PRACTICE PAPER 01 (2026-27) – ANSWER KEY WITH SOLUTIONS
CHAPTER 01 : RELATIONS AND FUNCTIONS

SUBJECT: MATHEMATICS	**MAX. MARKS:** 40
CLASS: XII	**DURATION:** 1½ hrs

SECTION – A

Questions 1 to 10 carry 1 mark each.

1. Domain of $R = \{(x, y) : x + 2y = 12, x, y \in \mathbb{N}\}$

Ans: (a) {2, 4, 6, 8, 10}

$x = 12 - 2y$. For $y = 1, 2, 3, 4, 5$ we get $x = 10, 8, 6, 4, 2$. For $y = 6$, $x = 0 \notin \mathbb{N}$.

So domain = {2, 4, 6, 8, 10}.

2. Equivalence class [2] in $A = \{0, 1, \ldots, 14\}$, $|a - 2|$ a multiple of 5

Ans: (a) {2, 7, 12}

$a - 2 = 0, \pm5, \pm10, \ldots$ gives $a = 2, 7, 12$ ($a = -3$ and $a = 17$ are not in A). So $[2] = \{2, 7, 12\}$.

3. Number of reflexive relations on a 3-element set

Ans: (b) 64

A reflexive relation must contain all 3 pairs (a, a). Of the $3 \times 3 = 9$ pairs in $A \times A$, the remaining $9 - 3 = 6$ pairs may be included or not.

Number $= 2^6 = 64$.

4. Type of function from the diagram ($1 \to p$, $2 \to q$, $3 \to r$, $4 \to q$)

Ans: (b) onto but not one-one

Elements 2 and 4 have the same image q, so f is many-one. Every element p, q, r of Y is an image, so f is onto.

5. One-one functions from a 3-element set to a 5-element set

Ans: (c) 60

Number $= {}^5P_3 = 5 \times 4 \times 3 = 60$.

6. $f(x) = x|x|$

Ans: (c) bijective

$f(x) = x^2$ for $x \geq 0$ and $f(x) = -x^2$ for $x < 0$. It is strictly increasing, hence one-one.

For $y \geq 0$ take $x = \sqrt{y}$ and for $y < 0$ take $x = -\sqrt{(-y)}$; then $f(x) = y$. So f is onto. Hence f is bijective.

7. $(fog)(2) - (gof)(2)$

Ans: (a) −4

$(fog)(2) = f(g(2)) = f(5) = 13$. $(gof)(2) = g(f(2)) = g(4) = 17$.

Difference $= 13 - 17 = -4$.

8. $f^{-1}(8)$ for $f(x) = 5x - 7$

Ans: (a) 3

$f^{-1}(y) = (y + 7)/5$, so $f^{-1}(8) = 15/5 = 3$.

9. Assertion–Reason on $f(x) = 2x + 1$, $f : \mathbb{Z} \to \mathbb{Z}$

Ans: (c) A is true but R is false

A: $f(x_1) = f(x_2) \Rightarrow 2x_1 + 1 = 2x_2 + 1 \Rightarrow x_1 = x_2$, so f is one-one. For $y = 2$ we need $2x + 1 = 2$, $x = 1/2 \notin \mathbb{Z}$, so f is not onto. A is true.

R says every $y \in \mathbb{Z}$ has a pre-image, which is false (no even integer has one). R is false.

10. Assertion–Reason on $f(x) = x^2$, $f : \mathbb{R} \to \mathbb{R}$

Ans: (a) Both A and R are true and R is the correct explanation of A

$f(1) = f(-1) = 1$, so f is not one-one, hence not bijective and therefore not invertible. A is true. R is the standard characterisation of invertible functions and it explains A. So (a).

SECTION – B

Questions 11 to 14 carry 2 marks each.

11. $A = \{1, 2, 3, 4\}$, $R = \{(a, b) : a \cdot b \text{ is even}\}$

$R = \{(1, 2), (1, 4), (2, 1), (2, 2), (2, 3), (2, 4), (3, 2), (3, 4), (4, 1), (4, 2), (4, 3), (4, 4)\}$.

Not reflexive: $(1, 1) \notin R$ as $1 \times 1 = 1$ is odd. (½)

Symmetric: if $a \cdot b$ is even then $b \cdot a$ is even, so $(a, b) \in R \Rightarrow (b, a) \in R$. (½)

Not transitive: $(1, 2) \in R$ and $(2, 3) \in R$, but $(1, 3) \notin R$ since $1 \times 3 = 3$ is odd. (1)

Hence R is symmetric but neither reflexive nor transitive.

