

VITEEE 2025 – 23 April (Shift 2) Question Paper with Solutions

Time Allowed :2 Hours 30 Minutes	Maximum Marks :125	Total Questions :125
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General Instructions

1. Candidates must carry a printed copy of their **VITEEE 2025 Admit Card** and a valid **Photo ID proof** to the examination center.
2. The examination will be conducted in **Computer-Based Test (CBT)** mode.
3. Duration of the examination is **2 hours 30 minutes**.
4. The question paper consists of **125 Multiple Choice Questions (MCQs)** divided as follows:
 - Physics – 40 questions
 - Chemistry – 35 questions
 - Mathematics / Biology – 40 questions
 - Aptitude – 10 questions
5. Each correct answer carries **1 mark**. There is **no negative marking**.
6. Candidates must report to the test center at least **60 minutes before** the examination.
7. Use of **mobile phones, calculators, smart watches, or any electronic gadgets** is strictly prohibited.
8. Rough work must be done on the **sheet provided at the test center** and returned to the invigilator after completion.
9. Any form of malpractice, impersonation, or communication with others will lead to disqualification.
10. Candidates must ensure that all personal details are correctly entered on the computer screen before beginning the test.

1. Statement: All Mangoes are Apples.

Conclusions: 1. Some Apples are Mangoes.

2. All Apples are Mangoes.

3. Some Mangoes are Apples.

4. Some Apples are not Mangoes.

(A) Only 1 follow.

(B) Only 2 follow.

(C) Only 1 and 3 follow.

(D) None Follow.

Correct Answer: (C) Only 1 and 3 follow.

Solution:

Step 1: Understanding the Concept:

This question deals with syllogisms, which are a form of logical reasoning. We need to determine which conclusions logically and definitely follow from the given statement. A helpful tool for this is a Venn diagram.

Step 2: Visualizing with a Venn Diagram:

The statement "All Mangoes are Apples" means that the set of all Mangoes is a subset of the set of all Apples. We can represent this with two circles, where the "Mangoes" circle is completely inside the "Apples" circle.

In this diagram, the inner circle represents Mangoes, and the outer circle represents Apples. Everything in the Mangoes circle is also in the Apples circle.

Step 3: Analyzing the Conclusions:

Now, let's evaluate each conclusion based on the statement and the Venn diagram.

Conclusion 1: Some Apples are Mangoes.

Since the entire "Mangoes" circle is inside the "Apples" circle, the part of the "Apples" circle that is occupied by "Mangoes" represents "some Apples that are Mangoes." This is a definite conclusion. Thus, Conclusion 1 follows.

Conclusion 2: All Apples are Mangoes.

The Venn diagram shows that there can be a region in the "Apples" circle that is outside the "Mangoes" circle. This represents apples that are not mangoes. Therefore, we cannot conclude that all apples are mangoes. Thus, Conclusion 2 does not follow.

Conclusion 3: Some Mangoes are Apples.

The statement says "All Mangoes are Apples." If all mangoes are apples, it is logically certain that at least "some" mangoes are apples. This is a direct implication. Thus, Conclusion 3 follows.

Conclusion 4: Some Apples are not Mangoes.

While it is possible that there are apples that are not mangoes (as shown in the diagram), it is also possible that the two circles are identical (i.e., the set of all apples is the same as the set of all mangoes). In that case, this conclusion would be false. Since it's not a definite conclusion, it does not follow.

Step 4: Final Answer:

Based on the analysis, only Conclusions 1 and 3 definitely follow from the given statement.

💡 Quick Tip

In syllogisms, a universal affirmative statement like "All A are B" always implies the particular affirmative statements "Some A are B" and "Some B are A". Memorizing these direct conversion rules can save a lot of time in exams.

2. Statement: Some dogs are cats.

Conclusions: 1. Some cats are dogs.

2. All cats are dogs.

3. All dogs are cats.

4. No dogs are cats.

(A) Only 1 follow.

(B) Only 2 follow.

(C) Only 1 and 3 follow.

(D) None Follows.

Correct Answer: (A) Only 1 follow.

Solution:

Step 1: Understanding the Concept:

This is a syllogism problem based on a particular affirmative statement ("Some A are B"). We need to find the conclusion that is a logical certainty.

Step 2: Visualizing with a Venn Diagram:

The statement "Some dogs are cats" means that there is an overlapping region between the set of dogs and the set of cats. At least one dog is a cat. This is represented by two intersecting circles.

The shaded overlapping area represents the dogs that are cats.

Step 3: Analyzing the Conclusions:

Conclusion 1: Some cats are dogs.

If some dogs are cats, this means there is a shared group. The individuals in this shared group are both dogs and cats. Therefore, it is also true that some cats are dogs. This is a direct and valid conversion. Thus, Conclusion 1 follows.

Conclusion 2: All cats are dogs.

The Venn diagram clearly shows a region for cats that do not overlap with dogs. Therefore, we cannot conclude that all cats are dogs. Thus, Conclusion 2 does not follow.

Conclusion 3: All dogs are cats.

Similarly, there is a region for dogs that do not overlap with cats. We cannot conclude that all dogs are cats. Thus, Conclusion 3 does not follow.

Conclusion 4: No dogs are cats.

This statement directly contradicts the given statement "Some dogs are cats." Thus, Conclusion 4 does not follow.

