SL Paper 1

Consider the following propositions.

p : *Students stay up late.*

q : *Students fall asleep in class.*

a. Write the following compound proposition in symbolic form. [2]

If students do not stay up late then they will not fall asleep in class.

b. Complete the following truth table. [3]

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

c. Write down a reason why the statement $\neg(p \vee \neg q)$ is not a contradiction. [1]

Markscheme

a. $\neg p \Rightarrow \neg q$ ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for any 2 correct symbols seen in a statement, ***(A1)*** for all 3 correct symbols in correct order.

b.

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**

(A1)(A1)**(ft)*****(A1)*****(ft)** ***(C3)***

Note: Award ***(A1)*** for each correct column. 4th column is follow through from 3rd, 5th column is follow through from 4th.

c. Not all of last column is F ***(R1)*****(ft)** ***(C1)***

Note: Award ***(R1)*****(ft)** if final column does not lead to a contradiction.

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

Consider the statement $p \Rightarrow q$.

If I break my arm, then it will hurt.

a. Write down in words, the inverse of $p \Rightarrow q$. [2]

b. Complete the following truth table. [2]

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

c. State whether the converse and the inverse of an implication are logically equivalent. [2]

Justify your answer.

Markscheme

a. 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.

b.

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.

c. 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

a. [N/A]
b. [N/A]
c. [N/A]

For events A and B, the probabilities are $\mathrm{P}(A) = \frac{4}{13}$ and $\mathrm{P}(B) = \frac{5}{13}$.

a. If events *A* and *B* are mutually exclusive, write down the value of $\mathrm{P}(A \cap B)$. [1]

b. If events *A* and *B* are independent, find the value of $\mathrm{P}(A \cap B)$. [2]

c. If $\mathrm{P}(A \cup B) = \frac{7}{13}$, find the value of $\mathrm{P}(A \cap B)$. [3]

Markscheme

a. $\mathrm{P}(A \cap B) = 0$ ***(A1)*** ***(C1)***

[1 mark]

b. $\mathrm{P}(A \cap B) = \mathrm{P}(A) \times \mathrm{P}(B)$

$= \frac{4}{13} \times \frac{5}{13}$ ***(M1)***

Note: Award ***(M1)*** for product of two fractions, decimals or percentages.

$\mathrm{P}(A \cap B) = \frac{20}{169} (= 0.118)$ ***(A1)*** ***(C2)***

[2 marks]

c. $\frac{7}{13} = \frac{4}{13} + \frac{5}{13} - \mathrm{P}(A \cap B)$ ***(M1)(M1)***

Notes: Award ***(M1)*** for $\frac{4}{13} + \frac{5}{13}$ seen, ***(M1)*** for subtraction of $\frac{7}{13}$ shown.

OR

Award ***(M1)*** for Venn diagram with 2 intersecting circles, ***(A1)*** for correct probabilities in diagram.

$\mathrm{P}(A \cap B) = \frac{2}{13} (= 0.154)$ ***(A1)*** ***(C3)***

[3 marks]

Examiners report

a. This question proved to be difficult with many candidates unaware of the significance of mutually exclusive events in probability. A significant number gave the answer to (b) as the answer to (a).

b. This question proved to be difficult with many candidates unaware of the significance of mutually exclusive events in probability. A significant number gave the answer to (b) as the answer to (a).

c. This question proved to be difficult with many candidates unaware of the significance of mutually exclusive events in probability.

This part proved to be difficult for some but most of the candidates who used the formula were able to achieve full marks. Very few candidates used Venn diagrams to answer this question.

The universal set U is the set of integers from 1 to 20 inclusive.

A and B are subsets of U where:

A is the set of even numbers between 7 and 17.

B is the set of multiples of 3.

a. List the elements of the following sets: [1]

A,

b. List the elements of the following sets: [1]

B,

c. List the elements of the following sets: [2]

$A \cup B$,

d. List the elements of the following sets: [2]

$A \cap B'$.

Markscheme

a. A = 8, 10, 12, 14, 16 ***(A1)*** ***(C1)***

[1 mark]

b. B = 3, 6, 9, 12, 15, 18 ***(A1)*** ***(C1)***

[1 mark]

c. $A \cup B$ = 3, 6, 8, 9,10,12,14,15,16,18 ***(A2)*****(ft)**

Award ***(A1)*** *only if a single element is missing or a single extra element is present,* ***(A0)*** *otherwise.* ***(C2)***

[2 marks]

d. B' = 1, 2, 4, 5, 7, 8, 10, 11, 13, 14, 16, 17, 19, 20 ***(A1)*****(ft)**

$A \cap B'$ = 8, 10, 14, 16 ***(A1)*****(ft)** ***(C2)***

[2 marks]

Examiners report

a. Parts (a) and (b) were well done although some candidates added 1 as a multiple of 3.

