defects.
Therefore, this is the correct answer.

Option (D): None of the above

Since concave mirror is correctly used by dentists, this option is incorrect.

Final Conclusion:

A dentist uses a concave mirror because it produces a magnified and upright image of the teeth, making examination easier and more accurate.
Hence, the correct answer is:

Concave mirror

Quick Tip: Remember the uses of mirrors:

- Plane mirror → Same size image
- Convex mirror → Wider view, smaller image
- Concave mirror → Magnified image when object is close

Dentists, shaving mirrors, and makeup mirrors commonly use concave mirrors because they enlarge the image.

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2. The geometric center of a spherical mirror is called:

(A) Focus

(B) Pole

(C) Magnification

(D) Center of curvature

Correct Answer: (B) Pole

Solution:

Concept:

A spherical mirror is a mirror whose reflecting surface forms a part of a sphere. There are two types of spherical mirrors:

- Concave mirror
- Convex mirror

Important terms related to spherical mirrors are:

- Pole
- Principal axis
- Center of curvature
- Radius of curvature
- Focus

The pole is the midpoint or geometric center of the reflecting surface of a spherical mirror.
It is usually represented by the letter P.

Step 1: Understanding what is meant by geometric center.
The geometric center means the exact middle point of the mirror surface.
In spherical mirrors, the midpoint of the reflecting surface is known as the pole.
Thus, the geometric center and pole refer to the same point.

Step 2: Studying each option carefully.
Option (A): Focus
The focus of a spherical mirror is the point where rays parallel to the principal axis either:

- Meet after reflection (concave mirror), or
- Appear to diverge from (convex mirror)

Focus is not the geometric center of the mirror.
Hence, this option is incorrect.

Option (B): Pole
The pole is:

- The center point of the mirror surface
- The geometric midpoint of the reflecting surface

Since the question asks for the geometric center of a spherical mirror, pole is the correct answer.
Therefore, this option is correct.

Option (C): Magnification
Magnification is not a point on the mirror.
It is a quantity that tells how large or small the image is compared to the object.
Mathematically:

$$m = \frac{\text{Height of image}}{\text{Height of object}}$$

Thus, magnification cannot be the geometric center.
Hence, this option is incorrect.

Option (D): Center of curvature
The center of curvature is the center of the sphere of which the mirror forms a part.

It is represented by C.

This point lies away from the mirror surface and is not the geometric center of the mirror itself.

Therefore, this option is incorrect.

Final Conclusion:

The geometric center or midpoint of a spherical mirror is called the pole.

Hence, the correct answer is:

Pole

Quick Tip: Important terms of spherical mirrors:

- Pole (P) → Geometric center of mirror
- Focus (F) → Point where reflected rays meet
- Center of curvature (C) → Center of the sphere

Always remember: the pole lies directly on the mirror surface.

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3. We get a diminished image with a concave mirror when the object is placed:

(A) At focus

(B) Between the pole and focus

(C) At the center of curvature

(D) Beyond center of curvature

Correct Answer: (D) Beyond center of curvature

Solution:

Concept:

A concave mirror can form different types of images depending upon the position of the object with respect to:

- Pole (P)
- Focus (F)

- Center of curvature (C)

The nature, size, and position of the image change as the object position changes.
For a concave mirror:

- Object between pole and focus → magnified virtual image
- Object at focus → image at infinity
- Object at center of curvature → same size image
- Object beyond center of curvature → diminished image

Thus, a diminished image is formed when the object is placed beyond the center of curvature.

Step 1: Understanding the meaning of diminished image.
A diminished image means:

$$\text{Image size} < \text{Object size}$$

In other words, the image formed is smaller than the actual object.
We must determine the object position for which a concave mirror produces a smaller image.

Step 2: Analyzing each option carefully.
Option (A): At focus
When the object is placed at the focus of a concave mirror:

- Reflected rays become parallel
- Image forms at infinity
- Image becomes highly enlarged

Hence, the image is not diminished.
Therefore, this option is incorrect.

Option (B): Between the pole and focus
When the object lies between the pole and focus:

- The image formed is virtual
- The image is erect
- The image is magnified

Since the image becomes larger than the object, it is not diminished.

Thus, this option is incorrect.

Option (C): At the center of curvature

When the object is placed at the center of curvature:

- Image is formed at the center of curvature
- Image is real and inverted
- Image size is equal to object size

Therefore, the image is neither magnified nor diminished.

