

## Topic 3 Part 2 [221 marks]

1a. [2 marks]

### Markscheme

If I do not break my arm, then it will not hurt (A1)(A1) (C2)

**Note:** Award (A1) for “if... then...”

For Spanish candidates, **only** accept “Si” and “entonces”.

Award (A1) for “not break my arm” and “not hurt” in correct order.

### Examiners report

[N/A]

1b. [2 marks]

### Markscheme

$p$	$q$	$p \Rightarrow q$	Inverse of $p \Rightarrow q$	Converse of $p \Rightarrow q$
T	T	T	T	T
T	F	F	T	T
F	T	T	F	F
F	F	T	T	T

(A1)(A1) (C2)

**Notes:** Award (A1) for each correct column.

### Examiners report

[N/A]

1c. [2 marks]

### Markscheme

logically equivalent (A1)(ft)

last two columns of the truth table are identical (R1)(ft) (C2)

**Notes:** Do not award (A1)(ft)(R0).

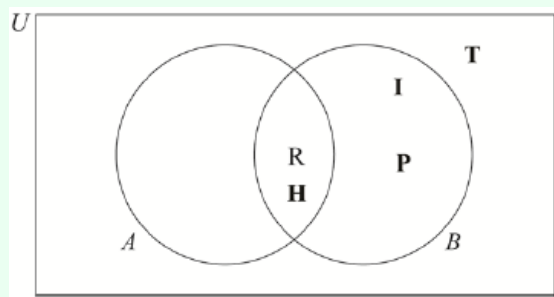
Follow through from the last two columns of the table in part (a).

### Examiners report

[N/A]

2a. [3 marks]

## Markscheme



(A3) (C3)

**Note:** Award **(A3)** if all four letters placed correctly,

**(A2)** if three letters are placed correctly,

**(A1)** if two letters are placed correctly.

## Examiners report

[N/A]

2b. [3 marks]

## Markscheme

(i) Rhombus and rectangle **OR** H and R **(A1)(ft)**

(ii) Scalene triangle **OR** T **(A2)(ft) (C3)**

**Notes:** Award **(A1)** for a list R, H, I, P seen (identifying the union).

Follow through from their part (a).

## Examiners report

[N/A]

3a. [3 marks]

## Markscheme

(i)  $\frac{1}{3}$  (0.333333..., 33.3333...%) **(A1)**

(ii)  $\frac{1}{2}$  (0.5, 50%) **(A1)**

(iii)  $\frac{1}{4}$  (0.25, 25%) **(A1)**

## Examiners report

[N/A]

3b.

[7 marks]

## Markscheme

(i)  $\frac{1}{3} \times \frac{1}{4}$  **(M1)**

$= \frac{1}{12}$  (0.0833333..., 8.33333...%) **(A1)(G2)**

(ii)  $\frac{1}{3} \times \frac{1}{2} + \frac{1}{3} \times \frac{1}{4} + \frac{1}{3} \times \frac{1}{4}$  **(A1)(ft)(M1)**

**Note:** Award **(A1)(ft)** for their three correct products seen, **(M1)** for addition of their products.

$= \frac{1}{3}$  (0.333333..., 33.3333...%) **(A1)(ft)(G2)**

**Note:** Follow through from their parts (a)(i) and (a)(iii).

(iii)  $1 - \frac{1}{12} - \frac{1}{3}$  **(M1)**

**Note:** Follow through from parts (b)(i) and (b)(ii).

**OR**

$\frac{1}{3} \times \frac{1}{2} + \frac{1}{3} \times \frac{1}{4} + \frac{1}{3}$  **(M1)**

**Note:** Follow through from parts (a)(i) and (a)(ii).

$= \frac{7}{12}$  (0.583333..., 58.3333...%) **(A1)(ft)(G2)**

## Examiners report

[N/A]

3c.

[2 marks]

## Markscheme

Sonya is not correct. **(A1)(ft)**

The probability that Mike escapes is  $\frac{7}{12}$ , which is

greater than  $\frac{5}{12}$  (or greater than  $\frac{1}{2}$ ). **(R1)(ft)**

**Notes:** Do not award **(A1)(R0)**.

Follow through from their answers to part (b).

## Examiners report

[N/A]

3d.

[3 marks]

## Markscheme

$\frac{\frac{1}{3}}{\frac{7}{12}}$  **(A1)(A1)(ft)**

**Note:** Award **(A1)** for correct numerator, **(A1)** for correct denominator.

$= \frac{4}{7}$  ( $\frac{12}{21}$ , 0.571428..., 57.1428...%) **(A1)(ft)(G2)**

**Note:** Follow through from their answer to part (b)(iii).

## Examiners report

[N/A]

4a.

[2 marks]

### Markscheme

2 3 3 4 4 5 5 5 6 7 **(M1)**

**Note:** Award **(M1)** for correct ordered set.

(Median =) 4.5 **(A1)** **(C2)**

### Examiners report

Part (a) was generally well done although some candidates seemed to be confused between the mean and median.

4b.

[2 marks]

### Markscheme

5 – 3 **(M1)**

**Note:** Award **(M1)** for correct quartiles seen.

= 2 **(A1)** **(C2)**

### Examiners report

In part (b) it was not unusual to see an upper quartile of 5.5 (resulting from  $(5+6)/2$ ).

4c.

[2 marks]

### Markscheme

$\frac{7}{10}$  (0.7, 70%) **(A2)** **(C2)**

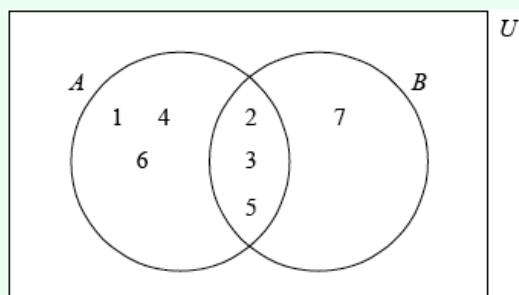
### Examiners report

A significant number of candidates had difficulty with “at least four” in part (c), answering 2/10 which resulted from calculating the probability of a grade equal to 4 and not at least 4.

5a.

[2 marks]

### Markscheme



**(A1)(A1)** **(C2)**

**Note:** Award **(A1)** for 2, 3, 5 in intersection, **(A1)** for 1, 4, 6, 7 correctly placed.

## Examiners report

The Venn diagram in part (a) was successfully completed by the majority of candidates.

5b. [2 marks]

### Markscheme

1 (M1)(A1)(ft) (C2)

**Notes:** Award (M1)(A0) for listing the elements of their set  $B \cap A'$ ; shading the correct region on diagram; or an answer of  $1/7$  with a correct Venn diagram. Follow through from part (a).

## Examiners report

Many identified correctly the set  $B \cap A'$ , but listed the element instead of writing the number of elements in the set.

5c. [2 marks]

### Markscheme

Correct, from (2, 2) (3, 3) and (5, 5) on sample space

**OR**

Correct, from a labelled tree diagram

**OR**

Correct, from a sample space diagram

**OR**

Correct, from  $3 \times \frac{1}{4} \times \frac{1}{6}$  (or equivalent) (A1)(ft)(R1) (C2)

**Notes:** Do not award (A1)(ft)(R0). Award (R1) for a consistent reason with their part (a). Follow through from part (a).

## Examiners report

In part (c) the majority stated that Shin was incorrect giving probabilities of  $3/8$  ( $3/6 \times 3/4$ ) or  $3/7$  as being the correct probability. The few candidates using a sample space diagram usually answered correctly, tree diagrams were hardly used. Many candidates did not realize that it was not enough for each to roll one of the three numbers in the intersection, but that they needed to roll the same number. Probabilities of joined events seemed to be too difficult for the majority.

6a. [1 mark]

### Markscheme

0.9 (A1) (C1)

## Examiners report

Surprisingly, in part (a) the majority of candidates answered incorrectly. The usual answer was 0.225, resulting from  $0.25 \times 0.9$ ; the probability that Peter walks and arrives on time.

### Markscheme

$$0.75 \times 0.05 \quad \textbf{(M1)}$$

$$= 0.0375 \quad \left(\frac{3}{80}, 3.75\%\right) \quad \textbf{(A1)} \quad \textbf{(C2)}$$

### Examiners report

In part (b) the answers were mostly correct as the candidates repeated the same procedure, which was correct for this part.

