HIGHER

IG.M2 Sets and Venn Notation

EDEXCEL 4MA1 · Calculator allowed · about 75 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The universal set is xi = {1, 2, 3, ..., 20}. A is the set of multiples of 4 in xi. B is the set of multiples of 6 in xi.

(a) List the elements of A. **(1)**

(b) List the elements of B. **(1)**

(c) List the elements of A intersection B. **(1)**

(d) List the elements of A union B. **(1)**

(e) Find n((A union B)'). **(1)**

.....

(Total for Question 1 is 5 marks)

2 P = {x : x is a prime number, x < 20}. List the elements of P.

(Total for Question 2 is 2 marks)

3 A = {4, 8, 12, 16, 20} (the multiples of 4 up to 20). C = {2, 4, 6}. State, giving a reason, whether C is a subset of A.

(Total for Question 3 is 2 marks)

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4 The universal set is xi = {1, 2, 3, ..., 20}. B is the set of multiples of 6 in xi, so B = {6, 12, 18}. State whether each of the following statements is true or false.

(i) 12 is a member of B. **(1)**

(ii) 20 is a member of B. **(1)**

(Total for Question 4 is 2 marks)

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5 R = {even numbers from 1 to 9} and S = {odd numbers from 1 to 9}. Find R intersection S, giving a reason for your answer.

(Total for Question 5 is 2 marks)

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6 The universal set is xi = {1, 2, 3, ..., 15}. A is the set of multiples of 3 in xi. B is the set of multiples of 5 in xi.

(a) Find n(A). **(1)**

.....

(b) Find A intersection B. **(2)**

.....

(Total for Question 6 is 3 marks)

7 In a group of 60 students, 34 like Football (F), 28 like Netball (N), and 10 like neither sport.

Figure (to be drawn): A two-circle Venn diagram inside a rectangle labelled xi. The circles are labelled F and N and overlap. Numeric values are not pre-filled; this diagram is to be completed as part of solving the question.

(a) Find n(F union N). **(2)**

.....

(b) Find n(F intersection N). **(2)**

.....

(c) Find the number of students who like Football only (Football but not Netball). **(1)**

.....

(d) A student is chosen at random from the group of 60. Find the probability that the student likes Netball but not Football. Give your answer as a fraction in its simplest form. **(2)**

.....

(Total for Question 7 is 7 marks)

8 In a survey of 100 students, the number studying French (F), German (G) and Spanish (S) is shown in the Venn diagram: the region where all three subjects overlap contains 5 students; the region for F and G only (not S) contains x students; the region for F and S only (not G) contains 8 students; the region for G and S only (not F) contains 6 students; the region for F only contains 20 students; the region for G only contains 15 students; the region for S only contains 2x students; and 10 students, outside all three circles, study none of the three languages.

Figure (to be drawn): A three-circle Venn diagram (circles F, G and S, all overlapping in the classic three-set arrangement) inside a rectangle labelled xi. Region values: all three = 5, F and G only = x, F and S only = 8, G and S only = 6, F only = 20, G only = 15, S only = 2x, outside all three circles = 10.

(a) Form an equation in x, and solve it to find the value of x. **(3)**

(b) Find the number of students who study Spanish. **(3)**

(c) Find the number of students who study at least two of the three languages. **(2)**

(d) A student is selected at random from the 100 students. Find the probability that the student studies exactly one of the three languages. **(2)**

(Total for Question 8 is 10 marks)

9 The Venn diagram shows two sets, A and B, inside the universal set xi. The region inside circle A but outside circle B is shaded. Which of the following correctly describes the shaded region?

Figure (to be drawn): A two-circle Venn diagram, circles A and B overlapping, inside a rectangle labelled xi. Only the part of circle A that does not overlap with circle B is shaded.

- ☐ A) A intersection B
- ☐ B) A union B
- ☐ C) A intersection B'
- ☐ D) A' intersection B

(Total for Question 9 is 1 mark)

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10 Using the same two-circle Venn diagram as Question 9 (circles A and B inside universal set xi), write down the set notation for each region described below.