Hence, this option is incorrect.

Option (D): Beyond center of curvature

When the object is placed beyond the center of curvature:

- The image forms between focus and center of curvature
- The image is real
- The image is inverted
- The image is smaller than the object

Thus, the image formed is diminished.

Therefore, this option is correct.

Final Conclusion:

A concave mirror forms a diminished image when the object is placed beyond the center of curvature.

Hence, the correct answer is:

Beyond center of curvature

Quick Tip: For concave mirrors:

- Beyond $C \rightarrow$ diminished image
- At $C \rightarrow$ same size image
- Between F and $C \rightarrow$ magnified image
- Between P and $F \rightarrow$ virtual magnified image

Remember:

$$\text{Far object} \Rightarrow \text{Smaller image}$$

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4. If the radius of curvature of a spherical mirror is 16 cm, then the focal length of the mirror is:

(A) 16 cm

(B) 8 cm

(C) 24 cm

(D) 32 cm

Correct Answer: (B) 8 cm

Solution:

Concept:

For every spherical mirror, there exists a fixed relationship between:

- Radius of curvature (R)
- Focal length (f)

The relationship is:

$$f = \frac{R}{2}$$

This means the focal length of a spherical mirror is always half of its radius of curvature.

Where:

- $R =$ Radius of curvature
- $f =$ Focal length

Step 1: Writing the given information.

The radius of curvature is given as:

$$R = 16\,\text{cm}$$

We have to find the focal length f.

Step 2: Using the relation between focal length and radius of curvature.

We know:

$$f = \frac{R}{2}$$

Substituting the value of R:

$$f = \frac{16}{2}$$

$$f = 8\,\text{cm}$$

Thus, the focal length of the mirror is:

$$8\,\text{cm}$$

Step 3: Checking the options carefully.

- Option (A): 16 cm → Incorrect
- Option (B): 8 cm → Correct
- Option (C): 24 cm → Incorrect
- Option (D): 32 cm → Incorrect

Therefore, the correct answer is option (B).

Final Conclusion:

If the radius of curvature of a spherical mirror is 16 cm, then its focal length is:

$$\boxed{8\,\text{cm}}$$

Quick Tip: For spherical mirrors, always remember:

$$f = \frac{R}{2}$$

This means:

- Radius of curvature is twice the focal length
- Focal length is half the radius of curvature

Example:

$$R = 20\,\text{cm} \Rightarrow f = 10\,\text{cm}$$

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5. When a convex lens is placed in water, its focal length:

(A) Increases

(B) Decreases

(C) Does not change

(D) None of the above

Correct Answer: (A) Increases

Solution:

Concept:

The focal length of a lens depends upon:

- The refractive index of the lens material
- The refractive index of the surrounding medium
- The curvature of the lens surfaces

A convex lens converges light rays because its refractive index is greater than that of the surrounding medium.

Normally, lenses are used in air. When the lens is placed in water, the difference between the refractive index of the lens and the surrounding medium decreases.

As a result:

- The converging power of the lens decreases

- The lens bends light less strongly
- The focal length becomes larger

Hence, the focal length increases.

Step 1: Understanding the behavior of a convex lens.

A convex lens is also called a converging lens because it brings parallel rays of light together at a point called the principal focus.

The power of convergence depends upon how strongly the lens refracts light rays.

Greater refraction means:

Smaller focal length

Less refraction means:

Larger focal length

Step 2: Understanding what happens in water.

When the convex lens is placed in air:

- The refractive index difference between glass and air is large
- The lens bends light strongly

But when the lens is placed in water:

- Water itself has a refractive index greater than air
- The difference between the refractive index of glass and water becomes smaller

Therefore, the lens loses some of its converging ability.

It bends light rays less than before.

Step 3: Connecting lens power and focal length.

We know:

$$P = \frac{1}{f}$$

Where:

- $P =$ Power of the lens
- $f =$ Focal length

If the converging power decreases, then:

$$f \text{ increases}$$

Thus, placing the convex lens in water increases its focal length.

Step 4: Analyzing the options carefully.

Option (A): Increases

This is correct because the lens bends light less strongly in water, causing the focal length to become larger.

Option (B): Decreases

Incorrect. The focal length does not become smaller because the lens power decreases in water.

