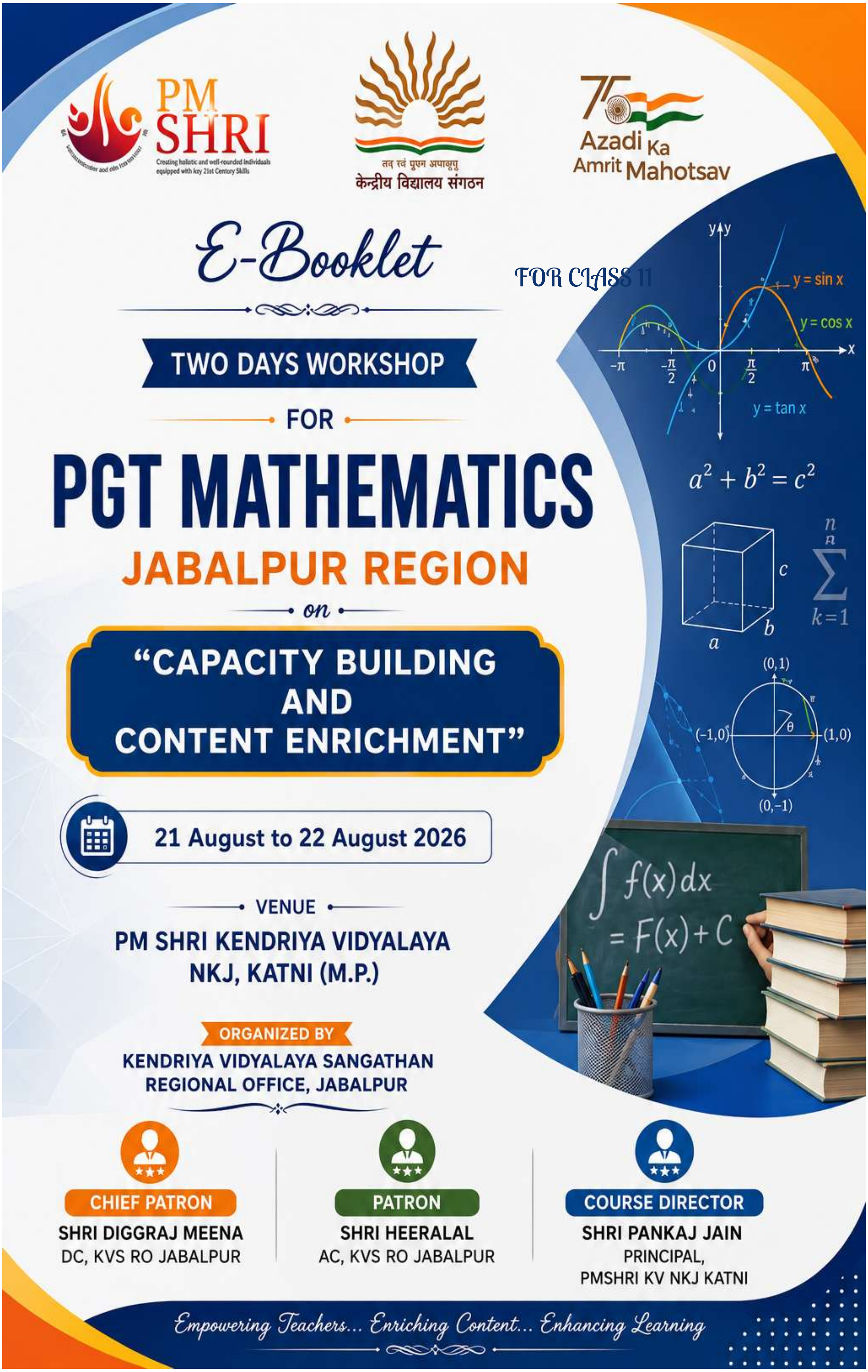
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E-Booklet
FOR CLASS 11
TWO DAYS WORKSHOP
FOR
PGT MATHEMATICS
JABALPUR REGION
on
"CAPACITY BUILDING AND CONTENT ENRICHMENT"
21 August to 22 August 2026
VENUE
PM SHRI KENDRIYA VIDYALAYA NKJ, KATNI (M.P.)
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y = sin x
y = cos x
y = tan x
$a^2 + b^2 = c^2$
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E-Booklet • Two Days Workshop for PGT Mathematics • Jabalpur Region

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Question bank on CBQ_Class 11

Class XI — Mathematics
CHAPTER -1 &2

Competency Based Questions with Solutions

(Relations and Functions)

Q1. A school runs 4 buses (B1, B2, B3, B4) that cover 5 residential colonies (C1, C2, C3, C4, C5). The set of colonies served by each bus is recorded as an ordered pair (Bus, Colony) whenever that bus stops at that colony. Suppose:
R = {(B1, C1), (B1, C2), (B2, C2), (B2, C3), (B3, C4), (B4, C5), (B4, C1)} is a relation from the set of buses A = {B1, B2, B3, B4} to the set of colonies B = {C1, C2, C3, C4, C5}.

Based on the above, answer the following:

(a) Write the domain and range of the relation R.
(b) Is R a function from A to B? Justify your answer with reason.
(c) A transport officer wants every bus to serve exactly one colony as its 'home base', with no two buses sharing the same home base. Which type of function (one-one, onto, or bijective) would best model this requirement? Explain.

Solution:

(a) Domain of R = {B1, B2, B3, B4}. Range of R = {C1, C2, C3, C4, C5} (the set of all second elements actually appearing in the ordered pairs).
(b) R is NOT a function from A to B, because B1 is related to two colonies (C1 and C2), and B2 is also related to two colonies (C2 and C3). For R to be a function, every element of A must have exactly one image in B.
(c) A one-one (injective) function would best model this requirement, since each bus must map to a distinct colony (no two buses share a home base), ensuring every element of the domain has a unique image.

Q2. A telecom company offers a data plan where the cost f(x) (in ₹) of a recharge depends on the number of GB of data x purchased, given by the function:

$$f(x) = 50 + 12x, \quad x \in \{1, 2, 3, 4, 5\}$$

where x denotes the number of GB (a natural number from 1 to 5).

