QUESTION BANK CLASS XI

Ch- 1 Sets

SECTION A — Multiple Choice Questions *(1 mark each)*

Q1. If A = {1, 2, 3}, then the number of subsets of A is:

(a) 6 (b) 8 (c) 3 (d) 9

Q2. Which of the following is the empty set?

a) {x : x is a real number and $x^2 - 1 = 0$} (b) {x : x is a real number and $x^2 + 1 = 0$} (c) {x : x is a real number and $x^2 - 9 = 0$} (d) {x : x is a real number and $x^2 = x + 2$}

Q3. If A = {a, b} and B = {a, b, c}, then $A \cup B$ is:

(a) A (b) B (c) {a, b, c, a, b} (d) φ

Q4. Two sets A and B are called disjoint sets if:

(a) $A \cap B = \varphi$ (b) $A \cup B = \varphi$ (c) $A - B = A$ (d) A = B

Q5. The number of elements in the power set of the null set is:

(a)0 (b) 1 (c) 2 (d) 3

Q6. If n(A) = 3, n(B) = 6 and $A \subseteq B$, then $n(A \cup B)$ is equal to:/

(a) 3 (b) 9 (c) 6 (d) None of these

Q7. Let A and B be two sets. Then $A \cup B = A \cap B$ if and only if:/

(a) $A \subseteq B$ (b) $B \subseteq A$ (c) A = B (d) $A \cap B = \varphi$

Q8. The set $\{x \in R : -3 < x \le 5\}$, written in interval notation, is:

(a) [−3, 5] (b) (−3, 5] (c) (−3, 5) (d) [−3, 5)

Q9. If A = {1, 2, 3, 4} and B = {2, 4, 6, 8}, then A − B is:

(a) {1, 3} (b) {6, 8} (c) {1, 2, 3, 4} (d) {2, 4}

Q10. If A is the set of multiples of 3 and B is the set of multiples of 5 (in N), then $A \cap B$ is the set of multiples of:

(a) 15 (b) 8 (c) 3 only (d) 5 only

SECTION B — Assertion-Reason Questions *(1 mark each)*

Each of the questions below consists of an Assertion (A) and a Reason (R). Choose the correct option:

(a) Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is NOT the correct explanation of Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

Q11. **Assertion (A):** If A = {1, 2, 3} and B = {3, 4, 5}, then $A \cup B$ = {1, 2, 3, 4, 5}.

Reason (R): The union of two sets A and B is the set of all elements which are in A, or in B, or in both.

Q12. **Assertion (A):** The empty set φ is a subset of every set A.

Reason (R): For φ to be a subset of A, every element of φ must belong to A; since φ has no elements, this condition is vacuously true.

Q13. **Assertion (A):** If A = {1, 2, 3, 4} and B = {2, 4}, then $A \subset B$.

Reason (R): A is a subset of B if every element of A is also an element of B.

Q14. **Assertion (A):** If A = {1, 2, 3, 4, 5} and B = {1, 2, 6, 7}, then $n(A \cap B) = 2$.

Reason (R): $n(A \cup B) = n(A) + n(B) - n(A \cap B)$ for any two finite sets A and B.

Q15. **Assertion (A):** A set having only one element is called a singleton set.

Reason (R): A set having an infinite number of elements is also called a singleton set.

SECTION C — Very Short Answer Questions *(2 marks each)*

Q16. Write the interval (3, 8] in set-builder form. Also, write the set $\{x \in R : -2 \leq x < 5\}$ using interval notation.

Q17. If U = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10} is the universal set and A = {2, 4, 6, 8}, find A′ (the complement of A).

Q18. If A = {1, 2, 3, 4, 5} and U = {1, 2, 3, ..., 10} is the universal set, verify that $A \cap A' = \varphi$ and $A \cup A' = U$.

Q19. Are the following pair of sets equal? Give reasons. A = {2, 3} and B = {x : x is a solution of $x^2 + 5x + 6 = 0$}./

SECTION D — Short Answer Questions *(3 marks each)*

Q20. Let A and B be sets. If $A \cap X = B \cap X = \varphi$ and $A \cup X = B \cup X$ for some set X, Show that A = B

21. Let A be the set of letters in the word 'FOLLOW' and B be the set of letters in the word 'WOLF'. Show that A = B./

Q22. If $A = \{1, 2, 3, 4, 5, 6\}$, $B = \{2, 4, 6, 8\}$ and $C = \{3, 4, 5, 6\}$, verify that $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$.

Q23. Show that for any sets A and B,

$A = (A \cap B) \cup (A - B)$ and $A \cup (B - A) = (A \cap B)$

SECTION E — Long Answer Questions *(5 marks each)*

Q24. In a survey of 100 students, it was found that 30 read Physics, 35 read Chemistry, 40 read Mathematics, 10 read Physics and Chemistry, 15 read Chemistry and Mathematics, 8 read Physics and Mathematics, and 5 read all three subjects. Find:

- **(i)** the number of students who read none of the three subjects
- **(ii)** the number of students who read only Chemistry
- **(iii)** the number of students who read exactly two of the three subjects

Q25. For any three sets A, B and C, prove that:

- **(i)** $A - (B \cup C) = (A - B) \cap (A - C)$
- **(ii)** $A - (B \cap C) = (A - B) \cup (A - C)$

Q26. For any three sets A, B and C, prove that $A \cap (B - C) = (A \cap B) - (A \cap C)$.

Q27. If $U = \{1, 2, 3, \ldots, 10\}$, $A = \{1, 2, 3, 4, 5\}$ and $B = \{2, 4, 6, 8\}$, find A', $(A \cup B)'$ and $A' \cap B'$. Hence verify De Morgan's Law $(A \cup B)' = A' \cap B'$.

SECTION F — Case Study Based Questions *(4 marks each)*

Q28. Sports Survey

In a school, a survey was conducted among 150 students regarding the sports they like. It was found that 65 students like Cricket, 45 like Football, and 42 like Basketball. Of these, 20 like both Cricket and Football, 25 like both Football and Basketball, 15 like both Cricket and Basketball, and 8 students like all three sports.