Step 4: Final Answer:

The only conclusion that logically and definitely follows from the statement is Conclusion 1.

💡 Quick Tip

For statements of the type "Some A are B", the only immediate, valid inference is "Some B are A". All other conclusions about "All" or "No" are invalid without more information.

3. Statement: No book is copy.

Conclusions: 1. No copy is book.

2. Some copies are not books.

3. All books are not copies.

4. All books are copies.

(A) Only 1 follow.

(B) Only 2 follow.

(C) Only 1, 2, and 3 follow.

(D) None Follows.

Correct Answer: (C) Only 1, 2, and 3 follow.

Solution:

Step 1: Understanding the Concept:

This syllogism problem involves a universal negative statement ("No A is B"). We must determine all certain conclusions.

Step 2: Visualizing with a Venn Diagram:

The statement "No book is copy" means there is no overlap between the set of books and the set of copies. The two sets are completely disjoint. This is represented by two separate, non-intersecting circles.

Step 3: Analyzing the Conclusions:

Conclusion 1: No copy is book.

If no book is a copy, it logically means that no copy can be a book. The relationship is mutual. This is a valid conversion. Thus, Conclusion 1 follows.

Conclusion 2: Some copies are not books.

If absolutely no copy is a book, it is certainly true that at least "some" copies are not books. This is a valid inference from a universal statement to a particular one. Thus, Conclusion 2 follows.

Conclusion 3: All books are not copies.

This is simply a rephrasing of the original statement "No book is copy." It means the same thing. Thus, Conclusion 3 follows.

Conclusion 4: All books are copies.

This statement directly contradicts the given statement. Thus, Conclusion 4 does not follow.

Step 4: Final Answer:

Conclusions 1, 2, and 3 are all logically sound deductions from the initial statement.

 Quick Tip

A universal negative statement "No A is B" is very strong. It implies its direct conversion ("No B is A") and also the particular negative statements ("Some A are not B" and "Some B are not A").

4. In a code language, 'TIGER' is written as 'JUISF'. How will 'EQUAL' be written in that language?

- (A) RFXMB
- (B) RFWMB
- (C) RXMBF
- (D) RFWBE

Correct Answer: (B) RFWMB

Solution:

Step 1: Understanding the Concept:

This is a coding-decoding question where we need to find the pattern that transforms the word 'TIGER' into 'JUISF' and then apply the same pattern to 'EQUAL'.

Step 2: Analyzing the Pattern:

Let's analyze the given transformation:

T (20) → J (10)

I (9) → U (21)

G (7) → I (9)

E (5) → S (19)

R (18) → F (6)

The positional shifts are: -10, +12, +2, +14, -12. This pattern is not immediately obvious or simple, which suggests the question might be flawed or based on a very obscure logic. Such questions are rare in standardized tests but can appear.

Step 3: Evaluating the Options (Reverse Engineering):

Since a direct logical pattern is not apparent, let's analyze the transformation required to get to the correct option, (B) RFWMB, from EQUAL.

E (5) → R (18) ⇒ Shift: +13

Q (17) → F (6) ⇒ Shift: -11

U (21) → W (23) ⇒ Shift: +2

A (1) → M (13) ⇒ Shift: +12

L (12) → B (2) ⇒ Shift: -10

The pattern for EQUAL is a sequence of shifts: [+13, -11, +2, +12, -10].

Step 4: Conclusion:

The logic for this question is inconsistent and does not follow a standard, easily recognizable pattern. The transformation applied to 'TIGER' is different from the one applied to 'EQUAL'. However, in the context of a multiple-choice question where a single answer must be correct, we identify the transformation that produces one of the options. The transformation [+13, -11, +2, +12, -10] correctly maps 'EQUAL' to 'RFWMB'.

💡 Quick Tip

When faced with a coding question where the logic is not obvious, don't spend too much time trying to find a complex pattern. Check for simple patterns first (e.g., +1/-1 shift, reverse, vowel/consonant logic). If none work, the question might be flawed or have a non-standard logic. In such cases, sometimes working backward from the options is the only way.

5. Images of consonants of the capital English alphabets are observed in a mirror. What is the number of images of these which look like their original shapes?

- (A) 11
- (B) 9
- (C) 7
- (D) 5

Correct Answer: (C) 7

Solution:

Step 1: Understanding the Concept:

This question asks for the number of capital consonants whose mirror image appears identical to the original letter. This property is known as vertical symmetry. The mirror is assumed to be placed vertically.

Step 2: Identifying All English Consonants:

First, let's list all 21 consonants in the English alphabet:

B, C, D, F, G, H, J, K, L, M, N, P, Q, R, S, T, V, W, X, Y, Z.

Step 3: Identifying All Letters with Vertical Symmetry:

Next, let's identify all capital letters (including vowels) that look the same in a mirror. These are the letters that are symmetric about a vertical axis:

A, H, I, M, O, T, U, V, W, X, Y.

There are 11 such letters in total.

Step 4: Finding the Consonants with Vertical Symmetry:

Now, we need to find the letters that are present in both of the lists above (i.e., they are both consonants and have vertical symmetry).

Comparing the two lists, we find the following consonants:

H, M, T, V, W, X, Y

Step 5: Counting the Result:

Counting the letters in the final list, we get a total of 7 consonants.