Answer the following:

(a) Find the range of f. Represent f as a set of ordered pairs.
(b) A customer is charged ₹110. Use the function to find how many GB of data were purchased.
(c) State, with reason, whether f is a one-one function on its given domain.

Solution:

(a) f(1)=62, f(2)=74, f(3)=86, f(4)=98, f(5)=110. Range = {62, 74, 86, 98, 110}. f = {(1,62), (2,74), (3,86), (4,98), (5,110)}.

(b) $50 + 12x = 110 \Longrightarrow 12x = 60 \Longrightarrow x = 5$. So the customer purchased 5 GB of data.
(c) Yes, f is one-one, because all five outputs (62, 74, 86, 98, 110) are distinct — no two different values of x give the same f(x), since f is a strictly increasing linear function.

Competency Based Questions

(UNSOLVED)

Chapter: Sets

Q1. Mobile App Permissions:

A mobile app requests access to three device features while installing: Camera (Ca), Location (L), and Contacts (Co). A user may choose to grant any combination of these permissions (including none, or all three). Let U = {Ca, L, Co} be the set of all available permissions.

Answer the following:

(a) List all possible subsets a user could choose while granting permissions, i.e., write the power set P(U).
(b) How many total permission combinations (subsets) are possible? Verify using the formula for the number of subsets of a set with n elements.
(c) The app developer decides that 'granting no permission at all' should not be an allowed choice (the user must select at least one). Which subsets of P(U) would now represent valid choices, and how many are there?

Q2. Vehicle Speed Limits on a Highway:

On a certain highway stretch, the traffic authority has set the following rules for permissible speeds (in km/h) for cars
$A = \{x : x \in R, 40 \le x \le 100\}$ (legal range for cars)
$B = \{x : x \in R, 60 \le x \le 120\}$ (legal range for cars on the expressway extension)
A car travels on a route that covers both the highway stretch and the expressway extension.

Answer the following:

(a) Express A and B in interval notation, and find $A \cap B$. What does this intersection represent for the car travelling on the full route?
(b) Find $A \cup B$, and express it in set-builder form.
(c) A traffic inspector wants to identify speeds that are legal on the highway stretch but NOT on the expressway extension. Find $A - B$ and express it in interval notation.

Q3. Real-Life Context: Sibling Relations in a Housing Society

In a housing society, let A be the set of all children living there: A = {Aarav, Bhavna, Chirag, Divya, Esha}. Define a relation R on set A as:

R = {(x, y) : x and y have the same set of parents, x, y ∈ A}
Given that Aarav and Bhavna are siblings, and Chirag, Divya, and Esha are each an only child in their respective families.

Answer the following:

(a) List all the ordered pairs that belong to R.
(b) Verify whether R is reflexive, symmetric, and transitive. Hence state whether R is an equivalence relation.
(c) If R is an equivalence relation, identify the equivalence classes formed by R on set A, and explain what each equivalence class represents in real life.

****

Competency Based Questions with Solutions
(TRIGONOMETRIC FUNCTIONS)

QUE.1: Show that : $\sqrt{2+\sqrt{2+\sqrt{2+2\cos 8x}}} = 2\cos x$

Solution:

$$\text{L.H.S} = \sqrt{2+\sqrt{2+\sqrt{2+2\cos 8x}}}$$

$$= \sqrt{2+\sqrt{2+\sqrt{2(1+\cos 8x)}}}$$

$$= \sqrt{2+\sqrt{2+\sqrt{2\times 2\cos^2 4x}}}$$

$$= \sqrt{2+\sqrt{2+2\cos 4x}}$$

$$= \sqrt{2+\sqrt{2\times 2\cos^2 2x}}$$

$$= \sqrt{2+2\cos 2x}$$

$$= \sqrt{2(1+\cos 2x)}$$

$$= \sqrt{2\times 2\cos^2 x}$$

$= 2\cos x$

= R.H.S

QUE.2: In any cyclic quadrilateral ABCD, prove that: cos A + cos B + cos C + cos D=0

Solution:

$A+C=\pi$ (Opposite angles of cyclic quadrilateral are supplementary) .

$A = \pi -$.

$\cos A = \cos(\pi - C)$.

$\cos A = -\cos C$

$\cos A + \cos C = 0$-----------------------(1)

Similarly ,

$\cos B + \cos D = 0$----------------(2)

By adding equation (1) and (2), we get

CosA + cosB + cosC + cosD = 0

Competency Based Questions
(UNSOLVEDQUESTIONS)

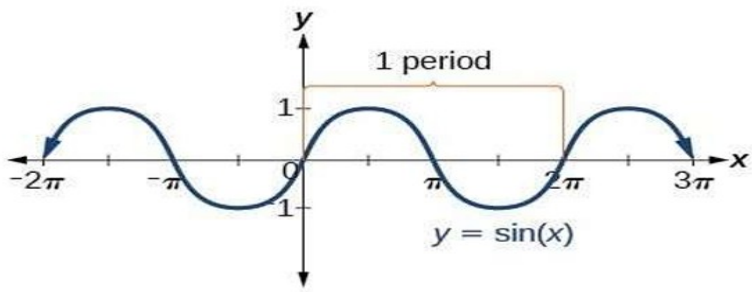
CHAPTER: TRIGONOMETRIC FUNCTIONS

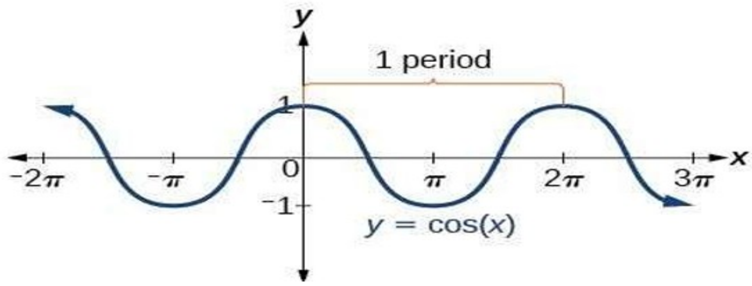
QUE.1: If α and β are acute angles such that $\tan\alpha = \frac{m}{m+1}$ and an $\beta = \frac{1}{2m+1}$, prove that

$$\alpha + \beta = \frac{\pi}{4}$$

QUE.2: If $\tan x = -\frac{4}{3}$, x lies in quadrant III ,Find the values of $\sin\frac{x}{2}$, $\cos\frac{x}{2}$ and $\tan\frac{x}{2}$.