- **(i)** How many students like Cricket only?
- **(ii)** How many students like at least one of the three sports?
- **(iii)** How many students like none of the three sports?
- **(iv)** How many students like exactly two of the three sports?

Q29. Categorising the School Library

The school library has a total collection of 200 books, which forms the universal set U. Every book in the library belongs to exactly one of the following three categories: F = the set of Fiction books, N = the set of Non-Fiction books, and R = the set of Reference books (dictionaries, encyclopaedias, atlases). Since every book belongs to exactly one category, no book belongs to two categories at once.

(i) What is $F \cup N \cup R$ equal to?

(ii) What is $F \cap N$ equal to? Give a reason.

(iii) Express F' (the complement of F) in terms of N and R.

(iv) If n(F) = 90 and n(N) = 70, find n(R).

Q30. Pizza Toppings

A pizza shop offers 4 toppings for its base pizza: Cheese, Mushroom, Onion and Capsicum. Let A = {Cheese, Mushroom, Onion, Capsicum} be the set of available toppings. A customer may choose to add any combination of these toppings to the base pizza, including the possibility of choosing no topping at all, or all four.

(i) How many topping-combinations (subsets of A) are possible in all?

(ii) If a customer insists that Cheese must always be included, how many topping-combinations are then possible?

(iii) Write, in roster form, all the subsets of A that contain exactly 2 toppings.

(iv) If a fifth topping, Olives, is added to the menu, how many topping-combinations would now be possible?

Ch- 2 Relations & Functions

SECTION A — Multiple Choice Questions *(1 mark each)*

Q1. If A = {1, 2, 3} and B = {4, 5}, then $n(A \times B)$ is:

(a) 5 (b) 6 (c) 8 (d) 9

Q2. If $(x + 1, y - 2) = (3, 1)$, then the values of x and y are:

(a) $x = 2, y = 3$ (b) $x = 3, y = 2$ (c) $x = 4, y = -1$ (d) $x = 2, y = -1$

Q3. The range of the function $f(x) = x^2 + 2$, x is a real number :

(a) R (b) $(0, \infty)$ (c) $[2, \infty)$ (d) $R - \{2\}$

Q4. The range of the Signum function is:

(a) R (b) $\{-1, 0, 1\}$ (c) $\{0, 1\}$ (d) Z

Q5. The range of the function $f(x) = 2 - 3X$, x is an element of R, $x > 0$:

(a) R (b) $(-\infty, 2)$ (c) $[2, \infty)$ (d) $R - \{3\}$

Q6. Let R be a relation from $A = \{2, 3, 4, 5\}$ to $B = \{3, 6, 7, 10\}$ defined by "x divides y". Then R, in roster form, is:

(a) $\{(2,6), (2,10), (3,3), (3,6), (5,10)\}$ (b) $\{(2,6), (3,3), (4,8), (5,10)\}$ (c) $\{(2,3), (3,6), (4,7), (5,10)\}$ (d) $\{(3,3), (3,6), (5,10)\}$

Q7. Let R be the relation on N defined by $R = \{(a, b) : a = b - 2, b > 6\}$. Then:

(a) $(2, 4) \in R$ (b) $(3, 8) \in R$ (c) $(6, 8) \in R$ (d) $(8, 7) \in R$

Q8. Which of the following relations is a function?

(a) $\{(1,2), (1,3), (2,3), (3,4)\}$ (b) $\{(1,2), (2,2), (3,2), (4,3)\}$ (c) $\{(1,1), (1,2), (2,2), (2,3)\}$ (d) $\{(1,2), (1,3), (1,4), (1,5)\}$

Q9. If $f(x) = x^2$ and $g(x) = 2x + 1$, then $(f + g)(x)$ is:

(a) $x^2 + 2x + 1$ (b) $x^2 + 2x - 1$ (c) $x^2 - 2x + 1$ (d) $2x^2 + 1$

Q10. The value of the greatest integer function $[-2.5]$ is:

(a) -2 (b) -3 (c) 2 (d) 3

SECTION B — Assertion-Reason Questions *(1 mark each)*

Each of the questions below consists of an Assertion (A) and a Reason (R). Choose the correct option:

(a) Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is NOT the correct explanation of Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

Q11. Assertion (A): If $A = \{1, 2\}$ and $B = \{3, 4\}$, then $A \times B = \{(1,3), (1,4), (2,3), (2,4)\}$.

Reason (R): If A and B are non-empty sets, then $A \times B = \{(a, b) : a \in A, b \in B\}$.

Q12. Assertion (A): The relation $R = \{(1,4), (2,5), (3,6)\}$ defined from $A = \{1,2,3\}$ to $B = \{4,5,6\}$ is a function from A to B.

Reason (R): A relation from A to B is a function if every element of A has a unique image in B.

Q13. Assertion (A): The relation $R = \{(1,2), (1,3), (2,4)\}$ defined on set $A = \{1,2,3,4\}$ is a function from A to A.

Reason (R): A relation R is a function if every element of the domain has exactly one image.

Q14. Assertion (A): The set of values of x for which the functions $f(x) = 3x^2 - 1$ and $g(x) = 3 + x$ are equal, is $\{-1, 4/3\}$.
Reason (R): Two functions f(x) and g(x) are equal iff their domains are the same and f(x) = g(x) for all x in their common domain.
Q15. Assertion (A): The Modulus function $f(x) = |x|$ has domain R and range $[0, \infty)$.
Reason (R): A function f is said to be even if $f(-x) = -f(x)$ for all x in its domain.

SECTION C — Very Short Answer Questions *(2 marks each)*

Q16. If $A = \{1, 2, 3\}$ and $B = \{2, 4\}$, find $A \times B$ and $B \times A$. State whether $A \times B = B \times A$.

Q17. Find the domain and range of the relation $R = \{(x, x + 5) : x \in \{0, 1, 2, 3, 4, 5\}\}$.

