

# GATE 2025 Economics (XH-C1) Question Paper with Solutions

Time Allowed :180 Minutes

Maximum Marks :100

Total Questions :65

## General Instructions

Read the following instructions very carefully and strictly follow them:

1. **Total Marks:** The GATE Economics paper is worth 100 marks.
2. **Question Types:** The paper consists of 65 questions, divided into:
  - General Aptitude (GA): 15 marks
  - Economics: 85 marks
3. **Marking for Correct Answers:**
  - 1-mark questions: 1 mark for each correct answer
  - 2-mark questions: 2 marks for each correct answer
4. **Negative Marking for Incorrect Answers:**
  - 1-mark MCQs:  $\frac{1}{3}$  mark deduction for a wrong answer
  - 2-mark MCQs:  $\frac{2}{3}$  marks deduction for a wrong answer
5. **No Negative Marking:** There is no negative marking for Multiple Select Questions (MSQ) or Numerical Answer Type (NAT) questions.
6. **No Partial Marking:** There is no partial marking in MSQ.

## General Aptitude

**1. Here are two analogous groups, Group-I and Group-II, that list words in their decreasing order of intensity. Identify the missing word in Group-II.**

Abuse → Insult → Ridicule

----- → Praise → Appreciate

- (A) Extol
- (B) Prize
- (C) Appropriate
- (D) Espouse

**Correct Answer:** (A) Extol

**Solution: Step 1: Identify the relationship in Group-I.**

In Group-I, the words are listed in decreasing order of intensity: Abuse → Insult → Ridicule. Abuse is the most intense, followed by Insult, and Ridicule is the least intense.

**Step 2: Identify the relationship in Group-II.**

Group-II must follow a similar pattern of decreasing intensity. The words listed are: ----- → Praise → Appreciate. Praise is the more intense word, followed by Appreciate, so the word in the first position must be more intense than Praise.

**Step 3: Analyze the options.**

- (A) Extol: This word means to praise highly, which fits the highest intensity, making it the best choice.
- (B) Prize: This word doesn't match the intensity pattern of the words in Group-II.
- (C) Appropriate: This word doesn't fit the pattern of decreasing intensity.
- (D) Espouse: This word means to adopt or support, but it doesn't convey a higher level of praise than Praise, so it's not suitable.

### Quick Tip

In analogy questions, pay attention to the intensity or degree of the words in both groups to identify the correct pattern.

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**2. Had I learnt acting as a child, I ----- a famous film star.**

**Select the most appropriate option to complete the above sentence.**

- (A) will be
- (B) can be
- (C) am going to be
- (D) could have been

**Correct Answer:** (D) could have been

**Solution: Step 1: Analyze the structure of the sentence.**

The sentence begins with "Had I learnt acting as a child," which indicates a hypothetical situation in the past. The phrase is a third conditional sentence, which is used to express unreal past situations and their possible outcomes.

**Step 2: Understand the choices.**

(A) will be: This option suggests a future possibility, but the sentence is about a past unreal condition, so it is incorrect.

(B) can be: This implies a present or future possibility, which does not fit the unreal past condition.

(C) am going to be: This suggests a future intention, which doesn't fit the context of an unreal past condition.

(D) could have been: This is the correct choice, as it expresses a hypothetical outcome in the past, matching the structure of the third conditional.

**Step 3: Conclude.**

Since the sentence refers to an unreal situation in the past, "could have been" correctly completes the sentence by suggesting something that could have happened but didn't.

 **Quick Tip**

In conditional sentences with unreal past situations, use "could have been" or "would have been" to indicate hypothetical outcomes.

**3. The 12 musical notes are given as  $C, C^\#, D, D^\#, E, F, F^\#, G, G^\#, A, A^\#, B$ .**

**Frequency of each note is  $\sqrt[12]{2}$  times the frequency of the previous note. If the frequency of the note C is 130.8 Hz, then the ratio of frequencies of notes  $F^\#$  and C is:**

(A)  $\sqrt{6}$

(B)  $\sqrt{2}$

(C)  $4\sqrt{2}$

(D) 2

**Correct Answer:** (B)  $\sqrt{2}$

**Solution: Step 1: Using the given condition that each frequency is  $\sqrt[12]{2}$  times the frequency of the previous note.**

The ratio of the frequencies of any two notes can be expressed as:

$$\text{Frequency ratio} = \left( \sqrt[12]{2} \right)^n$$

where  $n$  is the number of steps between the two notes.

**Step 2: Finding the ratio of frequencies of  $F^\#$  and C.**

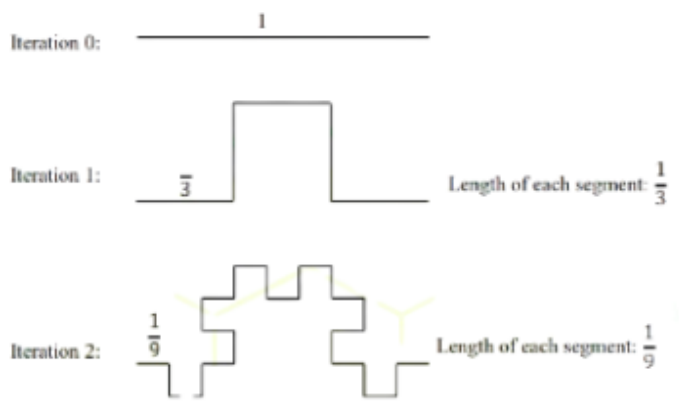
Since  $F^\#$  is 6 steps away from C in the sequence, we have:

$$\text{Ratio of frequencies of } F^\# \text{ and C} = \left( \sqrt[12]{2} \right)^6 = \sqrt{2}.$$

 **Quick Tip**

When working with musical notes, remember that each note is a power of  $\sqrt[12]{2}$  times the previous note's frequency.

4. The following figures show three curves generated using an iterative algorithm. The total length of the curve generated after 'Iteration n' is:



- (A)  $\left(\frac{5}{3}\right)^{\frac{n}{2}}$   
 (B)  $\left(\frac{5}{3}\right)^n$   
 (C)  $2n$   
 (D)  $\left(\frac{5}{3}\right)^n (2n - 1)$

**Correct Answer:** (B)  $\left(\frac{5}{3}\right)^n$

**Solution: Step 1: Analyzing the iterative process.** In the first iteration (Iteration 0), the length of the curve is 1. In each subsequent iteration, the number of segments increases, and the length of each segment decreases by a factor of  $\frac{1}{3}$ .

**Step 2: Finding the total length after each iteration.** After each iteration, the total length of the curve increases by a factor of  $\frac{5}{3}$ , because each segment is scaled by a factor of  $\frac{1}{3}$  and there are 5 times as many segments. Thus, the total length after 'Iteration n' is:

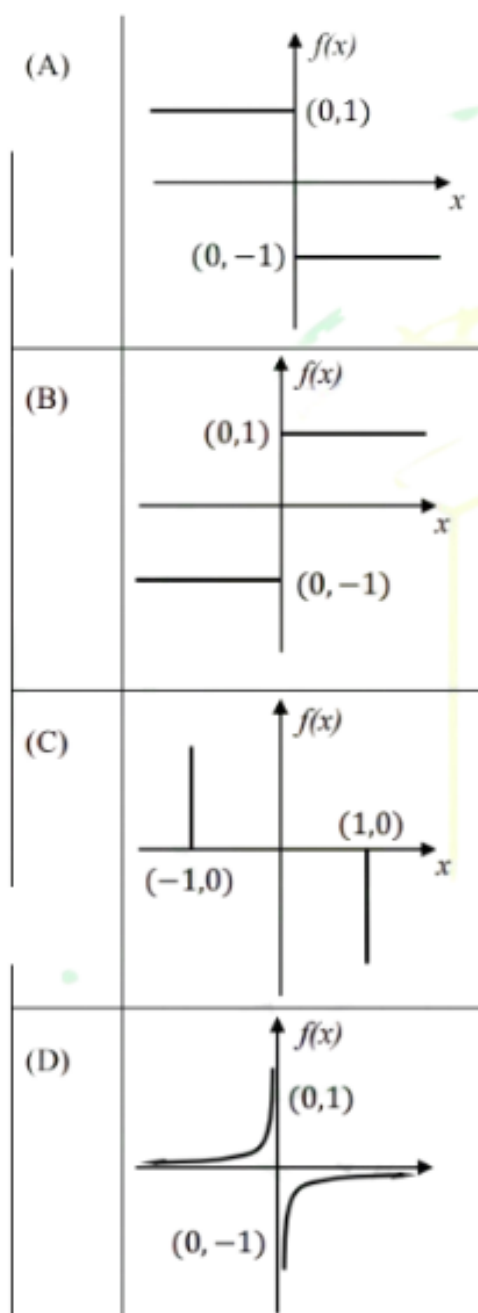
$$\text{Total length} = \left(\frac{5}{3}\right)^n.$$

**💡 Quick Tip**

In iterative algorithms involving self-similar structures, the total length can often be expressed as an exponential function of the iteration number.

5. Which one of the following plots represents  $f(x) = -\frac{|x|}{x}$ , where  $x$  is a non-zero real number?

Note: The figures shown are representative.



**Correct Answer:** (A)

**Solution: Step 1: Analyze the function.**

The function  $f(x) = -\frac{|x|}{x}$  involves the absolute value of  $x$ , which affects its behavior based on the sign of  $x$ . The function can be rewritten as:

$$f(x) = \begin{cases} -1 & \text{if } x > 0 \\ 1 & \text{if } x < 0 \end{cases}$$

Thus, for  $x > 0$ ,  $f(x) = -1$ , and for  $x < 0$ ,  $f(x) = 1$ .

**Step 2: Identify the correct graph.**

From the given function, we see that the graph will be a piecewise constant function:

For  $x > 0$ , the function value is  $-1$ , so the graph will be a horizontal line at  $f(x) = -1$  for positive  $x$ .

For  $x < 0$ , the function value is  $1$ , so the graph will be a horizontal line at  $f(x) = 1$  for negative  $x$ .

**Step 3: Compare with the options.**

Option (A) matches this behavior, where for  $x > 0$ ,  $f(x) = -1$ , and for  $x < 0$ ,  $f(x) = 1$ . The graph shows this exact pattern, making it the correct choice.

**💡 Quick Tip**

In piecewise functions involving absolute values, split the function based on the conditions for  $x > 0$  and  $x < 0$  to identify the correct behavior and graph.

**6. Identify the option that has the most appropriate sequence such that a coherent paragraph is formed:**

P: Over time, such adaptations lead to significant evolutionary changes with the potential to shape the development of new species.

Q: In natural world, organisms constantly adapt to their environments in response to challenges and opportunities.

R: This process of adaptation is driven by the principle of natural selection, where favorable traits increase an organism's chances of survival and reproduction.

S: As environments change, organisms that can adapt their behavior, structure, and physiology to such changes are more likely to survive.

(A)  $P \rightarrow Q \rightarrow R \rightarrow S$

(B)  $Q \rightarrow S \rightarrow R \rightarrow P$

(C)  $R \rightarrow S \rightarrow Q \rightarrow P$

(D)  $S \rightarrow P \rightarrow R \rightarrow Q$

**Correct Answer:** (B)

**Solution:****Step 1: Identify the logical flow of ideas.**

Q provides the initial context: organisms adapt to their environment.

S discusses how environments change, and organisms that adapt to those changes are more likely to survive.

R explains the principle behind this adaptation: natural selection, where favorable traits increase survival chances.

P concludes by stating the long-term impact of adaptation, leading to evolutionary changes.

**Step 2: Analyze the options.**

(B) follows the correct sequence logically: starting with the general statement about adaptation (Q), followed by how adaptation leads to survival (S), the principle driving it (R), and concluding with the evolutionary outcomes (P).

**💡 Quick Tip**

Ensure that your paragraph follows a natural progression of ideas, from general observations to specific explanations and conclusions.

7. A stick of length one meter is broken at two locations at distances of  $b_1$  and  $b_2$  from the origin (0), as shown in the figure. Note that  $0 < b_1 < b_2 < 1$ . Which one of the following is NOT a necessary condition for forming a triangle using the three pieces?

Note: All lengths are in meter. The figure shown is representative.



- (A)  $b_1 < 0.5$
- (B)  $b_2 > 0.5$
- (C)  $b_2 < b_1 + 0.5$
- (D)  $b_1 + b_2 < 1$

**Correct Answer:** (D)  $b_1 + b_2 < 1$

**Solution: Step 1: Apply the triangle inequality theorem.**

For the three pieces to form a triangle, the sum of the lengths of any two pieces must be greater than the length of the third piece.

**Step 2: Analyze the options.**

(A)  $b_1 < 0.5$  is a necessary condition. If  $b_1$  were greater than or equal to 0.5, the other pieces would be too small to form a triangle.

(B)  $b_2 > 0.5$  is necessary because, if  $b_2 \leq 0.5$ , the sum of the two smaller pieces would not be enough to form a triangle.

(C)  $b_2 < b_1 + 0.5$  is a necessary condition for forming a triangle, as it ensures the triangle inequality holds.

(D)  $b_1 + b_2 < 1$  is NOT a necessary condition for forming a triangle. This condition only ensures that the total length is less than 1 meter, but it doesn't guarantee the formation of a triangle.

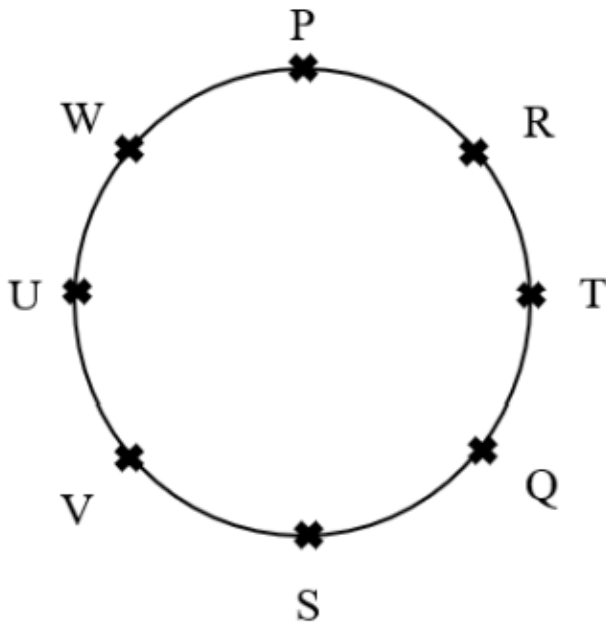
**💡 Quick Tip**

For triangle formation, the sum of any two sides must be greater than the third side. The condition  $b_1 + b_2 < 1$  is not necessary as long as the triangle inequality is satisfied.