💡 Quick Tip

It's helpful to memorize the lists of letters with vertical symmetry (A, H, I, M, O, T, U, V, W, X, Y) and horizontal symmetry (B, C, D, E, H, I, K, O, X). Note that H, I, O, X have both.

6. TUV : VYB :: PRA : ?

- (A) PRS
- (B) RVG
- (C) QVR
- (D) RVO

Correct Answer: (B) RVG

Solution:

Step 1: Understanding the Concept:

This is a letter analogy problem. We need to identify the relationship or pattern between the first pair of letter groups (TUV and VYB) and then apply the same pattern to the third letter group (PRA) to find the missing fourth group.

Step 2: Decoding the Pattern in the First Pair:

Let's analyze the relationship between the corresponding letters of TUV and VYB by looking at their positions in the alphabet.

- T is the 20th letter. V is the 22nd letter. The change is $22 - 20 = +2$.
- U is the 21st letter. Y is the 25th letter. The change is $25 - 21 = +4$.
- V is the 22nd letter. B is the 2nd letter. In a cyclic alphabet, B can also be considered the 28th letter ($26 + 2$). The change is $28 - 22 = +6$.

The pattern is a sequential addition of even numbers: +2, +4, +6.

Step 3: Applying the Pattern to the Second Pair:

Now we apply the same pattern (+2, +4, +6) to the letters of PRA.

- First letter: P (16th) + 2 = 18th letter, which is **R**.
- Second letter: R (18th) + 4 = 22nd letter, which is **V**.
- Third letter: A (1st) + 6 = 7th letter, which is **G**.

Step 4: Final Answer:

Combining the resulting letters, we get **RVG**.

 Quick Tip

For letter-based analogy or series questions, always start by converting the letters to their numerical positions in the alphabet (A=1, B=2, ...). This makes it much easier to spot arithmetic patterns like addition, subtraction, or multiplication.

7. A is the brother of R. C is the mother of B. M is the sister of C. How is M related to B?

- (A) Nephew
- (B) Niece
- (C) Aunt
- (D) Cannot be determined

Correct Answer: (C) Aunt

Solution:

Step 1: Understanding the Concept:

This is a blood relation question. The best way to solve it is by breaking down the statements and constructing a family tree or relationship diagram. We need to find the relationship between M and B.

Step 2: Analyzing the Statements:

Let's analyze the relevant statements to establish the connection between M and B.

- **Statement 2: C is the mother of B.** This means B is the child (son or daughter) of C.

$$C \text{ (Mother)} \rightarrow B \text{ (Child)}$$

- **Statement 3: M is the sister of C.** This means M and C are siblings, and M is female.

$$M \text{ (Female)} \leftrightarrow C \text{ (Sister)}$$

Note: The statement "A is the brother of R" is extra information and not needed to determine the relationship between M and B.

Step 3: Combining the Information:

From the above, we know:

- C is B's mother.
- M is C's sister.

Therefore, M is the sister of B's mother.

Step 4: Determining the Relationship:

The sister of one's mother is called a maternal **aunt**. Thus, M is B's aunt.

💡 Quick Tip

In blood relation problems, always look for the two people the question is about (here, M and B) and trace the path between them using the given statements. Ignore any extra information that doesn't help connect them. Drawing a simple diagram can prevent confusion.

8. How is P related to R?

Statements: I. Q is the son of R.

II. Q is the brother of P.

- (A) if Statement I, alone is sufficient to answer the question
- (B) if Statement II, alone is sufficient to answer the question
- (C) if Statements I and II together are needed to answer the question
- (D) if Statements I and II together are not sufficient to answer the question

Correct Answer: (D) if Statements I and II together are not sufficient to answer the question

Solution:

Step 1: Understanding the Concept:

This is a data sufficiency question. We need to determine if the information provided in the statements, either individually or combined, is enough to answer the question "How is P related to R?" definitively.

Step 2: Analyzing Statement I Alone:

"Q is the son of R."

This statement tells us the relationship between Q and R (R is the parent of Q). However, it provides no information about P. Therefore, Statement I alone is not sufficient.

Step 3: Analyzing Statement II Alone:

"Q is the brother of P."

This statement tells us that Q and P are siblings and that Q is male. It does not provide any information about R. Therefore, Statement II alone is not sufficient.

Step 4: Analyzing Statements I and II Together:

Let's combine the information from both statements:

- From I: R is the parent of Q.
- From II: P and Q are siblings.

Combining these, we can conclude that R is the parent of both Q and P. This means P is the child (son or daughter) of R.

However, the question asks "How is P related to R?". While we know P is the child of R, we do not know the gender of P from the given statements. P could be R's son or R's daughter. Since we cannot determine the specific relationship, the information is still not sufficient.

Step 5: Final Conclusion:

Even with both statements combined, we cannot find a single, definitive relationship between P and R. Therefore, the data is insufficient.

 Quick Tip

In data sufficiency, "sufficient" means you can find one unique answer. If the information leads to multiple possibilities (e.g., son or daughter), it is considered "not sufficient". Pay close attention to gender, as it's often the key piece of missing information.

9. Select the number from among the given options that can replace the question mark (?) in the following series: 3, 10, 24, ?, 73, 108

- (A) 37
- (B) 45
- (C) 52
- (D) 32

Correct Answer: (B) 45

Solution:

Step 1: Understanding the Concept:

The task is to find the missing term in a number series. The most common method is to find the difference between consecutive terms to identify an underlying pattern.