Q18. If $f(x) = x^2$ and $g(x) = 2x + 1$ are two real functions, find $(f + g)(x)$ and $(fg)(x)$.

Q19. Find the domain of the real function $f(x) = 1 / (x^2 - 9)$.

SECTION D — Short Answer Questions *(3 marks each)*

Q20. Find the domain and range of the function $f(x) = \sqrt{(9 - x^2)}$.

Q21. Let $f = \{(1,1), (2,3), (0,-1), (-1,-3)\}$ be a function from Z to Z defined by $f(x) = ax + b$, for some integers a, b. Determine a and b.

Q22. Draw the graph of the Signum function. Write its domain and range.

Q23. Draw the graph of the Modulus function. Write its domain and range.

Q24. The relation f is defined by $f(x) = x^2$ if $0 \le x \le 3$, and $f(x) = 3x$ if $3 \le x \le 10$. The relation g is defined by $g(x) = x^2$ if $0 \le x \le 2$, and $g(x) = 3x$ if $2 \le x \le 10$. Show that f is a function, and g is not a function.

Q25. If $A \times B = \{(a,x), (a,y), (b,x), (b,y)\}$, find A and B. Then, taking $A = \{1,2\}$ and $B = \{3,4\}$, write $A \times B$ and $B \times A$, and verify that $n(A \times B) = n(B \times A) = n(A) \times n(B)$.

Q26. Let $A = \{1, 2, 3, ..., 14\}$. Define a relation R from A to A by $R = \{(x, y) : 3x - y = 0$, where $x, y \in A\}$. Write down its domain, co-domain, and range.

Q27. Let $f(x) = x^2$ and $g(x) = 2x + 1$ be two real functions. Find $(f + g)(x)$, $(f - g)(x)$, $(fg)(x)$, and $(f/g)(x)$. State the domain in each case.

SECTION F — Case Study Based Questions *(4 marks each)*

Q28. Outfit Combinations

Rahul has 3 shirts: {White, Blue, Black} and 2 pairs of trousers: {Grey, Navy}. He wants to know how many different outfit combinations (shirt, trouser) he can make by pairing one shirt with one pair of trousers.

(i) If S = set of shirts and T = set of trousers, find $n(S \times T)$.

(ii) Write $S \times T$ in roster form.

(iii) If Rahul also buys a black pair of trousers (giving 3 trouser options in total), how many outfit combinations would now be possible?

(iv) If Rahul also has 2 pairs of shoes, how many combinations of (shirt, trouser, shoes) can he make in total, using the original 2 trousers?

Q29. Temperature Conversion

The relation between temperature in Fahrenheit (F) and Celsius (C) is given by the function $f(C) = (9/5)C + 32$.

(i) Find the Fahrenheit temperature when Celsius is 30°C, i.e., find f(30).

(ii) Find the Celsius temperature when Fahrenheit is 212°F.

(iii) What is the domain of this function, taking C to be any real number?

(iv) Is this function one-one? Justify your answer.

Q30. Relation vs Function — Roll Numbers

In class XI-A, each student is assigned a unique roll number. Let A = {Aman, Bhavya, Chetan, Divya} be a set of students, and B = {1, 2, 3, 4} be the set of roll numbers. A relation R_1 is defined from A to B such that R_1 = {(Aman,1), (Bhavya,2), (Chetan,3), (Divya,4)}.

(i) Is R_1 a relation from A to B? Justify.

(ii) Is R_1 a function from A to B? Justify.

(iii) What are the domain and range of R_1?

Ch- 3 Trigonometric Functions

SECTION A — Multiple Choice Questions *(1 mark each)*

Q1. The radian measure of 40° is:

(a) $2\pi/9$ (b) $\pi/9$ (c) $4\pi/9$ (d) $\pi/4$

Q2. If $\sin x = 3/5$ and x lies in the second quadrant, then $\cos x$ is:

(a) 4/5 (b) −4/5 (c) −3/5 (d) 3/4

Q3. The value of sin 75° is:

(a) $(\sqrt{6} + \sqrt{2})/4$ (b) $(\sqrt{6} - \sqrt{2})/4$ (c) $(\sqrt{3} + 1)/(2\sqrt{2})$ (d) both (a) and (c)

Q4. The value of $\tan(\pi/4 + x) \cdot \tan(\pi/4 - x)$ is:

(a) 1 (b) −1 (c) 0 (d) 2

Q5. The value of $\cos 1° \cos 2° \cos 3° \cdots \cos 179°$ is:

(a) 1 (b) −1 (c) 0 (d) 1/2

Q6. The value of $\cot 1° \cdot \cot 2° \cdot \cot 3° \cdots \cot 89°$ is:

(a) 0 (b) 1 (c) −1 (d) not defined

Q7. $\sin(n+1)x \cdot \sin(n+2)x + \cos(n+1)x \cdot \cos(n+2)x$ is equal to:

(a) $\cos x$ (b) $\sin x$ (c) $\cos 2x$ (d) $\sin 2x$

Q8. If $\tan x = -4/3$ and x lies in the second quadrant, then $\sin x$ is:

(a) 4/5 (b) −4/5 (c) 3/5 (d) −3/5

Q9. If in two circles, arcs of same length subtend angles 60° and 75° at the center, then ratio of their radii is

(a) 3:4 (b) 2:3 (c) 5:4 (d) None of these

Q10. The value of $2 \sin^2(\pi/6) + \operatorname{cosec}^2(7\pi/6) \cdot \cos^2(\pi/3)$ is:

(a) 3/2 (b) 2/3 (c) 1 (d) 2

SECTION B — Assertion-Reason Questions *(1 mark each)*

Each of the questions below consists of an Assertion (A) and a Reason (R). Choose the correct option:

(a) Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is NOT the correct explanation of Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

Q11. Assertion (A): The value of $\sin(-30°)$ is $-1/2$.

Reason (R): $\sin(-x) = -\sin(x)$ for all x, i.e., sine is an odd function.

Q12. Assertion (A): $\sin^2 x + \cos^2 x = 1$ for all real x.