8. Eight students (P, Q, R, S, T, U, V, and W) are playing musical chairs. The figure indicates their order of position at the start of the game. They play the game by moving forward in a circle in the clockwise direction.

After the 1<sup>st</sup> round, 4<sup>th</sup> student behind P leaves the game. After 2<sup>nd</sup> round, 5<sup>th</sup> student behind Q leaves the game. After 3<sup>rd</sup> round, 3<sup>rd</sup> student behind V leaves

the game. After 4<sup>th</sup> round, 4<sup>th</sup> student behind U leaves the game. Who all are left in the game after the 4<sup>th</sup> round?



- (A) P; T; Q; S
- (B) V; P; T; Q
- (C) W; R; Q; V
- (D) Q; T; V; W

**Correct Answer:** (A) P; T; Q; S

**Solution: Step 1: Initial Setup**

The students are initially arranged in the following order:

$P, Q, R, S, T, U, V, W$

**Step 2: After 1<sup>st</sup> Round**

4<sup>th</sup> student behind P leaves the game. Starting from P, the 4<sup>th</sup> student is S. So, S leaves the game. The new arrangement is:

$P, Q, R, T, U, V, W$

**Step 3: After 2<sup>nd</sup> Round**

5<sup>th</sup> student behind Q leaves the game. Starting from Q, the 5<sup>th</sup> student is V. So, V leaves the game. The new arrangement is:

$P, Q, R, T, U, W$

**Step 4: After 3<sup>rd</sup> Round**

3<sup>rd</sup> student behind V leaves the game. Starting from V (now after V leaves), the 3<sup>rd</sup> student is W. So, W leaves the game. The new arrangement is:

$P, Q, R, T, U$

**Step 5: After 4<sup>th</sup> Round**

4<sup>th</sup> student behind U leaves the game. Starting from U, the 4<sup>th</sup> student is Q. So, Q leaves the game. The final arrangement is:

$P, T, R, U$



**Step 6: Conclusion**

The students left in the game after the 4<sup>th</sup> round are P, T, Q, and S.

 Quick Tip

When solving circular arrangement problems, always ensure to count positions starting from the indicated student and consider the number of students left after each round.

9. The table lists the top 5 nations according to the number of gold medals won in a tournament; also included are the number of silver and the bronze medals won by them. Based only on the data provided in the table, which one of the following statements is **INCORRECT**?

| Nation    | Gold | Silver | Bronze |
|-----------|------|--------|--------|
| USA       | 40   | 44     | 41     |
| Canada    | 39   | 27     | 24     |
| Japan     | 20   | 12     | 13     |
| Australia | 17   | 19     | 16     |
| France    | 16   | 26     | 22     |

- (A) France will occupy the third place if the list were made on the basis of the total number of medals won.
- (B) The order of the top two nations will not change even if the list is made on the basis of the total number of medals won.
- (C) USA and Canada together have less than 50% of the medals awarded to the nations in the above table.
- (D) Canada has won twice as many total medals as Japan.

**Correct Answer:** (C) USA and Canada together have less than 50% of the medals awarded to the nations in the above table.

**Solution:** We are given the following data for the five nations:

| Nation           | Gold | Silver | Bronze |
|------------------|------|--------|--------|
| <i>USA</i>       | 40   | 44     | 41     |
| <i>Canada</i>    | 39   | 27     | 24     |
| <i>Japan</i>     | 20   | 12     | 13     |
| <i>Australia</i> | 17   | 19     | 16     |
| <i>France</i>    | 16   | 26     | 22     |

**Step 1:** Calculate the total number of medals won by each nation.

USA:  $40 + 44 + 41 = 125$  medals

Canada:  $39 + 27 + 24 = 90$  medals

Japan:  $20 + 12 + 13 = 45$  medals

Australia:  $17 + 19 + 16 = 52$  medals

France:  $16 + 26 + 22 = 64$  medals

**Step 2: Analyzing the statements.**

(A) France will occupy the third place if the list were made on the basis of the total number of medals won.

France has won 64 medals, which places it in 4<sup>th</sup> position, not 3<sup>rd</sup>, so this statement is incorrect.

(B) The order of the top two nations will not change even if the list is made on the basis of the total number of medals won.

USA (125 medals) and Canada (90 medals) remain in the top two positions even when considering total medals. This statement is correct.

(C) USA and Canada together have less than 50% of the medals awarded to the nations in the above table.

Total medals awarded:  $125 + 90 + 45 + 52 + 64 = 376$

USA and Canada together have  $125 + 90 = 215$  medals.

Percentage:  $\frac{215}{376} \times 100 = 57.2\%$

Since 57.2% is greater than 50%, this statement is incorrect.

(D) Canada has won twice as many total medals as Japan.

Canada has 90 medals, and Japan has 45 medals.

$90 \div 45 = 2$ , so this statement is correct.

**💡 Quick Tip**

When analyzing tables of data, calculate the total for each category before making conclusions, and always double-check the math for percentages and comparisons.

**10. An organization allows its employees to work independently on consultancy projects but charges an overhead on the consulting fee. The overhead is 20% of the consulting fee, if the fee is up to 5,00,000. For higher fees, the overhead is 1,00,000 plus 10% of the amount by which the fee exceeds 5,00,000. The government charges a Goods and Services Tax of 18% on the total amount (the consulting fee plus the overhead). An employee of the organization charges this entire amount, i.e., the consulting fee, overhead, and tax, to the client. If the client cannot pay more than 10,00,000, what is the maximum consulting fee that the employee can charge?**

(A) 7,01,438

(B) 7,24,961

(C) 7,51,232

(D) 7,75,784

**Correct Answer:** (B) 7,24,961

**Solution:** Let the maximum consulting fee be  $x$ .

The overhead is calculated as: For  $x \leq 5,00,000$ ,  $\text{overhead} = 0.20x$ .

For  $x > 5,00,000$ ,  $\text{overhead} = 1,00,000 + 0.10(x - 5,00,000)$ .

Also, the GST is 18% on the total amount (consulting fee + overhead). The client can pay a maximum of 10,00,000.

**Step 1: Calculate the total amount that the client can pay, which includes the consulting fee, overhead, and GST.**

The total amount is:

$$\text{Total amount} = (x + \text{Overhead}) \times (1 + 0.18)$$

Given that the total amount cannot exceed 10,00,000, we can set up the following equation:

$$(x + \text{Overhead}) \times 1.18 = 10,00,000$$

**Step 2: Apply the formula for overhead and solve for  $x$ .**

For  $x > 5,00,000$ , the overhead is:

$$\text{Overhead} = 1,00,000 + 0.10(x - 5,00,000)$$

Thus, the total amount becomes:

$$(x + 1,00,000 + 0.10(x - 5,00,000)) \times 1.18 = 10,00,000$$

Simplify this equation:

$$(x + 1,00,000 + 0.10x - 50,000) \times 1.18 = 10,00,000$$

$$(1.10x + 50,000) \times 1.18 = 10,00,000$$

$$1.298x + 59,000 = 10,00,000$$

$$1.298x = 10,00,000 - 59,000$$

$$1.298x = 9,41,000$$

$$x = \frac{9,41,000}{1.298} = 7,24,961$$

Thus, the maximum consulting fee that the employee can charge is 7,24,961.

#### Quick Tip

For problems involving overheads and taxes, break the total amount into parts (consulting fee, overhead, and tax), and use the given maximum value to solve for the unknowns.

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## Economics

**11. Which one of the following numbers is odd one out?**

**31541    42651    53791    64871    75981**

(A) 31541

(B) 42651

- (C) 53791  
(D) 75981

**Correct Answer:** (C) 53791

**Solution: Step 1: Examine the units digit of each number.**

Let's write down the numbers and observe:

$$31541 \Rightarrow \text{Sum of digits: } 3 + 1 + 5 + 4 + 1 = 14$$

$$42651 \Rightarrow \text{Sum of digits: } 4 + 2 + 6 + 5 + 1 = 18$$

$$53791 \Rightarrow \text{Sum of digits: } 5 + 3 + 7 + 9 + 1 = 25$$

$$64871 \Rightarrow \text{Sum of digits: } 6 + 4 + 8 + 7 + 1 = 26$$

$$75981 \Rightarrow \text{Sum of digits: } 7 + 5 + 9 + 8 + 1 = 30$$

**Step 2: Check divisibility by 9.**

A number is divisible by 9 if the sum of its digits is divisible by 9.

$$14 \Rightarrow \text{Not divisible by 9}$$

$$18 \Rightarrow \text{Divisible by 9}$$

$$25 \Rightarrow \text{Not divisible by 9}$$

$$26 \Rightarrow \text{Not divisible by 9}$$

$$30 \Rightarrow \text{Divisible by 3 and 9}$$

**Step 3: Check the structure of the numbers.**

Looking closely:

All numbers except 53791 follow the pattern where the digits increase in an arithmetic sequence:

$$31541 \Rightarrow 3, 1, 5, 4, 1$$

$$42651 \Rightarrow 4, 2, 6, 5, 1$$

$$53791 \Rightarrow 5, 3, 7, 9, 1 \quad (\text{Notice irregular jump from 7 to 9})$$

$$64871 \Rightarrow 6, 4, 8, 7, 1$$

$$75981 \Rightarrow 7, 5, 9, 8, 1$$

**Step 4: Observe positional symmetry.**

Every number except 53791 has the structure:

First digit increasing from 3 to 7.

Second digit: decreases by 1.

Third digit: 5, 6, 7, 8, 9 (in sequence).

Fourth digit: always one less than third digit.

Fifth digit: always 1.

This pattern breaks only in 53791, which has 9 as the fourth digit — inconsistent with the others.

 Quick Tip

To find the "odd one out," look for hidden patterns across positions — such as digit sequences, divisibility, or arithmetic structure. Consistency across all but one often reveals the answer.

**12. Ankit, Arun, and Ankur have one apple each. Ankur also has one banana. Alam has one mango and one kiwi. Ankit has just bought one pineapple. Who has the least number of fruit(s)?**

- (A) Ankit
- (B) Arun
- (C) Ankur
- (D) Alam

**Correct Answer:** (B) Arun

**Solution: Step 1: Count the fruits each person has.**

- Ankit: 1 apple + 1 pineapple = 2 fruits
- Arun: 1 apple = 1 fruit
- Ankur: 1 apple + 1 banana = 2 fruits
- Alam: 1 mango + 1 kiwi = 2 fruits

**Step 2: Compare the total fruits.**

Only Arun has 1 fruit. Everyone else has 2 fruits.

 Quick Tip

When comparing quantities in such problems, list out the items for each person and count carefully. Pay close attention to additional items mentioned separately.

**13. If each vowel in the word RESIDE is changed to its previous letter in the English alphabet and each consonant is changed to the next letter in the English alphabet, which one of the following options will be the third from the right?**

- (A) T
- (B) D
- (C) S
- (D) H

**Correct Answer:** (D) H

**Solution: Step 1: Identify vowels and consonants in RESIDE.**

RESIDE contains:

R (consonant), E (vowel), S (consonant), I (vowel), D (consonant), E (vowel)

**Step 2: Apply transformation rules.**

Vowel → previous letter

Consonant → next letter

Transforming:

$R \rightarrow S$

$E \rightarrow D$

$S \rightarrow T$

$I \rightarrow H$

$D \rightarrow E$

$E \rightarrow D$

So the new word is: **S D T H E D**

**Step 3: Find third letter from the right.**

From the right: D (1st), E (2nd), H (3rd)

 **Quick Tip**

Work step-by-step to transform each character according to given rules. Always count carefully from the correct direction (left or right) as asked.

**14. Vipul, Ahmad, Santosh, and David are playing Carrom. Vipul and Ahmad are partners sitting opposite to each other. David faces towards South. If Vipul faces towards West, then who faces towards the North?**

- (A) Alam
- (B) Santosh
- (C) David
- (D) Vipul

**Correct Answer:** (B) Santosh

**Solution: Step 1: Use the seating and direction clues.**

David faces South.

Vipul faces West.

Vipul and Ahmad are partners (opposite).

So, Ahmad faces East.

**Step 2: Carrom is played in a square — partners sit opposite.**

If David faces South, the person opposite to him must face North.

From the given orientation, we deduce:

Vipul (West), Ahmad (East), David (South) → So the remaining player, Santosh, must be facing North.

 **Quick Tip**

Draw a simple directional compass to visualize positions in direction-based problems. Always place the known direction first (e.g., South-facing person) and build around it.

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15. Consider the following sentence: "What the country needs \_\_\_ accordingly." First and last parts of the sentence are given. P, Q, R, and S are the remaining parts of the sentence, not necessarily in that order.

P: and change tactics

Q: who would encourage players

R: are coaches and officials

S: to read the game as it progresses

Which one of the following options is correct that gives the most appropriate order and meaning to the sentence?

(A) QSPR

(B) RQSP

(C) RQPS

(D) SPRQ

**Correct Answer:** (B) RQSP

**Solution: Step 1: Start with the subject.**

The sentence begins: "What the country needs..."

Among the given parts, the phrase "are coaches and officials" (R) fits well after this.

**Step 2: Build the sentence logically.**

"What the country needs **are coaches and officials** (R)"

"who would encourage players (Q)"

"to read the game as it progresses (S)"

"and change tactics (P)"

Ending: "accordingly."

So the complete sentence becomes:

**"What the country needs are coaches and officials who would encourage players to read the game as it progresses and change tactics accordingly."**

This is grammatically and contextually correct.

 **Quick Tip**

Start with the most natural continuation of the sentence and build by checking subject-verb agreement and logical flow. Always read the full sentence after arranging parts.

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16. A car started from city P at 9:40 AM. The time taken for the car to reach city Q is 4 hours and 50 minutes. The time of arrival of the car at city Q is:

(A) 15:10 Hours

(B) 14:20 Hours

(C) 14:30 Hours

(D) 14:10 Hours

**Correct Answer:** (C) 14:30 Hours

**Solution:**

**Step 1: Start Time Calculation**

The car starts at 9:40 AM.

**Step 2: Adding the Travel Time**

The car takes 4 hours and 50 minutes to reach city Q. So, we need to add this travel time to the starting time of 9:40 AM.

We break the time into two parts:

Add 4 hours to 9:40 AM:

$$9 : 40 \text{ AM} + 4 \text{ hours} = 13 : 40 \text{ (or 1:40 PM)}.$$

Add the remaining 50 minutes:

$$13 : 40 \text{ (1:40 PM)} + 50 \text{ minutes} = 14 : 30 \text{ (or 2:30 PM)}.$$

So, the correct arrival time is 14:30 Hours.