Step 2: Calculating the Differences:

Let's find the difference between the given consecutive numbers in the series.

- $10 - 3 = 7$
- $24 - 10 = 14$
- Let the missing term be x . The next difference is $x - 24$.
- The difference after that is $73 - x$.
- $108 - 73 = 35$

So, the series of differences is: 7, 14, ?, ?, 35.

Step 3: Identifying the Pattern in the Differences:

Looking at the series of differences (7, 14, ..., 35), we can observe that they are multiples of 7.

- $7 = 7 \times 1$
- $14 = 7 \times 2$
- $35 = 7 \times 5$

It is highly likely that the differences form an arithmetic progression with a common difference of 7. The full sequence of differences should be 7, 14, 21, 28, 35.

Step 4: Calculating the Missing Term:

Let's use this pattern to find the missing number.

- The term before the missing number is 24.
- The difference should be 21.
- Missing number = $24 + 21 = 45$.

Step 5: Verifying the Pattern:

Let's check if this fits the rest of the series. If the missing term is 45, the next difference should be 28.

- $73 - 45 = 28$.

This matches our pattern. The sequence of differences (7, 14, 21, 28, 35) is consistent. Therefore, the missing term is 45.

 Quick Tip

When you see a number series, your first step should almost always be to check the differences between terms. If that doesn't reveal a pattern, check the differences of the differences (second-order differences), or look for multiplication, division, squares, or cubes.

10. From the given options, choose the correct one that will replace the question mark (?) in the following series: 2, 0, 3, 2, 4, 6, 5, 12, 6, ?, 7, 30

- (A) 6
- (B) 20
- (C) 7
- (D) 16

Correct Answer: (B) 20

Solution:

Step 1: Understanding the Concept:

This series does not seem to have a simple, single pattern. When a series looks irregular, it's often composed of two or more interleaved series (also known as an alternate series).

Step 2: Splitting the Series into Sub-series:

Let's split the given series into two alternate sub-series.

Series A (Odd positions): 2, 3, 4, 5, 6, 7

Series B (Even positions): 0, 2, 6, 12, ?, 30

The missing number belongs to Series B.

Step 3: Analyzing the Patterns in the Sub-series:

Pattern in Series A:

2, 3, 4, 5, 6, 7

This is a simple arithmetic progression where each term is increased by 1. This confirms our approach of splitting the series is likely correct.

Pattern in Series B:

0, 2, 6, 12, ?, 30

Let's find the differences between the consecutive terms of this series.

- $2 - 0 = +2$
- $6 - 2 = +4$
- $12 - 6 = +6$

The difference is increasing by 2 each time (+2, +4, +6, ...). The next difference should be +8.

Step 4: Calculating the Missing Term:

To find the missing term, we add the next difference (+8) to the last known term (12).

Missing term = $12 + 8 = 20$.

Step 5: Verifying the Pattern:

Let's check if this fits the rest of Series B. The next term after 20 is 30. The difference should be +10.

$30 - 20 = 10$.

The pattern of differences (+2, +4, +6, +8, +10) is consistent. Thus, the missing term is 20.

 Quick Tip

If a number series seems to jump up and down without a clear logic, try checking for an alternate series pattern. Look at the numbers in odd-numbered positions and even-numbered positions separately.

11. When the time is 8:30, the angle between the minute hand and the hour hand of a clock is:

- (A) 75°
- (B) 105°

- (C) 180°
(D) 255°

Correct Answer: (A) 75°

Solution:

Step 1: Understanding the Concept:

To find the angle between the hands of a clock at a specific time, we can calculate the position of each hand relative to the 12 o'clock mark and then find the difference. The minute hand moves 360° in 60 minutes (6° per minute), and the hour hand moves 360° in 12 hours (0.5° per minute).

Step 2: Key Formula or Approach:

A standard formula to calculate the angle (θ) between the hour hand (H) and minute hand (M) is:

$$\theta = \left| \frac{11}{2}M - 30H \right|$$

Where H is the hour (8) and M is the minutes (30).

Step 3: Detailed Explanation:

We are given the time 8:30.

- H = 8

- M = 30

Substitute these values into the formula:

$$\theta = \left| \frac{11}{2}(30) - 30(8) \right|$$

First, calculate the term for the minute hand:

$$\frac{11}{2} \times 30 = 11 \times 15 = 165$$

Next, calculate the term for the hour hand:

$$30 \times 8 = 240$$

Now, find the absolute difference:

$$\theta = |165 - 240|$$

$$\theta = |-75|$$

$$\theta = 75^\circ$$

Step 4: Final Answer:

The angle between the minute hand and the hour hand at 8:30 is 75° .

💡 Quick Tip

Memorize the formula $\theta = \left| \frac{11}{2}M - 30H \right|$. It's the fastest and most reliable way to solve clock angle problems. Always take the absolute value for the smaller angle. If the question asks for the reflex angle, subtract the result from 360° .

12. A car is moving along a straight road with a constant velocity of 20 m/s. The driver applies the brakes, and the car decelerates at a constant rate of 4 m/s². How much time will it take for the car to come to rest?