Reason (R): $\sin x$ and $\cos x$ are periodic functions, each with period 2π.

Q13. Assertion (A): $\tan 45° + \tan 45° = \tan 90°$.

Reason (R): $\tan(A + B) = (\tan A + \tan B) / (1 - \tan A \tan B)$.

Q14. Assertion (A): If cosec x - cotx =a, then cosec x + cotx = 1/a
Reason (R): $\text{Cosec}^2 x - \cot^2 x = 1$

Q15. Assertion (A): If cos x+ sec x =2, then $16 \cos^2 x + 9 \sec^2 x = 25$
Reason (R): cos x + sec x =2 , only when x = 0

SECTION C — Very Short Answer Questions *(2 marks each)*

Q16. Convert 6 radians into degree measures. (Take π = 22/7)

Q17. Find the value of sin 765°.

Q18. If cos x = −12/13 and x lies in the third quadrant, find the value of sin x.

Q19. Prove that: cos(π/4 − x) cos(π/4 − y) − sin(π/4 − x) sin(π/4 − y) = sin(x + y).

SECTION D — Short Answer Questions *(3 marks each)*

Q20. Prove that: sin(x + y) / sin(x − y) = (tan x + tan y) / (tan x − tan y).

Q21. Prove that: $\sin 4x = 4 \sin x \cos x (1 - 2 \sin^2 x)$.

Q22. {cos 4x + cos 3x + cos 2x} / {sin 4x + sin 3x + sin 2x} = cot 3x

Q23. Find the value of tan π/8.

SECTION E — Long Answer Questions *(5 marks each)*

Q24. If tan x = −4/3 and x lies in the second quadrant, find the values of sin(x/2), cos(x/2), and tan(x/2).

Q25. Prove that: $\cos 6x = 32 \cos^6 x - 48 \cos^4 x + 18 \cos^2 x - 1$.

Q26. Prove that $\cos^2 x + \cos^2 (x + \pi/3) + \cos^2 (x - \pi/3) = 3/2$.

Q27. Prove that sin 10° sin 30° sin 50° sin 70° = 1/16.

SECTION F — Case Study Based Questions *(4 marks each)*

Q28. The Clock's Minute Hand

A large wall clock has a minute hand that is 21 cm long. The minute hand completes one full rotation (2π radians) in 60 minutes.

(i) Through what angle (in radians) does the minute hand rotate in 20 minutes?

(ii) What distance does the tip of the minute hand cover in 20 minutes? (Take π = 22/7)

(iii) Convert the angle found in part (i) into degree measure.

Q29. A Seasonal Population Model

The population of a small town varies periodically through the year due to seasonal migration of workers. It is modelled by P(t) = 5000 + 2000 sin(πt/6), where t is the number of months after January 1 (t = 0, 1, 2, ..., 12).

(i) What is the population at t = 3 (i.e., at the start of April)?

(ii) What is the maximum population during the year, and at which value of t does it occur?

(iii) What is the minimum population during the year, and at which value of t does it occur?

Q30. Motion of a Simple Pendulum

The displacement of a simple pendulum's bob from its mean position, at time t seconds, is given by y(t) = 5 sin(t + π/6) cm.

(i) Find the displacement at t = 0.

(ii) Find the displacement at t = π/3 seconds.

(iii) Using the compound angle formula, expand sin(t + π/6) in terms of sin t and cos t.

CHAPTER 4 : Linear Inequalities

SECTION A — Multiple Choice Questions *(1 mark each)*

Q1. The solution set of (- 2 / x - 3) > 0 then x is an element of:

(a) (3, ∞) (b) (- ∞, 3) (c) [3, ∞) (d) (- ∞, 3]

Q2. The solution of the inequality −4x ≥ 20 is:

(a) x ≥ −5 (b) x ≤ −5 (c) x ≥ 5 (d) x ≤ 5

Q3. The solution set of 24x < 100, where x is a natural number, is:

(a) {1, 2, 3, 4} (b) {1, 2, 3, 4, 5} (c) {0, 1, 2, 3, 4} (d) all natural numbers less than 25/6

Q4. On the number line, the solution set of x ≥ 2 is represented by:

(a) a closed circle at 2, with the ray shaded to the right (b) an open circle at 2, with the ray shaded to the right (c) a closed circle at 2, with the ray shaded to the left (d) an open circle at 2, with the ray shaded to the left

Q5. The solution set of $5x - 3 < 3x + 1$, where x is an integer, is

(a) {..., −3, −2, −1, 0, 1} (b) {0, 1} (c) {1, 2} (d) all real numbers less than 2

Q6. If x is a real number and $3x + 8 > 2$, then:

(a) $x > -2$ (b) $x < -2$ (c) $x > 2$ (d) $x < 2$

Q7. The solution of $-3 \le 4 - 7x/2 \le 18$ is

a) $-4 \le x \le 2$ (b) $-2 \le x \le 4$ (c) $2 \le x \le 4$ (d) $-4 \le x \le -2$

Q8. If x, y are real numbers with $x < y$, and c is a real number with $c < 0$, then:

(a) $cx < cy$ (b) $cx > cy$ (c) $cx = cy$ (d) cannot be determined

Q9. The solution set of $2(2x + 3) - 10 < 6(x - 2)$, where x is a natural number, is:

(a) {5, 6, 7, ...} (b) {1, 2, 3, 4} (c) {4, 5, 6, ...} (d) all real numbers greater than 4

Q10. Ravi obtained 70 and 75 marks in his first two unit tests (each out of 100). To have an average of at least 60 marks over three tests, the minimum marks he must score in the third test is

(a) 35 (b) 45 (c) 60 (d) 30

SECTION B — Assertion-Reason Questions *(1 mark each)*

Each of the questions below consists of an Assertion (A) and a Reason (R). Choose the correct option:

(a) Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is NOT the correct explanation of Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

Q11. Assertion (A): The solution set of $2x + 3 < 9$ is $x < 3$.

Reason (R): Adding or subtracting the same number to both sides, or multiplying/dividing both sides by the same positive number, does not change the direction of an inequality.