Option (C): Does not change

Incorrect. The surrounding medium affects the focal length significantly.

Option (D): None of the above

Incorrect because option (A) is correct.

Final Conclusion:

When a convex lens is placed in water, its converging power decreases and therefore its focal length increases.

Hence, the correct answer is:

$$\boxed{\text{Increases}}$$

Quick Tip: Remember:

$$\text{Power} \propto \frac{1}{\text{Focal length}}$$

If the surrounding medium becomes optically denser:

- Lens power decreases
- Focal length increases

A convex lens in water becomes less effective in converging light rays.

6. A spherical aggregate of a soap molecule in water is called:

(A) Hydrophilic end

(B) Hydrophobic end

(C) Micelle

(D) Cation

Correct Answer: (C) Micelle

Solution:

Concept:

Soap molecules have a special structure consisting of two parts:

- A hydrophilic end (water-attracting end)
- A hydrophobic end (water-repelling end)

When soap is added to water, many soap molecules come together and arrange themselves in the form of a spherical cluster.
In this arrangement:

- The hydrophobic tails remain inward away from water
- The hydrophilic heads remain outward towards water

This spherical arrangement of soap molecules is called a micelle.
Micelles help trap oil and grease inside them, which is why soap is effective for cleaning.

Step 1: Understanding the structure of soap molecules.
A soap molecule contains:

- A long hydrocarbon tail
- An ionic head

The hydrocarbon tail:

- Does not mix with water
- Is called hydrophobic

The ionic head:

- Mixes easily with water
- Is called hydrophilic

Thus, soap molecules possess both water-loving and water-repelling properties.

Step 2: What happens when soap is mixed in water?

When soap is dissolved in water:

- Soap molecules arrange themselves in groups
- Their hydrophobic tails move inward
- Their hydrophilic heads face outward towards water

This creates a spherical structure.

The oily dirt gets trapped inside this structure and is washed away with water.

This spherical cluster is known as a micelle.

Step 3: Analyzing the options carefully.

Option (A): Hydrophilic end

The hydrophilic end is only one part of a soap molecule.

It is not the name of the spherical aggregate.

Hence, this option is incorrect.

Option (B): Hydrophobic end

The hydrophobic end is also just a part of the soap molecule.

It refers to the water-repelling tail.

Thus, this option is incorrect.

Option (C): Micelle

A micelle is the spherical arrangement formed by soap molecules in water.

Therefore, this option is correct.

Option (D): Cation

A cation is a positively charged ion.

It has no relation to the spherical aggregate formed by soap molecules.

Hence, this option is incorrect.

Final Conclusion:

The spherical aggregate formed by soap molecules in water is called a micelle.

Hence, the correct answer is:

Micelle

Quick Tip: Remember:

- Hydrophilic head → attracts water
- Hydrophobic tail → repels water
- Spherical arrangement of soap molecules → Micelle

Micelles trap oily dirt inside them and help in the cleaning process.

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7. Best conductor of electricity is:

(A) Graphite

(B) Graphene

(C) Diamond

(D) Nanotube

Correct Answer: (B) Graphene

Solution:

Concept:

Electric conductivity depends upon the availability and movement of free electrons inside a material.

Carbon exists in different forms called allotropes, such as:

- Diamond
- Graphite
- Graphene
- Carbon nanotubes

Each allotrope has a different structure and therefore different electrical properties.
Among these, graphene is considered one of the best conductors of electricity because:

- It has extremely high electron mobility
- Electrons move almost freely through its structure
- It has a single layer hexagonal arrangement of carbon atoms

Thus, graphene shows exceptional electrical conductivity.

Step 1: Understanding the conductivity of carbon allotropes.
Different carbon allotropes conduct electricity differently because of differences in bonding and electron movement.
Materials with free-moving electrons conduct electricity better.
We now examine each option carefully.

Step 2: Analyzing each option.
Option (A): Graphite
Graphite conducts electricity because:

- Each carbon atom forms three covalent bonds
- One electron remains free for conduction

Thus, graphite is a good conductor of electricity.
However, its conductivity is lower than graphene.
Therefore, this option is not the best answer.

Option (B): Graphene
Graphene consists of:

- A single layer of carbon atoms
- Hexagonal arrangement
- Extremely high electron mobility

Electrons move very rapidly through graphene with very little resistance.
Because of this:

- Graphene is an excellent conductor

- It is considered one of the best electrical conductors known

Hence, this option is correct.