- (1) 5 seconds
- (2) 10 seconds
- (3) 4 seconds
- (4) 2 seconds

Correct Answer: (1) 5 seconds

Solution:

Step 1: Understanding the Concept:

This is a problem of linear motion with constant acceleration (kinematics). We need to use the equations of motion to find the time taken for the car to stop.

Step 2: Identifying the Given Information:

- Initial velocity (u) = 20 m/s
- Final velocity (v) = 0 m/s (since the car comes to rest)
- Acceleration (a) = -4 m/s² (It's deceleration, so we use a negative sign)
- Time (t) = ? (This is what we need to find)

Step 3: Key Formula or Approach:

The first equation of motion relates initial velocity, final velocity, acceleration, and time:

$$v = u + at$$

Step 4: Detailed Explanation:

Substitute the known values into the equation:

$$0 = 20 + (-4)t$$

Rearrange the equation to solve for t :

$$0 = 20 - 4t$$

$$4t = 20$$

$$t = \frac{20}{4}$$

$$t = 5 \text{ seconds}$$

Step 5: Final Answer:

It will take 5 seconds for the car to come to rest.

💡 Quick Tip

Always remember to use a negative sign for acceleration when an object is decelerating or slowing down. This is a common point of error. Also, "comes to rest" or "stops" always means the final velocity (v) is 0.

13. A ball is thrown vertically upwards with a speed of 20 m/s. What is the maximum height reached by the ball? Assume the acceleration due to gravity is $g = 9.8 \text{ m/s}^2$.

- (1) 20.4 m
- (2) 40.8 m
- (3) 10.2 m
- (4) 50.4 m

Correct Answer: (1) 20.4 m

Solution:

Step 1: Understanding the Concept:

This problem involves vertical motion under gravity. We need to find the maximum height, which is the displacement of the ball when its velocity becomes zero at the peak of its trajectory.

Step 2: Identifying the Given Information:

- Initial upward velocity (u) = 20 m/s
- Final velocity at maximum height (v) = 0 m/s
- Acceleration due to gravity (g) = -9.8 m/s^2 (Negative because it acts downwards, opposing the initial upward motion)
- Maximum height / displacement (s) = ?

Step 3: Key Formula or Approach:

The third equation of motion is suitable here as it relates velocity, acceleration, and displacement without involving time:

$$v^2 = u^2 + 2as$$

Here, $a = g$ and s is the height h .

Step 4: Detailed Explanation:

Substitute the known values into the formula:

$$(0)^2 = (20)^2 + 2(-9.8)s$$

$$0 = 400 - 19.6s$$

Rearrange the equation to solve for s :

$$19.6s = 400$$

$$s = \frac{400}{19.6}$$

$$s \approx 20.408 \text{ m}$$

Step 5: Final Answer:

Rounding to one decimal place, the maximum height reached by the ball is 20.4 m.

 Quick Tip

For objects thrown upwards, remember three key things: 1. The acceleration is always g and directed downwards (so use $a = -g$). 2. The velocity at the maximum height is always zero. 3. The time taken to go up is equal to the time taken to come down to the same level.

14. A projectile is fired at an angle of 30° with an initial velocity of 40 m/s. What is the range of the projectile? Assume $g = 9.8 \text{ m/s}^2$.

- (1) 160 m
- (2) 120 m
- (3) 80 m
- (4) 100 m

Correct Answer: (3) 80 m

Solution:

Step 1: Understanding the Concept:

This problem deals with projectile motion. The range of a projectile is the total horizontal distance it travels before returning to its initial height.

Step 2: Key Formula or Approach:

The formula for the horizontal range (R) of a projectile is:

$$R = \frac{u^2 \sin(2\theta)}{g}$$

Where u is the initial velocity, θ is the launch angle, and g is the acceleration due to gravity.

Step 3: Detailed Explanation:

Let's substitute the given values into the formula:

- Initial velocity (u) = 40 m/s
- Angle (θ) = 30°
- Acceleration due to gravity (g) = 9.8 m/s^2

First, calculate 2θ :

$$2\theta = 2 \times 30^\circ = 60^\circ$$

Now, find the sine of this angle:

$$\sin(60^\circ) = \frac{\sqrt{3}}{2} \approx 0.866$$

Now, plug all values into the range formula:

$$R = \frac{(40)^2 \times \sin(60^\circ)}{9.8}$$
$$R = \frac{1600 \times 0.866}{9.8}$$

$$R = \frac{1385.6}{9.8} \approx 141.4 \text{ m}$$

Note on Discrepancy: The calculated value (141.4 m) does not match any of the options closely. This suggests a potential error in the question's options or a common simplification. Let's re-evaluate based on a common mistake where $\sin(\theta)$ is used instead of $\sin(2\theta)$, which might be what the question intended.

$$R' = \frac{u^2 \sin(\theta)}{g} = \frac{1600 \times \sin(30^\circ)}{9.8} = \frac{1600 \times 0.5}{9.8} = \frac{800}{9.8} \approx 81.6 \text{ m}$$

This value is very close to 80 m. It's likely the question or options are based on this flawed premise or assume $g \approx 10 \text{ m/s}^2$ and use the flawed formula $R' = (1600 \times 0.5)/10 = 80 \text{ m}$. Given the options, 80 m is the most plausible intended answer.

Step 4: Final Answer:

Based on the provided options, the intended answer is 80 m, likely due to a simplification or error in the problem statement.