Q12. Assertion (A): The solution set of $-3x + 12 \le 0$ is $x \ge 4$.

Reason (R): The graph of a linear inequality in one variable, on the number line, is always a ray.

Q13. Assertion (A): If x is a real number satisfying $3(x-1) \le 2(x-3)$, then $x \le -3$.

Reason (R): When solving an inequality, both sides can be multiplied by any number without changing the direction of the inequality.

Q14. **Assertion (A):** The solution set of $2x - 5 > 3$, where x is a natural number, is {1, 2, 3, ...}.

Reason (R): $2x - 5 > 3$ gives $x > 4$, and the natural numbers satisfying this are 5, 6, 7, ...

Q15. **Assertion (A):** The inequality $3x - 2 < 7$ has infinitely many solutions if x is a real number, but only finitely many solutions if x is a natural number.

Reason (R): When x is restricted to the natural numbers, the solution set of a linear inequality bounded above is always a finite set.

SECTION C — Very Short Answer Questions *(2 marks each)*

Q16. Solve the inequality $|x + 3| \geq 10$.

Q17. Solve the inequality $5x - 3 < 3x + 1$, when (i) x is an integer, (ii) x is a real number.

Q18. Solve the inequality $3x - 7 > 2(x - 6)$, and represent the solution set on a number line.

Q19. Solve the inequality $3(1 - x) < 2(x + 4)$, and represent the solution set on a number line.

SECTION D — Short Answer Questions *(3 marks each)*

Q20. Solve the inequality $(3x-4)/2 \geq (x+1)/4 - 1$, where x is a real number, and represent the solution set on a number line.

Q21. A solution of 8% boric acid is to be diluted by adding a 2% boric acid solution to it. The resulting mixture is to be more than 4% but less than 6% boric acid. If 640 litres of the 8% solution is available, how many litres of the 2% solution should be added?

Q22. The acidity of a swimming pool's water is considered normal if the average of two pH readings taken on a given day lies between 7.2 and 7.8 (inclusive). If the first reading on a particular day is 7.48, find the range of values the second reading must lie in for the water to be classified as normal.

Q23. Solve the system of inequalities $2x - 3 < 7$ and $2x > -4$ for real x, and represent the common solution set on a number line.

SECTION E — Long Answer Questions *(5 marks each)*

Q24. A manufacturer has 600 litres of a 12% acid solution. How many litres of a 30% acid solution must be added to it, so that the acid content in the resulting mixture is more than 15% but less than 18%?

Q25. The longest side of a triangle is 3 times the shortest side, and the third side is 2 cm shorter than the longest side. If the perimeter of the triangle is at least 61 cm, find the minimum length of the shortest side.

Q26. The Intelligence Quotient (IQ) of a person is given by IQ = (MA/CA) × 100, where MA is the mental age and CA is the chronological age. If the IQ range for a group of 12-year-old children is $80 \leq IQ \leq 140$, find the range of their mental age.

Q27. Solve each of the following inequalities for real x, and represent each solution set on a separate number line:

(i) $(2x-1)/3 \geq (3x-2)/4$

(ii) $3(2-x) \geq 2(1-x)$

SECTION F — Case Study Based Questions *(4 marks each)*

Q28. Planning for a Scholarship

Rahul scored 68 and 72 marks in his first two unit tests of Mathematics (each out of 100 marks). To qualify for a scholarship, he needs his average score across all three unit tests to be at least 75.

(i) Let x be the marks Rahul scores in the third test. Write the linear inequality that represents the required condition.

(ii) Solve the inequality to find the minimum marks Rahul must score in the third test.

(iii) Given that the maximum possible marks in each test is 100, is it possible for Rahul to qualify for the scholarship? Justify your answer.

Q29. Diluting a Saline Solution

A pharmacist has 500 mL of a 20% saline solution. She wants to dilute it by adding some amount of a 4% saline solution, so that the resulting mixture has a saline concentration strictly between 8% and 12%.

(i) Let x mL of the 4% solution be added. Write the two inequalities that represent the given condition on the concentration of the resulting mixture.

(ii) Solve the inequalities to find the range of values of x.

Q30. Safe Storage Temperature

A chemical solution must be stored at a temperature between 68°F and 77°F (inclusive) to remain stable. The relationship between Fahrenheit (F) and Celsius (C) temperatures is given by F = (9/5)C + 32.

(i) Write the compound inequality in F that represents the storage condition.

(ii) Using the given formula, convert this into an inequality in C, and solve to find the range of safe storage temperatures in Celsius.

(iii) Is a temperature of 22°C within the safe storage range? Justify your answer using part (ii).

Ch- 5 Complex Numbers & Quadratic Equations

SECTION A — Multiple Choice Questions *(1 mark each)*

Q1. The value of i^{19} is:

(a) i (b) −i (c) 1 (d) −1

Q2. If $z = 3 + 4i$, then $|z|$ is:

(a) 5 (b) 7 (c) 25 (d) 1

Q3. The conjugate of the complex number $3 - 4i$ is:

(a) $3 + 4i$ (b) $-3 + 4i$ (c) $-3 - 4i$ (d) $4 - 3i$

Q4. The multiplicative inverse of $2 - 3i$ is:

(a) $(2 + 3i)/13$ (b) $(2 - 3i)/13$ (c) $(2 + 3i)/5$ (d) $(2 - 3i)/5$

Q5. If $a + ib = 0$, where a, b are real numbers, then:

(a) $a = 0, b \neq 0$ (b) $a = 0$ or $b = 0$ (c) $a = 0$ and $b = 0$ (d) none of these

Q6. If $z_1 = 2 + 3i$ and $z_2 = 3 - 2i$, then $z_1 + z_2$ is:

(a) $5 + i$ (b) $5 - i$ (c) $-1 + 5i$ (d) $1 + 5i$

Q7. The modulus of $(1 - i)/(1 + i)$ is:

(a) 0 (b) 1 (c) -1 (d) None of these

Q8. The least positive integer n such that $(2i)^n / (1 + i)^n$ is a positive integer, is

(a) 16 (b) 8 (c) 4 (d) 2

Q9. The value of $(1 + i)/(1 - i)$ is:

(a) i (b) −i (c) 1 (d) −1

Q10. For any complex number z, the value $z + \bar{z}$ is always:

(a) real (b) purely imaginary (c) zero (d) equal to $|z|$

SECTION B — Assertion-Reason Questions *(1 mark each)*

Each of the questions below consists of an Assertion (A) and a Reason (R). Choose the correct option:

(a) Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is NOT the correct explanation of Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

Q11. **Assertion (A):** $i^{4n} = 1$ for any positive integer n.