### Markscheme

$$\frac{0.75 \times 0.05}{0.75 \times 0.05 + 0.25 \times 0.1} \quad \textbf{(M1)(M1)}$$

**Note:** Award **(M1)** for their correct numerator, **(M1)** for their correct denominator, ie,  $\left(\frac{\text{their (b)}}{\text{their (b)} + 0.25 \times 0.1}\right)$ .

Do not award **(M1)** for *their* 0.0375 or 0.0625 if not a correct part of a fraction.

$$= 0.6 \quad \left(\frac{3}{5}, 60\%\right) \quad \textbf{(A1)(ft)} \quad \textbf{(C3)}$$

**Note:** Follow through from part (b).

### Examiners report

The conditional probability in part (c) was too much for most. In some cases a correct numerator or denominator was found. More candidates could have received method marks if working had been shown.

### Markscheme

$r$	$p$	$q$	$r \wedge p$	$\neg q$	$(r \wedge p) \vee \neg q$	$\neg((r \wedge p) \vee \neg q)$	$\neg(r \wedge p)$	$\neg(r \wedge p) \wedge q$
T	T	T	T	F	T	F	F	F
T	T	F	T	T	T	F	F	F
T	F	T	F	F	F	T	T	T
T	F	F	F	T	T	F	T	F
F	T	T	F	F	F	T	T	T
F	T	F	F	T	T	F	T	F
F	F	T	F	F	F	T	T	T
F	F	F	F	T	T	F	T	F

**(C4)** **(A1)(A1)(ft)(A1)(ft)(A1)**

**Notes:** Award **(A1)** for each correct column.

For the “ $(r \wedge p) \vee \neg q$ ” follow through from the “ $r \wedge p$ ” column.

For the “ $\neg((r \wedge p) \vee \neg q)$ ” column, follow through from the preceding column.

### Examiners report

[N/A]

7b.

[2 marks]

Markscheme

tautology (A1)(ft)  
columns  $\neg((r \wedge p) \vee \neg q)$  and  $\neg(r \wedge p) \wedge q$  are identical (R1)(C2)

Notes: Do not award (R0)(A1)(ft). Follow through from their table in part (a).  
Award the (R1) for an additional column representing  $\neg((r \wedge p) \vee \neg q) \Leftrightarrow \neg(r \wedge p) \wedge q$  that is consistent with their table.

Examiners report

[N/A]

8.

[6 marks]

Markscheme

Set	Diagram	(A6)(C6)
$(A \cup B)'$	3	
$A' \cup B'$	1	
$A \cap B'$	2	
$A \cap B$	6	
$A' \cup B$	5	
$A'$	4	

Note: Award (A1) for each correct entry.

Examiners report

[N/A]

9a.

[1 mark]

Markscheme

$x$  is not a multiple of 12 (A1) (C1)

Examiners report

[N/A]

9b.

[2 marks]

Markscheme

$p \Rightarrow q$  (A1)(A1)(C2)  
Note: Award (A1) for  $\Rightarrow$ , (A1) for  $p$  and  $q$  in the correct order.  
Accept  $q \Leftarrow p$ .

Examiners report

[N/A]

9c. [1 mark]

## Markscheme

Converse **(A1) (C1)**

## Examiners report

[N/A]

9d. [2 marks]

## Markscheme

not valid **(A1)**

for example 18 is a multiple of 6 and not a multiple of 12 **(R1) (C2)**

**Notes:** Do not award **(A1)(R0)**. Any multiple of 6 that is not a multiple of 12 can be accepted as a counterexample.

## Examiners report

[N/A]

10a. [3 marks]

## Markscheme

$(p \wedge q) \Rightarrow r$  **(A1)(A1)(A1)**

**Notes:** Award **(A1)** for conjunction seen, award **(A1)** for implication seen, award **(A1)** for correct simple propositions in correct order (the parentheses **are** required). Accept  $r \Leftarrow (p \wedge q)$ .

## Examiners report

Forming the statement in part (a) was attainable by the great majority, although the lack of parentheses was a common fault.

10b. [2 marks]

## Markscheme

$p$	$q$	$r$	$(p \wedge q)$	$(p \wedge q) \Rightarrow r$
T	T	T	<b>T</b>	<b>T</b>
T	T	F	<b>T</b>	<b>F</b>
T	F	T	<b>F</b>	<b>T</b>
T	F	F	<b>F</b>	<b>T</b>
F	T	T	<b>F</b>	<b>T</b>
F	T	F	<b>F</b>	<b>T</b>
F	F	T	<b>F</b>	<b>T</b>
F	F	F	<b>F</b>	<b>T</b>

**(A1)(ft)(A1)(ft)**

**Notes:** Award **(A1)(ft)** for each correct column, follow through to the final column from **their**  $(p \wedge q)$  column. For the second **(A1)(ft)** to be awarded there must be an implication in part (a).

Follow through from part (a).

## Examiners report

The truth table in part (b) saw less success and it was clear that some centres simply had not prepared their candidates in this area of the course.



10c.

[2 marks]

## Markscheme

The argument is not valid since not all entries in the final column are T. **(A1)(ft)(R1)**

**Notes:** Do not award **(A1)(ft)(R0)**. Follow through from part (b).

Accept "The argument is not valid since  $(p \wedge q) \Rightarrow r$  is not a tautology".

## Examiners report

Where the truth table was correctly constructed many candidates were not aware of the conditions required for an argument to be valid and in part (d) the converse and the inverse were often confused.

10d.

[4 marks]

## Markscheme

(i)  $\neg(p \wedge q) \Rightarrow \neg r$  **(A1)(ft)(A1)(ft)**

**OR**

$(\neg p \vee \neg q) \Rightarrow \neg r$  **(A1)(ft)(A1)(ft)**

**Notes:** Award **(A1)(ft)** for the negation of their antecedent and the negation of their consequent, **(A1)(ft)** for their fully correct answer.

Follow through from part (a). Accept  $\neg r \Leftarrow \neg(p \wedge q)$  or  $\neg r \Leftarrow (\neg p \vee \neg q)$ . Follow through from part (a).

(ii) if it is **not the case** that the land has been purchased **and** the building permit has been obtained then the land can **not** be used for residential purposes. **(A1)(A1)(ft)**

**OR**

if (either) the land has **not** been purchased **or** the building permit has **not** been obtained then the land can **not** be used for residential purposes. **(A1)(A1)(ft)**

**Notes:** Award **(A1)** for "if... then..." seen, **(A1)(ft)** for correct statements in correct order. Follow through from part (d)(i).

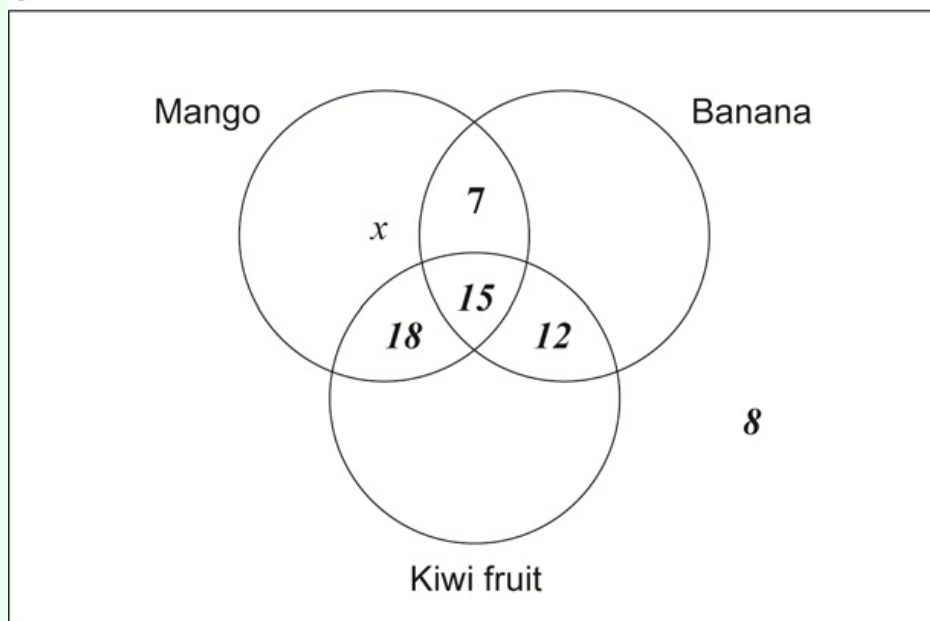
## Examiners report

Where the truth table was correctly constructed many candidates were not aware of the conditions required for an argument to be valid and in part (d) the converse and the inverse were often confused.