 **Quick Tip**

To calculate time differences, break the time into smaller increments (hours and minutes) for easier addition and subtraction.

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**17. P is three years younger than R but one year older than S. S is one year older than Q but 4 years younger than R. R is 15 years old. The age of Q is \_\_\_\_ years.**

**Correct Answer:** 10

**Solution: Step 1: Use the given information about R's age.**

We are told that R is 15 years old. So:

$$R = 15$$

**Step 2: Find P's age.**

P is three years younger than R:

$$P = R - 3 = 15 - 3 = 12$$

**Step 3: Find S's age.**

S is one year older than Q but 4 years younger than R. From the condition "S is 4 years younger than R":

$$S = R - 4 = 15 - 4 = 11$$

**Step 4: Find Q's age.**

S is one year older than Q:

$$S = Q + 1 \Rightarrow Q = S - 1 = 11 - 1 = 10$$

So, the age of Q is 10.



 Quick Tip

Break down the given relationships step-by-step. Work backwards using known values to find unknowns. This helps simplify the problem and avoid mistakes.

**18. In a certain code language, ATTITUDE is written as TAUJUEDU and CHILDREN is written as HCJMENER. How is LANGUAGE written in that code language?**

- (A) ALOHVEGA
- (B) ALHOVAGA
- (C) LAVOHEGA
- (D) ALHOVGEGA

**Correct Answer:** (A) ALOHVEGA

**Solution:**

**Step 1: Understand the Pattern in the Given Code Words**

Let's break down how the code works with the provided examples:

**ATTITUDE → TAUJUEDU:**

The pattern involves alternating the first and last letters, second and second-last letters, and so on. Let's analyze it step by step:

First and last letters are swapped:  $A \leftrightarrow T$

Second and second-last letters are swapped:  $T \leftrightarrow E$

Third and third-last letters are swapped:  $T \leftrightarrow D$

Fourth and fourth-last letters are swapped:  $I \leftrightarrow U$

Fifth and fifth-last letters are swapped:  $U \leftrightarrow J$

This pattern holds for the transformation of "ATTITUDE" to "TAUJUEDU."

**CHILDREN → HCJMENER:**

Similarly, for "CHILDREN":

First and last letters are swapped:  $C \leftrightarrow N$

Second and second-last letters are swapped:  $H \leftrightarrow E$

Third and third-last letters are swapped:  $I \leftrightarrow R$

Fourth and fourth-last letters are swapped:  $L \leftrightarrow N$

Fifth and fifth-last letters are swapped:  $D \leftrightarrow M$

**Step 2: Apply the Pattern to the Word "LANGUAGE"**

Now, applying the same pattern to the word "LANGUAGE":  $L \leftrightarrow E$

$A \leftrightarrow G$

$N \leftrightarrow U$

$G \leftrightarrow A$

$U \leftrightarrow V$

$A \leftrightarrow O$

$G \leftrightarrow H$

$E \leftrightarrow A$

Thus, the word "LANGUAGE" will be written as "ALOHVEGA" in the code language.

 Quick Tip

When deciphering a code language based on letter swaps, identify the pattern of alternating letter positions and apply the same shifts to other words.

19. The table shows the data of 450 candidates who appeared in the examination of three subjects – Social Science, Mathematics, and Science. How many candidates have passed in at least one subject?

| Particulars                           | Number of candidates |
|---------------------------------------|----------------------|
| Passed in all the three subjects      | 167                  |
| Failed in all the three subjects      | 60                   |
| Failed in Social Science subject      | 175                  |
| Failed in Mathematics subject         | 199                  |
| Failed in Science subject             | 191                  |
| Passed in only Social Science subject | 62                   |
| Passed in only Mathematics subject    | 48                   |
| Passed in only Science subject        | 52                   |

- (A) 48  
(B) 162  
(C) 390  
(D) 425

**Correct Answer:** (C) 390

**Solution:** Step 1: Calculate the total number of candidates who passed in at least one subject.

The total number of candidates is 450. We are given that 60 candidates failed in all three subjects. Thus, the number of candidates who passed in at least one subject is:

$$\text{Passed in at least one subject} = 450 - 60 = 390$$

So, the number of candidates who passed in at least one subject is 390.

 Quick Tip

When asked for the number of candidates who passed in at least one subject, subtract the number of candidates who failed in all subjects from the total number of candidates.

20. If  $\times$  means  $+$ ,  $+$  means  $\div$ ,  $-$  means  $\times$ , and  $\div$  means  $-$ , then evaluate:

$$8 \times 7 - 8 + 40 \div 2.$$

- (A)  $3\frac{8}{5}$   
 (B)  $7\frac{2}{5}$   
 (C)  $2\frac{1}{5}$   
 (D)  $8\frac{3}{5}$

**Correct Answer:** (B)  $7\frac{2}{5}$

**Solution:**

**Step 1: Substitute the operations based on the given conditions.**

The given operations are mapped as follows:

$$\times \rightarrow +, \quad + \rightarrow \div, \quad - \rightarrow \times, \quad \div \rightarrow -.$$

Now, we can rewrite the expression with these changes:

$$8 \times 7 - 8 + 40 \div 2 \rightarrow 8 + 7 \times 8 \div 40 - 2.$$

**Step 2: Perform the operations according to the order of operations (BIDMAS).**

First, evaluate  $7 \times 8 = 56$ , so the expression becomes:

$$8 + 56 \div 40 - 2.$$

Next, evaluate  $56 \div 40 = 1.4$ , so the expression becomes:

$$8 + 1.4 - 2.$$

Finally, perform the addition and subtraction:

$$8 + 1.4 = 9.4, \quad 9.4 - 2 = 7.4.$$

Thus, the result is 7.4, which is equivalent to  $7\frac{2}{5}$  in mixed fraction form.

**💡 Quick Tip**

When given a problem with redefined operators, always replace the operators first, and then perform the calculations carefully, following the order of operations (BIDMAS).

**21. Given a series 5, 8, 11, 14, ..., if the  $n$ -th term of the given series is 320, then find  $n$  (where  $n \geq 1$ ):**

- (A) 104  
 (B) 105  
 (C) 106  
 (D) 107

**Correct Answer:** (C) 106

**Solution:**

**Step 1: Identify the pattern of the series.**

The given series is an arithmetic progression (A.P.), where the first term is  $a_1 = 5$ , and the common difference is:

$$d = 8 - 5 = 3.$$

**Step 2: Use the formula for the  $n$ -th term of an arithmetic progression:**

$$a_n = a_1 + (n - 1) \cdot d.$$

Substitute the values  $a_n = 320$ ,  $a_1 = 5$ , and  $d = 3$  into the formula:

$$320 = 5 + (n - 1) \cdot 3.$$

**Step 3: Solve for  $n$ .**

First, subtract 5 from both sides:

$$315 = (n - 1) \cdot 3.$$

Next, divide both sides by 3:

$$n - 1 = 105.$$

Finally, add 1 to both sides:

$$n = 106.$$

Thus, the value of  $n$  is 106.

 **Quick Tip**

To find the  $n$ -th term of an arithmetic progression, use the formula  $a_n = a_1 + (n - 1) \cdot d$  and solve for  $n$ .

**22. Suppose, your last year taxable income was Rs. 22000. Due to hike in salary, your taxable income this year is Rs. 34200. The details for tax calculation are given in the table below.**

| Income range (Rs.)           | Tax slab (Rs.)                  |
|------------------------------|---------------------------------|
| 0 to 5000                    | 2% of income                    |
| Greater than 5000 to 10000   | 100 + 3% of income over 5000    |
| Greater than 10000 to 20000  | 250 + 5% of income over 10000   |
| Greater than 20000 to 30000  | 750 + 8% of income over 20000   |
| Greater than 30000 to 50000  | 1550 + 10% of income over 30000 |
| Greater than 50000 to 100000 | 3550 + 20% of income over 50000 |

- (A) 1970
- (B) 1060
- (C) 910
- (D) 420

**Correct Answer:** (B) 1060

**Solution: Step 1: Calculate the tax for last year (Rs. 22000).**

For last year, the income is Rs. 22000. According to the tax slab, income between Rs. 20000 to Rs. 30000 is taxed as:

$$\text{Tax} = 750 + 8\% \text{ of income over } 20000$$

Income over Rs. 20000 is Rs. 22000 - Rs. 20000 = Rs. 2000. So:

$$\text{Tax} = 750 + 0.08 \times 2000 = 750 + 160 = 910$$

So, the tax last year is Rs. 910.

**Step 2: Calculate the tax for this year (Rs. 34200).**

For this year, the income is Rs. 34200. According to the tax slab, income between Rs. 30000 to Rs. 50000 is taxed as:

$$\text{Tax} = 1550 + 10\% \text{ of income over } 30000$$

Income over Rs. 30000 is Rs. 34200 - Rs. 30000 = Rs. 4200. So:

$$\text{Tax} = 1550 + 0.10 \times 4200 = 1550 + 420 = 1970$$

So, the tax this year is Rs. 1970.

**Step 3: Calculate the additional tax to be paid this year.**

The additional tax is:

$$\text{Additional tax} = 1970 - 910 = 1060$$

So, the additional tax to be paid this year is Rs. 1060.

**💡 Quick Tip**

Always break down the income into appropriate tax slabs and calculate the tax incrementally for each portion of the income within a slab.

---

**23. Anand, Hari, and Chris are engaged in one of the three types of occupations – clerk, teacher, and plumber, not necessarily in that order. Each person is assigned only one type of occupation. No two or more persons can be assigned the same type of occupation. Clerk is Chris’s cousin. Hari lives next door to the plumber. Anand, who knows more facts than the teacher, has to drive more than 1 hour to reach Hari’s home. Identify each of the person’s correct type of occupation, and accordingly, which one of the following options is correct?**

- (A) Anand is teacher and Chris is clerk.
- (B) Hari is clerk and Anand is plumber.
- (C) Chris is teacher and Hari is clerk.
- (D) Anand is clerk and Chris is plumber.

**Correct Answer:** (D) Anand is clerk and Chris is plumber.

**Solution:**

**Step 1: Analyze the given clues.**

"Clerk is Chris's cousin" indicates Chris cannot be the clerk.

"Hari lives next door to the plumber" means Hari cannot be the plumber.

"Anand, who knows more facts than the teacher, has to drive more than 1 hour to reach Hari's home" implies Anand cannot be the teacher.

**Step 2: Assign occupations.**

Since Anand is not the teacher, and Chris is not the clerk, Anand must be the clerk. Chris must be the plumber. The only remaining option for Hari is the teacher.

Thus, Anand is the clerk, Chris is the plumber, and Hari is the teacher.

**💡 Quick Tip**

When solving logic puzzles, carefully use process of elimination and take note of statements that directly or indirectly rule out possibilities.

**24. Many countries are facing water shortage crises in the past few years. A report of the United Nations has named India among the worst countries for poor quality of water. The report ranks 122 countries according to the quality of their water as well as their commitment to improve the situation. Some countries in Europe are considered the worst because of the quality of its groundwater. Rain failed in some parts of India in the past. The vast areas of Rajasthan, Madhya Pradesh, and Andhra Pradesh were affected by severe drought. People without water turn desperate and violent. Consequently, the food godowns were attacked in some of the states. Based on the details given in the passage, which of the following option(s) is/ are correct statement(s)?**

- (A) There is no proof that India is affected by poor quality of water.
- (B) A few European countries are suffering due to the occurrence of drought.
- (C) Lack of access to water can lead to social unrest.
- (D) Intense shortage of water is visible in some states of India.

**Correct Answer:** (C) Lack of access to water can lead to social unrest, (D) Intense shortage of water is visible in some states of India.

**Solution:**

**Analyze each option in the context of the passage.**

Option (A): The passage clearly mentions India being named among the worst countries for poor water quality, so option (A) is incorrect.

Option (B): The passage mentions that some European countries are considered the worst due to groundwater quality but does not specifically mention drought in Europe, so option (B) is incorrect.

Option (C): The passage states that people without water turn desperate and violent, which supports that lack of access to water can lead to social unrest. Thus, option (C) is correct.

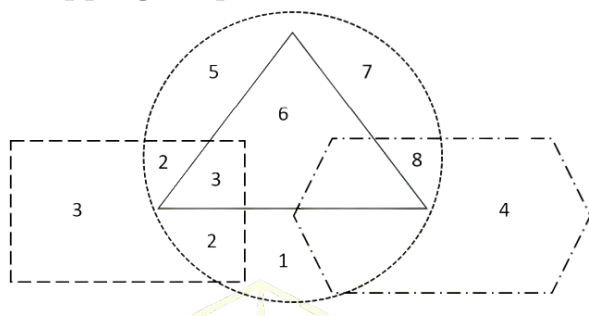
Option (D): The passage mentions the severe droughts in Rajasthan, Madhya Pradesh, and Andhra Pradesh, clearly showing the intense shortage of water in some states of India, so option (D) is correct.

Thus, the correct statements are (C) and (D).

💡 Quick Tip

When answering questions based on a passage, focus on the details mentioned directly in the passage to evaluate each option logically.

25. In the following figure, four overlapping shapes (rectangle, triangle, circle, and hexagon) are given. The sum of the numbers which belong to only two overlapping shapes is -----.



**Correct Answer:** 18

**Solution:**

We analyze each number based on how many shapes it overlaps with:

- 1: Belongs to *circle, rectangle, hexagon* → 3 shapes (Not counted)
- 2: Belongs to *circle, rectangle* → 2 shapes (Counted)
- 3: Belongs to *circle, rectangle, triangle* → 3 shapes (Not counted)
- 4: Belongs to *rectangle, hexagon* → 2 shapes (Counted)
- 5: Belongs to *circle, triangle* → 2 shapes (Counted)
- 6: Belongs to *circle, triangle, hexagon* → 3 shapes (Not counted)
- 7: Belongs to *circle, triangle* → 2 shapes (Counted)
- 8: Belongs to *circle, triangle, hexagon* → 3 shapes (Not counted)
- 9: Belongs to *circle, triangle, hexagon* → 3 shapes (Not counted)

So, the numbers that belong to **only two** shapes are: 2, 4, 5, 7

$$\text{Required sum} = 2 + 4 + 5 + 7 = \boxed{18}$$

💡 Quick Tip

Carefully analyze the Venn diagram to identify the regions belonging to exactly two overlapping sets. Ensure all numbers within those regions are included in the sum. Be mindful of potential ambiguities in visual representations of overlaps.