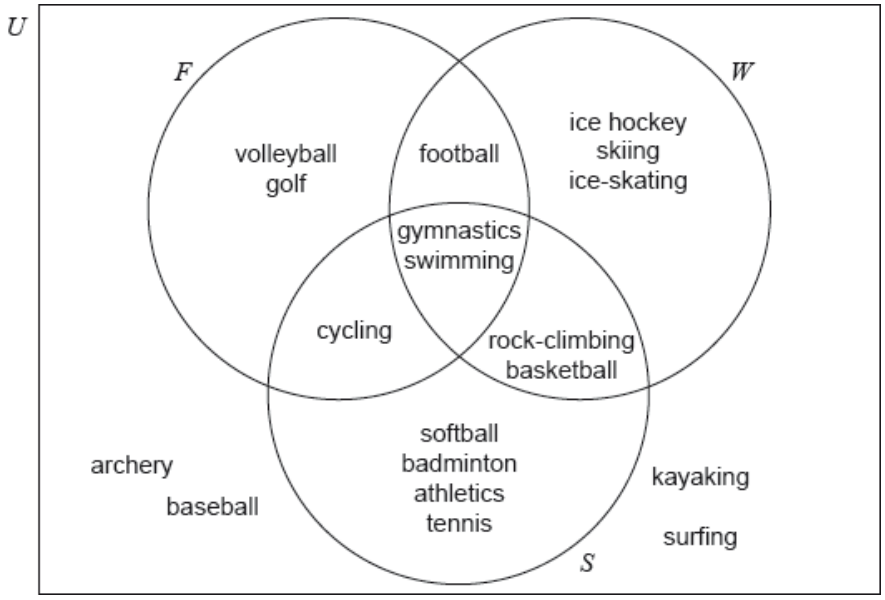
b. Parts (a) and (b) were well done although some candidates added 1 as a multiple of 3.

c. Part (c) was reasonably well attempted although some candidates found the intersection instead of the union.

d. Part (d) was successfully completed by those candidates who managed to find the complement of B correctly. If they had not shown the set containing the complement of B in the working they could not be awarded the method mark.

Dune Canyon High School organizes its **school year** into three trimesters: fall/autumn (F), winter (W) and spring (S). The school offers a variety of sporting activities during and outside the school year.

The activities offered by the school are summarized in the following Venn diagram.



a. Write down the number of sporting activities offered by the school during its **school year**. [1]

b. Determine whether rock-climbing is offered by the school in the fall/autumn trimester. [1]

c.i. Write down the elements of the set $F \cap W'$; [1]

c.ii. Write down $n(W \cap S)$. [1]

d. Write down, in terms of F, W and S, an expression for the set which contains only archery, baseball, kayaking and surfing. [2]

Markscheme

a. 15 ***(A1)*** ***(C1)***

[1 mark]

b. no ***(A1)*** ***(C1)***

Note: Accept “it is only offered in Winter and Spring”.

[1 mark]

c.i. volleyball, golf, cycling ***(A1)*** ***(C1)***

Note: Responses must list all three sports for the ***(A1)*** to be awarded.

[1 mark]

c.ii. 4 ***(A1)*** ***(C1)***

[1 mark]

d. $(F \cup W \cup S)'$ **OR** $F' \cap W' \cap S'$ (or equivalent) ***(A2)*** ***(C2)***

[2 marks]

Examiners report

a. [N/A]
b. [N/A]
c.i. [N/A]
c.ii. [N/A]
d. [N/A]

Let p and q represent the propositions

p: food may be taken into the cinema

q: drinks may be taken into the cinema

a. Complete the truth table below for the symbolic statement $\neg(p \vee q)$. [2]

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

b. Write down in words the meaning of the symbolic statement $\neg(p \vee q)$. [2]

c. Write in symbolic form the compound statement: [2]

“no food and no drinks may be taken into the cinema”.

Markscheme

a.

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

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

Note: ***(A1)*** for each correct column.