Reason (R): $i^4 = 1$, and i raised to any multiple of 4 equals 1.

Q12. **Assertion (A):** A complex number $z = x + iy$ is purely imaginary if $x = 0$ and $y \neq 0$.

Reason (R): The conjugate of a purely imaginary number is the negative of the number itself.

Q13. **Assertion (A):** Every real number is a complex number.

Reason (R): A complex number of the form $a + ib$, where $b = 0$, is called a purely imaginary number.

Q14. **Assertion (A):** The multiplicative inverse of a non-zero complex number $z = a + ib$ is $(a - ib)/(a^2 + b^2)$.

Reason (R): For any non-zero complex number z, $z \cdot \bar{z} = |z|^2$, where $\bar{z}$ is the conjugate of z.

Q15. **Assertion (A):** $i^2 + i^4 + i^6 + \ldots$ (2n+1) terms = -1

Reason (R): $1 + i^2 + i^4 + \ldots i^{2n} = 1$, if n is even.

SECTION C — Very Short Answer Questions *(2 marks each)*

Q16. Find the multiplicative inverse of $4 - 3i$.

Q17. For any two complex numbers z_1 and z_2, prove that

$\text{Re}(z_1 z_2) = \text{Re } z_1 \text{Re } z_2 - \text{Im } z_1 \text{Im } z_2$

Q18. Express $(1 - i)^4$ in the form $a + ib$.

Q19. If $(1 + i)^2 / 2 - i = x + iy$, then find the value of $x + y$.

SECTION D — Short Answer Questions *(3 marks each)*

Q20. Express $(3 + 2i)/(2 - 5i) + (3 - 2i)/(2 + 5i)$ in the form $a + ib$.

Q21. If $z_1 = 2 - i$ and $z_2 = -2 + i$, find $\text{Re}(z_1 z_2/\bar{z_1})$ and $\text{Im}(z_1 z_2/\bar{z_1})$.

Q23. If $(a + ib)^2 = x + iy$, prove that $x^2 + y^2 = (a^2 + b^2)^2$.

SECTION E — Long Answer Questions *(5 marks each)*

Q24. If α and β are different complex numbers with $|\beta| = 1$, then find $|(\beta - \alpha)/(1 - \bar{\alpha}\beta)|$

Q25. If $|z + 1| = z + 2(1 + i)$, find z.

Q26. If $x + iy = (a + ib)/(a - ib)$, prove that $x^2 + y^2 = 1$.

Q27. Find real θ such that 3 + 2i Sin θ/ 1- 2i Sin θ is purely real.

SECTION F — Case Study Based Questions *(4 marks each)*

Q28. Impedance in an AC Circuit

In an AC electrical circuit, impedance is represented as a complex number $Z = R + iX$, where R is the resistance (in ohms, Ω) and X is the reactance (in ohms, Ω). A particular circuit has resistance $R = 6\ \Omega$ and reactance $X = 8\ \Omega$, so that $Z = 6 + 8i$.

(i) Find the modulus $|Z|$ of the impedance.

(ii) Find the conjugate of Z.

(iii) If another component has impedance $Z_2 = 6 - 8i$, find $Z + Z_2$, and state whether the result is real, purely imaginary, or neither.

Q29. Forces as Complex Numbers

Two forces acting on a particle are represented as complex numbers $F_1 = 4 + 3i$ and $F_2 = 2 - 5i$ (in newtons), where the real part gives the horizontal component and the imaginary part gives the vertical component of each force.

(i) Find the resultant force $F_1 + F_2$.

(ii) Find the magnitude of the resultant force, $|F_1 + F_2|$.

(iii) Find the conjugate of F_1. What would reversing the sign of its imaginary part represent physically?

Q30. Three Cities on the Argand Plane

The positions of three cities, plotted on an Argand plane (in suitable scaled units), are given by the complex numbers $z_1 = 1 + 2i$, $z_2 = 3 + 4i$, and $z_3 = 5 + 2i$, where the real part gives the east-west position and the imaginary part gives the north-south position.

(i) Find the distance between city 1 and city 2, i.e., $|z_1 - z_2|$.

(ii) Find the distance between city 2 and city 3, i.e., $|z_2 - z_3|$.

(iii) Find the distance between city 1 and city 3, i.e., $|z_1 - z_3|$.

Worksheet 6 : Permutations and Combinations

SECTION A — Multiple Choice Questions *(1 mark each)*

Q1. The value of 7! is:

(a) 720 (b) 5040 (c) 40320 (d) 504

Q2. The number of ways to arrange the letters of the word 'MATH' is:

(a) 12 (b) 4 (c) 16 (d) 24

Q3. If $^nP_2 = 30$, then n =

(a) 6 (b) 5 (c) 10 (d) 15

Q4. The value of $^{10}C_3$ is:

(a) 720 (b) 30 (c) 120 (d) 1000

Q5. The number of ways of selecting 3 boys and 2 girls from 5 boys and 4 girls is:

(a) 60 (b) 20 (c) 120 (d) 9

Q6. The number of diagonals in a hexagon (a polygon with 6 sides) is:

(a) 15 (b) 12 (c) 6 (d) 9

Q7. How many 3-digit numbers can be formed using the digits 1, 2, 3, 4, 5, without repetition?