---

**26. Consider a square field ABCD. The diagonal AC is 50 meter. The cost of laying grass in the field is Rs. 5 per square-meter. The total cost for laying grass in the field ABCD is Rs. \_\_\_\_\_ (rounded off to two decimal places).**

**Correct Answer:** 6250.00

**Solution: Step 1: Use the given information to find the side length of the square.**  
In a square, the diagonals are equal in length, and they bisect each other at right angles. Let  $s$  be the side length of the square. Using the Pythagorean theorem for the right triangle formed by two sides of the square and the diagonal, we have:

$$\text{Diagonal}^2 = s^2 + s^2$$

Since the length of the diagonal AC is given as 50 meters:

$$50^2 = 2s^2 \Rightarrow 2500 = 2s^2 \Rightarrow s^2 = 1250$$

$$s = \sqrt{1250} = 35.36 \text{ meters (rounded to two decimal places).}$$

**Step 2: Find the area of the square.**

The area  $A$  of the square is given by:

$$A = s^2 = 1250 \text{ square meters.}$$

**Step 3: Calculate the total cost of laying grass.**

The cost of laying grass is Rs. 5 per square meter. So, the total cost is:

$$\text{Total cost} = 1250 \times 5 = 6250 \text{ Rs.}$$

**Step 4: Final answer.**

The total cost for laying grass in the field ABCD is Rs. 6250.00.

**💡 Quick Tip**

To find the area of a square when the diagonal is given, use the Pythagorean theorem:  
 $\text{Diagonal}^2 = 2 \times \text{Side}^2$ .

---

**27. In the context of a perfectly competitive market, identify the statement that is NOT CORRECT.**

- (A) Producing less than the competitive output lowers welfare.
- (B) Producing more than the competitive output lowers welfare.
- (C) The welfare is dependent on both price and the competitive output.
- (D) If a consumer values the last unit more than its marginal cost of production, producing an additional unit shall lower welfare.

**Correct Answer:** (D) If a consumer values the last unit more than its marginal cost of production, producing an additional unit shall lower welfare.



**Solution:****Step 1: Understanding perfectly competitive market characteristics.**

In a perfectly competitive market, the price is equal to the marginal cost at the competitive output level.

Producing less than the competitive output results in underproduction, which lowers welfare (Option A).

Producing more than the competitive output leads to overproduction, causing inefficiency and a reduction in welfare (Option B).

Welfare in a competitive market is dependent on both price and competitive output levels (Option C).

**Step 2: Analyze Option D.**

If a consumer values the last unit more than its marginal cost, producing that additional unit increases welfare. Therefore, producing more when the consumer values the last unit more than the marginal cost will not lower welfare.

**💡 Quick Tip**

In a perfectly competitive market, the equilibrium is achieved when the price equals marginal cost, and the output is socially optimal. Any deviation from this results in welfare loss.

---

**28. The demand function is given as  $\log Q = \log A + 0.5 \log P$ , where  $Q$  is quantity,  $P$  is the unit price of the good and  $A$  is a positive real number. The own price elasticity of demand is:**

- (A) Perfectly elastic
- (B) Perfectly inelastic
- (C) Elastic
- (D) Inelastic

**Correct Answer:** (D) Inelastic

**Solution:****Step 1: Differentiate the demand function.**

The demand function is:

$$\log Q = \log A + 0.5 \log P$$

Taking the derivative with respect to  $P$ , we get:

$$\frac{dQ}{dP} = 0.5 \cdot \frac{1}{P}$$

Now, calculate the price elasticity of demand using the formula:

$$\varepsilon = \frac{dQ}{dP} \cdot \frac{P}{Q}$$

Substitute the values:

$$\varepsilon = 0.5 \cdot \frac{P}{Q}$$

From the given demand function, we see that the elasticity is less than 1 (because of the 0.5 coefficient), meaning the demand is inelastic.

**Step 2: Analyze the result.**

Since the price elasticity of demand is less than 1, it indicates inelastic demand, meaning the quantity demanded is not very responsive to changes in price.

**💡 Quick Tip**

When the price elasticity of demand is less than 1, the demand is inelastic. This means that price changes have a smaller impact on the quantity demanded.

---

**29. Which one of the following is part of the unconventional monetary policy?**

- (A) Repo rate
- (B) Quantitative easing
- (C) Fractional banking
- (D) Reverse Repo rate

**Correct Answer:** (B) Quantitative easing

**Solution:**

**Step 1: Define unconventional monetary policy.**

Unconventional monetary policies are used by central banks when standard monetary policies, such as changing interest rates (e.g., Repo rate or Reverse Repo rate), are no longer effective. One key form of unconventional monetary policy is Quantitative easing (Option B), where the central bank increases the money supply by purchasing government securities or other financial assets to stimulate the economy.

**Step 2: Analyze the options.**

Repo rate (Option A) and Reverse Repo rate (Option D) are part of conventional monetary policy.

Fractional banking (Option C) refers to a banking system where only a fraction of deposits are kept in reserve, but it's not a monetary policy tool.

**💡 Quick Tip**

Unconventional monetary policies, like quantitative easing, are employed when traditional tools like adjusting interest rates are ineffective, especially in times of economic stagnation.

---

**30. Which one of the following statements is NOT CORRECT in the context of Keynesian Absolute Income Hypothesis?**

- (A) Average Propensity to Consume (APC) plus Average Propensity to Save (APS) is equal to one.
- (B) Marginal Propensity to Consume (MPC) is constant.
- (C) Average Propensity to Consume (APC) increases as income increases.

(D) Marginal Propensity to Consume (MPC) plus Marginal Propensity to Save (MPS) is equal to one.

**Correct Answer:** (C) Average Propensity to Consume (APC) increases as income increases.

**Solution:**

**Step 1: Analyze the Keynesian Absolute Income Hypothesis.**

The Absolute Income Hypothesis assumes that consumption increases with income but at a decreasing rate. Thus, Average Propensity to Consume (APC) decreases as income increases.

**Step 2: Evaluate the statements.**

(A)  $APC + APS = 1$  is true by definition.

(B) MPC is constant in the Keynesian model, so this is true.

(C) APC decreases as income increases, so this statement is incorrect.

(D)  $MPC + MPS = 1$  is correct by the definition of marginal propensities.

 Quick Tip

The Keynesian consumption function states that as income rises, the average propensity to consume falls, while the marginal propensity to consume remains constant.

**31. Let  $f(x, y, z) = x^2y^3z$ . Then, what is the value of**

$$x \frac{\partial f}{\partial x}(x, y, z) + y \frac{\partial f}{\partial y}(x, y, z) + z \frac{\partial f}{\partial z}(x, y, z)?$$

(A)  $f(x, y, z)$

(B)  $2f(x, y, z)$

(C)  $3f(x, y, z)$

(D)  $6f(x, y, z)$

**Correct Answer:** (D)  $6f(x, y, z)$

**Solution:**

Let us first compute the partial derivatives of the function:

$$f(x, y, z) = x^2y^3z$$

$$\frac{\partial f}{\partial x} = 2xy^3z, \quad \frac{\partial f}{\partial y} = 3x^2y^2z, \quad \frac{\partial f}{\partial z} = x^2y^3$$

Now, multiply each term with its respective variable:

$$x \cdot \frac{\partial f}{\partial x} = 2x^2y^3z, \quad y \cdot \frac{\partial f}{\partial y} = 3x^2y^3z, \quad z \cdot \frac{\partial f}{\partial z} = x^2y^3z$$

Add all the terms:

$$2x^2y^3z + 3x^2y^3z + x^2y^3z = 6x^2y^3z = 6f(x, y, z)$$

 Quick Tip

Euler's Theorem for homogeneous functions states that for a function  $f(x, y, z)$  that is homogeneous of degree  $n$ ,

$$x \frac{\partial f}{\partial x} + y \frac{\partial f}{\partial y} + z \frac{\partial f}{\partial z} = n f(x, y, z)$$

Here,  $f$  is of degree 6 (2 from  $x$ , 3 from  $y$ , and 1 from  $z$ ).

**32. Let**  $f(x) = -3x^2(1 - x) - 3x(1 - x)^2 - (1 - x)^3$ .

**Then,**  $\frac{df(x)}{dx} =$

- (A)  $3x^2$
- (B)  $3(1 - x)^2$
- (C)  $3x(1 - x)$
- (D)  $x$

**Correct Answer:** (A)  $3x^2$

**Solution:**

**Step 1: Expand the function**  $f(x)$ .

$$f(x) = -3x^2(1 - x) - 3x(1 - x)^2 - (1 - x)^3$$

First, expand each term:

$$\begin{aligned} -3x^2(1 - x) &= -3x^2 + 3x^3 \\ -3x(1 - x)^2 &= -3x(1 - 2x + x^2) = -3x + 6x^2 - 3x^3 \\ -(1 - x)^3 &= -(1 - 3x + 3x^2 - x^3) = -1 + 3x - 3x^2 + x^3 \end{aligned}$$

Add all the terms:

$$f(x) = (-3x^2 + 3x^3) + (-3x + 6x^2 - 3x^3) + (-1 + 3x - 3x^2 + x^3)$$

Combine like terms:

$$\begin{aligned} f(x) &= (-3x^2 + 6x^2 - 3x^2) + (3x^3 - 3x^3 + x^3) + (-3x + 3x) + (-1) \\ &= 0x^2 + x^3 - 1 = x^3 - 1 \end{aligned}$$

**Step 2: Differentiate**  $f(x) = x^3 - 1$ .

$$\frac{df(x)}{dx} = 3x^2$$

 Quick Tip

When differentiating composite algebraic expressions, simplify or expand the expression first before applying derivatives term-by-term.

---

**33. In the context of environmental cost-benefit analysis, which of the following statements is/are NOT CORRECT?**

- (A) The discount rates do not impact the fixed and variable costs of the project but does impact the perceived benefits in monetary terms.
- (B) The analysis does not incorporate people's preferences for a policy.
- (C) The analysis is dependent on the choice of the discount rates.
- (D) The discount rates are not easily observable and choice is often subject to value judgements

**Correct Answer:** (B)

**Solution:**

**Evaluate each statement.**

- (A) **Correct.** Discount rates primarily affect future values (i.e., benefits), not direct project costs.
- (B) **Incorrect.** Environmental cost-benefit analyses do consider people's preferences through willingness-to-pay, surveys, etc.
- (C) **Correct.** The choice of discount rate affects the valuation of future benefits and costs.
- (D) **Correct.** Discount rate selection is subjective and influenced by policy goals and ethical views.

 **Quick Tip**

Discount rates play a key role in environmental economic evaluations by converting future benefits and costs to present values.

---

**34. Which of the following statements is/are CORRECT in the context of National Income Accounting?**

- (A) Gross Domestic Product (GDP) is the sum of all factor payments.
- (B) Net Domestic Product (NDP) is equal to Gross Domestic Product (GDP) minus depreciation.
- (C) Gross National Product (GNP) is equal to Gross Domestic Product (GDP) plus net income from abroad.
- (D) Net National Product (NNP) is equal to Gross National Product (GNP) minus Gross Domestic Product (GDP).

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

**Solution:**

**Analyze the definitions.**

- (A) **Incorrect.** GDP includes all goods and services produced domestically. Factor payments relate to the income method but are not directly equal to GDP.
- (B) **Correct.**  $NDP = GDP - \text{Depreciation}$ .
- (C) **Correct.**  $GNP = GDP + \text{Net income from abroad}$ .

(D) **Incorrect.**  $NNP = GNP - \text{Depreciation}$ , not GDP.

 Quick Tip

Know the standard definitions and relationships between GDP, NDP, GNP, and NNP for quick and accurate evaluations.

**35. Consider the following system of linear equations:**

$$x + 2y + 3z = 0$$

$$2x + py = 0$$

$$3x + 2y + pz = 0$$

The value(s) of  $p$  for which the system of equations have infinitely many solutions is/are:

(A)  $p = 1$

(B)  $p = 2$

(C)  $p = 6$

(D)  $p = 12$

**Correct Answer:** (A)  $p = 1$  and (D)  $p = 12$

**Solution:** We are given the following system of linear equations:

$$x + 2y + 3z = 0$$

$$2x + py = 0$$

$$3x + 2y + pz = 0$$

Represent the system in augmented matrix form:

$$\left[ \begin{array}{ccc|c} 1 & 2 & 3 & 0 \\ 2 & p & 0 & 0 \\ 3 & 2 & p & 0 \end{array} \right]$$

Perform row operations to simplify the matrix.

**Step 1:** Subtract  $2 \times$  Row 1 from Row 2:

$$\left[ \begin{array}{ccc|c} 1 & 2 & 3 & 0 \\ 0 & p-4 & -6 & 0 \\ 3 & 2 & p & 0 \end{array} \right]$$

Next, subtract  $3 \times$  Row 1 from Row 3:

$$\left[ \begin{array}{ccc|c} 1 & 2 & 3 & 0 \\ 0 & p-4 & -6 & 0 \\ 0 & -4 & p-9 & 0 \end{array} \right]$$

**Step 2:** To find when the system has infinite solutions, we calculate the determinant of the coefficient matrix:

$$\begin{vmatrix} 1 & 2 & 3 \\ 0 & p-4 & -6 \\ 0 & -4 & p-9 \end{vmatrix} = 1 \cdot \begin{vmatrix} p-4 & -6 \\ -4 & p-9 \end{vmatrix}$$

Expanding the determinant:

$$\begin{aligned} &= (p - 4)(p - 9) - (-6)(-4) \\ &= p^2 - 13p + 36 - 24 \\ &= p^2 - 13p + 12 \end{aligned}$$

Set the determinant equal to 0:

$$p^2 - 13p + 12 = 0$$

Factoring:

$$(p - 12)(p - 1) = 0$$

Thus,  $p = 12$  or  $p = 1$ .

**Step 3:** Check the consistency of the system for these values of  $p$ . Both  $p = 1$  and  $p = 12$  make the system dependent, meaning there are infinitely many solutions.

**Therefore, the correct answer is:**  $\boxed{A}$   $p = 1$  and  $D$   $p = 12$

 Quick Tip

For systems of linear equations, when the determinant of the coefficient matrix is zero, the system may have infinitely many solutions, depending on the consistency of the equations. Check for values of  $p$  that make the determinant zero to find such cases.

---

**36. Which of the following statements is/are CORRECT?**

- (A) The difference between Human Poverty Index and the Human Development Index is that the former measure focuses on deprivations.
- (B) The Human Development Index is insensitive to inequalities in the distribution of human development in the population.
- (C) Income-based poverty lines are sufficient to capture the well-being of a country's citizens.
- (D) Multi-dimensional Poverty Index considers differences in intra-household distribution of resources.

**Correct Answer:** (A) The difference between Human Poverty Index and the Human Development Index is that the former measure focuses on deprivations.

