Class 11 Mathematics · Chapter 1: Sets

Answer key and marking scheme · 20 marks · about 40 minutes · based on NCERT

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1. Which of the following is a singleton set? [1]

(a) $\{x : x \in R \text{ and } x^3 = 27\}$ (b) $\{x : x \in Z \text{ and } x^2 = 9\}$

(c) $\{x : x \in N \text{ and } x + 3 = 2\}$ (d) $\{x : x \in N \text{ and } x \text{ divides } 9\}$

Answer: (a) The only real number whose cube is 27 is 3, so the set is {3}, with one element. The others are {−3, 3}, ϕ and {1, 3, 9}.

2. The set $\{x : x \in Z \text{ and } -2 < 2x \le 5\}$ in roster form is [1]

(a) {−1, 0, 1, 2} (b) {0, 1, 2, 3}

(c) {0, 1, 2} (d) {1, 2}

Answer: (c) $-2 < 2x \le 5$ gives $-1 < x \le 2.5$. The integers in this range are 0, 1 and 2. $x = -1$ fails since $2x = -2$ is not greater than −2; $x = 3$ gives $2x = 6 > 5$.

3. Which of the following sets is infinite? [1]

(a) The set of divisors of 1000000 (b) The set of points on a line segment 1 cm long

(c) The set of districts of India (d) $\{x : x \in N \text{ and } x < 1000000000\}$

Answer: (b) A line segment, however short, contains infinitely many points. The other three sets are very large but have a definite number of elements, so they are finite.

4. The set {3, 8, 15, 24, 35} in set-builder form is [1]

(a) $\{x : x = n^2 - 1, n \in N \text{ and } 1 \le n \le 5\}$ (b) $\{x : x = 2n + 1, n \in N \text{ and } 1 \le n \le 5\}$

(c) $\{x : x = n^2 - 1, n \in N \text{ and } 2 \le n \le 6\}$ (d) $\{x : x = n^2 + 2, n \in N \text{ and } 1 \le n \le 5\}$

Answer: (c) $3 = 2^2 - 1$, $8 = 3^2 - 1$, $15 = 4^2 - 1$, $24 = 5^2 - 1$, $35 = 6^2 - 1$, so $x = n^2 - 1$ with n from 2 to 6. Option (a) would start at 0 and stop at 24.

5. The number of subsets of the set of prime numbers less than 20 is [1]

(a) 256 (b) 255

(c) 128 (d) 64

Answer: (a) The primes less than 20 are 2, 3, 5, 7, 11, 13, 17, 19: eight elements. The number of subsets is $2^8 = 256$ (255 is the number of proper subsets).

6. A set A has 2 more elements than a set B, and A has 48 more subsets than B. Find n(A) and n(B). [2]

Let n(B) = b, so n(A) = b + 2. Then $2^{b+2} - 2^b = 4 \times 2^b - 2^b = 3 \times 2^b = 48$, so $2^b = 16$ and b = 4. Hence n(B) = 4 and n(A) = 6.

- forms $2^{b+2} - 2^b = 48$ (1)
- n(B) = 4, n(A) = 6 (1)

7. Write $A = \{x : x \in R \text{ and } -3 < x \le 5\}$ and $B = \{x : x \in R \text{ and } 1 \le x < 8\}$ as intervals, and write $A \cap B$ as an interval. [2]

A = (−3, 5] and B = [1, 8). The real numbers in both satisfy $1 \le x \le 5$, so $A \cap B = [1, 5]$.

- A = (−3, 5] and B = [1, 8) (1)
- $A \cap B = [1, 5]$ (1)

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8. Write in roster form: (i) $\{x : x \in Z \text{ and } x^3 = 4x\}$, (ii) $\{x : x \in N \text{ and } x^3 = 4x\}$. [2]

$x^3 - 4x = x(x - 2)(x + 2) = 0$ gives $x = 0, 2, -2$. (i) All three are integers: $\{-2, 0, 2\}$. (ii) Only 2 is a natural number: $\{2\}$.

- factorises to get $x = 0, 2, -2$ (1)
- (i) $\{-2, 0, 2\}$ and (ii) $\{2\}$ (1)

9. For subsets A and B of a universal set U, prove that $A - B = A \cap B'$. [3]

Let $x \in A - B$. Then $x \in A$ and $x \notin B$, so $x \in A$ and $x \in B'$, i.e. $x \in A \cap B'$; hence $A - B \subset A \cap B'$. Conversely let $x \in A \cap B'$. Then $x \in A$ and $x \in B'$, i.e. $x \in A$ and $x \notin B$, so $x \in A - B$; hence $A \cap B' \subset A - B$. Since each is a subset of the other, $A - B = A \cap B'$.

- shows $A - B \subset A \cap B'$ (1)
- shows $A \cap B' \subset A - B$ (1)
- concludes equality from the two inclusions (1)

10. A and B are finite sets with $n(A) = 12$, $n(A \cap B) = 5$ and $n(B - A) = 9$. Using the fact that $A - B$, $A \cap B$ and $B - A$ are mutually disjoint, find $n(A - B)$, $n(B)$ and $n(A \cup B)$. [3]

$A = (A \cap B) \cup (A - B)$ with the two parts disjoint, so $n(A - B) = 12 - 5 = 7$. $B = (A \cap B) \cup (B - A)$, disjoint, so $n(B) = 5 + 9 = 14$. $A \cup B$ is the union of the three disjoint sets, so $n(A \cup B) = 7 + 5 + 9 = 21$.

- $n(A - B) = 7$ (1)
- $n(B) = 14$ (1)
- $n(A \cup B) = 21$ (1)

11. Using the laws of the algebra of sets, show that $A \cap (A' \cup B) = A \cap B$, stating the law used at each step. [3]

$A \cap (A' \cup B) = (A \cap A') \cup (A \cap B)$ by the distributive law; $= \phi \cup (A \cap B)$ since $A \cap A' = \phi$ (complement law); $= A \cap B$ since ϕ is the identity of union.

- distributive law applied (1)
- $A \cap A' = \phi$ (1)
- $\phi \cup (A \cap B) = A \cap B$ (1)