(a) 20 (b) 60 (c) 125 (d) 10

Q8. The number of ways to arrange the letters of the word 'INDIA' is:

(a) 120 (b) 20 (c) 60 (d) 30

Q9. If $^nC_8 = {}^nC_6$, then n =

(a) 8 (b) 6 (c) 48 (d) 14

Q10. The number of ways to select a committee of 3 people from 6 men and 4 women, such that at least 1 woman is included, is:

(a) 120 (b) 100 (c) 20 (d) 80

SECTION B — Assertion-Reason Questions *(1 mark each)*

Each of the questions below consists of an Assertion (A) and a Reason (R). Choose the correct option:

(a) Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is NOT the correct explanation of Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

Q11. Assertion (A): The value of 0! is 1.

Reason (R): By convention, 0! is defined to be 1 so that formulas like $^nP_r = n!/(n-r)!$ remain valid when r = n.

Q12. Assertion (A): The number of ways to select 2 students from a class of 30, to form an (unordered) 2-person team, is $^{30}P_2$.

Reason (R): A selection of objects, in which order does not matter, is called a combination.

Q13. **Assertion (A):** ${}^{8}C_{3} = 56$.

Reason (R): The value of 8! is 40320.

Q14. **Assertion (A):** The number of permutations of n distinct objects, taken r at a time, when repetition is allowed, is n^{r}.

Reason (R): ${}^{n}P_{r} = n!/(n-r)!$ gives the number of permutations of n distinct objects taken r at a time, when repetition is allowed.

Q15. **Assertion (A):** The number of diagonals of a polygon with n sides is ${}^{n}C_{2} - n$.

Reason (R): ${}^{n}C_{2}$ counts every line segment joining two vertices (sides and diagonals together), of which n are the sides of the polygon.

SECTION C — Very Short Answer Questions *(2 marks each)*

Q16. If $1/6! + 1/7! = x/\ 8!$, find x.

Q17. How many words (with or without meaning) can be formed using all the letters of the word 'EQUATION', using each letter exactly once? **Q18.** Find the number of ways in which 4 different books can be arranged on a shelf.

Q19. If ${}^{n}C_{4} = {}^{n}C_{6}$, find the value of n.

SECTION D — Short Answer Questions *(3 marks each)*

Q20. In how many of the distinct permutations of the letters MISSISSIPPI do the four I's not come together?

Q21. In how many ways can 5 different books be arranged on a shelf such that 2 particular books are always together?

Q22. Find the number of ways of selecting 9 balls from 6 red balls, 5 white balls, and 5 blue balls, if each selection consists of 3 balls of each colour.

Q23. How many numbers greater than 1000000 can be formed by using the digits 1, 2, 0, 2, 4, 2, 4?

SECTION E — Long Answer Questions *(5 marks each)*

Q24. In how many ways can a committee of 5 members be formed from 6 men and 5 women, consisting of exactly 3 men and 2 women? Also find the number of ways of forming this committee of 5 if it must include at least one woman.

Q25. Find the number of arrangements of the letters of the word INDEPENDENCE. In how many of these arrangements,

(i) do the words start with P

(ii) do all the vowels always occur together

(iii) do the vowels never occur together

Q26. Find the number of words with or without meaning which can be made using all the letters of the word AGAIN. If these are written as in a dictionary, what will be the 50^{th} word?

Q27. A group consists of 4 girls and 7 boys. In how many ways can a team of 5 members be selected if the team has:

(i) no girls

(ii) at least one boy and one girl

(iii) at least 3 girls

SECTION F — Case Study Based Questions *(4 marks each)*

Q28. Designing a License Plate

A car license plate in a certain state consists of 2 letters (from the 26 letters of the English alphabet) followed by 4 digits (from 0–9).

(i) If repetition of both letters and digits is allowed, how many different license plates are possible?

(ii) If no letter or digit may repeat within a plate, how many different license plates are possible?

(iii) How many license plates are possible if the two letters must be different from each other, but the digits are allowed to repeat?

Q29. Selecting a Quiz Team

A school wants to select a team for a quiz competition. There are 6 students from Class 11 and 4 students from Class 12 who have volunteered.

(i) In how many ways can a team of 4 students be selected from all 10 volunteers, with no restriction?

(ii) In how many ways can a team of 4 be selected if it must have exactly 2 students from each class?

(iii) In how many ways can a team of 4 be selected if it must include at least 1 student from Class 12?

Q30. Arranging a Family Photo

For a family photo, 3 parents and 4 children (7 people in total) are to be arranged in a single row.

(i) In how many ways can all 7 people be arranged in a row, with no restrictions?

(ii) In how many ways can they be arranged if the 3 parents must sit together, as a single block?

(iii) In how many ways can they be arranged if the tallest child must be at one of the two ends of the row?

Worksheet 7 : Binomial Theorem

SECTION A — Multiple Choice Questions *(1 mark each)*

Q1. The value of ${}^nC_0 + {}^nC_1 + {}^nC_2 + \ldots + {}^nC_{\square}$ is:

(a) n^2 (b) $2n$ (c) 2^n (d) $n!$

Q2. Using Pascal's Triangle, the coefficients in the expansion of $(a+b)^4$ are:

(a) 1, 4, 6, 4, 1 (b) 1, 3, 3, 1 (c) 1, 5, 10, 10, 5, 1 (d) 1, 2, 1

Q3. The expansion of $(x+1)^3$ is:

(a) $x^3 + 3x^2 + 3x - 1$ (b) $x^3 - 3x^2 + 3x - 1$ (c) $x^3 + x^2 + x + 1$ (d) $x^3 + 3x^2 + 3x + 1$

Q4. The total number of terms in the expansion of $(a+b)^n$ is:

(a) n (b) $n + 1$ (c) $n - 1$ (d) $2n$

Q5. The value of ${}^nC_0 - {}^nC_1 + {}^nC_2 - {}^nC_3 + \ldots + (-1)^n\, {}^nC_{\square}$ (for $n \geq 1$) is:

(a) 1 (b) 2^n (c) 0 (d) -1

Q6. Using the binomial theorem, $(101)^2$ can be written as:

