Sets (Advanced)

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. A set A has 8 elements. How many elements does its power set P(A) have?
(a) 64 **(b)** 16 **(c)** 255 **(d)** 256

2. Of 48 people, 37 drink tea, 30 drink coffee and 1 do neither. How many do both?
(a) 17 **(b)** 10 **(c)** 21 **(d)** 20

3. The empty set φ is a subset of:
(a) only infinite sets **(b)** no set at all
(c) only the empty set **(d)** every set

4. If n(A ∪ B) = 63 and n(B) = 39, then n(A − B) is:
(a) 24 **(b)** 42 **(c)** 102 **(d)** 45

5. U = {1, 2, 3, …, 78}. A is the set of multiples of 3 and B the set of multiples of 7 in U. Find n(A ∪ B).
(a) 3 **(b)** 37 **(c)** 34 **(d)** 35

6. A − B is the set of elements that are:
(a) in neither A nor B **(b)** in A but not in B
(c) in B but not in A **(d)** in both A and B

7. In a survey of 140 shoppers, 73 bought rice and 116 bought wheat flour. The least possible number who do both is:
(a) 59 **(b)** 24 **(c)** 73 **(d)** 49

8. n(A) = 35, n(B) = 40 and n(A ∩ B) = 5. How many elements are in exactly one of A and B?
(a) 65 **(b)** 75 **(c)** 70 **(d)** 10

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

9. U = {1, 2, …, 16}, A = {1, 9, 13, 15, 16} and B = {1, 3, 8, 9, 12, 13}. Find A ∪ B, A ∩ B, A − B and (A ∪ B)′.

10. Write the power set of {d, x, z}. How many proper subsets does the set have?

11. U = {1, 2, 3, …, 25} and A = {x ∈ U : x is a prime number}. Write A′ in roster form and find n(A′).

12. n(A) = 46, n(B) = 25 and n(A ∪ B) = 55. Find (a) n(A ∩ B) (b) n(A − B) (c) n(B − A).

13. Of 120 families in a village, 80% watch the news on TV, 55% read it in a newspaper and 40% do both. How many do neither?

14. Set A has 3 more elements than set B, and the power set of A has 448 more elements than the power set of B. Find (a) n(A) (b) n(B).

15. Each of 96 students chose at least one of Origami, Music and Fine Arts: 46 chose Origami, 50 chose Music, 41 chose Fine Arts and 7 chose all three. How many chose exactly two?

16. How many subsets of {1, 2, 3, …, 6} contain both 1 and 2?

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

17. In a group of 51 students, 10 play cricket, 3 of these also play football, and 20 do neither of the two. Find how many (a) play football (b) play football but not cricket (c) do exactly one of the two.

18. In a survey of 93 people about newspaper P, newspaper Q and newspaper R: 36 chose newspaper P, 37 chose newspaper Q, 35 chose newspaper R; 14 chose newspaper P and newspaper Q, 12 chose newspaper Q and newspaper R, 13 chose newspaper R and newspaper P, and 8 chose all three. How many chose (a) at least two (b) at most one (c) none of the three?

19. For a competitive exam, 90% of the students took a Mathematics mock test and 85% took a Science mock test. (a) What is the least possible percentage who took both? (b) If 10% took neither, what percentage took both?

20. Every one of 73 customers chose at least one of shampoo A, shampoo B and shampoo C: 35 chose shampoo A, 32 shampoo B, 46 shampoo C; 11 chose shampoo A and shampoo B, 17 chose shampoo B and shampoo C, 21 chose shampoo C and shampoo A. Find (a) how many chose all three (b) how many chose exactly one.

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Answer key

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Q	Answer	Working
1	**(d) 256**	n[P(A)] = 2^8 = 256
2	**(d) 20**	n(A ∪ B) = 48 − 1 = 47; n(A ∩ B) = 37 + 30 − 47 = 20
3	**(d) every set**	φ has no element that could fail to be in another set
4	**(a) 24**	A − B is the part of A ∪ B outside B: 63 − 39 = 24
5	**(c) 34**	n(A) = 26, n(B) = 11, A ∩ B = multiples of 21: 3; 26 + 11 − 3 = 34
6	**(b) in A but not in B**	A − B = {x : x ∈ A and x ∉ B}
7	**(d) 49**	n(A ∪ B) ≤ 140, so n(A ∩ B) ≥ 73 + 116 − 140 = 49
8	**(a) 65**	35 + 40 − 2 × 5 = 65
9	**A ∪ B = {1, 3, 8, 9, 12, 13, 15, 16}; A ∩ B = {1, 9, 13}; A − B = {15, 16}; (A ∪ B)′ = {2, 4, 5, 6, 7, 10, 11, 14}**	(A ∪ B)′ is everything in U outside A ∪ B
10	**P = {φ, {d}, {x}, {z}, {d, x}, {d, z}, {x, z}, {d, x, z}}; 7 proper subsets**	2^3 = 8 subsets; all but the set itself are proper: 8 − 1 = 7
11	**A′ = {1, 4, 6, 8, 9, 10, 12, 14, 15, 16, 18, 20, 21, 22, 24, 25}; n(A′) = 16**	n(A) = 9, so n(A′) = 25 − 9 = 16
12	**(a) 16; (b) 30; (c) 9**	n(A ∩ B) = 46 + 25 − 55 = 16; then 46 − 16 and 25 − 16
13	**6**	80% + 55% − 40% = 95% do at least one, so 5% of 120 = 6
14	**(a) 9; (b) 6**	$2^9 - 2^6 = 2^6(2^3 - 1)$ = 448, so 2^6 = 64
15	**27**	sum of the three = exactly one + 2 × exactly two + 3 × all three; 137 − 96 − 2 × 7 = 27
16	**16**	1 and 2 are fixed in; the other 4 are free: 2^4
17	**(a) 24; (b) 21; (c) 28**	n(A ∪ B) = 51 − 20 = 31; n(B) = 31 − 10 + 3 = 24; only B = 24 − 3; exactly one = 7 + 21
18	**(a) 23; (b) 70; (c) 16**	n(A ∪ B ∪ C) = 36 + 37 + 35 − (14 + 12 + 13) + 8 = 77; exactly two = 14 + 12 + 13 − 3 × 8 = 15
19	**(a) 75%; (b) 85%**	(a) n(M ∩ S) = 90 + 85 − n(M ∪ S) ≥ 90 + 85 − 100; (b) n(M ∪ S) = 90%, so 90 + 85 − 90 = 85
20	**(a) 9; (b) 42**	(a) 73 = 113 − 49 + n(all three); (b) only shampoo A = 35 − 11 − 21 + 9 = 12, and so on: 12 + 13 + 17