11a.

[3 marks]

## Markscheme

 $U$ **(A1)(A1)(A1)**

**Notes:** Award **(A1)** for 15 in the correct place.

Award **(A1)** for 7, 18 and 12 seen in the correct places.

Award **(A1)** for 8 in the correct place.

Award at most **(A0)(A1)(A1)** if diagram is missing the rectangle.

## Examiners report

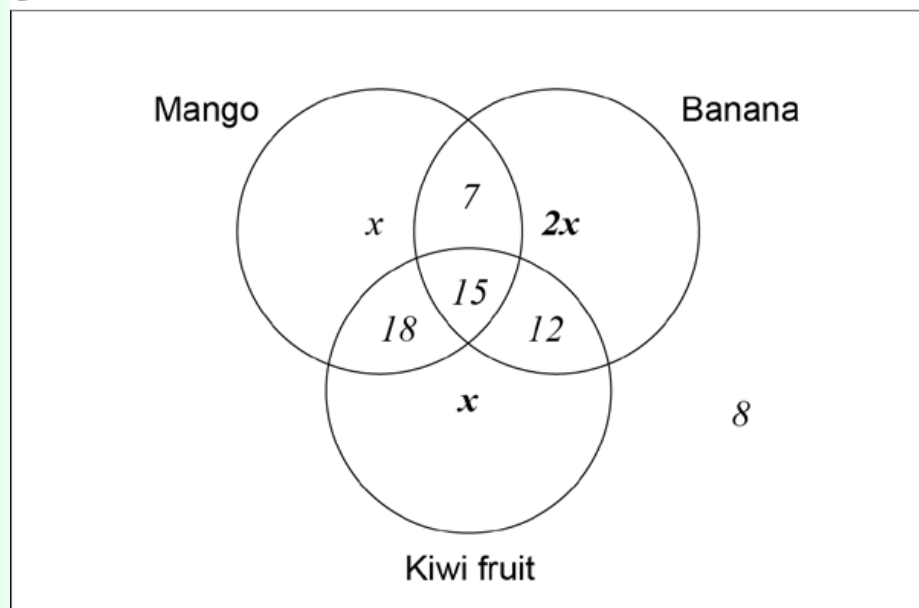
[N/A]

11b.

[2 marks]

## Markscheme

$U$



(A1)(A1)

**Notes:** Award **(A1)** for  $x$  seen in the correct places.

Award **(A1)** for  $2x$  seen in the correct place.

Award **(A0)(A1)(ft)** if  $x$  and  $2x$  are replaced by 10 and 20 respectively.

## Examiners report

[N/A]

11c.

[2 marks]

## Markscheme

$$2x + x + x + 15 + 8 + 7 + 18 + 12 = 100 \quad (4x + 60 = 100 \text{ or equivalent}) \quad \textbf{(M1)}$$

**Note:** Award **(M1)** for equating the sum of the elements of their Venn diagram to 100. Equating to 100 may be implied.

$$(x =) 10 \quad \textbf{(A1)(ft)(G2)}$$

**Note:** Follow through from their Venn diagram. The answer must be a positive integer.

## Examiners report

[N/A]

11d. [2 marks]

## Markscheme

(i)  
50 **(A1)(ft)**

(ii)  
82 **(A1)(ft)**

**Note:** Follow through from their answer to part (c) and their Venn diagram.

Award **(A0)(ft)(A1)(ft)** if answer is  $\frac{50}{100}$  and  $\frac{82}{100}$ .

## Examiners report

[N/A]

11e. [4 marks]

## Markscheme

(i)  $\frac{8}{100}$   $\left(\frac{2}{25}; 0.08; 8\%\right)$  **(A1)**

**Note:** Correct answer only. There is no follow through.

(ii)  $\frac{37}{100}$   $(0.37, 37\%)$  **(A1)(ft)**

**Note:** Follow through from their Venn diagram.

(iii)  $\frac{15}{22}$   $(0.681; 0.682; 68.2\%)$   $(0.681818\dots)$  **(A1)(A1)(ft)(G2)**

**Notes:** Award **(A1)** for numerator, **(A1)(ft)** for denominator, follow through from their Venn diagram. Award **(A0)(A0)** if answer is given as incorrect reduced fraction without working.

## Examiners report

[N/A]

11f. [3 marks]

## Markscheme

$\frac{8}{100} \times \frac{7}{99}$  **(A1)(ft)(M1)**

**Note:** Award **(A1)(ft)** for correct fractions, follow through from their answer to part (e)(i), **(M1)** for multiplying their fractions.

$= \frac{56}{9900}$   $\left(\frac{14}{2475}, 0.00565656\dots, 0.00566, 0.0056, 0.566\%\right)$  **(A1)(ft)(G2)**

## Examiners report

[N/A]

12a. [2 marks]

## Markscheme

If Eva is losing weight then Eva is on a diet (AI)(AI) (C2)

**Notes:** Award (AI) for If... then...

For Spanish candidates, **only** accept “Si” and “entonces”.

For French candidates, **only** accept “Si” and “alors”.

*For all 3 languages these words are from the subject guide.*

Award (AI) for correct propositions in correct order.

[2 marks]

## Examiners report

[N/A]

12b. [2 marks]

## Markscheme

If Eva is not on a diet then she is not losing weight (AI)(AI) (C2)

**Notes:** Award (AI) for “not on a diet” and “not losing weight” seen, (AI) for complete correct answer.

No follow through from part (a).

[2 marks]

## Examiners report

[N/A]

12c. [2 marks]

## Markscheme

The statements are logically equivalent (AI)(ft)

The contrapositive is always logically equivalent to the original statement (RI)(ft)

**OR**

A correct truth table showing the equivalence (RI)(ft) (C2)

**Note:** Follow through from their answers to part (a) and part (b).

[2 marks]

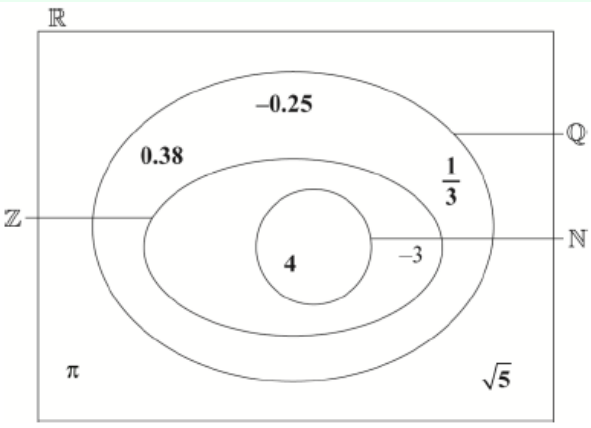
## Examiners report

[N/A]

13a.

[1 mark]

Markscheme



(A1)(A1)(A1)(A1)(A1)(A1) (C6)

**Note:** Award (A1) for each number correctly placed.  
Award (A0) for any entry in more than one region.

[1 mark]

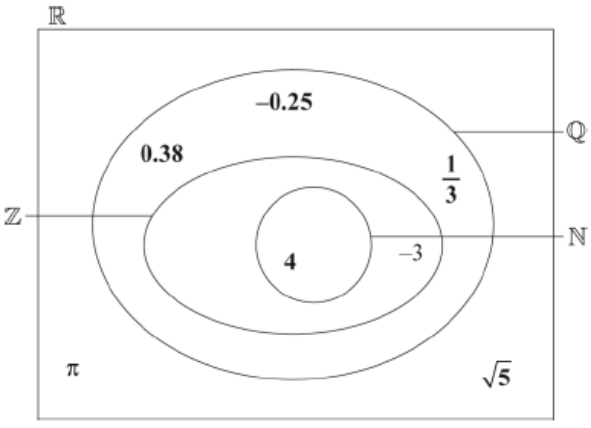
Examiners report

[N/A]

13b.