(a) The region where circles A and B overlap. **(1)**

.....

(b) The region outside both circles. **(1)**

.....

(c) The region inside circle B but not inside circle A. **(1)**

.....

(Total for Question 10 is 3 marks)

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11 The universal set is xi = {1, 2, 3, ..., 10}. A = {1, 2, 3, 4, 5}. B = {4, 5, 6, 7, 8}.

(a) Find (A union B)'. **(2)**

.....

(b) Find A' intersection B', and state whether it is equal to your answer to part (a) **(2)**
(this checks De Morgan's law, (A union B)' = A' intersection B', for this example).

.....

(Total for Question 11 is 4 marks)

12 The universal set is xi = {1, 2, 3, ..., 12}. E = {even numbers in xi}. M = {multiples of 3 in xi}. Find the elements of E intersection M.

(Total for Question 12 is 2 marks)

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13 Using the sets E and M from Question 12, complete each statement with 'is a member of' or 'is not a member of'.

(i) 9 ..... E **(1)**

(ii) 9 ..... M **(1)**

(Total for Question 13 is 2 marks)

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14 Using the sets E and M from Question 12 (xi = {1, ..., 12}, E = {2,4,6,8,10,12}, M = {3,6,9,12}), find n(E union M).

(Total for Question 14 is 3 marks)

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15 A and B are sets, with universal set xi. n(xi) = 50, n(A) = 22, n(B) = 19, and n(A union B) = 35. Find n(A intersection B).

(Total for Question 15 is 3 marks)

16 The universal set is xi = {1, 2, 3, ..., 10}. A = {2, 4, 6, 8, 10}. B = {4, 8}.

(a) Is B a subset of A? Give a brief justification. **(1)**

(b) List all the subsets of B that contain exactly one element. **(2)**

(Total for Question 16 is 3 marks)

Mark scheme · IG.M2 Sets and Venn Notation

Question 1

- (a) **B1** A = {4, 8, 12, 16, 20} cao
- **(a) Answer: A = {4, 8, 12, 16, 20}**
- (b) **B1** B = {6, 12, 18} cao
- **(b) Answer: B = {6, 12, 18}**
- (c) **B1** A intersection B = {12} cao, ft from parts (a) and (b)
- **(c) Answer: A intersection B = {12}**
- (d) **B1** A union B = {4, 6, 8, 12, 16, 18, 20} cao, ft from parts (a) and (b)
- **(d) Answer: A union B = {4, 6, 8, 12, 16, 18, 20}**
- (e) **B1** n((A union B)') = 13 cao, ft from part (d)
- **(e) Answer: n((A union B)') = 13**

Question 2

- **M1** at least 5 correct prime numbers less than 20 listed, with no non-prime numbers included
- **A1** P = {2, 3, 5, 7, 11, 13, 17, 19} cao, all 8 elements, none extra
- **Answer: P = {2, 3, 5, 7, 11, 13, 17, 19}**

Question 3

- **B1** correct conclusion: C is not a subset of A
- **B1** valid reason: identifies an element of C that is not a member of A, e.g. 2 is a member of C but 2 is not a member of A (6 is also not a member of A)
- **Answer: C is not a subset of A**

Question 4

- (i) **B1** True cao
- **(i) Answer: True**
- (ii) **B1** False cao
- **(ii) Answer: False**

Question 5

- **B1** R intersection S = the empty set (or { }), cao
- **B1** correct reason, e.g. no number between 1 and 9 can be both even and odd, so R and S have no elements in common
- **Answer: R intersection S = the empty set**

Question 6

- (a) **B1** n(A) = 5 cao
- **(a) Answer: n(A) = 5**
- (b) **M1** identifies that A intersection B consists of numbers in xi that are multiples of both 3 and 5, i.e. multiples of 15
- (b) **A1** A intersection B = {15} cao
- **(b) Answer: A intersection B = {15}**