Option (C): Diamond

In diamond:

- Every carbon atom forms four strong covalent bonds
- No free electrons are available

Therefore, diamond does not conduct electricity.

It is an electrical insulator.

Hence, this option is incorrect.

Option (D): Nanotube

Carbon nanotubes also conduct electricity very well and possess remarkable electrical properties.

However, in standard school-level science questions, graphene is considered the best conductor among the given options because of its exceptional electron mobility and conductivity.

Therefore, this option is not taken as the correct answer here.

Final Conclusion:

Among the given options, graphene is the best conductor of electricity.

Hence, the correct answer is:

Graphene

Quick Tip: Important properties of carbon allotropes:

- Diamond → Hardest natural substance, electrical insulator
- Graphite → Good conductor of electricity
- Graphene → Excellent electrical conductor
- Nanotubes → Strong and conductive nanostructures

Graphene is a single atomic layer of carbon with extraordinary electrical properties.

8. sp^3 **Hybridization is found in:**

(A) CH_4

(B) C_2H_2

(C) C_2H_4

(D) C_2H_6

Correct Answer: (A) CH_4 and (D) C_2H_6

Solution:

Concept:

Hybridization is the mixing of atomic orbitals of nearly equal energy to form new hybrid orbitals.

The type of hybridization depends upon:

- Number of sigma (σ) bonds
- Number of lone pairs
- Geometry around the central atom

Important types of hybridization are:

- sp hybridization
- sp^2 hybridization
- sp^3 hybridization

For sp^3 hybridization:

- One s orbital mixes with three p orbitals
- Four equivalent hybrid orbitals are formed
- Geometry becomes tetrahedral
- Bond angle is approximately 109.5°

Compounds having only single bonds around carbon generally show sp^3 hybridization.

Step 1: Analyzing CH_4.

Methane (CH_4) has:

- Four single covalent bonds
- Four sigma bonds around carbon
- No double or triple bonds

Carbon mixes:

$$1s + 3p \rightarrow sp^3$$

Thus, carbon in methane is sp^3 hybridized.

Therefore, option (A) is correct.

Step 2: Analyzing C_2H_2.

Ethyne (C_2H_2) contains:

- A carbon-carbon triple bond

Each carbon atom forms:

- Two sigma bonds
- Two pi bonds

Triple-bonded carbon atoms show:

$$sp \text{ hybridization}$$

Thus, C_2H_2 is not sp^3 hybridized.

Hence, option (B) is incorrect.

Step 3: Analyzing C_2H_4.

Ethene (C_2H_4) contains:

- A carbon-carbon double bond

Each carbon atom forms:

- Three sigma bonds

- One pi bond

Double-bonded carbon atoms show:

$$sp^2 \text{ hybridization}$$

Therefore, C_2H_4 is not sp^3 hybridized.
Hence, option (C) is incorrect.

Step 4: Analyzing C_2H_6.
Ethane (C_2H_6) contains:

- Only single bonds
- Four sigma bonds around each carbon atom

Thus, each carbon atom undergoes:

$$sp^3 \text{ hybridization}$$

Therefore, option (D) is also correct.

Final Conclusion:
Compounds containing carbon atoms with only single bonds generally show sp^3 hybridization.
Hence, the compounds showing sp^3 hybridization are:

$$\boxed{CH_4 \text{ and } C_2H_6}$$

Quick Tip: Shortcut to identify hybridization:

- Single bond only $\rightarrow sp^3$
- Double bond present $\rightarrow sp^2$
- Triple bond present $\rightarrow sp$

Examples:

$$CH_4 \rightarrow sp^3$$

$$C_2H_4 \rightarrow sp^2$$

$$C_2H_2 \rightarrow sp$$

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9. Glycerol is _____

(A) $CH_2OH-CHOH-CH_2$

(B) $CH_2OH-CH_2OH-CHOH$

(C) $C_{17}H_{35}COONa$

(D) $CH_2OH-CHOH-CH_2OH$

Correct Answer: (D) $CH_2OH-CHOH-CH_2OH$

Solution:

Concept:

Glycerol is an important organic compound belonging to the alcohol family. It is commonly known as **glycerine** and chemically called **propane-1,2,3-triol**.