[1 mark]

Markscheme



(A1)(A1)(A1)(A1)(A1)(A1) (C6)

**Note:** Award (A1) for each number correctly placed.  
Award (A0) for any entry in more than one region.

[1 mark]

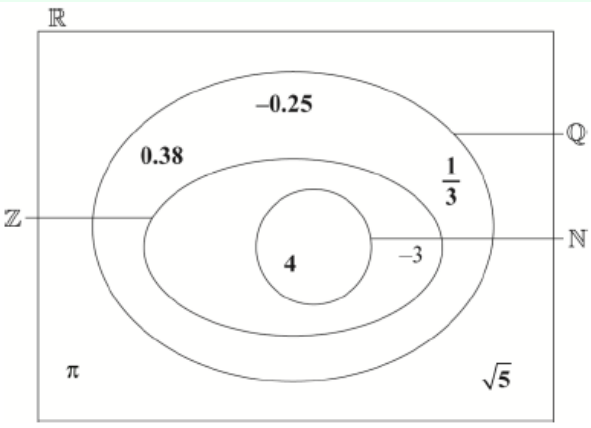
Examiners report

[N/A]

13c.

[1 mark]

Markscheme



(A1)(A1)(A1)(A1)(A1)(A1) (C6)

**Note:** Award (A1) for each number correctly placed.  
Award (A0) for any entry in more than one region.

[1 mark]

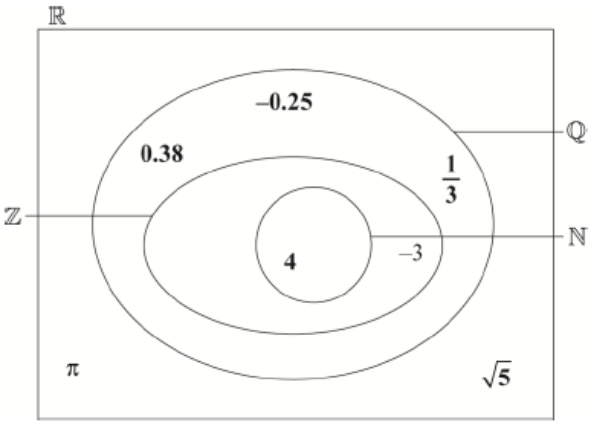
Examiners report

[N/A]

13d.

[1 mark]

Markscheme



(A1)(A1)(A1)(A1)(A1)(A1) (C6)

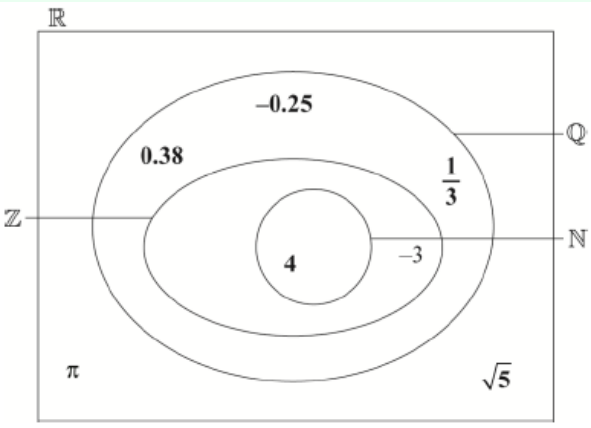
**Note:** Award (A1) for each number correctly placed.  
Award (A0) for any entry in more than one region.

[1 mark]

Examiners report

[N/A]

Markscheme



(A1)(A1)(A1)(A1)(A1)(A1) (C6)

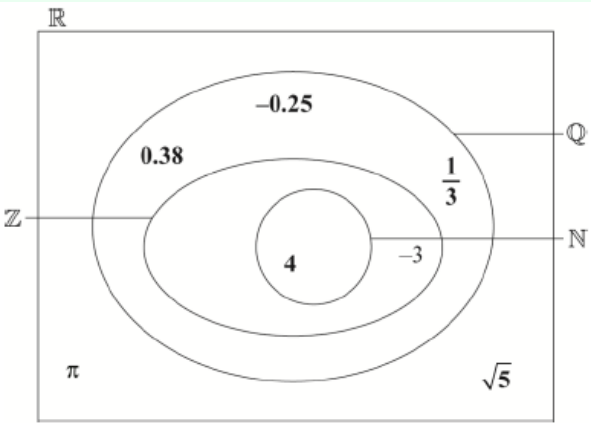
**Note:** Award (A1) for each number correctly placed.  
Award (A0) for any entry in more than one region.

[1 mark]

Examiners report

[N/A]

Markscheme



(A1)(A1)(A1)(A1)(A1)(A1) (C6)

**Note:** Award (A1) for each number correctly placed.  
Award (A0) for any entry in more than one region.

[1 mark]

Examiners report

[N/A]



14a. [3 marks]

## Markscheme

(i)

$$0.7 \left( \frac{70}{100}, \frac{7}{10}, 70\% \right) \quad (A1)$$

(ii)

$$0.2 \left( \frac{20}{100}, \frac{2}{10}, \frac{1}{5}, 20\% \right) \quad (A1)$$

(iii)

$$0.85 \left( \frac{85}{100}, \frac{17}{20}, 85\% \right) \quad (A1)$$

[3 marks]

## Examiners report

[N/A]

14b. [8 marks]

## Markscheme

(i)

$$0.7 \times 0.85 \quad (M1)$$

**Note:** Award *(M1)* for multiplying their values from parts (a)(i) and (a)(iii).

$$= 0.595 \left( \frac{119}{200}, 59.5\% \right) \quad (A1)(ft)(G1)$$

**Note:** Follow through from part (a).

(ii)

$$0.3 \times 0.2 + 0.7 \times 0.85 \quad (M1)(M1)$$

**Note:** Award *(M1)* for their two products, *(M1)* for adding their two products.

$$= 0.655 \left( \frac{131}{200}, 65.5\% \right) \quad (A1)(ft)(G2)$$

**Note:** Follow through from part (a).

(iii)

$$\frac{0.595}{0.655} \quad (A1)(ft)(A1)(ft)$$

**Notes:** Award *(A1)(ft)* for correct numerator, *(A1)(ft)* for correct denominator. Follow through from parts (b)(i) and (ii).

$$= 0.908 \left( 0.90839\dots, \frac{119}{131}, 90.8\% \right) \quad (A1)(ft)(G2)$$

[8 marks]

## Examiners report

[N/A]

14c. [2 marks]

## Markscheme

$$0.3 \times 0.3 \quad (M1)$$

$$= 0.09 \left( \frac{9}{100}, 9\% \right) \quad (A1)(G2)$$

[2 marks]

## Examiners report

[N/A]

14d. [3 marks]

### Markscheme

$$0.3 \times 0.7 \quad (M1)$$

$$0.3 \times 0.7 \times 2 \quad \text{OR}$$

$$(0.3 \times 0.7) + (0.7 \times 0.3) \quad (M1)$$

**Note:** Award *(M1)* for their correct product seen, *(M1)* for multiplying their product by 2 or for adding their products twice.

$$= 0.42 \left( \frac{42}{100}, \frac{21}{50}, 42\% \right) \quad (A1)(ft)(G2)$$

**Note:** Follow through from part (a)(i).

[3 marks]

## Examiners report

[N/A]

15a. [1 mark]

### Markscheme

$$2, 4, 6, 8, 10 \quad (A1) \quad (CI)$$

**Note:** Do not penalize the use of { }.

[1 mark]

## Examiners report

This question was done well by most candidates. The most frequent error was to omit the placement of 1 and 5 or to include 0 in the set of even integers.

15b. [1 mark]

### Markscheme

$$3, 6, 9 \quad (A1) \quad (CI)$$

**Note:** Do not penalize the use of { }.

Follow through from part (a) only if their U is listed.