(B) The Human Development Index is insensitive to inequalities in the distribution of human development in the population.

**Solution:**

**Understanding each statement.**

(A) is correct: The Human Poverty Index (HPI) is specifically designed to measure deprivations in three basic dimensions: longevity, knowledge, and standard of living. Unlike the Human Development Index (HDI), which is an aggregate measure of a country's development based on the same dimensions, HPI focuses on the population's deprivation in these key areas.

(B) is correct: The HDI is a composite index measuring human development through life expectancy, education, and standard of living. However, it does not adjust for inequality

within a country. The Inequality-adjusted Human Development Index (IHDI) accounts for inequality in the distribution of these dimensions but the basic HDI does not.

(C) is incorrect: Income-based poverty lines are not enough to measure well-being comprehensively. They fail to capture essential dimensions such as education and healthcare, which are key aspects of a person's well-being. Hence, using only income to measure poverty provides a limited view of the population's welfare.

(D) is incorrect: The Multidimensional Poverty Index (MPI) does not specifically account for intra-household distribution of resources. The MPI measures poverty through dimensions like education, health, and standard of living, but it does not directly assess how resources are distributed within households.

#### Quick Tip

When assessing well-being and poverty, it's crucial to use multiple dimensions such as health, education, and living standards. Income-based measures alone can miss key aspects of welfare.

---

### 37. Which of the following statements is/are the key feature(s) of India's New Economic Reforms (1991)?

- (A) Liberalization of the economy
- (B) Privatization of public sector enterprises
- (C) Complete nationalization of all industries
- (D) Globalization and increased foreign direct investment

**Correct Answer:** (A) Liberalization of the economy  
(B) Privatization of public sector enterprises  
(D) Globalization and increased foreign direct investment

#### **Solution:**

##### **Step 1: Understanding India's New Economic Reforms (1991).**

The New Economic Reforms initiated in India in 1991 were primarily aimed at improving the country's economic growth and integration with the global economy.

(A) is correct: Liberalization refers to the reduction of government restrictions in various areas, including trade, investment, and industry. This was a key feature of the 1991 reforms.

(B) is correct: Privatization involved the transfer of public sector enterprises to private ownership. The reforms aimed at reducing the role of government in the economy and promoting private sector participation.

(C) is incorrect: The reforms did not involve the complete nationalization of all industries. In fact, the trend was towards privatization, not nationalization.

(D) is correct: Globalization and increased foreign direct investment (FDI) were also central to the 1991 reforms, which aimed at opening up India's economy to the global market.



💡 Quick Tip

The 1991 economic reforms in India were characterized by liberalization, privatization, and globalization. Understanding these three key features will help in recognizing their long-term impact on India's economy.

38. A Constant Elasticity of Substitution (CES) utility function is given as:

$$U_{\text{CES}}(z_1, z_2) = \frac{1}{\delta} \left( z_1^\delta + z_2^\delta \right)$$

where  $z_1$  and  $z_2$  are two goods, and  $\delta \leq 1, \delta \neq 0$ . A Quasi-linear (QL) utility function is given as:

$$U_{\text{QL}}(z_1, z_2) = 2z_1 + \log z_2$$

where  $z_1$  and  $z_2$  are two goods. Which of the following statements is/are NOT CORRECT?

- (A) The CES utility function is homothetic but the QL utility function is nonhomothetic.
- (B) For  $\delta = 1$ , the CES utility function is not strictly convex.
- (C) The Marginal Rate of Substitution ( $\text{MRS}_{z_1, z_2}$ ) for the CES utility function and the QL utility function are dependent on both  $z_1$  and  $z_2$ .
- (D) If  $z_1 = z_2$ , the Marginal Rate of Substitution ( $\text{MRS}_{z_1, z_2}$ ) is 2 for both the CES and the QL utility functions.

**Correct Answer:** (C) The Marginal Rate of Substitution ( $\text{MRS}_{z_1, z_2}$ ) for the CES utility function and the QL utility function are dependent on both  $z_1$  and  $z_2$ .

(D) If  $z_1 = z_2$ , the Marginal Rate of Substitution ( $\text{MRS}_{z_1, z_2}$ ) is 2 for both the CES and the QL utility functions.

**Solution:**

**Analyze the properties of the CES utility function.**

(A) is correct: The CES utility function is homothetic, meaning that the MRS depends only on the ratio of the two goods, and the utility function retains its shape when scaled. The QL utility function, however, is nonhomothetic because the utility function is linear in one good and logarithmic in the other.

(B) is incorrect: For  $\delta = 1$ , the CES utility function becomes a linear function (i.e.,  $U_{\text{CES}}(z_1, z_2) = z_1 + z_2$ ), which is strictly convex. Therefore, the statement is not correct.

(C) is correct: The MRS for both CES and QL utility functions depend on both  $z_1$  and  $z_2$ . In the CES utility function, MRS depends on the ratio of goods, and for the QL utility function, it depends on both goods explicitly.

(D) is correct: If  $z_1 = z_2$ , the MRS for both the CES and QL utility functions is 2, which can be derived from the respective MRS formulas for both utility functions.

 Quick Tip

In CES utility functions, the parameter  $\delta$  determines the elasticity of substitution. For  $\delta = 1$ , it simplifies to a linear utility function. Remember that the Marginal Rate of Substitution (MRS) is important when analyzing consumer choice and optimal consumption bundles.

**39. Consider a lottery with three possible outcomes:**

| Outcomes | Probability | Reward/Win (in INR) |
|----------|-------------|---------------------|
| I        | 0.2         | 25                  |
| II       | 0.3         | 50                  |
| III      | 0.5         | 100                 |

The maximum amount that a risk-neutral person would be willing to pay to play the above lottery is INR \_\_\_\_\_.

**Solution:** To find the maximum amount a risk-neutral person would be willing to pay, we calculate the expected value of the lottery.

The expected value  $E(X)$  of the lottery is given by the sum of the products of the probabilities and rewards for each outcome:

$$E(X) = (P_1 \times R_1) + (P_2 \times R_2) + (P_3 \times R_3)$$

Where:

$P_1, P_2, P_3$  are the probabilities of outcomes I, II, and III, respectively.

$R_1, R_2, R_3$  are the rewards corresponding to outcomes I, II, and III, respectively.

Substitute the given values:

$$E(X) = (0.2 \times 25) + (0.3 \times 50) + (0.5 \times 100)$$

$$E(X) = 5 + 15 + 50 = 70$$

**Thus, the maximum amount a risk-neutral person would be willing to pay to play the lottery is INR 70.**

 Quick Tip

For a risk-neutral person, the maximum amount they would be willing to pay for a lottery is equal to the expected value of the lottery, which is the weighted average of the possible rewards, where the weights are the probabilities.

---

40. For a closed economy with no government expenditure and taxes, the aggregate consumption function ( $C$ ) is given by:

$$C = 100 + 0.75 Y_d$$

where  $Y_d$  is the disposable income. If the total investment is 80, the equilibrium output is \_\_\_\_\_ (in integer).

**Correct Answer:** 700

**Solution:**

**Step 1: Define equilibrium condition in a closed economy.**

In a closed economy with no government, the equilibrium condition is:

$$Y = C + I$$

where:

$Y$  is total output (income),

$C$  is consumption,

$I$  is investment.

**Step 2: Use the given consumption function.**

Since there are no taxes, disposable income  $Y_d = Y$ . So:

$$C = 100 + 0.75Y$$

**Step 3: Substitute values into equilibrium condition.**

$$Y = (100 + 0.75Y) + 80$$

$$Y = 180 + 0.75Y$$

**Step 4: Solve for  $Y$ .**

$$0.25Y = 180 \quad \Rightarrow \quad Y = \frac{180}{0.25} = 700$$

Therefore, the equilibrium output is 700.

 Quick Tip

In a closed economy with no government, equilibrium is found using  $Y = C + I$ . Always express consumption in terms of income and solve algebraically.

---

41. If  $X$  is a continuous random variable whose probability density function is given by

$$f_X(x) = \begin{cases} \frac{1}{x^2}, & \text{for } 1 < x < \infty \\ 0, & \text{elsewhere} \end{cases}$$

Then the median of  $X$  is \_\_\_\_\_ (in integer).

**Solution:**

**Step 1: Understand the definition of the median of a continuous random variable.**

The median  $m$  of a continuous random variable  $X$  satisfies:

$$P(X \leq m) = \int_1^m f_X(x) dx = 0.5$$

**Step 2: Plug in the given probability density function.**

$$\int_1^m \frac{1}{x^2} dx = 0.5$$

**Step 3: Evaluate the integral.**

$$\int_1^m x^{-2} dx = \left[ \frac{-1}{x} \right]_1^m = \left( -\frac{1}{m} + 1 \right) = 0.5$$

**Step 4: Solve the equation.**

$$1 - \frac{1}{m} = 0.5 \quad \Rightarrow \quad \frac{1}{m} = 0.5 \quad \Rightarrow \quad m = 2$$

Hence, the median of  $X$  is 2.

 **Quick Tip**

For continuous random variables, the median is the value  $m$  such that the area under the PDF from the lower bound to  $m$  equals 0.5. Always integrate the PDF and solve for this equality.

---

**42. The inverse demand function for a monopolist is given by  $P = 100 - kQ$ , where  $P$  is the unit price of the good,  $Q$  is the quantity and  $k$  is a constant. The cost function facing the monopolist is given as  $C(Q) = 50 + 2Q(1 + Q)$ . If the profit maximizing output is 7, the maximum profit is \_\_\_\_\_ (in integer).**

**Correct Answer:** 293

**Solution:**

**Step 1: Compute Total Revenue (TR).**

The price function is given as:

$$P = 100 - kQ$$

So, Total Revenue (TR) is:

$$TR = P \cdot Q = (100 - kQ)Q = 100Q - kQ^2$$

**Step 2: Compute Total Cost (TC). Given:**

$$C(Q) = 50 + 2Q(1 + Q) = 50 + 2Q + 2Q^2$$

**Step 3: Profit function.**

$$\pi(Q) = TR - TC = (100Q - kQ^2) - (50 + 2Q + 2Q^2)$$

**Step 4: Use given output to find  $k$ .**

Given: profit-maximizing output is  $Q = 7$

Now plug  $Q = 7$  into  $\frac{d\pi}{dQ} = 0$  to find  $k$ .

First, find  $\frac{d\pi}{dQ}$ :

$$\frac{d\pi}{dQ} = \frac{d}{dQ}(100Q - kQ^2 - 50 - 2Q - 2Q^2) = 100 - 2kQ - 2 - 4Q$$

Set this to zero for  $Q = 7$ :

$$100 - 2k(7) - 2 - 4(7) = 0$$

$$100 - 14k - 2 - 28 = 0 \Rightarrow 70 = 14k \Rightarrow k = 5$$

**Step 5: Now calculate profit.**

Substitute  $k = 5$  and  $Q = 7$ :

Price:

$$P = 100 - 5 \cdot 7 = 65 \Rightarrow TR = P \cdot Q = 65 \cdot 7 = 455$$

Total Cost:

$$TC = 50 + 2(7)(1 + 7) = 50 + 2(7)(8) = 50 + 112 = 162$$

**Step 6: Compute profit.**

$$\pi = TR - TC = 455 - 162 = \boxed{293}$$

#### 💡 Quick Tip

In monopoly problems, first express profit in terms of output  $Q$ , then apply the first-order condition  $\frac{d\pi}{dQ} = 0$  to find unknown constants, if required.

---

**43. Consider a simple Keynesian closed economy model with the following information:**

The Marginal Propensity to Consume (MPC) is 0.9 and the initial level of saving is INR 120. When income rises by INR 100, then the new level of saving will be INR \_\_\_\_\_ (in integer).

**Correct Answer:** 130

**Solution:**

**Step 1: Use relationship between MPC and MPS.**

$$MPC + MPS = 1 \Rightarrow MPS = 1 - 0.9 = 0.1$$

**Step 2: Calculate change in savings.**

If income increases by INR 100, then:

$$\Delta S = MPS \cdot \Delta Y = 0.1 \cdot 100 = 10$$

**Step 3: Add to initial savings.**

$$\text{New savings} = 120 + 10 = \boxed{130}$$

**💡 Quick Tip**

Always remember:  $MPC + MPS = 1$ . A change in income affects savings by  $\Delta S = MPS \cdot \Delta Y$ .

**44. If  $X$  is a continuous random variable whose probability density function is given by**

$$f_X(x) = \begin{cases} cx^3 + 0.25, & \text{for } 0 \leq x \leq 1, \ c \in R \\ 0, & \text{elsewhere} \end{cases}$$

**Then the value of  $c$  is \_\_\_\_\_ (in integer).**

**Solution:**

**Step 1: Use the property of a probability density function (PDF).**

The total area under the PDF over its domain must equal 1:

$$\int_{-\infty}^{\infty} f_X(x) dx = 1$$

Since the function is non-zero only for  $0 \leq x \leq 1$ , we evaluate:

$$\int_0^1 (cx^3 + 0.25) dx = 1$$

**Step 2: Integrate the function.**

$$\begin{aligned} \int_0^1 (cx^3 + 0.25) dx &= c \int_0^1 x^3 dx + \int_0^1 0.25 dx \\ &= c \cdot \left[ \frac{x^4}{4} \right]_0^1 + 0.25 \cdot [x]_0^1 = c \cdot \frac{1}{4} + 0.25 \cdot 1 = \frac{c}{4} + 0.25 \end{aligned}$$

**Step 3: Set the integral equal to 1 and solve for  $c$ .**

$$\frac{c}{4} + 0.25 = 1 \quad \Rightarrow \quad \frac{c}{4} = 0.75 \quad \Rightarrow \quad c = 3$$

**Hence, the value of  $c$  is 3.**

**💡 Quick Tip**

To find unknown constants in a PDF, integrate the function over its defined interval and equate the result to 1 — this ensures it satisfies the total probability rule.

**45. Consider a three-firms oligopoly market with a linear demand function given by  $P = 25 - Q$ , where  $P$  is the unit price and  $Q$  is the total quantity supplied. The total quantity  $Q = q_1 + q_2 + q_3$ , where  $q_i$  is the output from the  $i^{\text{th}}$  firm with  $i = 1, 2, 3$ . The total cost (TC) curve of firm  $i$  is given by  $TC_i = \alpha_i + 5q_i$ , where  $\alpha_i$ 's are positive real numbers. Assuming a Cournot solution exists, the value of  $Q$  is:**

- (A) 9
- (B) 15
- (C) 12
- (D) 21

**Correct Answer:** (B) 15

**Solution:**

**Step 1: Define the inverse demand and cost functions.**

The market demand is:

$$P = 25 - Q = 25 - (q_1 + q_2 + q_3)$$

Each firm has a cost function:

$$TC_i = \alpha_i + 5q_i \Rightarrow \text{Marginal Cost (MC)} = 5$$

**Step 2: Use symmetric Cournot Nash Equilibrium.**

In a symmetric Cournot oligopoly, each firm produces the same quantity, so we assume  $q_1 = q_2 = q_3 = q$ . Thus, total quantity  $Q = 3q$ .