QUE.3: Sine and cosine functions can be used to model many real life scenarios-radio waves, tides, musical tones, electrical signals. Following are shown the graphs of sine and cosine curves. Looking to these graphs, answer the following questions: -





(i) If we draw line y= $\frac{1}{2}$,at how many points the graph of sine and this line intersects between interval [-π,π].

(ii) At how many points the graph of cosine cuts on X axis between (0, 2π) ?

(iii) If both sine and cosine curve are drawn on the same graph and on the same interval [-2 π, 2π] , then at how many points their graph will intersects ?

OR

At how many points will be sin x = √2 in interval [-π, π]

Competency -Based Question

Linear Inequalities (Class XI)

Case Study 1: School Trip

A school is organising a trip. Each student has to pay ₹850 for transportation and ₹350 for food. The school wants to give a discount of ₹x per student, but the final amount collected from each student should be at least ₹1,000. The discount cannot be negative.

Questions

(i) Write the expression for the amount collected after giving the discount. (1 mark)

(ii) Form the inequality representing the condition. (1 mark)

(iii) Find the maximum discount that can be offered. (2 mark)

OR

(iv) If the discount is ₹150, will the condition be satisfied?

Solution:

- **(i)** 1200-x
- **(ii)** $1200 - x \geq 1000$
- **(iii)** $-x \geq -200$

  $x \leq 200$ **Maximum Discount: 200**
- **(iv)** **For x=150:**

  1200-150=1050≥1000

  Therefore, yes, the condition is satisfied.

Case Study 2: Production Limit — Changing the Constraint

A workshop produces notebooks. The cost of producing x notebooks is

C=35x+500.

The workshop has a budget of ₹4,000.

Later, the supplier increases the cost per notebook by ₹5.

Questions

(a) Before the price increase, find the maximum number of notebooks that can be produced. (1)

(b) After the increase, form the new inequality. (1)

(c) Find the new maximum number of notebooks. (2)

OR

(d) By how many notebooks does the production limit decrease?

Solution: Before increase:

(a) $35x+500 \leq 4000$

$x \leq 100$ **Maximum: 100**

(b) **After Increase:** $40x + 500 \leq 4000$

(c) $40x \leq 3500$

$x \leq 87.5$

Since x represents notebooks: $x_{max} = 87$

(d) Decrease: $100-87=13$

Case study 3: Mobile Data Plan

A student has a monthly mobile-data plan with a fixed charge of ₹199 and an additional charge of ₹12 for every GB used beyond the included limit.

The student's maximum monthly budget is ₹500.

Let x be the number of additional GB used.

(a) Form the inequality representing the situation. (1 Mark)

(b) Find the maximum number of additional GB that can be used. (1 Mark)

(c) If the student uses 24 additional GB, will the budget be exceeded? (2 Mark)

OR

(d) What is the largest integer value of x?

CBQ 4: Parameter-Based Inequality

For a real number k, consider

$(k-2)\,x>3k-6.$

Answer the following:

(a) Solve the inequality when $k>2$. **(1 Mark)**

(b) Solve the inequality when $k<2$. **(1 Mark)**

(c) What happens when $k=2$? **(2 Mark)**

OR

(d) Explain why the nature of the solution changes at $k=2$

CBQ 5

For a real number x, (5 Mark)

$$3<\frac{2X+1}{X+2}<5.$$

Important: Consider separately the cases $x+2>0$ and $x+2<0$.

Find the complete solution set.

Marking Scheme

Case study 3: Mobile Data Plan

Solution

$199+12x\leq 500$

$12x\leq 301$

$x\leq 25.0833\ldots$

Therefore,

$x\leq 25$.

For x=24:

$199+12(24)=487.$

Hence the budget is not exceeded.

CBQ 4: Parameter-Based Inequality

Solution

Factor the right-hand side:

$3k-6=3(k-2).$

Thus,

$(k-2)x>3(k-2).$

Case 1: $k>2$

Since $k-2>0$, division does not reverse the inequality:

$x>3$.

Case 2: $k<2$

Since $k-2<0$, division reverses the inequality:

$x<3$.

Case 3: $k=2$

The inequality becomes

$0x>0$,

i.e.

$0>0$,

Which is false.

Therefore, there is

No solution.

Explanation

The critical value $k=2$ changes the sign of the coefficient of x. When the coefficient changes from positive to negative, the inequality reverses direction.

CBQ 5

Since $x+2 \neq 0$,

Case 1: $x>-2$

$3(x+2) <2x+1<5(x+2)$

From the first:

$3x+6<2x+1$ $x<-5$,

Which contradicts $x>-2$.

Hence no solution in this case. **(2.5)**

Case 2: $x<-2$

Multiplication by $x+2$ reverses the inequalities:

$3(x+2)>2x+1>5(x+2)$.

First:

$3x+6>2x+1$; $x>-5$.

Second:

2x+1>5x+10; x<−3.

Therefore,

−5<x<−3. (2.5)

COMPETENCY BASED QUESTIONS

TOPIC: PERMUTATION AND COMBINATION

Q1 Which one of the following is true?

a) The number of ways to choose four questions out of 10 questions on an essay test is ${}^{10}_{4}P$

b) If r > 1, ${}^{n}_{r}P$, is less than ${}^{n}_{r}C$

c) ${}^{7}_{3}P = 3!\ {}^{7}_{3}C$

d) *The* number of ways to pick a winner and first runner up in a piano recital with 20 contestants is ${}^{20}_{2}C$

Solution: option (c)

Q2 You are standing on a street corner and decide to take the following random walk. You toss a Coin and if the result is heads, you walk one block North. If the result is tails, you walk one block South. Once you reach the new corner, you apply the same rules. If you toss the coin 10 times, in how many ways will you return to the original corner?

Solution: To return to the **original corner after 10 tosses**, you must take the same number of steps North as South.

Let the number of North steps be 5. Then the number of South steps is also 5.

So, we need to choose which **5 of the 10 tosses** are Heads (North):

$${}^{10}_{5}C = \frac{10!}{5!5!} = 252$$

Therefore, the number of ways is

252

Answer: 252 ways.