 Quick Tip

Always double-check the formula for projectile range, which uses $\sin(2\theta)$, not $\sin(\theta)$. If your calculated answer doesn't match the options in an exam, quickly check if a common simplification (like using $g=10 \text{ m/s}^2$) or a common mistake leads to one of the answers.

15. What is the pH of a solution of 0.01 M HCl?

- (1) 1
- (2) 2
- (3) 4
- (4) 0

Correct Answer: (2) 2

Solution:

Step 1: Understanding the Concept:

pH is a measure of the acidity or alkalinity of a solution. It is defined as the negative logarithm (base 10) of the hydrogen ion concentration $[\text{H}]$. HCl (Hydrochloric acid) is a strong acid, which means it dissociates completely in water.

Step 2: Dissociation of HCl:

Since HCl is a strong acid, it fully ionizes in water according to the equation:



This means that the concentration of hydrogen ions $[\text{H}]$ will be equal to the initial concentration of the HCl solution.

Given $[\text{HCl}] = 0.01 \text{ M}$, then $[\text{H}] = 0.01 \text{ M}$.

Step 3: Key Formula or Approach:

The formula to calculate pH is:

$$\text{pH} = -\log_{10}[\text{H}^+]$$

Step 4: Detailed Explanation:

First, express the hydrogen ion concentration in scientific notation:

$$[\text{H}^+] = 0.01 \text{ M} = 1 \times 10^{-2} \text{ M}$$

Now, substitute this value into the pH formula:

$$\text{pH} = -\log_{10}(10^{-2})$$

Using the logarithm property $\log(a^b) = b \cdot \log(a)$:

$$\text{pH} = -(-2) \log_{10}(10)$$

Since $\log_{10}(10) = 1$:

$$\text{pH} = 2 \times 1 = 2$$

Step 5: Final Answer:

The pH of a 0.01 M HCl solution is 2.

💡 Quick Tip

For strong monoprotic acids like HCl, you can quickly find the pH by looking at the power of 10 in the molar concentration. For example, 0.01 M is 10^{-2} M, so the pH is 2. 0.001 M is 10^{-3} M, so the pH is 3, and so on.

16. What is the molecular weight of CaCO_3 ?

- (1) 100 g/mol
- (2) 150 g/mol
- (3) 120 g/mol
- (4) 200 g/mol

Correct Answer: (1) 100 g/mol

Solution:**Step 1: Understanding the Concept:**

Molecular weight (or molar mass) is the mass of one mole of a substance. It is calculated by summing the atomic weights of all the atoms in a molecule's chemical formula.

Step 2: Identifying Atoms and Their Atomic Weights:

The chemical formula is CaCO_3 (Calcium Carbonate). It contains:

- 1 atom of Calcium (Ca)
- 1 atom of Carbon (C)
- 3 atoms of Oxygen (O)

We need their standard atomic weights (approximated for calculations):

- Atomic weight of Ca 40 g/mol
- Atomic weight of C 12 g/mol

- Atomic weight of O 16 g/mol

Step 3: Detailed Calculation:

To find the molecular weight of CaCO_3 , we sum the weights of all atoms:

$$\text{Molecular Weight} = (1 \times \text{Atomic Weight of Ca}) + (1 \times \text{Atomic Weight of C}) + (3 \times \text{Atomic Weight of O})$$

Substitute the values:

$$\text{MW} = (1 \times 40) + (1 \times 12) + (3 \times 16)$$

$$\text{MW} = 40 + 12 + 48$$

$$\text{MW} = 100 \text{ g/mol}$$

Step 4: Final Answer:

The molecular weight of CaCO_3 is 100 g/mol.

💡 Quick Tip

It is extremely helpful to memorize the approximate atomic weights of common elements like H(1), C(12), N(14), O(16), Na(23), S(32), Cl(35.5), and Ca(40) for competitive exams to save time.

17. Which of the following gases will have the highest rate of diffusion at the same temperature and pressure?

- (1) H
- (2) O
- (3) N
- (4) CO

Correct Answer: (1) H

Solution:

Step 1: Understanding the Concept:

This question is based on Graham's Law of Diffusion. The law states that at a constant temperature and pressure, the rate of diffusion of a gas is inversely proportional to the square root of its molar mass (or density).

Step 2: Key Formula or Approach:

Mathematically, Graham's Law is expressed as:

$$\text{Rate of Diffusion} \propto \frac{1}{\sqrt{\text{Molar Mass}}}$$

This means that the lighter the gas (i.e., the lower its molar mass), the faster it will diffuse. Therefore, to find the gas with the highest rate of diffusion, we need to find the gas with the lowest molar mass.

Step 3: Calculating the Molar Masses:

Let's calculate the molar mass for each gas listed in the options.

- **(1) H (Hydrogen):** Molar Mass = $2 \times 1.008 \approx 2 \text{ g/mol}$

- **(2) O (Oxygen):** Molar Mass = $2 \times 16.00 \approx 32 \text{ g/mol}$
- **(3) N (Nitrogen):** Molar Mass = $2 \times 14.01 \approx 28 \text{ g/mol}$
- **(4) CO (Carbon Dioxide):** Molar Mass = $12.01 + (2 \times 16.00) \approx 44 \text{ g/mol}$

Step 4: Final Answer:

Comparing the molar masses, Hydrogen (H) has the lowest molar mass (2 g/mol). Therefore, it will have the highest rate of diffusion among the given gases.