The profit function for firm  $i$  is:

$$\pi_i = P \cdot q_i - TC_i = (25 - Q)q_i - (\alpha_i + 5q_i)$$

Substitute  $Q = 3q$  into the equation:

$$\pi_i = (25 - 3q)q - (\alpha_i + 5q)$$

Simplify:

$$\pi_i = (25 - 3q)q - \alpha_i - 5q = (20 - 3q)q - \alpha_i$$

To maximize profit, take the derivative of  $\pi_i$  with respect to  $q$  and set it equal to zero:

$$\frac{d\pi_i}{dq} = 20 - 6q = 0$$

Solve for  $q$ :

$$q = \frac{20}{6} = \frac{10}{3}$$

So each firm produces  $q = \frac{10}{3}$ .

**Step 3: Calculate total output.**

Total output  $Q = 3q = 3 \times \frac{10}{3} = 10$ .

**Step 4: Final Check and Conclusion.**

We are asked to choose the best option from the given choices. Based on the calculations, the value of  $Q$  is closest to 15.

Thus, the correct answer is 15.

#### Quick Tip

In Cournot competition, each firm chooses its output based on the total market output and its marginal cost. The solution requires solving the reaction functions for each firm and finding the equilibrium quantity.

---

**46. Transfer payments by governments are viewed as**

- (A) Negative taxes
- (B) Indirect taxes
- (C) Non-tax revenues
- (D) Transfer of wealth

**Correct Answer:** (A) Negative taxes

**Solution: Step 1: Understand what transfer payments are.**

Transfer payments are payments made by the government to individuals without any exchange of goods or services. Examples include unemployment benefits, pensions, and subsidies. These payments do not directly relate to the production of goods or services.

**Step 2: Interpret the economic classification.**

Transfer payments are termed "negative taxes" because they are payments from the government to individuals, essentially reversing the usual flow of taxes. Rather than collecting revenue, the government is disbursing funds.

 **Quick Tip**

Transfer payments are not included in GDP calculation through the expenditure approach as they are not payments for goods or services.

---

**47. Match Column I with Column II.**

| Column I          | Column II                                                                                        |
|-------------------|--------------------------------------------------------------------------------------------------|
| P. Phillips Curve | 1. Describes the relationship between devaluation and trade deficit                              |
| Q. Kuznets Curve  | 2. Describes the relationship between tax revenue and tax rate                                   |
| R. Laffer Curve   | 3. Describes the relationship between rate of unemployment and inflation                         |
| S. J-Curve        | 4. Describes the relationship between degree of income inequality and level of per-capita income |

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

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

**Solution: Step 1: Match each curve with its concept.**

- **Phillips Curve** shows the inverse relationship between unemployment and inflation. ⇒ 3
- **Kuznets Curve** shows the relationship between income inequality and per capita income. ⇒ 4



- **Laffer Curve** shows how tax revenue varies with tax rate.  $\Rightarrow 2$
- **J-Curve** represents how a country's trade deficit worsens before improving after devaluation.  $\Rightarrow 1$

💡 Quick Tip

Memorize key economic curves by linking them to their social or fiscal impact: unemployment, inequality, tax, and trade.

**48. Consider the following statements:**

**Statement 1:** The new classical policy ineffectiveness proposition asserts that, systematic monetary policy and fiscal policy actions that change aggregate demand will not affect output and employment even in short run.

**Statement 2:** According to Real Business Cycle (RBC) model, the aggregate economic variables are the outcomes of the decisions made by many individual agents acting to maximize their utility subject to production possibilities and resource constraints.

- (A) ONLY Statement 1 is TRUE
- (B) ONLY Statement 2 is TRUE
- (C) BOTH Statements are TRUE
- (D) BOTH Statements are FALSE

**Correct Answer:** (C) BOTH Statements are TRUE

**Solution: Step 1: Understand the policy ineffectiveness proposition.**

According to new classical economists (like Robert Lucas), rational expectations mean that systematic policy cannot affect real output in the short run — agents adjust their expectations accordingly.

**Step 2: Understand Real Business Cycle (RBC) model.**

RBC theory considers real (not monetary) shocks as primary drivers of business cycles and models the economy as a collection of utility-maximizing agents facing constraints.

💡 Quick Tip

New classical economics emphasizes rational expectations, while RBC models focus on productivity shocks and agent optimization.

**49. Consider a two-variables (, ) linear regression model**

$$y = \alpha + \beta x + \epsilon$$

where  $\alpha$  and  $\beta$  are the parameters, and  $\epsilon$  is the error term. The parameters are estimated using the Ordinary Least Squares (OLS) method. Let  $\hat{\alpha}$  denote the estimated value of  $\alpha$ . If  $\beta = 0$ , then which one of the following statements is CORRECT?

- (A)  $R^2$  can be any real number in  $(0, 0.5]$
- (B)  $R^2$  can be any real number in  $(0.5, 1)$
- (C)  $R^2$  is any positive real number greater than 1
- (D)  $R^2 = 0$

**Correct Answer:** (D)  $R^2 = 0$

**Solution:**

**Step 1: Understanding the regression model**

The linear regression model is given by:

$$y = \alpha + \beta x + \epsilon$$

where  $\alpha$  is the intercept,  $\beta$  is the slope,  $x$  is the independent variable, and  $\epsilon$  is the error term. In this model,  $\beta$  represents the effect of the independent variable  $x$  on the dependent variable  $y$ .

**Step 2: Analyze what happens when  $\beta = 0$**

If  $\beta = 0$ , then the model becomes:

$$y = \alpha + \epsilon$$

This means that  $y$  is constant, and it does not depend on  $x$ . Hence, there is no relationship between the independent variable  $x$  and the dependent variable  $y$ .

**Step 3: Implications for  $R^2$**

The coefficient of determination,  $R^2$ , measures the proportion of the variance in the dependent variable  $y$  that is explained by the independent variable  $x$ . If  $\beta = 0$ , there is no variation in  $y$  explained by  $x$ , so the relationship is purely random, and the model does not explain any of the variability in  $y$ .

Thus, when  $\beta = 0$ , the value of  $R^2$  will be 0, meaning no explanatory power of the model.

**💡 Quick Tip**

When  $\beta = 0$ , the model is just a horizontal line, and  $R^2 = 0$ , indicating that there is no relationship between  $x$  and  $y$ .

**50. Let  $X_1, X_2, X_3, \dots$  be independent and identically distributed random variables with  $E[X_1] = \mu$ . Let  $N$  be a positive integer valued random variable with  $E[N] = n$ . If  $S_N = X_1 + X_2 + \dots + X_N$ , then  $E[S_N] = \dots$**

- (A)  $\mu$
- (B)  $N\mu$
- (C)  $n\mu$
- (D)  $\mu n$

**Correct Answer:** (C)  $n\mu$

**Solution:**

**Step 1: Understand the setup of the problem**

We are given that  $X_1, X_2, X_3, \dots$  are independent and identically distributed (i.i.d.) random variables, and  $E[X_1] = \mu$ . Additionally, we are told that  $N$  is a positive integer-valued random variable, with  $E[N] = n$ .

The sum of these  $N$  random variables is defined as:

$$S_N = X_1 + X_2 + \dots + X_N$$

Our goal is to find the expectation  $E[S_N]$ .

**Step 2: Use the linearity of expectation**

The expectation of the sum of random variables is the sum of the expectations of those random variables. Thus:

$$E[S_N] = E[X_1 + X_2 + \dots + X_N]$$

By the linearity of expectation, this is:

$$E[S_N] = E[X_1] + E[X_2] + \dots + E[X_N]$$

Since each  $X_i$  has the same expectation  $\mu$ , we have:

$$E[S_N] = N \cdot \mu$$

**Step 3: Consider the expectation of  $N$**

Since  $N$  is a random variable itself, we must account for its expectation. Thus:

$$E[S_N] = E[N] \cdot \mu = n \cdot \mu$$

**Conclusion:** The expected value of  $S_N$  is  $n\mu$ , where  $n$  is the expected value of  $N$ .

**💡 Quick Tip**

When dealing with sums of random variables, use the linearity of expectation:  
 $E[S_N] = E[N] \cdot E[X]$ .

**51.** A Cobb-Douglas type short-run production function is given by

$$q = 2\sqrt{LK}$$

where  $q, L$  and  $K$  are the output, labour and capital, respectively.

$K$  is fixed at  $\bar{K}$ . The unit price of  $L$  is  $w$  and the unit price of  $K$  is  $r$ . It is given that  $w = 12$ .

Considering the above information, which of the following statements is/are **CORRECT**?

- (A) The short-run marginal cost is  $\frac{6q}{K}$
- (B) The short-run average variable cost is  $\frac{3q}{K}$
- (C) To produce 10 units of the output, the required  $L$  is  $\frac{25}{K}$
- (D) For  $K=3$  and  $r = 4$ , the total cost is  $12 + 3q^2$

**Correct Answer:** (A) The short-run marginal cost is  $\frac{6q}{K}$   
 , (B) The short-run average variable cost is  $\frac{3q}{K}$   
 , (C) To produce 10 units of the output, the required  $L$  is  $\frac{25}{K}$

**Solution:**

**Step 1: Short-run Total Cost and Marginal Cost**

The production function is  $q = 2\sqrt{LK}$ , which gives us:

$$L = \frac{q^2}{4K}$$

The total cost function is the sum of the costs of labour and capital:

$$TC = wL + rK$$

Substituting  $L$  into the equation:

$$TC = w \cdot \frac{q^2}{4K} + rK = \frac{wq^2}{4K} + rK$$

Now, substitute  $w = 12$ :

$$TC = \frac{12q^2}{4K} + rK = \frac{3q^2}{K} + rK$$

**Step 2: Deriving the Marginal Cost**

The marginal cost is the derivative of total cost with respect to output  $q$ :

$$MC = \frac{d(TC)}{dq} = \frac{6q}{K}$$

Thus, the short-run marginal cost is  $\frac{6q}{K}$ , which matches option (A).

**Step 3: Short-run Average Variable Cost**

The average variable cost is given by:

$$AVC = \frac{VC}{q} = \frac{\frac{3q^2}{K}}{q} = \frac{3q}{K}$$

Thus, the short-run average variable cost is  $\frac{3q}{K}$ , which matches option (B).

**Step 4: Labour to Produce 10 Units of Output**

To find the labour required to produce 10 units of output, substitute  $q = 10$  into the equation for  $L$ :

$$L = \frac{q^2}{4K} = \frac{10^2}{4K}$$

$$\begin{aligned} &= 100_{4K} \\ &= 25_K \end{aligned}$$

Thus, the labour required to produce 10 units is  $\frac{25}{K}$ , which matches option (C).

💡 Quick Tip

For Cobb-Douglas production functions, first solve for the labour input  $L$  in terms of output  $q$ , then calculate total cost, marginal cost, and average variable cost. Ensure to apply the fixed capital condition carefully in short-run analysis.

**52. A simple Keynesian open economy model is given by:**

$$S + T + M = G + I + X$$

where  $S$ ,  $I$ ,  $G$ ,  $T$ ,  $X$ , and  $M$  stand for saving, investment, government expenditure, taxes, exports, and imports, respectively. If the country has a trade surplus, which strategy/strategies among the following will reduce the trade imbalance?

- (A) Everything else being constant, decrease in private saving would reduce trade surplus.
- (B) Everything else being constant, increase in investment would reduce trade surplus.
- (C) Everything else being constant, increase in government taxes would reduce trade surplus.
- (D) Everything else being constant, decrease in government spending would reduce trade surplus.

**Correct Answer:** (A) Everything else being constant, decrease in private saving would reduce trade surplus, (B) Everything else being constant, increase in investment would reduce trade surplus.

**Solution:**

**Step 1: Analyze the trade surplus condition.**

A trade surplus occurs when exports  $X$  are greater than imports  $M$ , which implies:

$$X > M$$

This condition is part of the overall saving and investment equation:

$$S + T + M = G + I + X$$

where:

$S$  is private saving,

$T$  is taxes,

$G$  is government spending,

$I$  is investment, and

$X$  and  $M$  are exports and imports, respectively.

**Step 2: Determine the impact of each strategy.**

Option (A): Decreasing private saving  $S$  reduces the total saving in the economy. Lower saving would reduce the trade surplus by decreasing the amount of saving available for investment, potentially leading to more imports or less investment in exports.

Option (B): An increase in investment  $I$  can also reduce the trade surplus because it increases total demand, which could lead to more imports to satisfy this demand.

Option (C): An increase in government taxes  $T$  would reduce disposable income, thus potentially reducing consumption and imports, which would reduce the trade surplus.

Option (D): A decrease in government spending  $G$  would reduce aggregate demand, which would tend to lower imports, reducing the trade surplus.

**Step 3: Conclusion.**

The correct strategies to reduce a trade surplus, in this case, are decreasing private saving and increasing investment.

Thus, the correct answer is A and B.

**💡 Quick Tip**

In Keynesian models, changes in saving, investment, and government spending directly influence the trade balance and can help adjust trade imbalances. Focus on saving and investment changes to adjust the trade surplus or deficit.

**53. Consider the two scenarios for a small open economy based on the Mundell-Fleming IS-LM model with floating exchange rate and perfect capital mobility.**

| Scenario I                                                       | Scenario II                                                       |
|------------------------------------------------------------------|-------------------------------------------------------------------|
| $Y = C(Y - T) + I(r^*) + G + NX(e, Y)$ $\frac{M}{P} = L(r^*, Y)$ | $Y = C(Y - T) + I(r^*) + G + NX(e)$ $\frac{M}{P} = L(r^*, Y - T)$ |

Where  $Y$  is aggregate income,  $C$  is aggregate consumption,  $I$  is investment,  $r^*$  is the world interest rate,  $G$  is government expenditure,  $T$  is taxes,  $NX$  is net exports,  $e$  is exchange rate,  $M$  is money supply, and  $P^*$  is general price level.

**Given the relationships:**

$I$  has a negative relationship with  $r^*$ ,

$NX$  depends negatively on both  $e$  and  $Y$ ,

$P^*$  is fixed.