Q3 Meetal purchase new laptop and setup password using two different vowels, two different consonants and one numerical digit but she forget the password and she does not want to reset it she uses the concept of permutation and combination

(i) Find the total number of password she can have

(ii) If she remembers that she uses the numerical digit zero in her password and password word start with M, then how many password she can have now?

(iii) If she makes new password by arranging all the letters of the her name, then in how many passwords both E's will come together?

OR

If she makes new password by arranging all the letters of her name, then how many password she can have?

Q4 How many lawn tennis mixed doubles games can be arrange from 7 merit couples if no husband and wife pair is included in the same game

Q5 A man has 7 relatives, 4 of them are ladies and 3 gentleman ; his wife has also 7 relatives, 3 of them are ladies and 4 Gentlemen. In how many ways can they invite a dinner party of 3 ladies and 3 gentleman so that there are 3 of man's relative and three of the wife's relatives?

	CLASS – XI CHAPTER – 8 (SEQUENCE AND SERIES)
Q(1)	**The Building Construction** A contractor is building a staircase. The first step requires 20 bricks, the second step requires 23 bricks, the third requires 26 bricks, and so on, following an arithmetic progression. If the staircase has 15 steps: a) How many bricks are needed for the 15th step? b) What is the total number of bricks required to build the entire staircase?
	Solution: This is an A.P. where first term a = 20 , common difference d = 3 , terms n = 15 (a) $A_n = a + (n-1)d$, $A_{15} = 20 + (15-1)(3) = 20 + 14X3 = 20 + 42 = 62$ bricks (b) $S_n = n/2\{2a + (n-1)d\}$ $S_{15} = 15/2 [2(20) + (15-1)3] = 15/2 [40 + 42] = 15/2 [82] = 15 X 41 = 615$ bricks
Q(2).	**The Investment Growth** An investor deposits ₹10,000 in a scheme that gives a fixed annual return. The value of the investment grows in a Geometric Progression, increasing by 10% every year. Calculate the value of the investment at the end of the 4th year.
	Solution : This is a GP 10000 , 10000+10X10000/100=11000, --- --- where first term a = 10000 and common ratio r = 11000/10000=1.1 • The value at the end of the 1st year is $a_2 = ar$. Thus, at the end of the 4th year, we need the 5th term $a_n = ar^{n-1}$. $a^5 = ar^{(5-1)} = 10000 (1.1)^4 = 10000 X 1.4641 =$ ₹14,641.
	UNSOLVED QUESTIONS
Q(3)	A pendulum swings 40 cm in the first oscillation. In each subsequent oscillation, it swings 90% of the distance of the previous oscillation.

	a) Find the distance it covers in the 5th oscillation. b) What is the total distance the pendulum will cover if it oscillates infinitely?
Q(4)	An employee joins a company at a starting salary of ₹40,000 per month. The company offers an annual increment of ₹2,500 every year. a) What will be the monthly salary of the employee in their 10th year of service? b) What will be the total amount earned by the employee in the first 10 years (total salary received over 120 months)?
Q(5)	A town's population increases by a constant percentage every year (Geometric Progression). The population in 2020 was 50,000 and in 2021 it was 55,000. a) Find the common ratio (r) of the population growth. b) If this trend continues, what will the population be at the end of 2024? **SOLUTION OF THREE UNSOLVED QUESTIONS**
Q(3)	**SOLUTION OF QUESTION 3 :** **Given:** Distance covered in the first oscillation (a) = 40 cm Each subsequent oscillation covers 90% of the previous distance Common ratio (r) = 90/100 = 0.9 **(a) Distance covered in the 5th oscillation** The distances covered form a Geometric Progression (GP): $40, 40(0.9), 40(0.9)^2, 40(0.9)^3, 40(0.9)^4, ...$ The nth term of a GP is: $a_n = ar^{n-1}$ Therefore, $a_5 = 40(0.9)^4 = \quad = 40 \times 0.6561 \quad = 26.244$ cm Answer: The distance covered in the 5th oscillation is 26.244 cm. **(b) Total distance covered if the pendulum oscillates infinitely** The total distance is the sum of an infinite GP. For an infinite GP with $\|r\| < 1$: $S\infty = a / (1 - r)$ Here, a = 40 cm and r = 0.9. $S\infty = 40 / (1 - 0.9) \quad = \quad 40 / 0.1 \qquad = 400$ cm Answer: The total distance covered in infinitely many oscillations is 400 cm, or 4 m. 1. Distance covered in the 5th oscillation = 26.244 cm 2. Total distance covered infinitely = 400 cm = 4 m

Q(4)	**SOLUTION OF QUESTION (4)** **Given:** Starting monthly salary (a) = ₹40,000 Annual increment (d) = ₹2,500 Number of years = 10 **Since the salary increases by a fixed amount every year, the monthly salaries form an Arithmetic Progression (AP).** **(a) Monthly salary in the 10th year** The 10th year's monthly salary is the 10th term of the AP. Formula: $a_n = a + (n - 1)d$ $a_{10} = 40{,}000 + (10 - 1)(2{,}500)$ $= 40{,}000 + 9 \times 2{,}500$ $= 40{,}000 + 22{,}500$ = ₹62,500 Answer: The monthly salary in the 10th year is ₹62,500. **(b) Total amount earned in the first 10 years** Each year's monthly salary is received for 12 months. Therefore, first find the sum of the monthly salaries for the 10 years. Formula for sum of first n terms of an AP: $S_n = n/2\ [2a + (n - 1)d]$ $S_{10} = 10/2\ [2(40{,}000) + (10 - 1)(2{,}500)]$ $= 5\ [80{,}000 + 22{,}500]$ $= 5 \times 1{,}02{,}500$ = ₹5,12,500 This is the sum of the monthly salaries for one representative month across the 10 years. Since each salary is paid for 12 months: Total salary = 12 × ₹5,12,500 = ₹61,50,000 Answer: The total amount earned in the first 10 years is ₹61,50,000. 1. Monthly salary in the 10th year = ₹62,500 2. Total salary received in the first 10 years = ₹61,50,000
Q(5)	**SOLUTION OF QUESTION 5** **Given:** Population in 2020 = 50,000 Population in 2021 = 55,000 The population increases by a constant percentage every year, so it forms a Geometric Progression (GP). **(a) Find the common ratio (r)**