It is classified as a:

- Trihydric alcohol
- Polyhydric alcohol

because it contains:

$$3 \text{ hydroxyl } (-OH) \text{ groups}$$

The name **propane-1,2,3-triol** can be understood as:

- "Propane" → three carbon atoms in the chain

- "1,2,3" → hydroxyl groups attached to all three carbons
- "Triol" → presence of three alcohol groups

Thus, the structure of glycerol must contain:

- Three carbon atoms
- Three hydroxyl groups

Step 1: Writing the structure of glycerol carefully.

The carbon chain of glycerol contains three carbon atoms arranged in a straight chain.

The first carbon atom contains:

- Two hydrogen atoms
- One hydroxyl group
- One bond with the next carbon atom

Therefore, its group becomes:

$$CH_2OH$$

The second carbon atom contains:

- One hydrogen atom
- One hydroxyl group
- Bonds with neighboring carbon atoms

Thus, the middle group becomes:

$$CHOH$$

The third carbon atom is similar to the first carbon atom and forms:

$$CH_2OH$$

Combining all three parts together:

$$CH_2OH - CHOH - CH_2OH$$

This is the correct structural formula of glycerol.

Step 2: Checking each option carefully.

Option (A):

$$CH_2OH - CHOH - CH_2$$

This structure is incomplete because the last carbon atom does not satisfy its valency properly.
Therefore, this option is incorrect.

Option (B):

$$CH_2OH - CH_2OH - CHOH$$

This arrangement is chemically incorrect and does not represent propane-1,2,3-triol properly.
Hence, this option is incorrect.

Option (C):

$$C_{17}H_{35}COONa$$

This is sodium stearate, which is a soap molecule.
It is not glycerol.
Therefore, this option is incorrect.

Option (D):

$$CH_2OH - CHOH - CH_2OH$$

This structure contains:

- Three carbon atoms
- Three hydroxyl groups
- Correct bonding arrangement

Thus, it correctly represents glycerol.
Hence, this option is correct.

Final Conclusion:

The correct structural formula of glycerol is:

$$\boxed{CH_2OH - CHOH - CH_2OH}$$

Therefore, the correct answer is option (D).

Quick Tip: Remember:

- Glycerol contains 3 carbon atoms
- It has 3 hydroxyl ($-OH$) groups
- Hence it is called a trihydric alcohol

IUPAC Name:

Propane-1,2,3-triol

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10. The structure for 3-amino-2-bromo-hexan-1-ol is:

(A) $CH_3 - CH_2 - CH_2 - CH(NH_2) - CH(Br) - CH_2OH$

(B) $CH_2OH - CH(Br) - CH(NH_2) - CH_2 - CH_2 - CH_3$

(C) $CH_3 - CH(Br) - CH_2 - CH(NH_2) - CH_2 - CH_2OH$

(D) None

Correct Answer: (B)

Solution:

Concept:

To determine the correct structure of an organic compound from its IUPAC name, we must carefully analyze:

- The parent carbon chain
- The principal functional group
- The numbering of carbon atoms
- The substituents attached to the chain

The given compound is:

3-amino-2-bromo-hexan-1-ol

Each part of the name provides structural information.

Step 1: Identifying the parent carbon chain.

The word:

hexan

indicates that the parent chain contains:

6 carbon atoms

Thus, the basic carbon skeleton is:

$$C_1 - C_2 - C_3 - C_4 - C_5 - C_6$$

Step 2: Identifying the principal functional group.

The suffix:

-ol

indicates the presence of an alcohol group:

$$(-OH)$$

The name:

hexan-1-ol

means:

- The hydroxyl group is attached to carbon number 1

According to IUPAC rules:

- The principal functional group gets the lowest possible number

Therefore, numbering must begin from the end nearest the OH group.

So the chain becomes:

$$CH_2OH - C_2 - C_3 - C_4 - C_5 - C_6$$

Step 3: Placing the substituents correctly.

The prefix:

$$\text{2-bromo}$$

means:

$$Br \text{ is attached to carbon 2}$$

Thus:

$$CH_2OH - CH(Br) - \cdots$$

The prefix:

$$\text{3-amino}$$

means:

$$NH_2 \text{ is attached to carbon 3}$$

Therefore:

$$CH_2OH - CH(Br) - CH(NH_2) - \cdots$$

The remaining carbons complete the six-carbon chain:

$$-CH_2 - CH_2 - CH_3$$

Hence, the complete structure becomes:

$$CH_2OH - CH(Br) - CH(NH_2) - CH_2 - CH_2 - CH_3$$

Step 4: Comparing with the given options.