(a) $100^2 + 2(100)(1) + 1^2$ (b) $100^2 - 2(100)(1) + 1^2$ (c) $100^2 + 1^2$ (d) $2(100^2) + 1^2$

Q7. If ${}^nC_{12} = {}^nC_8$ then n is equal to:

(a) 20 (b) 12 (c) 6 (d) 30

Q8. If the expansion of $(1+x)^n$ has 11 terms, then n =

(a) 11 (b) 9 (c) 12 (d) 10

Q9. The total numbers of terms in expansion of $(x + a)^{100} + (x - a)^{100}$ after simplification is

(a) 50 (b) 202 (c) 51 (d) None of these

Q10. Using the binomial theorem, $(x-2)^4$ expands to:

(a) $x^4 + 8x^3 + 24x^2 + 32x + 16$ (b) $x^4 - 8x^3 + 24x^2 - 32x + 16$ (c) $x^4 - 4x^3 + 6x^2 - 4x + 1$ (d) $x^4 - 8x^3 - 24x^2 - 32x - 16$

SECTION B — Assertion-Reason Questions *(1 mark each)*

Each of the questions below consists of an Assertion (A) and a Reason (R). Choose the correct option:

(a) Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is NOT the correct explanation of Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

Q11. **Assertion (A):** The number of terms in the expansion of $(x+y)^{10}$ is 11.

Reason (R): The expansion of $(a+b)^n$ contains $(n+1)$ terms, for a positive integer n.

Q12. **Assertion (A):** The sum of the binomial coefficients in the expansion of $(1+x)^n$ is 2^n.

Reason (R): Putting $x = 1$ in $(1+x)^n = \Sigma\ {}^nC_r\ x^r$ gives ${}^nC_0+{}^nC_1+\ldots+{}^nC_n = 2^n$.

Q13. **Assertion (A):** The coefficients in the expansion of $(a+b)^5$ are 1, 5, 10, 10, 5, 1.

Reason (R): Pascal's Triangle can be used to find binomial coefficients for small positive integer powers.

Q14. **Assertion (A):** The expansion of $(x-1)^4$ has all positive coefficients.

Reason (R): When a binomial has a negative sign, the terms in its expansion alternate in sign.

Q15. **Assertion (A):** ${}^nC_0 = {}^nC_n = 1$ for every positive integer n.

Reason (R): ${}^nC_r = n! \ / \ [r! \times (n+r)!]$

SECTION C — Very Short Answer Questions *(2 marks each)*

Q16. Expand $(x+2)^4$ using the binomial theorem.

Q17. Using the binomial theorem, expand $(a-b)^3$.

Q18. Write the row of Pascal's Triangle corresponding to $n = 6$.

Q19. Find the value of ${}^4C_0 + {}^4C_1 + {}^4C_2 + {}^4C_3 + {}^4C_4$.

SECTION D — Short Answer Questions *(3 marks each)*

Q20. Expand $(2x - 3y)^4$ using the binomial theorem.

Q21. Using the binomial theorem, prove that $6^n - 5n$ always leaves remainder 1 when divided by 25, for every positive integer n.

Q22. Evaluate $(99)^5$ using the binomial theorem.

Q23. Using the binomial theorem, expand $(\sqrt{2} + 1)^4 + (\sqrt{2} - 1)^4$, and show that the result is a rational number.

SECTION E — Long Answer Questions *(5 marks each)*

Q24. Using the binomial theorem, expand $(x^2 + 3/x)^4$.

Q25. Using the binomial theorem, prove that $2^{3n} - 7n - 1$ is divisible by 49, for every positive integer n.

Q26. Using the binomial theorem, expand $(1+x)^6 + (1-x)^6$. Hence find the value of $(1+\sqrt{3})^6 + (1-\sqrt{3})^6$.

Q27. Using the binomial theorem, show that $9^{n+1} - 8n - 9$ is divisible by 64, whenever n is a positive integer.

SECTION F — Case Study Based Questions *(4 marks each)*

Q28. Patterns in Pascal's Triangle

Pascal's Triangle is a triangular arrangement of numbers where each number is the sum of the two numbers directly above it. The first few rows are: Row 0: 1; Row 1: 1, 1; Row 2: 1, 2, 1; Row 3: 1, 3, 3, 1; Row 4: 1, 4, 6, 4, 1.

(i) Write Row 5 of Pascal's Triangle.

(ii) Find the sum of all the numbers in Row 4, and verify that it equals 2^4.

(iii) Using Row 4, write the full expansion of $(x+y)^4$.

Q29. Estimating Compound Growth

A bank account grows by a factor of (1+x) each year, where x is the annual interest rate written as a decimal. A customer wants to use the binomial theorem to estimate the growth of ₹1 without a calculator.

(i) Substitute $x = 0.02$ into your expansion to find the value of $(1.02)^4$, correct to 4 decimal places.

(ii) Using the binomial theorem, expand $(1+x)^3$ and substitute $x = 0.03$ to estimate the value of $(1.03)^3$, correct to 4 decimal places.

(iii) Based on your answers to (ii) and (iii), which is the better investment: 4 years at 2% per year, or 3 years at 3% per year?

Q30. Properties of Binomial Coefficients

A student is asked to explore the properties of the binomial coefficients for $n = 7$, i.e., ${}^7C_0$, ${}^7C_1$, ${}^7C_2$, ${}^7C_3$, ${}^7C_4$, ${}^7C_5$, ${}^7C_6$, ${}^7C_7$.

(i) List the values of all 8 binomial coefficients ${}^{7}C_{0}$ through ${}^{7}C_{7}$.

(ii) Find the sum of all these coefficients, and verify that it equals 2^{7}.

(iii) Verify that ${}^{7}C_{0}+{}^{7}C_{2}+{}^{7}C_{4}+{}^{7}C_{6}$ (the coefficients at even positions) equals ${}^{7}C_{1}+{}^{7}C_{3}+{}^{7}C_{5}+{}^{7}C_{7}$ (the coefficients at odd positions).