[1 mark]

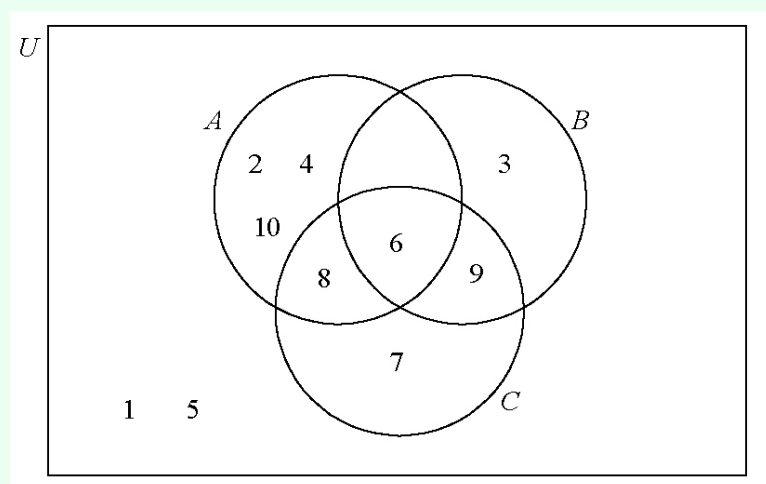
## Examiners report

This question was done well by most candidates. The most frequent error was to omit the placement of 1 and 5 or to include 0 in the set of even integers.

15c.

[4 marks]

## Markscheme



(AI)(ft)(AI)(ft)(AI)(ft)(AI)(ft) (C4)

**Notes:** Award (AI)(ft) for the correct placement of

6.

Award (AI)(ft) for the correct placement of

8 and

9 and the empty region.

Award (AI)(ft) for the correct placement of

2,

4,

3,

7, and

10.

Award (AI)(ft) for the correct placement of

1 and

5.

If an element is in more than one region, award (A0) for that element.

Follow through from their answers to parts (a) and (b).

[4 marks]

## Examiners report

This question was done well by most candidates. The most frequent error was to omit the placement of 1 and 5 or to include 0 in the set of even integers.

16a.

[3 marks]

Examiners report

[N/A]

16b. [3 marks]

Markscheme

$p$	$q$	$r$	$p \wedge q$	$\neg r$	$(p \wedge q) \Rightarrow \neg r$
T	T	T	T	F	F
T	T	F	T	T	T
T	F	T	F	F	T
T	F	F	F	T	T
F	T	T	F	F	T
F	T	F	F	T	T
F	F	T	F	F	T
F	F	F	F	T	T

(AI)(AI)(AI)(ft) (C3)

Notes: Award (AI) for each correct column.  
The final column must follow through from the previous two columns.

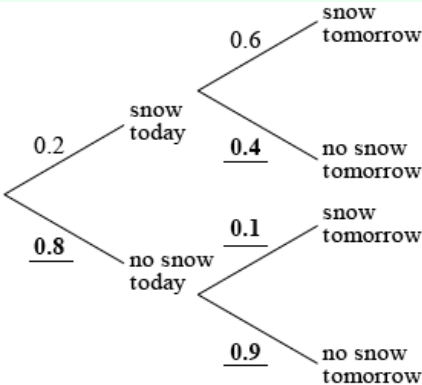
[3 marks]

Examiners report

[N/A]

17a. [3 marks]

Markscheme



(AI)(AI)(AI) (C3)

Note: Award (AI) for each correct pair of probabilities.

[3 marks]

Examiners report

[N/A]

17b. [3 marks]

## Markscheme

$$0.2 \times 0.6 + 0.8 \times 0.1 \quad (AI)(ft)(MI)$$

**Note:** Award  $(AI)(ft)$  for two correct products of probabilities taken from their diagram,  $(MI)$  for the addition of their products.

$$= 0.2 \left( \frac{1}{5}, 20\% \right) \quad (AI)(ft) \quad (C3)$$

**Note:** Accept any equivalent correct fraction.

Follow through from their tree diagram.

[3 marks]

## Examiners report

[N/A]

18a. [2 marks]

## Markscheme

$$q \Rightarrow p \quad (AI)(AI) \quad (C2)$$

**Note:** Award the first  $(AI)$  for seeing the implication sign, the second  $(AI)$  is for a correct answer only. Not using the implication earns **no** marks.

[2 marks]

## Examiners report

[N/A]

18b. [1 mark]

## Markscheme

$$p \Rightarrow q \quad (AI)(ft) \quad (C1)$$

**Note:** Award  $(AI)(ft)$  where the propositions in the implication in part (a) are exchanged.

[1 mark]

## Examiners report

[N/A]

18c. [2 marks]

## Markscheme

Not equivalent; a kite or an isosceles trapezium (for example) can have diagonals that are equal in length. **(AI)(RI) (C2)**

**Notes:** Accept a valid sketch as reasoning.

If the reason given is that *a square has diagonals of equal length, but is not a rectangle*, then award **(RI)(A0)**.

Do not award **(AI)(R0)**.

Do not accept solutions based on truth tables.

[2 marks]

## Examiners report

[N/A]

18d. [1 mark]

## Markscheme

Inverse **(AI) (CI)**

**Note:** Do not accept symbolic notation.

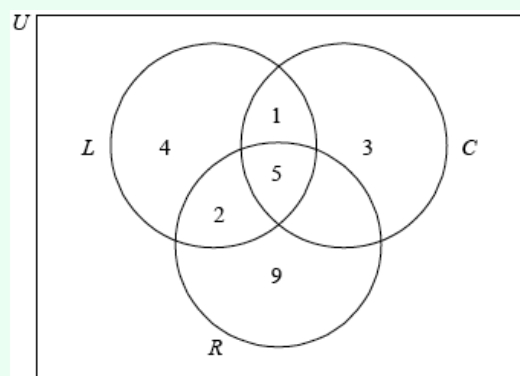
[1 mark]

## Examiners report

[N/A]

19a. [4 marks]

## Markscheme



**(AI)(AI)(AI)(AI)**

**Note:** Award **(AI)** for rectangle and three labelled intersecting circles (the rectangle need not be labelled), **(AI)** for 5, **(AI)** for 2 and 1, **(AI)** for 4, 3 and 9.

[4 marks]

## Examiners report

[N/A]

19b. [2 marks]

## Markscheme

$$25 - (5 + 2 + 1 + 4 + 3 + 9) \quad (M1)$$

**Notes:** Award *(M1)* for their

$5 + 2 + 1 + 4 + 3 + 9$  seen even if total is greater than 25.

Do not award *(A1)(ft)* if their total is greater than 25.

$$= 1 \quad (A1)(ft)(G2)$$

[2 marks]

## Examiners report

[N/A]

19c. [6 marks]

## Markscheme

(i)

$$\frac{12}{25} \text{ (0.48, 48\%)} \quad (A1)(ft)(A1)(G2)$$

**Notes:** Award *(A1)(ft)* for numerator, *(A1)* for denominator.

Follow through from Venn diagram.

(ii)

$$\frac{16}{25} \text{ (0.64, 64\%)} \quad (A1)(A1)(G2)$$

**Notes:** Award *(A1)* for numerator, *(A1)* for denominator.

There is no follow through; all information is given.

(iii)

$$\frac{4}{16} \text{ (0.25, 25\%)} \quad (A1)(A1)(ft)(G2)$$

**Notes:** Award *(A1)* for numerator, *(A1)(ft)* for denominator.

Follow through from part (c)(ii) **only**.

[6 marks]

## Examiners report

[N/A]

19d. [2 marks]

## Markscheme

$$\frac{6}{12} \text{ (0.5, 50\%)} \quad (A1)(A1)(ft)(G2)$$

**Notes:** Award *(A1)* for numerator, *(A1)(ft)* for denominator.

Follow through from Venn diagram.

[2 marks]

## Examiners report

[N/A]

20a.