	For a GP, r = Second term / First term r = 55,000 / 50,000 = 1.1 Therefore, the common ratio is r = 1.1. This means the population increases by 10% every year. **(b) Population at the end of 2024** Taking 2020 as the first term: a = 50,000, r = 1.1 The population in 2024 is the 5th term of the GP because: 2020 → 1st term 2021 → 2nd term 2022 → 3rd term 2023 → 4th term 2024 → 5th term The nth term of a GP is: $a_n = ar^{n-1}$ Therefore, $a_5 = 50{,}000(1.1)^4$ $= 50{,}000 \times 1.4641$ $= 73{,}205$ Therefore, the population at the end of 2024 will be 73,205. 1. Common ratio, r = 1.1 2. Population at the end of 2024 = 73,205

STRAIGHT LINES

Case Study Based Questions (CBQ) — Class XI Mathematics (041)

Q.1 Sonam is designing a walking track in a rectangular park. She plots the park on a coordinate grid (in metres) with the main gate at the origin O(0, 0). Two benches are placed at points A(2, 3) and B(6, 11) along a straight path. A water fountain is located at point C(4, 7), and Sonam wants to know whether the fountain lies exactly on the path joining the two benches. She also wants to mark a straight jogging track passing through A with a slope equal to that of AB, and to find the angle this track makes with the ground level (x-axis).

(1) Find the slope of the line joining the benches A(2, 3) and B(6, 11) **(1 mark)**

(2) Find the equation of the straight path AB **(1 mark)**

(3) Does the fountain at C(4, 7) lie on the path AB? Give reason **(2 mark)**

Solutions & Marking Scheme

(1)

Slope $m = (y_2 - y_1)/(x_2 - x_1) = (11 - 3)/(6 - 2) = 8/4 = 2$ **(1 mark)**

(2) Using point-slope form: $y - y_1 = m(x - x_1)$ with A(2, 3), m = 2

$y - 3 = 2(x - 2) \implies y - 3 = 2x - 4 \implies 2x - y - 1 = 0$ **(1 mark)**

(3) Substitute C(4, 7) in $2x - y - 1 = 0, 2(4) - 7 - 1 = 8 - 7 - 1 = 0$ **(1 mark)**

Since LHS = 0, point C satisfies the equation of line AB. **(1 mark)**

Q.2 A ship's radar station is set up at point S(1, 2) on a coordinate map (units in km), and the coastline is represented by the straight line $3x + 4y - 16 = 0$. The captain wants to know the shortest (perpendicular) distance of the radar station from the coastline so that the ship maintains a safe distance. A lighthouse is located at L(5, 6), and the captain also wants to compare its distance from the coastline, and to check whether the radar station and the lighthouse lie on the same side of the coastline.

(1) Find the perpendicular distance of the radar station S(1, 2) from the coastline $3x + 4y - 16 = 0$ **(1 mark)**

(2) Find The perpendicular distance of the lighthouse L(5, 6) from the coastline **(1 mark)**

(3) Do the radar station S and the lighthouse L lie on the same side of the coastline? **(2 mark)**

Solutions & Marking Scheme

(1) Formula: $d = |Ax_1 + By_1 + C| / \sqrt{(A^2 + B^2)}$

$d = |3(1) + 4(2) - 16| / \sqrt{(3^2 + 4^2)} = |3 + 8 - 16| / 5 = |-5| / 5 = 1$ **(1 mark)**

(2)$d = |3(5) + 4(6) - 16| / \sqrt{(3^2 + 4^2)} = |15 + 24 - 16| / 5 = |23| / 5 = 4.6$ **(1 mark)**

(3) For S(1,2): $3(1) + 4(2) - 16 = -5$ (negative)

For L(5,6): $3(5) + 4(6) - 16 = 23$ (positive) **(1 mark)**

No,because the signs are opposite, S and L lie on opposite sides of the coastline. **(1 mark)**

Q.3 Two roads in a city are represented on a map by the equations L_1: $x - y + 2 = 0$ and L_2: $2x + y - 5 = 0$. Traffic engineers want to install a signal at the point where the two roads cross, and they also need to know the angle at which the two roads intersect to design the signal timings correctly. They further want to construct a service road through the crossing point that is parallel to a third road L_3: $3x - y + 4 = 0$.

(1) Find the point of intersection of roads L_1 and L_2 (where the signal will be installed) **(1 mark)**

(2) Find the acute angle θ between roads L_1 and L_2 **(1 mark)**

(3) The equation of the service road through the intersection point, parallel to L_3: $3x - y + 4 = 0$ **(2 mark)**

Solutions & Marking Scheme

(1) Solve $x - y + 2 = 0$ and $2x + y - 5 = 0$ simultaneously.

Adding: $3x - 3 = 0 \implies x = 1$; then $y = x + 2 = 3$; Point of intersection(1,3) **(1 mark)**

(2)$\tan\theta = |(m_2 - m_1)/(1 + m_1m_2)| = |(-2 - 1)/(1 + (1)(-2))| = |-3 / -1| = 3$ **(1 mark)**

(2)Required line has slope 3 (parallel to L_3) and passes through the intersection point (1, 3).*(1 mark)*

$y - 3 = 3(x - 1) \implies y - 3 = 3x - 3 \implies 3x - y = 0$ **(1 mark)**

Q.4 A ladder is placed against a vertical wall such that it touches the wall at a point on the y-axis and the ground (x-axis) at a distance from the origin. The foot of the ladder is at A(6, 0) on the ground and the top of the ladder touches the wall at B(0, 8). The ladder forms a straight line on the coordinate plane, and a painter wants the equation of the line along the ladder, its distance from the origin, and to check whether a paint can placed at point P(3, 4) lies on the ladder.