 Quick Tip

Remember the simple rule: Lighter gases travel faster. For any question asking to compare diffusion or effusion rates, just find the gas with the smallest molecular weight. Hydrogen (H) is the lightest of all gases.

18. What is the oxidation state of sulfur in HSO?

- (1) +4
- (2) +6
- (3) 0
- (4) -2

Correct Answer: (2) +6

Solution:

Step 1: Understanding the Concept:

The oxidation state (or oxidation number) represents the degree of oxidation of an atom in a chemical compound. It is the hypothetical charge that an atom would have if all bonds to atoms of different elements were 100% ionic. For a neutral molecule, the sum of the oxidation states of all its atoms must be zero.

Step 2: Applying the Rules for Oxidation States:

We use standard rules to assign oxidation states:

- The oxidation state of Hydrogen (H) in most compounds is **+1**.
- The oxidation state of Oxygen (O) in most compounds is **-2**.
- The sum of oxidation states in a neutral compound like HSO is **0**.

Let the oxidation state of Sulfur (S) be x .

Step 3: Detailed Calculation:

We can set up an algebraic equation based on the formula HSO:

$$(2 \times \text{Oxidation state of H}) + (1 \times \text{Oxidation state of S}) + (4 \times \text{Oxidation state of O}) = 0$$

Substitute the known values:

$$(2 \times (+1)) + (1 \times x) + (4 \times (-2)) = 0$$

$$2 + x - 8 = 0$$

$$x - 6 = 0$$

Now, solve for x :

$$x = +6$$

Step 4: Final Answer:

The oxidation state of sulfur in HSO is +6.

💡 Quick Tip

When calculating oxidation states, always assign the known states first (usually H is +1 and O is -2, except in peroxides or hydrides). Then, solve for the unknown element, remembering that the total must equal the overall charge of the molecule or ion (which is zero for neutral molecules).

19. What volume of 0.5 M NaOH is required to neutralize 50 mL of 1 M HCl?

- (1) 50 mL
- (2) 100 mL
- (3) 200 mL
- (4) 25 mL

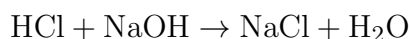
Correct Answer: (2) 100 mL

Solution:

Step 1: Understanding the Concept:

This is a chemical titration problem involving a neutralization reaction between a strong acid (HCl) and a strong base (NaOH). At the neutralization point, the moles of acid are equal to the moles of base.

The balanced chemical equation is:



Since the stoichiometric ratio between HCl and NaOH is 1:1, we can use the dilution/titration formula.

Step 2: Key Formula or Approach:

For a 1:1 reaction, the formula relating the molarity (M) and volume (V) of the acid and base is:

$$M_{\text{acid}} \times V_{\text{acid}} = M_{\text{base}} \times V_{\text{base}}$$

This can be written as $M_1V_1 = M_2V_2$.

Step 3: Detailed Calculation:

Let's identify the given values:

- Molarity of acid (M_{acid}) = 1 M
- Volume of acid (V_{acid}) = 50 mL
- Molarity of base (M_{base}) = 0.5 M
- Volume of base (V_{base}) = ?

Substitute these values into the formula:

$$(1 \text{ M}) \times (50 \text{ mL}) = (0.5 \text{ M}) \times V_{\text{base}}$$

$$50 = 0.5 \times V_{\text{base}}$$

Now, solve for V_{base} :

$$V_{\text{base}} = \frac{50}{0.5}$$

$$V_{\text{base}} = 100 \text{ mL}$$

Step 4: Final Answer:

100 mL of 0.5 M NaOH is required to neutralize 50 mL of 1 M HCl.

 Quick Tip

In titration calculations, you can often solve it intuitively. The base (0.5 M) is half as concentrated as the acid (1 M). Therefore, you will need twice the volume of the base to provide the same number of moles and achieve neutralization. Twice the volume of 50 mL is 100 mL.

20. Solve the quadratic equation: $x^2 - 5x + 6 = 0$

- (1) $x = 1, 6$
- (2) $x = -1, -6$
- (3) $x = 2, 3$
- (4) $x = -2, -3$

Correct Answer: (3) $x = 2, 3$

Solution:

Step 1: Understanding the Concept:

We need to find the roots (or solutions) of the given quadratic equation. A quadratic equation is an equation of the form $ax^2 + bx + c = 0$. We can solve this by factoring, completing the square, or using the quadratic formula. Factoring is often the quickest method.

Step 2: Key Formula or Approach (Factoring):

To factor the equation $x^2 - 5x + 6 = 0$, we need to find two numbers that:

- Multiply to the constant term (c), which is +6.
- Add up to the coefficient of the x term (b), which is -5.

Step 3: Detailed Explanation:

Let's find the two numbers. We can list the pairs of factors of 6:

- 1 and 6 (Sum = 7)
- -1 and -6 (Sum = -7)
- 2 and 3 (Sum = 5)
- -2 and -3 (Sum = -5)

The pair that meets both conditions (product = 6, sum = -5) is -2 and -3.