Question 7

- (a) **M1** 60 - 10, oe
- (a) **A1** n(F union N) = 50 cao
- **(a) Answer: n(F union N) = 50**
- (b) **M1** uses n(F intersection N) = n(F) + n(N) - n(F union N), ft from part (a)
- (b) **A1** n(F intersection N) = 12 cao
- **(b) Answer: n(F intersection N) = 12**
- (c) **B1** 22 cao, ft from part (b): 34 - 12
- **(c) Answer: 22**
- (d) **M1** finds Netball only = n(N) - n(F intersection N) = 28 - 12 = 16, ft, and forms 16/60
- (d) **A1** 4/15 oe cao (simplest form)
- **(d) Answer: 4/15**

Question 8

- (a) **M1** forms a correct equation by summing all eight regions to 100, e.g. 20 + 15 + 2x + x + 8 + 6 + 5 + 10 = 100
- (a) **M1** simplifies correctly, e.g. 64 + 3x = 100, leading to 3x = 36
- (a) **A1** x = 12 cao
- **(a) Answer: x = 12**
- (b) **M1** identifies that n(S) = (S only) + (F and S only) + (G and S only) + (all three), ft their x
- (b) **M1** substitutes their x = 12 correctly, e.g. S only = 2(12) = 24
- (b) **A1** n(S) = 43 cao (24 + 8 + 6 + 5)
- **(b) Answer: n(S) = 43**
- (c) **M1** identifies the correct four regions to add: all three, F and G only, F and S only, G and S only, ft their x
- (c) **A1** 31 cao (5 + 12 + 8 + 6)
- **(c) Answer: 31**
- (d) **M1** sums the three 'only' regions: 20 + 15 + their S only (24)
- (d) **A1** 59/100 cao
- **(d) Answer: 59/100**

Question 9

- **B1** C cao
- **Answer: C**

Question 10

- (a) **B1** A intersection B cao
- **(a) Answer: A intersection B**
- (b) **B1** (A union B)' oe, e.g. A' intersection B'
- **(b) Answer: (A union B)'**
- (c) **B1** A' intersection B cao
- **(c) Answer: A' intersection B**

Question 11

- (a) **M1** A union B = {1, 2, 3, 4, 5, 6, 7, 8} found
- (a) **A1** (A union B)' = {9, 10} cao
- **(a) Answer: (A union B)' = {9, 10}**
- (b) **M1** A' = {6, 7, 8, 9, 10} and B' = {1, 2, 3, 9, 10} both found
- (b) **A1** A' intersection B' = {9, 10} cao, with a correct statement that this equals the answer to part (a), confirming (A union B)' = A' intersection B' for these sets
- **(b) Answer: A' intersection B' = {9, 10}, which equals (A union B)' from part (a)**

Question 12

- **M1** E = {2, 4, 6, 8, 10, 12} and M = {3, 6, 9, 12} both correctly identified (may be implicit)
- **A1** E intersection M = {6, 12} cao
- **Answer: E intersection M = {6, 12}**

Question 13

- (i) **B1** 9 is not a member of E
- **(i) Answer: 9 is not a member of E**
- (ii) **B1** 9 is a member of M
- **(ii) Answer: 9 is a member of M**

Question 14

- **M1** finds n(E intersection M) = 2, ft from Question 12
- **M1** uses n(E union M) = n(E) + n(M) - n(E intersection M), e.g. 6 + 4 - 2
- **A1** n(E union M) = 8 cao
- **Answer: n(E union M) = 8**

Question 15

- **M1** quotes or uses n(A intersection B) = n(A) + n(B) - n(A union B)
- **M1** substitutes correctly, e.g. 22 + 19 - 35
- **A1** n(A intersection B) = 6 cao
- **Answer: n(A intersection B) = 6**

Question 16

- (a) **B1** Yes, because every element of B (4 and 8) is also an element of A
- **(a) Answer: Yes, B is a subset of A**
- (b) **M1** attempts to list single-element subsets of B
- (b) **A1** {4} and {8} cao, both listed and no others
- **(b) Answer: {4} and {8}**