12. $f(x) = x + 3$, $g(x) = x^2$

$(fog)(x) = f(g(x)) = f(x^2) = x^2 + 3$. (1)

$(gof)(x) = g(f(x)) = g(x + 3) = (x + 3)^2 = x^2 + 6x + 9$.

They are equal only when $6x + 9 = 3$, i.e. $x = -1$. For example, $(fog)(1) = 4$ but $(gof)(1) = 16$. So $fog \neq gof$. (1)

13. $f(n) = n^2 + 2$, $f : \mathbb{N} \to \mathbb{N}$

One-one: $f(n_1) = f(n_2) \Rightarrow n_1^2 + 2 = n_2^2 + 2 \Rightarrow n_1^2 = n_2^2 \Rightarrow n_1 = n_2$ (both are positive). (1)

Not onto: take $4 \in \mathbb{N}$. $n^2 + 2 = 4 \Rightarrow n^2 = 2 \Rightarrow n = \sqrt{2} \notin \mathbb{N}$. So 4 has no pre-image and f is not onto. (1)

14. $f(x) = (3x + 4)/5$

One-one: $(3x_1 + 4)/5 = (3x_2 + 4)/5 \Rightarrow x_1 = x_2$.

Onto: let $y \in \mathbb{R}$. Put $y = (3x + 4)/5 \Rightarrow x = (5y - 4)/3 \in \mathbb{R}$, and $f(x) = y$. (1)

So f is bijective and hence invertible, with $f^{-1}(y) = (5y - 4)/3$. (1)

SECTION – C

Questions 15 to 17 carry 3 marks each.

15. $R = \{(a, b) : 7 \text{ divides } 3a + 4b\}$ on $\mathbb{Z}$

Note that $3a + 4b = 3(a - b) + 7b$.

Reflexive: $3a + 4a = 7a$ is divisible by 7, so $(a, a) \in R$. (1)

Symmetric: let $(a, b) \in R$, i.e. $7 \mid 3a + 4b$. Then $7 \mid 3(a - b)$, and since 7 is prime and $7 \nmid 3$, $7 \mid (a - b)$, so $7 \mid (b - a)$. Now $3b + 4a = 3(b - a) + 7a$ is divisible by 7, so $(b, a) \in R$. (1)

Transitive: let $(a, b), (b, c) \in R$. As above, $7 \mid (a - b)$ and $7 \mid (b - c)$, so $7 \mid (a - c)$. Then $3a + 4c = 3(a - c) + 7c$ is divisible by 7, so $(a, c) \in R$. (1)

Hence R is an equivalence relation.

16. $f : [0, \infty) \to [2, \infty)$, $f(x) = x^2 + 2$

One-one: $f(x_1) = f(x_2) \Rightarrow x_1^2 = x_2^2 \Rightarrow x_1 = x_2$ since $x_1, x_2 \geq 0$. (1)

Onto: for any $y \geq 2$, take $x = \sqrt{(y - 2)} \geq 0$. Then $f(x) = (y - 2) + 2 = y$. (1)

So f is bijective, hence invertible, and $f^{-1}(y) = \sqrt{(y - 2)}$.

$f^{-1}(11) = \sqrt{9} = 3$. (1)

17. gof from the arrow diagram

$f : 1 \to a, 2 \to c, 3 \to b, 4 \to c$. $g : a \to 7, b \to 9, c \to 7, d \to 11$.

$(gof)(1) = g(a) = 7$, $(gof)(2) = g(c) = 7$, $(gof)(3) = g(b) = 9$, $(gof)(4) = g(c) = 7$.

So $gof = \{(1, 7), (2, 7), (3, 9), (4, 7)\}$. (1)

Not one-one: $(gof)(1) = (gof)(2) = 7$ although $1 \neq 2$. (1)

Not onto: the range of gof is $\{7, 9\}$; $11 \in C$ has no pre-image (d is not an image under f). (1)

SECTION – D

Question 18 carries 5 marks.