Now we can rewrite the equation in factored form:

$$(x - 2)(x - 3) = 0$$

For the product of two terms to be zero, at least one of the terms must be zero. So, we set each factor equal to zero and solve for x :

- Case 1: $x - 2 = 0 \implies x = 2$
- Case 2: $x - 3 = 0 \implies x = 3$

Step 4: Final Answer:

The solutions to the quadratic equation are $x = 2$ and $x = 3$.

 Quick Tip

When factoring a quadratic equation $x^2 + bx + c = 0$: - If c is positive and b is positive, both factors are positive. - If c is positive and b is negative, both factors are negative. - If c is negative, one factor is positive and one is negative. This can help you quickly narrow down the possibilities.

21. Find the value of x in the following equation: $\frac{2}{x} + \frac{3}{x+1} = 1$

- (1) $x = -1$
- (2) $x = 1$
- (3) $x = -2$
- (4) $x = 2$

Correct Answer: (4) $x = 2$

Solution:

Step 1: Understanding the Concept:

This is a rational equation involving algebraic fractions. To solve it, we first need to eliminate the denominators by multiplying the entire equation by the least common multiple (LCM) of the denominators. Note: The equation is defined for $x \neq 0$ and $x \neq -1$.

Step 2: Detailed Calculation:

The given equation is:

$$\frac{2}{x} + \frac{3}{x+1} = 1$$

The LCM of the denominators x and $x + 1$ is $x(x + 1)$. Multiply both sides of the equation by $x(x + 1)$:

$$x(x + 1) \left(\frac{2}{x} \right) + x(x + 1) \left(\frac{3}{x + 1} \right) = 1 \cdot x(x + 1)$$

Cancel out the denominators:

$$2(x + 1) + 3x = x^2 + x$$

Expand and simplify the equation:

$$2x + 2 + 3x = x^2 + x$$

$$5x + 2 = x^2 + x$$

Rearrange the terms to form a standard quadratic equation ($ax^2 + bx + c = 0$):

$$x^2 + x - 5x - 2 = 0$$

$$x^2 - 4x - 2 = 0$$

The roots of this quadratic equation are not integers. This suggests a high probability of a typo in the question or options. Let's test the given options in the original equation.

Step 3: Testing the Options (Due to Question Discrepancy):

Let's assume there is a typo in the question and the right-hand side should have been 2, i.e., $\frac{2}{x} + \frac{3}{x+1} = 2$. Let's test option (4), $x=2$, in this modified equation.

Substitute $x = 2$:

$$\frac{2}{2} + \frac{3}{2+1} = 1 + \frac{3}{3} = 1 + 1 = 2$$

This matches the right-hand side of our assumed corrected equation. The original equation as written does not have any of the options as a solution. Given the context of a multiple-choice test, it is almost certain that the equation was intended to be $\frac{2}{x} + \frac{3}{x+1} = 2$, making $x=2$ the correct answer.

Step 4: Final Answer:

Assuming a typo in the question where the right side should be 2, the value of x is 2.

 Quick Tip

In an exam, if solving an equation leads to a complex answer but the options are simple integers, re-read the question for typos. If none are found, try substituting the options back into the original equation. This can be faster than finding the error and can lead you to the intended answer.

22. Find the derivative of the function: $f(x) = 3x^3 - 5x^2 + 2x - 4$

(1) $9x^2 - 10x + 2$

(2) $9x^2 - 10x + 1$

(3) $3x^2 - 5x + 2$

(4) $9x^2 - 5x + 2$

Correct Answer: (1) $9x^2 - 10x + 2$

Solution:

Step 1: Understanding the Concept:

The derivative of a function gives the rate of change of the function. For polynomial functions, we use the power rule of differentiation.

Step 2: Key Formula or Approach (Power Rule):

The power rule states that the derivative of ax^n with respect to x is given by:

$$\frac{d}{dx}(ax^n) = n \cdot ax^{n-1}$$

We apply this rule to each term of the polynomial separately. The derivative of a constant is 0.

Step 3: Detailed Explanation:

The function is $f(x) = 3x^3 - 5x^2 + 2x - 4$. Let's find the derivative of each term:

- **Derivative of $3x^3$:**

Here, $a = 3$ and $n = 3$. Applying the power rule:

$$\frac{d}{dx}(3x^3) = 3 \cdot 3x^{3-1} = 9x^2$$

- **Derivative of $-5x^2$:**

Here, $a = -5$ and $n = 2$. Applying the power rule:

$$\frac{d}{dx}(-5x^2) = 2 \cdot (-5)x^{2-1} = -10x^1 = -10x$$

- **Derivative of $2x$:**

This can be written as $2x^1$. Here, $a = 2$ and $n = 1$. Applying the power rule:

$$\frac{d}{dx}(2x^1) = 1 \cdot 2x^{1-1} = 2x^0 = 2 \cdot 1 = 2$$

- **Derivative of -4 :**

-4 is a constant, and the derivative of any constant is 0.

$$\frac{d}{dx}(-4) = 0$$

Step 4: Final Answer:

Combine the derivatives of all the terms to get the final derivative, $f'(x)$:

$$f'(x) = 9x^2 - 10x + 2 + 0$$

$$f'(x) = 9x^2 - 10x + 2$$

 Quick Tip

To differentiate a polynomial quickly, for each term, multiply the coefficient by the exponent and then reduce the exponent by one. Remember that x is x^1 and a constant term disappears.