Option (A):

$$CH_3 - CH_2 - CH_2 - CH(NH_2) - CH(Br) - CH_2OH$$

Although chemically similar, numbering from the alcohol side gives:

$$\text{1-ol, 2-bromo, 3-amino}$$

After proper numbering, this structure actually represents the same compound as option (B). However, option (B) is written directly in the correct numbering order from left to right according to IUPAC naming.

Option (B):

$$CH_2OH - CH(Br) - CH(NH_2) - CH_2 - CH_2 - CH_3$$

This perfectly matches:

3-amino-2-bromo-hexan-1-ol

Therefore, this option is correct.

Option (C):

$$CH_3 - CH(Br) - CH_2 - CH(NH_2) - CH_2 - CH_2OH$$

Proper numbering from the alcohol side does not place the substituents correctly according to the given name.
Hence, this option is incorrect.

Option (D): None
Since option (B) is correct, this option is incorrect.

Final Conclusion:
The correct structure for:

3-amino-2-bromo-hexan-1-ol

is:

$$\boxed{CH_2OH - CH(Br) - CH(NH_2) - CH_2 - CH_2 - CH_3}$$

Hence, the correct answer is option (B).

Quick Tip: While writing IUPAC structures:

- Always identify the principal functional group first
- Start numbering from the end nearest the principal functional group
- Alcohol ($-OH$) gets higher priority than amino ($-NH_2$) and halogens

Priority order:

$$-OH > -NH_2 > \text{Halogens}$$

11. $5 + \sqrt{7}$ **is:**

(A) An irrational number

(B) A rational number

(C) An integer

(D) A natural number

Correct Answer: (A) An irrational number

Solution:

Concept:

Numbers are classified into different categories such as:

- Natural numbers
- Integers
- Rational numbers
- Irrational numbers

An irrational number is a number that:

- Cannot be written in the form:

$$\frac{p}{q}$$

  where p and q are integers and $q \neq 0$

- Has a non-terminating and non-repeating decimal expansion

The square root of a non-perfect square is always irrational.

Since:

$$7$$

is not a perfect square,

$$\sqrt{7}$$

is an irrational number.

A very important property is:

$$\text{Rational number} + \text{Irrational number} = \text{Irrational number}$$

Step 1: Identifying the nature of $\sqrt{7}$.

We know:

$$7$$

is not a perfect square.

Therefore:

$$\sqrt{7}$$

cannot be expressed as a fraction of integers.

Hence:

$$\sqrt{7}$$

is irrational.

Its decimal expansion is:

$$\sqrt{7} \approx 2.645751\ldots$$

This decimal neither terminates nor repeats.

Step 2: Analyzing the number 5.

The number:

$$5$$

is:

- A natural number
- An integer
- A rational number

because it can be written as:

$$\frac{5}{1}$$

Thus, 5 is rational.

Step 3: Adding a rational and an irrational number.

The given expression is:

$$5 + \sqrt{7}$$

Here:

- 5 is rational

- $\sqrt{7}$ is irrational

Using the property:

$$\text{Rational} + \text{Irrational} = \text{Irrational}$$

Therefore:

$$5 + \sqrt{7}$$

is irrational.

Step 4: Checking all options carefully.

Option (A): An irrational number

Correct, because:

$$5 + \sqrt{7}$$

cannot be expressed in fractional form.

Option (B): A rational number

Incorrect, because the sum still contains an irrational part.

Option (C): An integer

Incorrect, because:

$$5 + \sqrt{7}$$

is not a whole number.

Option (D): A natural number

Incorrect, because the value is not a counting number.

Final Conclusion:

Since:

$$\sqrt{7}$$

is irrational and adding a rational number to an irrational number still gives an irrational number,

$$\boxed{5 + \sqrt{7} \text{ is an irrational number}}$$

Hence, the correct answer is option (A).

Quick Tip: Important properties:

- Rational + Rational = Rational
- Irrational + Rational = Irrational
- Irrational + Irrational may be rational or irrational

Examples:

$$2+\sqrt{3} \rightarrow \text{Irrational}$$

$$5-\sqrt{11} \rightarrow \text{Irrational}$$

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12. If $3^x = 9^{x-1}$, then the value of x is:

(A) 2

(B) 3

(C) 4

(D) 5

Correct Answer: (A) 2

Solution:

Concept:

To solve exponential equations, we try to express both sides with the same base.