(1) Find the equation of the ladder in general form . **(1 mark)**

(2) What is the length of the ladder **(1 mark)**

(3) Does the paint can at P(3, 4) lie on the ladder? **(2 mark)**

Solutions & Marking Scheme

(1) $x/6 + y/8 = 1 \implies$ multiply by 24: $4x + 3y = 24 \implies 4x + 3y - 24 = 0$ **(1 mark)**

(2) $AB = \sqrt{[(6-0)^2 + (0-8)^2]} = \sqrt{(36 + 64)} = \sqrt{100} = 10$ **(1 mark)**

(3) Substitute P(3, 4) into $4x + 3y - 24 = 0;4(3) + 3(4) - 24 = 12 + 12 - 24 = 0$ **(1 mark)**

LHS = 0, P lies exactly on the ladder. **(1 mark)**

Q.5 Two parallel railway tracks are laid out on a map and represented by the lines L_1: $3x + 4y - 12 = 0$ and L_2: $3x + 4y + 8 = 0$. The railway authority wants to find the perpendicular distance between the two tracks to ensure they meet safety width regulations. They also want to find a point on the x-axis equidistant from both lines, and to verify whether a proposed third line $6x + 8y - 5 = 0$ is parallel to the existing tracks.

(1) Find perpendicular distance between the two parallel tracks L_1 and L_2 **(1 mark)**

(2) Is the proposed line $6x + 8y - 5 = 0$ parallel to L_1 and L_2? **(1 mark)**

(3) Find the coordinate of point on the x-axis equidistant from L_1 and L_2 . **(2 mark)**

Solutions & Marking Scheme

(1)Distance between parallel lines $Ax + By + C_1 = 0$ and $Ax + By + C_2 = 0$ is $|C_1 - C_2| / \sqrt{(A^2 + B^2)}$

$d = |-12 - 8| / \sqrt{(3^2 + 4^2)} = |-20| / 5 = 4$ **(1 mark)**

(2)Yes, since $6/3=8/4$ **(1 mark)**

(3) Let point be (x, 0). Distance from L_1 = Distance from L_2

$|3x - 12| / 5 = |3x + 8| / 5 \implies |3x - 12| = |3x + 8|$ **(1 mark)**

$3x - 12 = -(3x + 8) \implies 3x - 12 = -3x - 8 \implies 6x = 4 \implies x = 2/3$

Coordinate of point is (2/3,0) **(1 mark)**

Competency-Based Questions – Conic Sections (Class XI)

Solved Question 1 (Application Based)

A satellite dish is in the shape of a parabola. The dish is 8 m wide and 2 m deep. Find the equation of the parabola if its vertex is at the origin.

Solution:
For parabola $x^2=4ay$.
Point $(\pm4,2)$ lies on it.
$16=8a \Rightarrow a=2$.
Hence, $x^2=8y$.
Competency: Mathematical modelling and real-life application.

Solved Question 2 (Analytical Thinking)
The sum of distances of any point on an ellipse from two fixed points is 10 units. If the distance between the foci is 8 units, find the equation.

Solution:
$2a=10\Rightarrow a=5$, $2c=8\Rightarrow c=4$.
$b^2=a^2-c^2=25-16=9$.
Equation: $x^2/25 + y^2/9 =1$.
Competency: Conceptual understanding and analytical reasoning.

Unsolved Question 1
A whispering gallery is designed in the shape of an ellipse. The distance between its foci is 12 m and the major axis is 20 m. Find (i) a, b, c (ii) the equation of the ellipse.

Unsolved Question 2
The cross-section of a bridge arch is a parabola. The arch is 16 m wide and 4 m high. Taking the vertex as the origin, determine the equation of the parabola.

Unsolved Question 3
A point P lies on the hyperbola $x^2/16 - y^2/9 =1$. If the x-coordinate of P is 5, find the corresponding y-coordinate(s) and verify the points satisfy the equation.

Competency-Based Questions – Conic Sections (Class XI)
Solutions of Unsolved Questions

Unsolved Question 1 – Solution
A whispering gallery is designed in the shape of an ellipse. The distance between its foci is 12 m and the major axis is 20 m. Find (i) a, b, c (ii) the equation of the ellipse.
Solution:
For an ellipse, 2a = major axis = 20 $\Rightarrow$ a = 10 m.
Distance between the foci = 2c = 12 $\Rightarrow$ c = 6 m.
Using $b^2 = a^2 - c^2$:
$b^2 = 10^2 - 6^2 = 100 - 36 = 64 \Rightarrow b = 8$ m.
Therefore, a = 10 m, b = 8 m, c = 6 m.
Taking the major axis along the x-axis, the equation is:
$x^2/100 + y^2/64 = 1$.
Unsolved Question 2 – Solution
The cross-section of a bridge arch is a parabola. The arch is 16 m wide and 4 m high. Taking the vertex as the origin, determine the equation of the parabola.
Solution:
Since the vertex is at the origin and the arch opens downward, take:
$x^2 = -4ay$.

The arch is 16 m wide, so the endpoints are at $x = \pm 8$.
Its height is 4 m, so the endpoints are at $y = -4$.
Thus, the point $(8, -4)$ lies on the parabola.
$64 = -4a(-4) = 16a \Rightarrow a = 4$.
Hence, the equation of the parabola is:
$x^2 = -16y$.
Unsolved Question 3 – Solution
A point P lies on the hyperbola $x^2/16 - y^2/9 = 1$. If the x-coordinate of P is 5, find the corresponding y-coordinate(s) and verify the points satisfy the equation.
Solution:
Given $x = 5$.
Substitute $x = 5$ in $x^2/16 - y^2/9 = 1$:
$25/16 - y^2/9 = 1$.
$y^2/9 = 25/16 - 1 = 9/16$.
Therefore, $y^2 = 81/16$, so $y = \pm 9/4$.
Hence, the corresponding points are:
$P_1 = (5, 9/4)$ and $P_2 = (5, -9/4)$.
Verification:
For $(5, 9/4)$: $25/16 - (81/16)/9 = 25/16 - 9/16 = 1$.
For $(5, -9/4)$: $25/16 - (81/16)/9 = 25/16 - 9/16 = 1$.
Thus, both points satisfy the given hyperbola.