[2 marks]

### Markscheme

(i) 3, 4, 5, 6, 7, 8, 9 (A1)

(ii) 3, 4, 6, 8 (A1)(ft) (C2)

**Notes:** Follow through from part (a)(i).

[2 marks]

## Examiners report

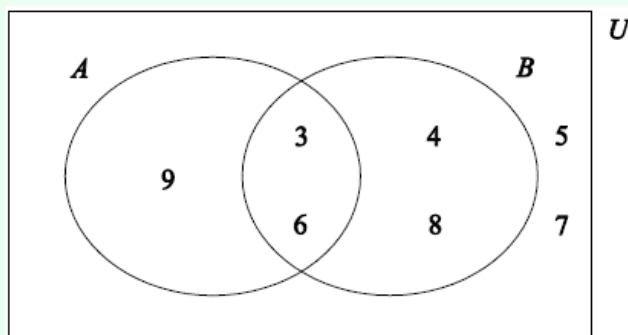
Many candidates were unable to write down correctly the universal set which was integers between 2 and

10. Some candidates did not read the direction “on the Venn diagram” so complained of lack of space for their answer. It is important candidates read the directions carefully. Many candidates listed the elements of the intersection rather than answering the question to specify the number of elements. The empty set for  $(A \cup B)'$  was awarded a maximum of 2 marks as this has simplified the problem.

20b.

[3 marks]

### Markscheme



(A1)(ft) for their 3, 6

(A1)(ft) for their 4, 8, 9

(A1)(ft) for their 5, 7 (A1)(ft)(A1)(ft)(A1)(ft) (C3)

**Note:** Follow through from their universal set and set B in part (a).

[3 marks]

## Examiners report

Many candidates were unable to write down correctly the universal set which was integers between 2 and

10. Some candidates did not read the direction “on the Venn diagram” so complained of lack of space for their answer. It is important candidates read the directions carefully. Many candidates listed the elements of the intersection rather than answering the question to specify the number of elements. The empty set for  $(A \cup B)'$  was awarded a maximum of 2 marks as this has simplified the problem.



20c. [1 mark]

## Markscheme

2 (AI)(ft) (C1)

**Note:** Follow through from their Venn diagram.

[1 mark]

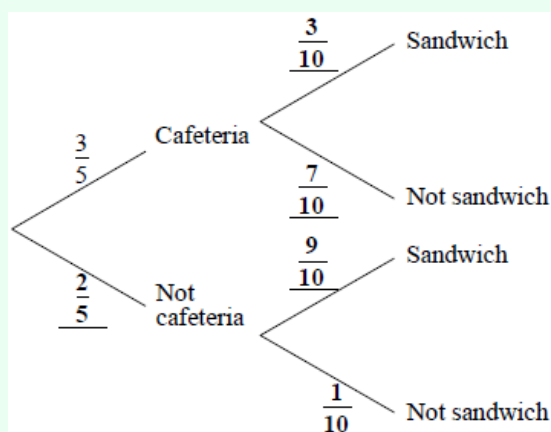
## Examiners report

Many candidates were unable to write down correctly the universal set which was integers between 2 and

10. Some candidates did not read the direction “on the Venn diagram” so complained of lack of space for their answer. It is important candidates read the directions carefully. Many candidates listed the elements of the intersection rather than answering the question to specify the number of elements. The empty set for  $(A \cup B)'$  was awarded a maximum of 2 marks as this has simplified the problem.

21a. [3 marks]

## Markscheme



(AI)(AI)(AI) (C3)

**Note:** Award (AI) for each correct pair of branches.

## Examiners report

[N/A]

21b. [3 marks]

## Markscheme

$$\frac{3}{5} \times \frac{3}{10} + \frac{2}{5} \times \frac{9}{10} \quad (AI)(ft)(MI)$$

**Notes:** Award (AI)(ft) for their two correct products, (MI) for addition of their products. Follow through from their tree diagram.

$$= \frac{27}{50} (0.54, 54\%) \quad (AI)(ft) \quad (C3)$$

## Examiners report

[N/A]

22a. [2 marks]

## Markscheme

$p$	$q$	$\neg p$	$\neg p \vee q$
T	T	F	T
T	F	F	F
F	T	T	T
F	F	T	T

(AI) for third column and (AI)(ft) for fourth column (AI)(AI)(ft) (C2)

## Examiners report

This was provocative in the G2 and the comments indicate that candidates found the wording confusing. Candidates were able to write in words the compound proposition

$\neg p \vee q$  and following from their truth table the candidates could state if this was true or false.

22b. [2 marks]

## Markscheme

$x$  is greater than or equal to (not less than) 10 or

$x^2$  is greater than 100. (AI)(AI) (C2)

**Note:** Award (AI) for “greater than or equal to (not less than) 10”, (AI) for “or  $x^2$  is greater than 100”.

## Examiners report

This was provocative in the G2 and the comments indicate that candidates found the wording confusing. Candidates were able to write in words the compound proposition

$\neg p \vee q$  and following from their truth table the candidates could state if this was true or false. In part (c) many candidates either stated the correct answer “true” or stated an answer consistent with their truth table and received follow-through marks. Candidates had difficulty writing down a value of

$x$  for which

$\neg p \vee q$  is false.

22c. [1 mark]

## Markscheme

True (AI)(ft) (C1)

**Note:** Follow through from their answer to part (a).

## Examiners report

This was provocative in the G2 and the comments indicate that candidates found the wording confusing. Candidates were able to write in words the compound proposition

$\neg p \vee q$  and following from their truth table the candidates could state if this was true or false. In part (c) many candidates either stated the correct answer “true” or stated an answer consistent with their truth table and received follow-through marks. Candidates had difficulty writing down a value of

$x$  for which  $\neg p \vee q$  is false.

22d. [1 mark]

## Markscheme

Any value of  $x$  such that

$$-10 \leq x < 10. \quad (AI)(ft) \quad (CI)$$

**Note:** Follow through from their answer to part (a).

## Examiners report

This was provocative in the G2 and the comments indicate that candidates found the wording confusing. Candidates were able to write in words the compound proposition

$\neg p \vee q$  and following from their truth table the candidates could state if this was true or false.

23a. [2 marks]

## Markscheme

$$\neg p \Rightarrow \neg q \quad (AI)(AI) \quad (C2)$$

**Note:** Award *(AI)* for any 2 correct symbols seen in a statement, *(AI)* for all 3 correct symbols in correct order.

## Examiners report

[N/A]

23b. [3 marks]

## Markscheme

$p$	$q$	$\neg q$	$p \vee \neg q$	$\neg(p \vee \neg q)$
T	T	F	T	F
T	F	T	T	F
F	T	F	F	T
F	F	T	T	F

*(AI)(AI)(ft)(AI)(ft) (C3)*

**Note:** Award *(AI)* for each correct column. 4<sup>th</sup> column is follow through from 3<sup>rd</sup>, 5<sup>th</sup> column is follow through from 4<sup>th</sup>.

## Examiners report

[N/A]

23c. [1 mark]

## Markscheme

Not all of last column is F *(RI)(ft) (CI)*

**Note:** Award *(RI)(ft)* if final column does not lead to a contradiction.

## Examiners report

[N/A]

24a. [3 marks]

### Markscheme

(i)

$$p \wedge \neg q \quad (AI)(AI)$$

**Note:** Award *(AI)* for conjunction, *(AI)* for negation of  $q$ .

(ii)

$$p \vee q \text{ OR}$$

$$(p \vee q) \vee (p \wedge q) \quad (AI) \quad (C3)$$

## Examiners report

Some candidates found the phrase “Yuiko is studying French but not Chinese” confusing as they did not realize in this context the word “but” means “and”. Alternative but correct logic notation was accepted.

24b. [3 marks]

### Markscheme

If Yuiko is not studying Chinese, (then) she is studying French.  $(AI)(AI)(AI) \quad (C3)$

**Notes:** Award *(AI)* for “if ... (then)” seen, award *(AI)* for “not studying Chinese” seen, *(AI)* for correct propositions in correct order.

## Examiners report

[N/A]

25a. [1 mark]

### Markscheme

$$\frac{3}{12} \left( \frac{1}{4}, 0.25, 25\% \right) \quad (AI) \quad (CI)$$

## Examiners report

[N/A]

25b. [2 marks]

### Markscheme

$$\left( \frac{2}{12} \right) \times \left( \frac{7}{11} \right) \quad (M1)$$

**Note:** Award *(M1)* for correct product.

$$= \frac{14}{132} \left( \frac{7}{66}, 0.10606..., 10.6\% \right) \quad (AI) \quad (C2)$$

## Examiners report

[N/A]

25c. [3 marks]

### Markscheme

$$\left(\frac{2}{12} \times \frac{1}{11}\right) + \left(\frac{3}{12} \times \frac{2}{11}\right) + \left(\frac{7}{12} \times \frac{6}{11}\right) \quad (M1)(M1)$$

**Note:** Award *(M1)* for addition of their 3 products, *(M1)* for 3 correct products.

$$= \frac{50}{132} \left(\frac{25}{66}, 0.37878\dots, 37.9\%\right) \quad (A1) \quad (C3)$$

## Examiners report

[N/A]

26a. [2 marks]

### Markscheme

If I do not have a bowl of soup then I have an ice cream. *(A1)(A1) (C2)*

**Notes:** Award *(A1)* for If... then...

Award *(A1)* for correct statements in correct order.