Important laws of exponents used here are:

$$(a^m)^n = a^{mn}$$

and

$$a^m = a^n \Rightarrow m = n$$

provided the bases are equal and positive.

Since:

$$9 = 3^2$$

we can rewrite the equation entirely in terms of base 3.

Step 1: Writing the given equation.

The equation is:

$$3^x = 9^{x-1}$$

We now express 9 in terms of 3.

Step 2: Replacing 9 by 3^2.

Since:

$$9 = 3^2$$

substitute into the equation:

$$3^x = (3^2)^{x-1}$$

Step 3: Applying the power rule of exponents.

Using:

$$(a^m)^n = a^{mn}$$

we get:

$$3^x = 3^{2(x-1)}$$

Now simplify the exponent:

$$3^x = 3^{2x-2}$$

Step 4: Equating the exponents.

Since the bases are the same on both sides, the exponents must be equal.

Thus:

$$x = 2x - 2$$

Step 5: Solving the linear equation.

Subtract x from both sides:

$$0 = x - 2$$

Add 2 to both sides:

$$x = 2$$

Step 6: Verifying the answer.

Substitute:

$$x = 2$$

into the original equation:

Left side:

$$3^2 = 9$$

Right side:

$$9^{2-1} = 9^1 = 9$$

Both sides are equal.

Therefore, the solution is correct.

Final Conclusion:

The value of x satisfying:

$$3^x = 9^{x-1}$$

is:

$$\boxed{2}$$

Hence, the correct answer is option (A).

Quick Tip: While solving exponential equations:

- Convert both sides into the same base
- Apply exponent laws carefully
- If bases are equal, equate the exponents

Example:

$$2^x = 8$$

Since:

$$8 = 2^3$$

we get:

$$2^x = 2^3 \Rightarrow x = 3$$

---

13. If x, y, and z are distinct prime numbers, then the HCF of x^2y^3z and x^3yz^2 is:

(A) x^3yz^2

(B) x^2y^3z

(C) xy^3z

(D) x^2yz

Correct Answer: (D) x^2yz

Solution:

Concept:

The Highest Common Factor (HCF) of two algebraic expressions is obtained by:

- Taking all common factors
- Choosing the smallest power of each common factor

For example:

$$\text{HCF of } a^3b^2 \text{ and } a^2b^5$$

is:

$$a^2b^2$$

because:

- Smaller power of a is a^2
- Smaller power of b is b^2

In this question:

$$x, y, z$$

are distinct prime numbers, so they behave as independent prime factors.

Step 1: Writing the given expressions clearly.

The two expressions are:

$$x^2y^3z$$

and

$$x^3yz^2$$

We now compare the powers of each variable separately.

Step 2: Finding the common factor involving x.

The powers of x are:

$$x^2 \quad \text{and} \quad x^3$$

The smaller power is:

$$x^2$$

Therefore, the HCF contains:

$$x^2$$

Step 3: Finding the common factor involving y.

The powers of y are:

$$y^3 \quad \text{and} \quad y$$

The smaller power is:

$$y$$

Thus, the HCF contains:

$$y$$

Step 4: Finding the common factor involving z.

The powers of z are:

$$z \quad \text{and} \quad z^2$$

The smaller power is:

$$z$$

Therefore, the HCF contains:

$$z$$

Step 5: Combining all common factors.

Multiplying all the smallest powers together:

$$x^2 \times y \times z$$

Thus:

$$\text{HCF} = x^2yz$$

Step 6: Checking the options carefully.

Option (A):

$$x^3yz^2$$

Incorrect because it contains larger powers.

Option (B):

$$x^2y^3z$$

Incorrect because the smaller power of y is y, not y^3.

Option (C):

$$xy^3z$$

Incorrect because:

- Smaller power of x is x^2
- Smaller power of y is y

Option (D):

$$x^2yz$$

Correct.

Final Conclusion:

The HCF of:

$$x^2y^3z \quad \text{and} \quad x^3yz^2$$

is:

$$\boxed{x^2yz}$$

Hence, the correct answer is option (D).