[2 marks]

b. It is not true that food or drinks may be taken into the cinema.

Note: ***(A1)*** for "it is not true". ***(A1)*** for "food or drinks".

OR

Neither food nor drinks may be taken into the cinema.

Note: ***(A1)*** for "neither". ***(A1)*** for "nor".

OR

No food and no drinks may be taken into the cinema.

Note: ***(A1)*** for "no food", "no drinks". ***(A1)*** for "and".

OR

No food or drink may be brought into the cinema. ***(A2)*** ***(C2)***

Note: ***(A1)*** for "no", ***(A1)*** for "food or drink". Do not penalize for use of plural/singular.

Note: the following answers are incorrect:
No food and drink may be brought into the cinema. Award ***(A1) (A0)***
Food and drink may not be brought into the cinema. Award ***(A1) (A0)***
No food or no drink may be brought into the cinema. Award ***(A1) (A0)***

[2 marks]

c. $\neg p \wedge \neg q$

Note: ***(A1)*** for both negations, ***(A1)*** for conjunction.

OR

$\neg(p \vee q)$ ***(A1)(A1)*** ***(C2)***

Note: ***(A1)*** for negation, ***(A1)*** for $p \vee q$ in parentheses.

[2 marks]

Examiners report

a. (a) was generally answered well.

b. (b) lack of precision in language led to many errors.

c. (a) was generally answered well.

(b) lack of precision in language led to many errors.

Consider the three propositions p, q and r.

p: *The food is well cooked*

q: *The drinks are chilled*

r: *Dinner is spoilt*

a. Write the following compound proposition in words. [3]

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

b. Complete the following truth table. [3]

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

Markscheme

a. **If** the food is well cooked **and** the drinks are chilled **then** dinner is **not spoilt**. ***(A1)(A1)(A1)*** ***(C3)***

Note: Award ***(A1)*** for "If…then" (then must be seen), ***(A1)*** for the two correct propositions connected with "and", ***(A1)*** for "not spoilt".

Only award the final ***(A1)*** if correct statements are given in the correct order.

[3 marks]

b.

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**

(A1)(A1)(A1)**(ft)** ***(C3)***

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

The final column must follow through from the previous two columns.

[3 marks]

Examiners report

a. [N/A]
b. [N/A]

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a. Consider the following propositions: [3]

p : The lesson is cancelled

q : The teacher is absent

r : The students are in the library.

Write, in words, the compound proposition $q \Rightarrow (p \wedge r)$.

b. Complete the following truth table. [2]

q	r	$\neg r$	$q \Rightarrow \neg r$
T	T		
T	F		
F	T		
F	F		

c. **Hence**, justify why $q \Rightarrow \neg r$ is not a tautology. [1]

Markscheme

a. if the teacher is absent then the lesson is cancelled and the students are in the library ***(A1)(A1)(A1) (C3)***

Note: Award ***(A1)*** for If…then.
For Spanish candidates, only accept “Si” and “entonces”.
For French candidates, only accept “Si” and “alors”.
For all three languages these words are from the subject guide.
Award ***(A1)*** for “and”,
Award ***(A1)*** for correct propositions in correct order.

b.

q	r	$\neg r$	$q \Rightarrow \neg r$
T	T	**F**	**F**
T	F	**T**	**T**
F	T	**F**	**T**
F	F	**T**	**T**

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

Note: Award ***(A1)*** for $\neg r$ column correct and ***(A1)*** for $q \Rightarrow \neg r$ column correct.
Award ***(A0)(A1)*(ft)** for a $q \Rightarrow \neg r$ column that correctly follows from an incorrect $\neg r$ column.

c. not all of the entries are true (or equivalent) ***(R1)*** ***(C1)***

Note: Accept "One entry is false".

Examiners report

a. Question 4: Logic.

All candidates recognized that to fill in a truth table the answer is either true or false. However, given that there are truth tables in the formula booklet it was surprising that some candidates made mistakes when negating a given column of the truth table. Most candidates recognized that in a tautology the column is always true with a small minority confusing tautology and contradiction. Candidates were able to write a compound proposition in words.

b. Question 4: Logic.

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c. Question 4: Logic.

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You may choose from three courses on a lunchtime menu at a restaurant.

s: you choose a salad,

m: you choose a meat dish (main course),

d: you choose a dessert.