18. $A = \{0, 1, \ldots, 10\}$, $R = \{(a, b) : 5 \text{ divides } a^2 - b^2\}$

Reflexive: $a^2 - a^2 = 0$ is divisible by 5, so $(a, a) \in R$ for every $a \in A$. (1)

Symmetric: if $5 \mid (a^2 - b^2)$ then $5 \mid -(a^2 - b^2) = (b^2 - a^2)$, so $(b, a) \in R$. (1)

Transitive: if $5 \mid (a^2 - b^2)$ and $5 \mid (b^2 - c^2)$, then $5 \mid [(a^2 - b^2) + (b^2 - c^2)] = (a^2 - c^2)$, so $(a, c) \in R$. (2)

Hence R is an equivalence relation.

[2]: we need $x \in A$ with $5 \mid (x^2 - 4)$. Checking $x = 0, 1, \ldots, 10$: $x^2 - 4 = -4, -3, 0, 5, 12, 21, 32, 45, 60, 77, 96$. Divisible by 5: $x = 2, 3, 7, 8$.

So $[2] = \{2, 3, 7, 8\}$. (1)

OR

$f : \mathbb{R} - \{-2\} \to \mathbb{R} - \{3\}$, $f(x) = (3x + 1)/(x + 2)$.

One-one: $f(x_1) = f(x_2) \Rightarrow (3x_1 + 1)(x_2 + 2) = (3x_2 + 1)(x_1 + 2)$

$\Rightarrow 3x_1x_2 + 6x_1 + x_2 + 2 = 3x_1x_2 + 6x_2 + x_1 + 2 \Rightarrow 5x_1 = 5x_2 \Rightarrow x_1 = x_2$. (2)

Onto: let $y \in \mathbb{R} - \{3\}$. Put $y = (3x + 1)/(x + 2) \Rightarrow xy + 2y = 3x + 1 \Rightarrow x(y - 3) = 1 - 2y \Rightarrow x = (1 - 2y)/(y - 3)$, which exists since $y \neq 3$. (1)

Also $x \neq -2$: if $x = -2$ then $1 - 2y = -2y + 6$, i.e. $1 = 6$, which is impossible. So $x \in \mathbb{R} - \{-2\}$ and $f(x) = y$. Hence f is onto. (1)

Thus f is one-one and onto, and $f^{-1}(y) = (1 - 2y)/(y - 3)$. (1)

SECTION – E (Case Study Based Questions)

Questions 19 and 20 carry 4 marks each.

19. Library case study

(i) $n(S) = 3$, $n(B) = 4$, so $|S \times B| = 12$. Number of relations $= 2^{12} =$ **4096**. (1)

(ii) Each of the 3 students can be mapped to any of 4 books: $4^3 =$ **64** functions. (1)

(iii) $f(s_1) = b_1$, $f(s_2) = b_3$, $f(s_3) = b_4$ are all different, so f is **one-one**. (1)

The book b_2 has no pre-image, so f is **not onto**. (1)

OR

(iii) $R = \{(b_1, b_1), (b_2, b_2), (b_3, b_3), (b_4, b_4), (b_1, b_2), (b_2, b_1)\}$. (½)

Reflexive: every book is of the same subject as itself; all $(b, b) \in R$. (½)

Symmetric: $(b_1, b_2) \in R$ and $(b_2, b_1) \in R$; the other pairs are of the form (b, b). (½)

Transitive: the only chains with different elements are $(b_1, b_2), (b_2, b_1) \Rightarrow (b_1, b_1) \in R$ and $(b_2, b_1), (b_1, b_2) \Rightarrow (b_2, b_2) \in R$. (½)

Hence R is an equivalence relation, with classes $\{b_1, b_2\}, \{b_3\}, \{b_4\}$.

20. Cab fare case study, $f(x) = 12x + 50$

(i) $f(6) = 12 \times 6 + 50 = 72 + 50 =$ **₹122**. (1)

(ii) $12x + 50 = 218 \Rightarrow 12x = 168 \Rightarrow x =$ **14 km**. (1)

(iii)(a) **One-one:** $f(x_1) = f(x_2) \Rightarrow 12x_1 + 50 = 12x_2 + 50 \Rightarrow x_1 = x_2$. (1)

Not onto: take $1 \in \mathbb{N}$. $12x + 50 = 1 \Rightarrow x = -49/12 \notin \mathbb{N}$. (In fact every fare is at least ₹62.) So f is not onto. (1)

OR

(iii)(b) $(gof)(x) = g(f(x)) = 1.1(12x + 50) =$ **13.2x + 55**. (1)

For $x = 10$: $(gof)(10) = 132 + 55 =$ **₹187**. (1)

— End of Solutions —