[2 marks]

## Examiners report

Most candidates were able to write the compound proposition in words, however many were not able to write the converse in symbolic form. While they were able to fill in the third column of the truth table, many were unable to complete the fourth column correctly.

26b. [2 marks]

### Markscheme

$p$	$q$	$\neg p$	$\neg p \Rightarrow q$
T	T	F	T
T	F	F	T
F	T	T	T
F	F	T	F

*(A1)(A1)(ft) (C2)*

**Note:** Follow through from third column to fourth column.

[2 marks]

## Examiners report

Most candidates were able to write the compound proposition in words, however many were not able to write the converse in symbolic form. While they were able to fill in the third column of the truth table, many were unable to complete the fourth column correctly.

26c.

[2 marks]

## Markscheme

$$q \Rightarrow \neg p \quad (AI)(AI) \quad (C2)$$

**Notes:** Award (AI) for

$\Rightarrow$ .

Award (AI) for

$q$  and

$\neg p$  in correct order.

Accept

$$\neg p \Leftarrow q.$$

[2 marks]

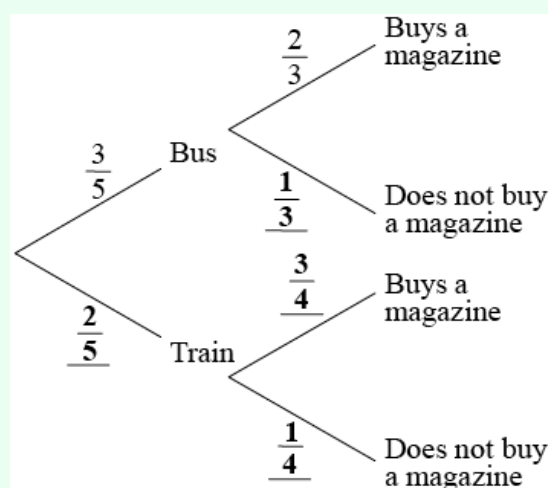
## Examiners report

Most candidates were able to write the compound proposition in words, however many were not able to write the converse in symbolic form. While they were able to fill in the third column of the truth table, many were unable to complete the fourth column correctly.

27a.

[3 marks]

## Markscheme



(AI)(AI)(AI) (C3)

**Note:** Award (AI) for each correct pair of branches.

[3 marks]

## Examiners report

Candidates showed that they were able to place probabilities in the correct position on the tree diagram and many went on to find the correct probability, gaining full marks for this question. Some candidates did not recognize that addition of two products was required. A mistake that was seen too frequently on candidate scripts was giving probabilities, in part (b), that were greater than 1.

27b. [3 marks]

## Markscheme

$$\frac{3}{5} \times \frac{2}{3} + \frac{2}{5} \times \frac{3}{4} \quad (AI)(ft)(MI)$$

**Notes:** Award *(AI)(ft)* for two consistent products from tree diagram, *(MI)* for addition of their products.

Follow through from their tree diagram provided all probabilities are between

0 and

1.

$$\frac{7}{10} \left( 0.7, 70\%, \frac{42}{60} \right) \quad (AI)(ft) \quad (C3)$$

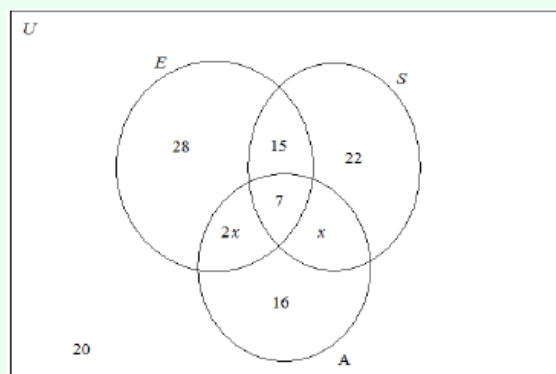
[3 marks]

## Examiners report

Candidates showed that they were able to place probabilities in the correct position on the tree diagram and many went on to find the correct probability, gaining full marks for this question. Some candidates did not recognize that addition of two products was required. A mistake that was seen too frequently on candidate scripts was giving probabilities, in part (b), that were greater than 1.

28a. [5 marks]

## Markscheme



*(AI)(AI)(AI)(AI)(AI)*

**Notes:** Award *(AI)* for rectangle and three labelled intersecting circles.

Award *(AI)* for

7 in correct place.

Award *(AI)* for

28,

22 and

16 in the correct places.

Award *(AI)* for

15,

$x$  and

$2x$  in the correct places.

Award *(AI)* for

20 in the correct place.

Accept

4 and

8 instead of

$x$  and

$2x$ .

Do not penalize if

$U$  is omitted from the diagram.

[5 marks]

## Examiners report

Candidates seemed to be well-drilled in the technique of creating Venn diagrams and using the data from their diagrams to solve problems in probability and this question was well answered. Except for the odd mistake in determining the value of  $x$  in part (b), many candidates scored full marks on the first two parts of the question. Indeed, those who calculated an incorrect value of  $x$  were able to recover many of the marks in the remainder of the question with the use of follow through marks. ‘Explain in words...’ required candidates to answer part (c) in the context of the question so ‘ $E$  union  $S$  intersection not  $A$ ’ earned no marks. Of those candidates who did answer in context, many scored 1 mark for ‘had not visited Asia’ but a significant number used ‘and’ rather than ‘or’ and consequently were not awarded the other mark for expressing  $E \cup S$  in words. Whilst many correct answers of 20 were seen for part (d), a significant number of candidates wrote down the incorrect value of 113 which presumably was arrived at by evaluating  $n((E \cap S \cap A)')$  rather than the actual demand of the question. Having a Venn diagram seemed to be a good aid for parts (e) and (f) and much good work was seen in these two parts. However, in part (g), a significant number of candidates either chose a “with replacement” method or simply did not know what to do with the probabilities once they were found. As a consequence, this part of the question proved to be quite a discriminator.

28b.

[2 marks]

## Markscheme

$$3x = 120 - (20 + 28 + 15 + 22 + 7 + 16) \quad (M1)$$

**Note:** Award **(M1)** for setting up a correct equation involving  $x$ , the 120 and values from their diagram.

$$x = 4 \quad (A1)(ft)(G2)$$

**Note:** Follow through from part (a). For the follow through to be awarded  $x$  must be a positive integer.

[2 marks]

## Examiners report

Candidates seemed to be well-drilled in the technique of creating Venn diagrams and using the data from their diagrams to solve problems in probability and this question was well answered. Except for the odd mistake in determining the value of  $x$  in part (b), many candidates scored full marks on the first two parts of the question. Indeed, those who calculated an incorrect value of  $x$  were able to recover many of the marks in the remainder of the question with the use of follow through marks. ‘Explain in words...’ required candidates to answer part (c) in the context of the question so ‘ $E$  union  $S$  intersection not  $A$ ’ earned no marks. Of those candidates who did answer in context, many scored 1 mark for ‘had not visited Asia’ but a significant number used ‘and’ rather than ‘or’ and consequently were not awarded the other mark for expressing  $E \cup S$  in words. Whilst many correct answers of 20 were seen for part (d), a significant number of candidates wrote down the incorrect value of 113 which presumably was arrived at by evaluating  $n((E \cap S \cap A)')$  rather than the actual demand of the question. Having a Venn diagram seemed to be a good aid for parts (e) and (f) and much good work was seen in these two parts. However, in part (g), a significant number of candidates either chose a “with replacement” method or simply did not know what to do with the probabilities once they were found. As a consequence, this part of the question proved to be quite a discriminator.