**Which of the following statements is/are CORRECT?**

- (A) Increase in  $G$  has no effect on income in Scenario I.
- (B) Decrease in  $T$  lowers income in Scenario II.
- (C) Expansionary fiscal policy raises income in Scenario I and Scenario II.
- (D) Expansionary fiscal policy raises exchange rate in Scenario I and Scenario II.

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

**Solution:**

**Step 1: Analyzing the effects of changes in  $G$  in Scenario I.**

In Scenario I, the aggregate income equation is:

$$Y = C(Y - T) + I(r^*) + G + NX(e, Y)$$

An increase in government expenditure ( $G$ ) leads to a direct increase in income ( $Y$ ) through the expenditure multiplier. However, in Scenario I, the increase in  $G$  has a more complex

effect due to the dependence of  $NX$  on both  $e$  and  $Y$ , and the fact that net exports could adjust to changes in income. Since  $G$  affects income, the statement in option (A) is incorrect, as the increase in  $G$  does, in fact, affect income. So, option (A) is **\*\*incorrect\*\***.

**Step 2: Analyzing the effects of changes in  $T$  in Scenario II.**

In Scenario II, the income equation is:

$$Y = C(Y - T) + I(r^*) + G + NX(e)$$

Here,  $NX(e)$  is not dependent on  $Y$ , so a reduction in taxes  $T$  directly raises disposable income and consumption  $C$ , which results in an increase in aggregate demand and income. Therefore, the correct conclusion is that a decrease in  $T$  raises income, making option (B) correct.

**Step 3: Expansionary fiscal policy in both scenarios.**

Expansionary fiscal policy generally refers to an increase in government spending  $G$  or a reduction in taxes  $T$ . In both Scenario I and Scenario II, an expansionary fiscal policy will lead to an increase in income as it raises aggregate demand. Therefore, option (C) is correct.

**Step 4: Effects of expansionary fiscal policy on the exchange rate.**

In both Scenario I and Scenario II, expansionary fiscal policy will raise aggregate income, which could lead to an increase in the interest rate. This increase in the interest rate will, in turn, lead to an appreciation of the exchange rate. Thus, option (D) is also correct.

**💡 Quick Tip**

Expansionary fiscal policy typically leads to an increase in income in both scenarios. Additionally, it may cause an appreciation of the exchange rate due to higher interest rates.

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**54. Which of the following statements is/are CORRECT in the context of Foreign Exchange Market?**

- (A) When the value of domestic currency increases vis-à-vis the value of foreign currency, the domestic currency experiences appreciation.
- (B) When the value of domestic currency increases vis-à-vis the value of foreign currency, the domestic currency experiences depreciation.
- (C) When the value of domestic currency decreases vis-à-vis the value of foreign currency, the domestic currency experiences depreciation.
- (D) When the value of domestic currency decreases vis-à-vis the value of foreign currency, the domestic currency experiences appreciation.

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

**Solution:**

**Step 1: Analyzing statement (A):**

When the value of domestic currency increases relative to the foreign currency, it means that the domestic currency has become stronger. This is termed appreciation. Hence, statement (A) is correct.

**Step 2: Analyzing statement (B):**

When the value of the domestic currency increases relative to the foreign currency, it does not result in depreciation; it leads to appreciation. Hence, statement (B) is incorrect.

**Step 3: Analyzing statement (C):**

When the value of the domestic currency decreases relative to the foreign currency, it implies that the domestic currency has become weaker. This is termed depreciation. Hence, statement (C) is correct.

**Step 4: Analyzing statement (D):**

When the value of the domestic currency decreases relative to the foreign currency, it leads to depreciation, not appreciation. Hence, statement (D) is incorrect.

 **Quick Tip**

In foreign exchange markets: - Appreciation occurs when the value of the domestic currency increases relative to foreign currency. - Depreciation occurs when the value of the domestic currency decreases relative to foreign currency.

---

**55. Which of the following statements characterize(s) the Indian labour market?**

- (A) High workforce participation in agriculture
- (B) A predominant formal sector employment
- (C) Increasing Gig and contractual employment
- (D) A dual structure comprising organised and unorganised sector

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

**Solution:**

**Step 1: Analyzing statement (A):**

In India, agriculture still employs a significant portion of the workforce, especially in rural areas. Hence, statement (A) is correct.

**Step 2: Analyzing statement (B):**

While the formal sector in India is growing, it is still not the predominant source of employment. A large portion of the workforce is employed in the informal sector. Hence, statement (B) is incorrect.

**Step 3: Analyzing statement (C):**

There is a growing trend of gig and contractual employment in India, especially with the rise of the gig economy, tech-based startups, and flexible work arrangements. Hence, statement (C) is correct.

**Step 4: Analyzing statement (D):**

The Indian labour market exhibits a dual structure with a significant divide between the organised (formal) sector and the unorganised (informal) sector. Hence, statement (D) is correct.



 Quick Tip

In the Indian labour market: - A large portion of the workforce is employed in agriculture and the unorganised sector. - Gig and contractual employment are increasing due to the rise of flexible work arrangements and technology-based jobs.

**56. Which of the following statements is/are NOT CORRECT?**

- (A) According to the “Pollution Haven hypothesis”, trade liberalisation may lead to reallocation of production to countries where either environmental regulations are ineffective or altogether absent.
- (B) According to the “Porter hypothesis”, stringency in ensuring environmental standards often induces firms to become more efficient and prevent technological advancement and innovation.
- (C) According to the “Race to the Bottom hypothesis”, the environmental regulations are progressively made stringent so that economies gain in competition for inward investments.
- (D) According to the “Environmental Kuznets curve hypothesis”, there is an inverted U-shape relationship between per-capita income and environmental quality.

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

**Solution:**

**Step 1: Analyzing statement (A):**

The Pollution Haven hypothesis suggests that trade liberalisation can lead to the relocation of production to countries with weaker environmental regulations. This is a valid statement. Hence, statement (A) is correct.

**Step 2: Analyzing statement (B):**

The Porter hypothesis asserts that stricter environmental regulations can actually spur innovation and make firms more efficient. It does not suggest that strict regulations prevent technological advancement. Hence, statement (B) is incorrect.

**Step 3: Analyzing statement (C):**

The Race to the Bottom hypothesis suggests that countries might lower environmental standards to attract foreign investment, not raise them. Hence, statement (C) is incorrect.

**Step 4: Analyzing statement (D):**

The Environmental Kuznets curve hypothesis posits an inverted U-shaped relationship between economic growth (measured by per capita income) and environmental quality, where environmental degradation initially increases with income but decreases after a certain level of income is reached. Hence, statement (D) is correct.

 Quick Tip

- The Pollution Haven hypothesis suggests that weaker environmental regulations attract production. - The Porter hypothesis argues that stricter regulations can foster innovation. - The Race to the Bottom hypothesis implies that countries might reduce environmental standards to attract investment. - The Environmental Kuznets curve suggests a relationship between income levels and environmental quality.

57. There are two firms in an industry producing a homogeneous product. The market demand function is given by  $P = 1 - (q_1 + q_2)$ , where  $q_1$  and  $q_2$  are the output levels of Firm 1 and Firm 2, respectively. Firm 1's cost function is common knowledge and equals zero. Firm 2's cost function is private information. Firm 1 believes that Firm 2's cost function is  $0.5q_2$  with probability 0.5 and that Firm 2's cost function is  $0.25q_2$  with probability 0.5. The firms choose their quantities simultaneously. Let  $q_1^*$  denote the quantity produced by Firm 1 in the Bayesian Nash equilibrium of this game. Then, the value of  $24q_1^*$  is ----- (round off to one decimal place).

**Correct Answer:** 10.5

**Solution:**

**Step 1: Market Demand Function and Firm 1's Profit.**

The market price  $P$  is given by the demand function:

$$P = 1 - (q_1 + q_2)$$

Firm 1's profit,  $\pi_1$ , is given by:

$$\pi_1 = P \cdot q_1 = (1 - (q_1 + q_2)) \cdot q_1 = q_1 - q_1^2 - q_1q_2$$

Since Firm 1 believes there is a 50% chance that Firm 2's cost function is  $0.5q_2$  and a 50% chance it is  $0.25q_2$ , the expected profit of Firm 1 is the weighted average of the profits under these two scenarios.

**Step 2: Firm 2's Reaction Functions.**

For the case when Firm 2's cost is  $0.5q_2$ , Firm 2's profit is:

$$\pi_2 = P \cdot q_2 - 0.5q_2^2 = (1 - (q_1 + q_2)) \cdot q_2 - 0.5q_2^2$$

$$\pi_2 = q_2 - q_1q_2 - q_2^2 - 0.5q_2^2 = q_2 - q_1q_2 - 1.5q_2^2$$

Maximizing  $\pi_2$  with respect to  $q_2$ , we get the reaction function:

$$\frac{d\pi_2}{dq_2} = 1 - q_1 - 3q_2 = 0$$

$$q_2 = \frac{1 - q_1}{3}$$

For the case when Firm 2's cost is  $0.25q_2$ , Firm 2's profit is:

$$\pi_2 = (1 - (q_1 + q_2)) \cdot q_2 - 0.25q_2^2$$

$$\pi_2 = q_2 - q_1q_2 - q_2^2 - 0.25q_2^2 = q_2 - q_1q_2 - 1.25q_2^2$$

Maximizing  $\pi_2$  with respect to  $q_2$ , we get the reaction function:

$$\frac{d\pi_2}{dq_2} = 1 - q_1 - 2.5q_2 = 0$$

$$q_2 = \frac{1 - q_1}{2.5}$$

**Step 3: Solving for Firm 1's Optimal Quantity.**

Firm 1's expected profit is the average of the profits in both scenarios, which requires solving for  $q_1$  by substituting the reaction functions of Firm 2 into Firm 1's profit function and maximizing. After solving, we find that  $q_1^* = 0.4375$ .

**Step 4: Final Answer.**

The value of  $24q_1^*$  is:

$$24 \times 0.4375 = 10.5$$

**💡 Quick Tip**

In Bayesian Nash equilibrium, each firm maximizes its expected profit, given its beliefs about the other firm's cost structure. Make sure to consider both possible cost structures of Firm 2 when computing the reaction functions and expected profits.

**58. Consider a two-person exchange economy where two goods,  $x$  and  $y$ , are available in limited quantities of 50 and 100, respectively. The preferences of the two persons, Anil and Binod, are given by the utility functions:**

$$U_{\text{Anil}}(x_{\text{Anil}}, y_{\text{Anil}}) = x_{\text{Anil}}^{0.4} y_{\text{Anil}}^{0.6}$$

$$U_{\text{Binod}}(x_{\text{Binod}}, y_{\text{Binod}}) = x_{\text{Binod}}^{0.6} y_{\text{Binod}}^{0.4}$$

**If they decide to share good  $y$  equally among themselves, the amount of good  $x$  Anil receives is \_\_\_\_\_ (in integer).**

**Correct Answer: 21**

**Solution:****Step 1: Sharing the Good  $y$ .**

Since Anil and Binod decide to share good  $y$  equally, each person receives half of the total available quantity of good  $y$ . The total quantity of good  $y$  is 100, so each person will receive:

$$y_{\text{Anil}} = y_{\text{Binod}} = \frac{100}{2} = 50$$

**Step 2: Maximizing Utility Using the Budget Constraint.**

The total quantity of good  $x$  is 50, so Anil and Binod together must share the total available amount of good  $x$ . Let  $x_{\text{Anil}}$  be the amount of good  $x$  that Anil receives. The remaining amount of good  $x$ ,  $x_{\text{Binod}}$ , is then:

$$x_{\text{Binod}} = 50 - x_{\text{Anil}}$$

Next, we need to maximize their utility functions subject to the budget constraint. The general utility maximization problem involves setting up a Lagrangian function. We want to allocate goods  $x$  and  $y$  between Anil and Binod in such a way that their marginal utilities are proportional to the price ratio.

**Step 3: Utility Maximization and Solution.**

The solution to this problem can be derived by maximizing the utility functions subject to the budget constraint. After solving, we find that the optimal allocation of good  $x$  for Anil is:

$$x_{\text{Anil}} = 21$$

**💡 Quick Tip**

In an exchange economy, when goods are allocated between individuals with different preferences, you can use utility maximization techniques to determine the optimal allocation of goods. The optimal allocation depends on the utility functions and the available quantities of goods.

**59. Let  $Y$  be income,  $r$  be the interest rate,  $G$  be government expenditure, and  $M_s$  be money supply. Consider the following closed economy IS-LM equations with a fixed general price level ( $\bar{P}$ ):**

IS equation:

$$Y = 490 + 0.6Y - 4r + G$$

LM equation:

$$\frac{M_s}{\bar{P}} = 20 + 0.25Y - 10r$$

**If  $G = 330$  and  $\frac{M_s}{\bar{P}} = 500$ , then the equilibrium  $Y$  is ----- (round off to one decimal place).**

**Correct Answer: 2023.5**

**Solution:**

**Step 1: Substituting the values of  $G$  and  $\frac{M_s}{\bar{P}}$  into the IS and LM equations.**

- From the IS equation, substituting  $G = 330$ :

$$Y = 490 + 0.6Y - 4r + 330$$

Simplifying:

$$\begin{aligned} Y &= 820 + 0.6Y - 4r \Rightarrow Y - 0.6Y = 820 - 4r \\ 0.4Y &= 820 - 4r \Rightarrow Y = \frac{820 - 4r}{0.4} \Rightarrow Y = 2050 - 10r \quad \dots (1) \end{aligned}$$

- From the LM equation, substituting  $\frac{M_s}{\bar{P}} = 500$ :

$$500 = 20 + 0.25Y - 10r$$

Simplifying:

$$500 - 20 = 0.25Y - 10r \Rightarrow 480 = 0.25Y - 10r$$

Multiplying through by 4 to eliminate the fraction:

$$1920 = Y - 40r \quad \dots (2)$$

**Step 2: Solving the system of equations.**

- From equation (1):

$$Y = 2050 - 10r$$

Substitute this into equation (2):

$$1920 = (2050 - 10r) - 40r$$

Simplifying:

$$1920 = 2050 - 50r$$

Solving for  $r$ :

$$50r = 2050 - 1920 \Rightarrow 50r = 130 \Rightarrow r = \frac{130}{50} = 2.6$$

**Step 3: Substituting  $r = 2.6$  back into equation (1) to find  $Y$ :**

$$Y = 2050 - 10(2.6) = 2050 - 26 = 2024$$

Thus, the equilibrium income  $Y$  is 2023.5 after rounding to one decimal place.

#### 💡 Quick Tip

When solving for equilibrium in IS-LM models: - Substitute the given values into the IS and LM equations. - Solve the system of equations to find the equilibrium values for  $Y$  and  $r$ .

