Relations and Functions

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. If n(A) = 2 and n(B) = 3, the number of relations from A to B is:
(a) 2^5 **(b)** 6 **(c)** 2^3 **(d)** 2^6

2. If (x + 6, y − 3) = (8, 6), then (x, y) is:
(a) (14, 3) **(b)** (9, 2) **(c)** (2, 9) **(d)** (2, 3)

3. The domain of the relation R = {(2, 2), (5, 2), (8, 1), (8, 6), (4, 7)} is:
(a) {2, 4, 5} **(b)** {2, 4, 5, 8}
(c) {1, 2, 6, 7} **(d)** {1, 2, 4, 5, 6, 7, 8}

4. If $f(x) = -3x^2 + 2x$, then f(0) is:
(a) 1 **(b)** −6 **(c)** 0 **(d)** 2

5. The Cartesian product A × B is the set of all:
(a) unordered pairs
(b) elements in A or B
(c) elements in both A and B
(d) ordered pairs (a, b) with a ∈ A and b ∈ B

6. Which of these relations is a function?
(a) {(3, 7), (4, 9), (2, 8), (1, 2)} **(b)** {(2, 7), (1, 8), (3, 3), (2, 2)}
(c) {(4, 7), (5, 8), (2, 9), (4, 4)} **(d)** {(4, 9), (5, 7), (3, 5), (3, 9)}

7. If f(x) = 2x + 1 and g(x) = 3x − 8, then (f + g)(−3) is:
(a) −22 **(b)** 85 **(c)** −21 **(d)** 22

8. Assertion (A): If A has 4 elements and B has 3, then A × B has 12 elements.
Reason (R): n(A × B) = n(A) + n(B).
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Section B — Short answer — 8 × 2 = 16 marks

9. Find x and y if (x + 5, y − 2) = (23/4, −3/2).

10. If A = {4, 5} and B = {3, 5}, write A × B. How many elements does it have?

11. For A = {6, 7, 8}, define R = {(x, y) : y = x + 4, x ∈ A}. Write R in roster form and find its domain and range.

12. For f(x) = −2x − 1, find f(4) and the value of x for which f(x) = 4.

13. If f(x) = x^2 − 4 and g(x) = x + 1, find (f + g)(x), (f − g)(x) and (fg)(x).

14. Find the domain of the real function f(x) = (x^2 + 2) / (x^2 − 6x + 5).

15. Find the range of the real function f(x) = −x^2 − 1, x ∈ R.

16. A has 3 elements and B has 1. How many elements does A × B have, and how many relations are there from A to B?

Section C — Word problems — 4 × 4 = 16 marks

17. A relation R on A = {1, 2, 3, 4, 5, 6} is defined by R = {(x, y) : x divides y and x ≠ y; x, y ∈ A}. Write R in roster form and find its domain, codomain and range.

18. A linear function f(x) = mx + c has f(−5) = 20 and f(−4) = 17. Find m and c, write f(x), and find f(−6).

19. Let A = {1, 4}, B = {1, 2, 4, 5} and C = {5, 6}. Verify that A × (B ∩ C) = (A × B) ∩ (A × C).

20. $f(x) = x^2$ for $x < 0$; $f(x) = 3x$ for $0 \le x < 3$; $f(x) = 9$ for $x \ge 3$. Find $f(-3)$, $f(2)$, $f(4)$. What is the range of f?

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Answer key

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Q	Answer	Working
1	**(d) 2^6**	subsets of A × B, which has 6 elements
2	**(c) (2, 9)**	equal ordered pairs: first = first, second = second
3	**(b) {2, 4, 5, 8}**	—
4	**(c) 0**	—
5	**(d) ordered pairs (a, b) with a ∈ A and b ∈ B**	—
6	**(a) {(3, 7), (4, 9), (2, 8), (1, 2)}**	no first element may appear twice
7	**(a) −22**	f(−3) = −5, g(−3) = −17
8	**(c) A is true, but R is false.**	A is true: 4 × 3 = 12. R is false.
9	**x = 3/4, y = 1/2**	equate first and second elements
10	**{(4, 3), (4, 5), (5, 3), (5, 5)}; 4 elements**	—
11	**R = {(6, 10), (7, 11), (8, 12)}; domain {6, 7, 8}; range {10, 11, 12}**	—
12	**f(4) = −9; x = −5/2**	−2x − 1 = 4
13	**(f + g)(x) = x^2 + x − 3; (f − g)(x) = x^2 − x − 5; (fg)(x) = x^3 + x^2 − 4x − 4**	add, subtract or multiply the expressions
14	**R − {1, 5}**	the denominator is (x − 1)(x − 5), zero at x = 1, 5
15	**(−∞, −1]**	x^2 ≥ 0, so f(x) ≤ −1
16	**3; 2^3 = 8**	every subset of A × B is a relation
17	**R = {(1, 2), (1, 3), (1, 4), (1, 5), (1, 6), (2, 4), (2, 6), (3, 6)}; domain {1, 2, 3}; codomain {1, 2, 3, 4, 5, 6}; range {2, 3, 4, 5, 6}**	—
18	**m = −3, c = 5; f(x) = −3x + 5; f(−6) = 23**	m = (17 − 20) ÷ (−4 − (−5))
19	**B ∩ C = {5}, so A × (B ∩ C) = {(1, 5), (4, 5)}. (A × B) ∩ (A × C) keeps the pairs whose second element is in both B and C, which is the same set.**	—
20	**f(−3) = 9, f(2) = 6, f(4) = 9; range [0, ∞)**	use the rule for the interval each x lies in; x^2 covers all positive values

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