## Markscheme

(Women who had visited) Europe **or** South America and (but had) **not** (visited) Asia (AI)(AI)

**Notes:** Award (AI) for “(visited) Europe **or** South America” (or both).

Award (AI) for “and (but) had **not** visited Asia”.

$E$ (urope) union

$S$ (outh America) intersected with not

$A$ (sia) earns no marks, (A0).

[2 marks]

## Examiners report

Candidates seemed to be well-drilled in the technique of creating Venn diagrams and using the data from their diagrams to solve problems in probability and this question was well answered. Except for the odd mistake in determining the value of  $x$  in part (b), many candidates scored full marks on the first two parts of the question. Indeed, those who calculated an incorrect value of  $x$  were able to recover many of the marks in the remainder of the question with the use of follow through marks. ‘Explain in words...’ required candidates to answer part (c) in the context of the question so ‘ $E$  union  $S$  intersection not  $A$ ’ earned no marks. Of those candidates who did answer in context, many scored 1 mark for ‘had not visited Asia’ but a significant number used ‘and’ rather than ‘or’ and consequently were not awarded the other mark for expressing  $E \cup S$  in words. Whilst many correct answers of 20 were seen for part (d), a significant number of candidates wrote down the incorrect value of 113 which presumably was arrived at by evaluating  $n((E \cap S \cap A)')$  rather than the actual demand of the question. Having a Venn diagram seemed to be a good aid for parts (e) and (f) and much good work was seen in these two parts. However, in part (g), a significant number of candidates either chose a “with replacement” method or simply did not know what to do with the probabilities once they were found. As a consequence, this part of the question proved to be quite a discriminator.

## Markscheme

20 (AI)

**Note:** Award (A0) for the embedded answer of  $n(20)$ .

[1 mark]

## Examiners report

Candidates seemed to be well-drilled in the technique of creating Venn diagrams and using the data from their diagrams to solve problems in probability and this question was well answered. Except for the odd mistake in determining the value of  $x$  in part (b), many candidates scored full marks on the first two parts of the question. Indeed, those who calculated an incorrect value of  $x$  were able to recover many of the marks in the remainder of the question with the use of follow through marks. ‘Explain in words...’ required candidates to answer part (c) in the context of the question so ‘ $E$  union  $S$  intersection not  $A$ ’ earned no marks. Of those candidates who did answer in context, many scored 1 mark for ‘had not visited Asia’ but a significant number used ‘and’ rather than ‘or’ and consequently were not awarded the other mark for expressing  $E \cup S$  in words. Whilst many correct answers of 20 were seen for part (d), a significant number of candidates wrote down the incorrect value of 113 which presumably was arrived at by evaluating  $n((E \cap S \cap A)')$  rather than the actual demand of the question. Having a Venn diagram seemed to be a good aid for parts (e) and (f) and much good work was seen in these two parts. However, in part (g), a significant number of candidates either chose a “with replacement” method or simply did not know what to do with the probabilities once they were found. As a consequence, this part of the question proved to be quite a discriminator.

28e.

[2 marks]

## Markscheme

$$\frac{58}{120} \left( \frac{29}{60}, 0.483, 48.3\% \right) (0.48333 \dots) \quad (AI)(ft)(AI)(G2)$$

**Note:** Award  $(AI)(ft)$  for numerator, follow through from their value of  $x$ , or their diagram,  $(AI)$  for denominator.

[2 marks]

## Examiners report

Candidates seemed to be well-drilled in the technique of creating Venn diagrams and using the data from their diagrams to solve problems in probability and this question was well answered. Except for the odd mistake in determining the value of  $x$  in part (b), many candidates scored full marks on the first two parts of the question. Indeed, those who calculated an incorrect value of  $x$  were able to recover many of the marks in the remainder of the question with the use of follow through marks. ‘Explain in words...’ required candidates to answer part (c) in the context of the question so ‘ $E$  union  $S$  intersection not  $A$ ’ earned no marks. Of those candidates who did answer in context, many scored 1 mark for ‘had not visited Asia’ but a significant number used ‘and’ rather than ‘or’ and consequently were not awarded the other mark for expressing  $E \cup S$  in words. Whilst many correct answers of 20 were seen for part (d), a significant number of candidates wrote down the incorrect value of 113 which presumably was arrived at by evaluating  $n((E \cap S \cap A)')$  rather than the actual demand of the question. Having a Venn diagram seemed to be a good aid for parts (e) and (f) and much good work was seen in these two parts. However, in part (g), a significant number of candidates either chose a “with replacement” method or simply did not know what to do with the probabilities once they were found. As a consequence, this part of the question proved to be quite a discriminator.

28f.

[2 marks]

## Markscheme

$$\frac{15}{35} \left( \frac{3}{7}, 0.429, 42.9\% \right) (0.428571 \dots) \quad (AI)(ft)(AI)(ft)(G2)$$

**Note:** Award  $(AI)(ft)$  for numerator,  $(AI)(ft)$  for denominator, follow through from their value of  $x$  or their diagram.

[2 marks]

## Examiners report

Candidates seemed to be well-drilled in the technique of creating Venn diagrams and using the data from their diagrams to solve problems in probability and this question was well answered. Except for the odd mistake in determining the value of  $x$  in part (b), many candidates scored full marks on the first two parts of the question. Indeed, those who calculated an incorrect value of  $x$  were able to recover many of the marks in the remainder of the question with the use of follow through marks. ‘Explain in words...’ required candidates to answer part (c) in the context of the question so ‘ $E$  union  $S$  intersection not  $A$ ’ earned no marks. Of those candidates who did answer in context, many scored 1 mark for ‘had not visited Asia’ but a significant number used ‘and’ rather than ‘or’ and consequently were not awarded the other mark for expressing  $E \cup S$  in words. Whilst many correct answers of 20 were seen for part (d), a significant number of candidates wrote down the incorrect value of 113 which presumably was arrived at by evaluating  $n((E \cap S \cap A)')$  rather than the actual demand of the question. Having a Venn diagram seemed to be a good aid for parts (e) and (f) and much good work was seen in these two parts. However, in part (g), a significant number of candidates either chose a “with replacement” method or simply did not know what to do with the probabilities once they were found. As a consequence, this part of the question proved to be quite a discriminator.

## Markscheme

$$\frac{48}{120} \times \frac{47}{119} \quad (AI)(ft)(MI)$$

**Notes:** Award  $(AI)(ft)$  for two correct fractions, follow through from their denominator in part (e), follow through the numerator from their answer to part (b) or from their diagram,  $(MI)$  for multiplication of their two fractions.

$$= \frac{2256}{14\,280} \left( \frac{94}{595}, 0.158, 15.8\% \right) (0.157983\dots) \quad (AI)(ft)(G2)$$

**Notes:** Award  $(AI)(MI)(AI)$  for correct fractions, correctly multiplied together with an answer of 0.16.

Award  $(A0)(MI)(A0)$  for

$$\frac{48}{120} \times \frac{48}{120} = 0.16.$$

Award  $(GI)$  for an answer of

0.16 with no working seen.

[3 marks]

## Examiners report

Candidates seemed to be well-drilled in the technique of creating Venn diagrams and using the data from their diagrams to solve problems in probability and this question was well answered. Except for the odd mistake in determining the value of  $x$  in part (b), many candidates scored full marks on the first two parts of the question. Indeed, those who calculated an incorrect value of  $x$  were able to recover many of the marks in the remainder of the question with the use of follow through marks. ‘Explain in words...’ required candidates to answer part (c) in the context of the question so ‘ $E$  union  $S$  intersection not  $A$ ’ earned no marks. Of those candidates who did answer in context, many scored 1 mark for ‘had not visited Asia’ but a significant number used ‘and’ rather than ‘or’ and consequently were not awarded the other mark for expressing  $E \cup S$  in words. Whilst many correct answers of 20 were seen for part (d), a significant number of candidates wrote down the incorrect value of 113 which presumably was arrived at by evaluating  $n((E \cap S \cap A)')$  rather than the actual demand of the question. Having a Venn diagram seemed to be a good aid for parts (e) and (f) and much good work was seen in these two parts. However, in part (g), a significant number of candidates either chose a “with replacement” method or simply did not know what to do with the probabilities once they were found. As a consequence, this part of the question proved to be quite a discriminator.