You choose a **two** course meal which **must** include a main course and either a salad or a dessert, but not both.

a. Write the sentence above using logic symbols. [2]

b. Write in words $s \Rightarrow \neg d$. [2]

c. Complete the following truth table. [2]

s	d	$\neg s$	$\neg s \Rightarrow d$
T	T		
T	F		
F	T		
F	F		

Markscheme

a. $m \wedge (s \veebar d)$ ***(A2)***

(A1) *for* $m\wedge$

(A1) *for* $(s \veebar d)$

(A1)(A0) *if brackets are missing*.

OR

$(m \wedge s) \veebar (m \wedge d)$ ***(A2)***

(A1) *for both brackets correct,* ***(A1)*** *for disjunctive "or"* ***(A1)(A0)*** *if brackets are missing.* ***(C2)***

[2 marks]

b. If you choose a salad then you do not choose a dessert. ***(A2)***

(A1) *for "if …then…"* ***(A1)*** *for salad and no dessert in the correct order.*

OR

If you choose a salad you do not choose a dessert. ***(A2)*** ***(C2)***

[2 marks]

c.

s	d	$\neg s$	$\neg s \Rightarrow d$
T	T	**F**	**T**
T	F	**F**	**T**
F	T	**T**	**T**
F	F	**T**	**F**

(A1) *for each correct column* ***(A1)(A1)(ft)*** ***(C2)***

[2 marks]

Examiners report

a. (a) This caused problems for many candidates. They seem to expect to include the implication symbol somewhere.

b. (b) Most candidates managed to write this correctly.

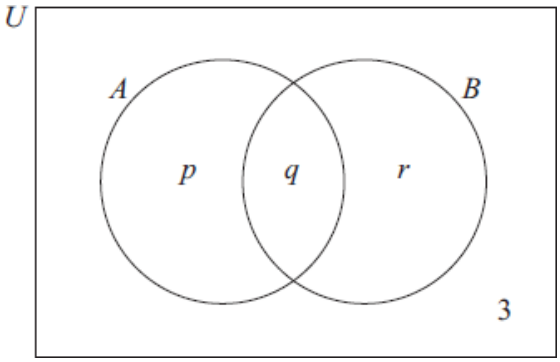
c. (c) Not all candidates could complete the truth table correctly. Many managed the first column but then made mistakes in the last column.

A group of 33 people was asked about the passports they have. 21 have Australian passports, 15 have British passports and 3 have neither.

A group of 33 people was asked about the passports they have. 21 have Australian passports, 15 have British passports and 3 have neither.

a. Find the number that have both Australian and British passports. [2]

b. In the Venn diagram below, set *A* represents the people in the group with Australian passports and set *B* those with British passports. [2]

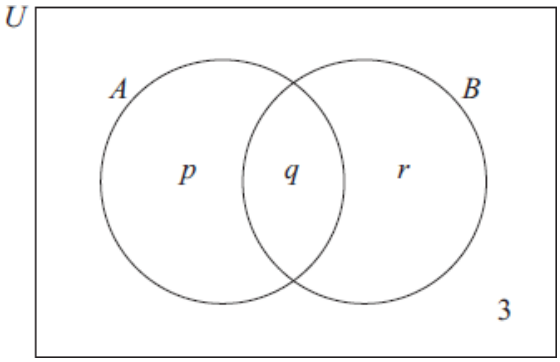


Write down the value of

(i) *q* ;

(ii) *p* and of *r* .

c. In the Venn diagram below, set *A* represents the people in the group with Australian passports and set *B* those with British passports. [2]



Find $n(A \cup B')$.

Markscheme

a. $21 + 15 + 3 - 33$ or equivalent ***(M1)***

Note: Award ***(M1)*** for correct use of all four numbers.

$= 6$ ***(A1)*** ***(C2)***

[2 marks]

b. (i) *q* = 6 ***(A1)*****(ft)**

(ii) *p* =15, *r* = 9 ***(A1)*****(ft)** ***(C2)***

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

[2 marks]

c. 15 + 6 + 3 ***(M1)***

Note: Award ***(M1)*** for their figures seen in a correct calculation:

15 + 6 + 3 or 21 + 3 or 33 – 9

= 24 ***(A1)*****(ft)** ***(C2)***

Note: Follow through from parts (a) and (b) or from values shown on Venn diagram.