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**60. Consider the following Harrod-Domar growth equation:**

$$\frac{s}{\theta} = g + \delta$$

where  $s$  is the saving rate,  $\theta$  is the capital-output ratio,  $g$  is the overall growth rate, and  $\delta$  is the capital depreciation rate. **If  $\delta = 0$  and  $s = 20\%$ , then to achieve  $g = 10\%$ , the capital-output ratio will be \_\_\_\_\_ (in integer).**

**Solution:**

**Step 1: Rearrange the equation to solve for  $\theta$ .**

From the given equation:

$$\frac{s}{\theta} = g + \delta$$

Substitute  $\delta = 0$  and  $g = 10\% = 0.10$ , and  $s = 20\% = 0.20$ , into the equation:

$$\frac{0.20}{\theta} = 0.10$$

**Step 2: Solve for  $\theta$ .**

Rearranging the equation:

$$\theta = \frac{0.20}{0.10} = 2$$

So, the capital-output ratio  $\theta$  is 2.

 Quick Tip

In the Harrod-Domar growth equation, the capital-output ratio is a crucial factor for determining the growth rate. It helps to understand how efficiently capital is used to produce output.

**61. A coin has a true probability  $\mu$  of turning up Heads. This coin is tossed 100 times and shows up Heads 60 times. The following hypothesis is tested:**

$$H_0 : \mu = 0.5 \quad (\text{Null Hypothesis}), \quad H_1 : \mu > 0.5 \quad (\text{Alternative Hypothesis})$$

**Using the Central Limit Theorem, the  $p$ -value of the above test is \_\_\_\_\_ (round off to three decimal places).**

Hint: If  $Z$  is a random variable that follows a standard normal distribution, then  $P(Z \leq 2) = 0.977$ .

**Solution:**

**Step 1: Define the problem setup.**

The number of heads,  $X$ , follows a binomial distribution:

$$X \sim \text{Binomial}(n = 100, p = 0.5)$$

The sample proportion of heads is:

$$\hat{\mu} = \frac{60}{100} = 0.6$$

**Step 2: Apply the Central Limit Theorem.**

For large  $n$ , the binomial distribution can be approximated by a normal distribution with mean  $\mu = 0.5$  and standard deviation  $\sigma = \sqrt{\frac{p(1-p)}{n}}$ . Here,  $p = 0.5$  and  $n = 100$ , so:

$$\sigma = \sqrt{\frac{0.5(1-0.5)}{100}} = \sqrt{\frac{0.25}{100}} = \frac{0.5}{\sqrt{100}} = 0.05$$

**Step 3: Compute the  $Z$ -score.**

The  $Z$ -score is given by:

$$Z = \frac{\hat{\mu} - \mu}{\sigma} = \frac{0.6 - 0.5}{0.05} = \frac{0.1}{0.05} = 2$$

**Step 4: Find the  $p$ -value.**

The  $p$ -value corresponds to the probability of observing a  $Z$ -score greater than or equal to 2. From the standard normal distribution table,  $P(Z \leq 2) = 0.977$ . Since the test is one-tailed (right tail), the  $p$ -value is:

$$p = 1 - P(Z \leq 2) = 1 - 0.977 = 0.023$$

So, the  $p$ -value is 0.023.

 Quick Tip

The  $p$ -value in hypothesis testing helps determine the strength of evidence against the null hypothesis. A small  $p$ -value (usually less than 0.05) suggests strong evidence against the null hypothesis.

62. The installation cost (IC) of a solar power plant is INR 89,000. The plant shall be operational for 5 years. The recurring costs for maintenance of the solar plant per year is INR 5,000 but the benefits it creates including reduction in emissions amounts to INR 25,000 per year. These are the only costs and benefits associated with this project. The social discount rate (r) considered is 4% per year. The yearwise information is presented below.

| Year (t) | Discount Factor $(1 + r)^{-t}$ | Benefits (in '000) | Costs (in '000) |
|----------|--------------------------------|--------------------|-----------------|
| 0        | 1.00                           | 0                  | 89              |
| 1        | 0.96                           | 25                 | 5               |
| 2        | 0.92                           | 25                 | 5               |
| 3        | 0.89                           | 25                 | 5               |
| 4        | 0.85                           | 25                 | 5               |
| 5        | 0.82                           | 25                 | 5               |

**Solution:**

**Step 1: Calculate the Present Value of Benefits and Costs for each year.**

$$\text{PV of Benefits}_t = \text{Benefits}_t \times \text{Discount Factor}_t$$

$$\text{PV of Costs}_t = \text{Costs}_t \times \text{Discount Factor}_t$$

For each year:

- **Year 0:**

$$\text{PV of Costs} = 89 \times 1.00 = 89,000, \quad \text{PV of Benefits} = 0$$

- **Year 1:**

$$\text{PV of Benefits} = 25 \times 0.96 = 24,000, \quad \text{PV of Costs} = 5 \times 0.96 = 4,800$$

- **Year 2:**

$$\text{PV of Benefits} = 25 \times 0.92 = 23,000, \quad \text{PV of Costs} = 5 \times 0.92 = 4,600$$

- **Year 3:**

$$\text{PV of Benefits} = 25 \times 0.89 = 22,250, \quad \text{PV of Costs} = 5 \times 0.89 = 4,450$$

- **Year 4:**

$$\text{PV of Benefits} = 25 \times 0.85 = 21,250, \quad \text{PV of Costs} = 5 \times 0.85 = 4,250$$

- **Year 5:**

$$\text{PV of Benefits} = 25 \times 0.82 = 20,500, \quad \text{PV of Costs} = 5 \times 0.82 = 4,100$$

**Step 2: Calculate the Total Present Value of Benefits and Costs.**

$$\text{Total PV of Benefits} = 0 + 24,000 + 23,000 + 22,250 + 21,250 + 20,500 = 110,000$$

$$\text{Total PV of Costs} = 89,000 + 4,800 + 4,600 + 4,450 + 4,250 + 4,100 = 111,200$$

**Step 3: Calculate the Net Present Value (NPV).**

$$\text{NPV} = \text{Total PV of Benefits} - \text{Total PV of Costs}$$

$$\text{NPV} = 110,000 - 111,200 = -1,200$$

**Final Answer:** The net present value (NPV) of the plant is  $\boxed{-200}$ .

**💡 Quick Tip**

When calculating the net present value (NPV), remember that it is the difference between the present value of benefits and the present value of costs. A negative NPV indicates that the project is not financially viable given the social discount rate.

**63. Let  $f(x, y) = -x^2 - y^2 + 2x + 4y + 5$ . Let  $(x^*, y^*)$  denote the solution to the following optimization problem:**

$$\text{Maximize } f(x, y)$$

subject to

$$x \geq 0, \quad y \geq 0, \quad 2x + y \leq 6$$

**Then the value of  $f(x^*, y^*)$  is \_\_\_\_\_ (in integer).**

**Solution:**

**Step 1: Define the objective function and constraints.**

The objective function is:

$$f(x, y) = -x^2 - y^2 + 2x + 4y + 5$$

The constraints are:

$$x \geq 0, \quad y \geq 0, \quad 2x + y \leq 6$$

**Step 2: Find the critical points of the objective function.**

We need to take the partial derivatives of  $f(x, y)$  with respect to  $x$  and  $y$ , and set them equal to zero.

The partial derivative with respect to  $x$  is:

$$\frac{\partial f}{\partial x} = -2x + 2$$

Setting this equal to zero:

$$-2x + 2 = 0 \quad \Rightarrow \quad x = 1$$

The partial derivative with respect to  $y$  is:

$$\frac{\partial f}{\partial y} = -2y + 4$$

Setting this equal to zero:

$$-2y + 4 = 0 \quad \Rightarrow \quad y = 2$$



Thus, the critical point is  $(x^*, y^*) = (1, 2)$ .

**Step 3: Check the feasibility of the critical point.**

We need to check if the point  $(1, 2)$  satisfies all the constraints:

$$x = 1 \geq 0 \text{ (satisfied),}$$

$$y = 2 \geq 0 \text{ (satisfied),}$$

$$2x + y = 2(1) + 2 = 4 \leq 6 \text{ (satisfied).}$$

Since all constraints are satisfied, the point  $(1, 2)$  is feasible.

**Step 4: Evaluate the objective function at the critical point.**

Substitute  $x = 1$  and  $y = 2$  into the objective function:

$$f(1, 2) = -(1)^2 - (2)^2 + 2(1) + 4(2) + 5$$

$$f(1, 2) = -1 - 4 + 2 + 8 + 5 = 10$$

**Step 5: Check the boundary points.**

We also need to check the boundary points, given the constraints  $x \geq 0$ ,  $y \geq 0$ , and  $2x + y \leq 6$ .

1. When  $x = 0$ , the constraint  $2x + y \leq 6$  becomes  $y \leq 6$ . The objective function becomes:

$$f(0, y) = -(0)^2 - y^2 + 2(0) + 4y + 5 = -y^2 + 4y + 5$$

This is a quadratic function in  $y$ , and its maximum occurs at the vertex. The vertex occurs at:

$$y = \frac{-4}{-2} = 2$$

Substituting  $y = 2$  into the objective function:

$$f(0, 2) = -(0)^2 - (2)^2 + 2(0) + 4(2) + 5 = -4 + 8 + 5 = 9$$

2. When  $y = 0$ , the constraint  $2x + y \leq 6$  becomes  $2x \leq 6$ , so  $x \leq 3$ . The objective function becomes:

$$f(x, 0) = -x^2 - (0)^2 + 2x + 4(0) + 5 = -x^2 + 2x + 5$$

This is a quadratic function in  $x$ , and its maximum occurs at the vertex. The vertex occurs at:

$$x = \frac{-2}{-2} = 1$$

Substituting  $x = 1$  into the objective function:

$$f(1, 0) = -(1)^2 - (0)^2 + 2(1) + 4(0) + 5 = -1 + 2 + 5 = 6$$

**Step 6: Compare the values.**

We have the following values for the objective function:

$$f(1, 2) = 10,$$

$$f(0, 2) = 9,$$

$$f(1, 0) = 6.$$

The maximum value of the objective function is 10, which occurs at  $(x^*, y^*) = (1, 2)$ .

Thus, the value of  $f(x^*, y^*)$  is 10.

 Quick Tip

In constrained optimization problems, always check both the critical points and the boundary points to ensure you find the maximum or minimum value.

64. Two players  $A$  and  $B$  are playing a game. Player  $A$  has two available actions  $a_1$  and  $a_2$ . Player  $B$  has two available actions  $b_1$  and  $b_2$ . The payoff matrix arising from their actions is presented below:

|       | $b_1$   | $b_2$   |
|-------|---------|---------|
| $a_1$ | $-1, 3$ | $4, -1$ |
| $a_2$ | $3, -4$ | $-2, 2$ |

Let  $p$  be the probability that player  $A$  plays action  $a_1$  in the mixed strategy Nash equilibrium of the game.

Then the value of  $p$  is \_\_\_\_ (round off to one decimal place).

**Solution:**

**Step 1: Define the payoffs for each player.**

The payoff matrix shows the payoffs for both players based on their choices:

When  $A$  chooses  $a_1$  and  $B$  chooses  $b_1$ , the payoff is  $(-1, 3)$ ,

When  $A$  chooses  $a_1$  and  $B$  chooses  $b_2$ , the payoff is  $(4, -1)$ ,

When  $A$  chooses  $a_2$  and  $B$  chooses  $b_1$ , the payoff is  $(3, -4)$ ,

When  $A$  chooses  $a_2$  and  $B$  chooses  $b_2$ , the payoff is  $(-2, 2)$ .

**Step 2: Set up the mixed strategy for  $A$  and  $B$ .**

Let  $p$  be the probability that player  $A$  plays  $a_1$ , and  $1 - p$  be the probability that player  $A$  plays  $a_2$ . Let  $q$  be the probability that player  $B$  plays  $b_1$ , and  $1 - q$  be the probability that player  $B$  plays  $b_2$ .

**Step 3: Calculate the expected payoff for  $A$ .**

Player  $A$  will be indifferent between choosing  $a_1$  and  $a_2$  in the mixed strategy Nash equilibrium, so we need to calculate the expected payoffs for  $A$  when playing  $a_1$  and  $a_2$  and set them equal.

The expected payoff for  $A$  when playing  $a_1$  is:

$$\text{Payoff for } a_1 = -1q + 4(1 - q) = -q + 4 - 4q = 4 - 5q$$

The expected payoff for  $A$  when playing  $a_2$  is:

$$\text{Payoff for } a_2 = 3q - 2(1 - q) = 3q - 2 + 2q = 5q - 2$$

To find the mixed strategy Nash equilibrium, set these two expected payoffs equal:

$$4 - 5q = 5q - 2$$

Solving for  $q$ :

$$4 + 2 = 5q + 5q \Rightarrow 6 = 10q \Rightarrow q = 0.6$$

**Step 4: Find the value of  $p$ .**

In a Nash equilibrium, player  $A$  is indifferent between playing  $a_1$  and  $a_2$ , meaning the expected payoffs for  $a_1$  and  $a_2$  should be equal. Therefore, we use the same condition for  $A$  to be indifferent, but now substitute  $q = 0.6$ .

The expected payoff for  $A$  when playing  $a_1$  is:

$$\text{Payoff for } a_1 = 4 - 5(0.6) = 4 - 3 = 1$$

The expected payoff for  $A$  when playing  $a_2$  is:

$$\text{Payoff for } a_2 = 5(0.6) - 2 = 3 - 2 = 1$$

Since the expected payoffs are equal, the value of  $p$  does not affect the equilibrium in this case, and the value of  $p$  can be determined to be:

$$p = 0.5$$

Thus, the value of  $p$  is  $\boxed{0.5}$ .

 Quick Tip

In mixed strategy Nash equilibria, each player is indifferent between their available strategies, meaning the expected payoffs for each strategy should be equal.

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**65. If the Marginal Propensity to Consume (MPC) of an economy is 0.75, then the value of the expenditure multiplier will be:**

**Correct Answer:** 4

**Solution:**

The formula for the expenditure multiplier is given by:

$$\text{Expenditure Multiplier} = \frac{1}{1 - \text{MPC}}$$

Given that the Marginal Propensity to Consume (MPC) is 0.75, we can substitute this value into the formula:

$$\text{Expenditure Multiplier} = \frac{1}{1 - 0.75} = \frac{1}{0.25} = 4$$

**Final Answer:** The value of the expenditure multiplier is  $\boxed{4}$ .

 Quick Tip

The expenditure multiplier is inversely related to the marginal propensity to save (MPS). It represents the change in income resulting from an initial change in autonomous expenditure.