▪▪

Chapter — STATISTICS

CASE-BASED QUESTIONS (CBQ)

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CASE-BASED QUESTION 1: QUALITY CONTROL IN MANUFACTURING

Case Scenario: A quality control manager at a manufacturing plant measures the weights (in grams) of 5 sample steel bearings produced by Machine A:
10, 12, 15, 18, 20
Questions:
1. Calculate the mean weight ($\bar{x}$) of the sample bearings. (1 Mark)
2. Write the general formula for the Mean Deviation about Mean, MD($\bar{x}$), for ungrouped data. (1
Mark)
3. Calculate the Mean Deviation about Mean for this sample. (2 Marks)

Solution & Marking Scheme:
1. Mean ($\bar{x}$) = (10 + 12 + 15 + 18 + 20) / 5 = 75 / 5 = 15 grams
• Marking Scheme: Correct substitution (0.5 Mark) + Correct answer with unit (0.5 Mark)
2. Formula: $MD(\bar{x}) = \Sigma|x_i - \bar{x}| / n$
• Marking Scheme: Correct formula statement (1 Mark)
3. Absolute deviations $|x_i - 15|$: |10-15|=5, |12-15|=3, |15-15|=0, |18-15|=3, |20-15|=5
Sum of deviations = 5 + 3 + 0 + 3 + 5 = 16
MD($\bar{x}$) = 16 / 5 = 3.2 grams
• Marking Scheme: Correct absolute deviations sum (1 Mark) + Final answer (1 Mark)

CASE-BASED QUESTION 2: SPORTS PERFORMANCE CONSISTENCY

Case Scenario: A sports analyst records the number of runs scored by a cricketer in 5 consecutive

ODI matches:
30, 40, 50, 60, 70
Questions:
1. Find the mean score ($\bar{x}$) of the cricketer. (1 Mark)
2. State the formula for Variance (σ^2) for ungrouped data. (1 Mark)
3. Compute the Variance (σ^2) and Standard Deviation (σ) for the cricketer's scores. (2 Marks)
Solution & Marking Scheme:
1. Mean ($\bar{x}$) = (30 + 40 + 50 + 60 + 70) / 5 = 250 / 5 = 50 runs• Marking Scheme: Correct answer (1 Mark)
2. Formula: $\sigma^2 = \Sigma(x_i - \bar{x})^2 / n$
• Marking Scheme: Correct formula statement (1 Mark)
3. Squared deviations $(x_i - 50)^2$: 400, 100, 0, 100, 400
Sum = 1000
Variance (σ^2) = 1000 / 5 = 200
Standard Deviation (σ) = $\sqrt{200} \approx 14.14$ runs
• Marking Scheme: Correct Variance (1 Mark) + Correct Standard Deviation (1 Mark)

CASE-BASED QUESTION 3: CLINIC PATIENT WAIT TIMES

Case Scenario: The daily wait times (in minutes) for 7 patients at an outpatient clinic were recorded as follows:
15, 22, 18, 30, 25, 12, 20
Questions:
1. Arrange data in ascending order and find the median wait time (M). (1 Mark)
2. Define the formula for Mean Deviation about Median, MD(M). (1 Mark)
3. Calculate the Mean Deviation about Median for these wait times. (2 Marks)
Solution & Marking Scheme:
1. Ascending Order: 12, 15, 18, 20, 22, 25, 30
Since n = 7 (odd), Median position = (7+1)/2 = 4th term $\Longrightarrow$Median (M) = 20 minutes
• Marking Scheme: Ascending order (0.5 Mark) + Median value (0.5 Mark)
2. Formula: $MD(M) = \Sigma|x_i - M| / n$
• Marking Scheme: Correct formula statement (1 Mark)
3. Absolute deviations $|x_i - 20|$: 8, 5, 2, 0, 2, 5, 10
Sum of deviations = 32
MD(M) = 32 / 7 ≈ 4.57 minutes
• Marking Scheme: Deviation sum (1 Mark) + Final answer (1 Mark)

CASE-BASED QUESTION 4: CLASS TEST ASSESSMENT

Case Scenario: In a mathematics class test, the marks obtained (x_i) and number of students (f_i) are
as follows:
• Marks (x_i): 5, 10, 15, 20
• No. of Students (f_i): 2, 4, 3, 1**Questions:**
1. Calculate the mean mark ($\bar{x}$) for the class test. (1 Mark)
2. Find total students ($N = \Sigma f_i$) and state the formula for Standard Deviation (σ). (1 Mark)
3. Calculate the Standard Deviation (σ) of the marks. (2 Marks)
Solution & Marking Scheme:
1. $\Sigma f_i x_i = (2\times5) + (4\times10) + (3\times15) + (1\times20) = 115$
N = 2 + 4 + 3 + 1 = 10
Mean ($\bar{x}$) = 115 / 10 = 11.5 marks
• Marking Scheme: Correct mean calculation (1 Mark)

2. N = 10; Formula: $\sigma = \sqrt{[\Sigma f_i(x_i - \bar{x})^2 / N]}$
• Marking Scheme: Value of N (0.5 Mark) + Correct formula (0.5 Mark)
3. Calculations for $f_i(x_i - 11.5)^2$:
- For x=5: $2 \times (-6.5)^2 = 84.50$
- For x=10: $4 \times (-1.5)^2 = 9.00$
- For x=15: $3 \times (3.5)^2 = 36.75$
- For x=20: $1 \times (8.5)^2 = 72.25$
Sum $\Sigma f_i(x_i - \bar{x})^2 = 202.50$
Variance (σ^2) = 202.50 / 10 = 20.25
Standard Deviation (σ) = $\sqrt{20.25}$ = 4.5 marks
• Marking Scheme: Sum of squared deviations (1 Mark) + Final answer (1 Mark)