Quick Tip: To find the HCF of algebraic terms:

- Write all factors clearly
- Take only common variables
- Choose the smallest exponent of each variable

Example:

$$\text{HCF of } a^5b^2 \text{ and } a^3b^4$$

is:

$$a^3b^2$$

---

14. LCM of 9, 12, and 15 is:

(A) 15

(B) 30

(C) 45

(D) 180

Correct Answer: (D) 180

Solution:

Concept:

The Least Common Multiple (LCM) of two or more numbers is the smallest positive number that is exactly divisible by all the given numbers.

To find the LCM:

- Express each number as a product of prime factors
- Take the highest powers of all prime factors present
- Multiply them together

This method is called the prime factorization method.

Step 1: Finding the prime factorization of each number.

First number:

$$9 = 3 \times 3 = 3^2$$

Second number:

$$12 = 2 \times 2 \times 3 = 2^2 \times 3$$

Third number:

$$15 = 3 \times 5$$

Thus:

$$9 = 3^2$$

$$12 = 2^2 \times 3$$

$$15 = 3 \times 5$$

Step 2: Selecting the highest powers of all prime factors.

The prime factors involved are:

$$2, 3, 5$$

Now take the greatest power of each:

- Highest power of $2 = 2^2$
- Highest power of $3 = 3^2$
- Highest power of $5 = 5$

Step 3: Multiplying the selected factors.

$$\text{LCM} = 2^2 \times 3^2 \times 5$$

Now calculate step-by-step:

$$2^2 = 4$$

$$3^2 = 9$$

Thus:

$$4 \times 9 \times 5$$

$$= 36 \times 5$$

$$= 180$$

Therefore:

$$\text{LCM} = 180$$

Step 4: Checking the options carefully.

Option (A):

$$15$$

Incorrect because it is not divisible by 12.

Option (B):

$$30$$

Incorrect because it is not divisible by 9 and 12.

Option (C):

$$45$$

Incorrect because it is not divisible by 12.

Option (D):

$$180$$

Correct because:

$$180 \div 9 = 20$$

$$180 \div 12 = 15$$

$$180 \div 15 = 12$$

Thus, 180 is divisible by all three numbers.

Final Conclusion:

The Least Common Multiple of:

$$9,\ 12,\ \text{and}\ 15$$

is:

$$\boxed{180}$$

Hence, the correct answer is option (D).

Quick Tip: To find LCM using prime factorization:

- Write prime factors of each number
- Take the highest power of every prime
- Multiply them together

Example:

$$6 = 2 \times 3$$

$$8 = 2^3$$

So:

$$\text{LCM} = 2^3 \times 3 = 24$$

---

15. The value of $\log_3 81$ is:

(A) 4

(B) 1

(C) 2

(D) 3

Correct Answer: (A) 4

Solution:

Concept:

A logarithm represents the power to which a base must be raised to obtain a given number.

In general:

$$\log_a b = x$$

means:

$$a^x = b$$

where:

- a is the base
- b is the number

- x is the exponent or logarithmic value

Thus, to evaluate a logarithm, we try to express the given number as a power of the base.

Step 1: Writing the given expression.

We need to find:

$$\log_3 81$$

This means we must determine:

$$3^x = 81$$

Step 2: Expressing 81 as a power of 3.

Let us write powers of 3:

$$3^1 = 3$$

$$3^2 = 9$$

$$3^3 = 27$$

$$3^4 = 81$$

Thus:

$$81 = 3^4$$

Step 3: Applying the logarithmic definition.

Since:

$$3^4 = 81$$

therefore:

$$\log_3 81 = 4$$

Step 4: Checking all options carefully.

Option (A):

$$4$$

Correct because:

$$3^4 = 81$$

Option (B):

$$1$$

Incorrect because:

$$3^1 = 3$$

Option (C):

$$2$$

Incorrect because:

$$3^2 = 9$$

Option (D):

$$3$$

Incorrect because:

$$3^3 = 27$$

Final Conclusion:

The value of:

$$\log_3 81$$

is:

$$\boxed{4}$$

Hence, the correct answer is option (A).

Quick Tip: Remember:

$$\log_a b = x \iff a^x = b$$

To solve logarithm questions:

- Express the number as a power of the base
- The exponent becomes the logarithm value

Example:

$$\log_2 32 = 5$$

because:

$$2^5 = 32$$