CASE-BASED QUESTION 5: RETAIL STORE CUSTOMER EXPENDITURE

Case Scenario: Daily spending (in hundreds of rupees) of 20 customers in a retail store:
• Class Interval (Spending): 0-10, 10-20, 20-30, 30-40
• No. of Customers (f_i): 4, 6, 8, 2
Questions:
1. Determine the class mid-points (x_i) for all class intervals. (1 Mark)
2. Calculate the mean expenditure ($\bar{x}$) of the customers. (1 Mark)
3. Calculate the Mean Deviation about Mean [MD($\bar{x}$)] for this distribution. (2 Marks)
Solution & Marking Scheme:
1. Mid-points (x_i): 0-10 $\Longrightarrow$5 | 10-20 $\Longrightarrow$15 | 20-30 $\Longrightarrow$25 | 30-40 $\Longrightarrow$35
• Marking Scheme: Mid-points determination (1 Mark)
2. $\Sigma f_i x_i = (4\times5) + (6\times15) + (8\times25) + (2\times35) = 380$
N = 20
Mean ($\bar{x}$) = 380 / 20 = 19 (hundreds of rupees)
• Marking Scheme: Correct mean calculation (1 Mark)3. Calculations for $f_i|x_i - 19|$:
- 0-10: $4 \times |5-19| = 56$
- 10-20: $6 \times |15-19| = 24$
- 20-30: $8 \times |25-19| = 48$
- 30-40: $2 \times |35-19| = 32$
Sum $\Sigma f_i|x_i - \bar{x}| = 160$
MD($\bar{x}$) = 160 / 20 = 8 (hundreds of rupees)
• Marking Scheme: Sum calculation (1 Mark) + Final Mean Deviation (1 Mark)

PROBABILITY

CBQ

SL	QUESTION
1	**Read the following text carefully and answer the questions that follow:** In a hostel 60% of the students read Hindi newspapers, 40% read English newspapersand 20% read both Hindi and English newspapers.    1. A student is selected at random. She reads Hindi or English newspaper? (1)

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2. A student is selected at random. Did she readneither Hindi nor English newspapers? (1)
3. A student is selected at random. She reads Hindi but not English Newspaper? (2)
OR
A student is selected at random. She reads English but not Hindi Newspaper? (2)

SOLUTION:
H: Student read Hindi newspaper
E: Student read English newspaper
$P(H) = \frac{60}{100}$, $P(E) = \frac{40}{100}$, $P(H \cap E) = \frac{20}{100}$
$\Rightarrow P(E \cup H) = P(E) + P(H) - P(E \cap H)$
$\Rightarrow P(E \cup H) = \frac{40}{100} + \frac{60}{100} - \frac{20}{100} = \frac{80}{100}$
⇒ 80% of students read English or Hindi newspaper
ii. H: Student read Hindi newspaper
E: Student read English newspaper
$P(H) = \frac{60}{100}$, $P(E) = \frac{40}{100}$, $P(H \cap E) = \frac{20}{100}$
$P(E \cup H)' = 1 - \frac{4}{5} = \frac{1}{5} = 20\%$
⇒ 20% of students read neither English nor Hindi newspapers
iii. H: Student read Hindi newspaper
E: Student read English newspaper
$P(H) = \frac{60}{100}$, $P(E) = \frac{40}{100}$, $P(H \cap E) = \frac{20}{100}$
$P(E' \cap H) = P(H) - P(E \cap H)$
$\Rightarrow P(E' \cap H) = \frac{60}{100} - \frac{20}{100} = \frac{40}{100} = 40\%$
⇒ 40% of students read only Hindi newspapers.
OR
H: Student read Hindi newspaper E: Student read English newspaper
$P(H) = \frac{60}{100}$, $P(E) = \frac{40}{100}$, $P(H \cap E) = \frac{20}{100}$
$\Rightarrow P(E \cap H') = P(E) - P(E \cap H) = \frac{40}{100} - \frac{20}{100} = \frac{20}{100} = 20\ \%$
⇒20 % of students read only English newspaper.
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Read the following text carefully and answer the questions that follow:
Four friends Dinesh, Yuvraj, Sonu, and Rajeev are playing cards. Dinesh, shuffling a cards and told to Rajeev choose any four cards.

1. What is the probability that Rajeev getting all face card. (1)
2. What is the probability that Rajeev getting two red cards and two black card. (1)
3. What is the probability that Rajeev getting one card from each suit. (2)
OR
What is the probability that Rajeev getting two king and two Jack cards. (2)
SOLUTION:
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	i. Total number of possible outcomes = ${}^{52}C_4$ We know that there are 12 face cards So,Number of favourable outcomes = ${}^{12}C_4$ Required probability = ${}^{12}C_4$ / ${}^{52}C_4$ ii. Total number of possible outcomes = ${}^{52}C_4$ We know that there are 26 red and 26 black cards. So,Number of favourable outcomes = ${}^{26}C_2$ x ${}^{26}C_2$ Required probability = $({}^{26}C_2)^2 / {}^{52}C_4$ iii. Total number of possible outcomes = ${}^{52}C_4$ Number of favourable outcomes = $({}^{13}C_1)^4$ Required probability = $(13)^4 / {}^{52}C_4$ OR Total number of possible outcomes = ${}^{52}C_4$ In playing cards there are 4 king and 4 jack cards. So,Number of favourable outcomes = ${}^{4}C_2$ x ${}^{4}C_2$ = 6 x 6 = 36 Required probability = $36 / {}^{52}C_4$
3	**Read the following text carefully and answer the questions that follow:** Two students Ankit and Vinod appeared in an examination. The probability that Ankit will qualify the examination is 0.05 and that Vinod will qualify is 0.10. The probability that both will qualify is 0.02. 1. Find the probability that at least one of them will qualify the exam. (1) 2. Find the probability that at least one of them will not qualify the exam. (1) 3. Find the probability that both Ankit and Vinod will not qualify the exam. (2) **OR** Find the probability that only one of them will qualify the exam. (2)
4	**Read the following text carefully and answer the questions that follow:** On her vacation, Priyanka visits four cities. Delhi, Lucknow, Agra, Meerut in a random order.  Meerut  New Delhi  Agra  Lucknow 4. What is the probability that she visits Delhi before Lucknow? (1) 5. What is the probability she visit Delhi before Lucknow and Lucknow before Agra? (1) 6. What is the probability she visits Delhi first and Lucknow last? (2) **OR** What is the probability she visits Delhi either first or second? (2)
5	**Read the following text carefully and answer the questions that follow:**

	In a bulb manufacturing company 10 defective bulbs are packed in a box with 90 non-defective bulbs by mistake. It is not possible to differentiate defective and non-defective bulbs by looking them. So manager draws a sample of three bulbs to decide box will be approved for selling or not. He will approve the box if all the bulbs are not defective. (i) Find the probability that box will be approved for selling. (1) (ii) Find the probability that box will not be approved for selling. (1) (iii) Find the probability that all bulbs in sample are defective. (2) OR Find the probability that at most one bulb in the sample is defective. (2)