[2 marks]

Examiners report

a. Much good work was seen in parts (a) and (b). However, there was much confusion in candidates' responses to part (c) as many could not determine the required answer where a union was involved with a complement. The result was that either candidates simply ignored $n[(A \cup B)']$ and evaluated $n(A) = 21$ or ignored $n[(A \cap B)]$ and evaluated $n(B') = 18$. Irrespective of ability, the modal mark for this question was four with very few candidates achieving more than this mark.

b. Much good work was seen in parts (a) and (b). However, there was much confusion in candidates' responses to part (c) as many could not determine the required answer where a union was involved with a complement. The result was that either candidates simply ignored $n[(A \cup B)']$ and evaluated $n(A) = 21$ or ignored $n[(A \cap B)]$ and evaluated $n(B') = 18$. Irrespective of ability, the modal mark for this question was four with very few candidates achieving more than this mark.

c. Much good work was seen in parts (a) and (b). However, there was much confusion in candidates' responses to part (c) as many could not determine the required answer where a union was involved with a complement. The result was that either candidates simply ignored $n[(A \cup B)']$ and evaluated $n(A) = 21$ or ignored $n[(A \cap B)]$ and evaluated $n(B') = 18$. Irrespective of ability, the modal mark for this question was four with very few candidates achieving more than this mark.

Police in a town are investigating the theft of mobile phones one evening from three cafés, "Alan's Diner", "Sarah's Snackbar" and "Pete's Eats".

They interviewed two suspects, Matthew and Anna, about that evening.

Matthew said:

"I visited Pete's Eats and visited Alan's Diner and I did not visit Sarah's Snackbar."

Let p , q and r be the statements:

p : I visited Alan's Diner
q : I visited Sarah's Snackbar
r : I visited Pete's Eats

a. Write down Matthew's statement in symbolic logic form. [3]

b. What Anna said was lost by the police, but in symbolic form it was [3]

$$(q \vee r) \Rightarrow \neg p$$

Write down, in words, what Anna said.

Markscheme

a. $r \wedge p \wedge \neg q$ ***(A1)(A1)(A1)*** ***(C3)***

Note: Award ***(A1)*** for two conjunctions, ***(A1)*** for negation seen on q, ***(A1)*** for correct compound statement.

[3 marks]

b. If I visited (either) Sarah's Snackbar **or** Pete's Eats (then) I did not visit Alan's Diner. ***(A1)(A1)(A1)*** ***(C3)***

Note: Award ***(A1)*** for If. . . (then), ***(A1)*** for Sarah's Snackbar **or** Pete's Eats, ***(A1)*** for did not visit Alan's Diner.

[3 marks]

Examiners report

a. The logic question was clearly difficult for many students. Part a was very poorly done with the majority of students not recognising that two conjunctions were required. Although candidates performed better on part b, many omitted the 'if, (then)'. One of the most common errors in part b was to translate the disjunction as 'and' rather than 'or'.

b. The logic question was clearly difficult for many students. Part a was very poorly done with the majority of students not recognising that two conjunctions were required. Although candidates performed better on part b, many omitted the 'if, (then)'. One of the most common errors in part b was to translate the disjunction as 'and' rather than 'or'.

Consider the following propositions.

p : the baby cries
q : the baby is happy
r : the baby wants to play

a. Write down, in words, $(q \wedge r) \Rightarrow \neg p$. [3]

b. Complete the following truth table. [2]

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

c. State whether $(q \wedge r) \Rightarrow \neg p$ is a tautology, contradiction or neither. [1]

Markscheme

a. if the baby is happy and wants to play then the baby does not cry ***(A1)(A1)(A1) (C3)***

Note: Award ***(A1)*** for "If… then…"; ***(A1)*** for "the baby is happy and wants to play", ***(A1)*** for "the baby does not cry". Crying must be negated.

[3 marks]

b.

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

(A1)(A1) (C2)

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

[2 marks]

c. Neither ***(A1)*(ft) *(C1)***

Note: Follow through from the last column in their part (b).

[1 mark]

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

Consider the statements

p : The numbers x and y are both even.

q : The sum of x and y is an even number.

a. Write down, in words, the statement $p \Rightarrow q$. [2]

b. Write down, in words, the inverse of the statement $p \Rightarrow q$. [2]

c. State whether the inverse of the statement $p \Rightarrow q$ is always true. Justify your answer. [2]

Markscheme

a. If (both) the numbers x and y are even (then) the sum of x and y is an even number. ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for If…(then), ***(A1)*** for the correct statements in the correct order.

[2 marks]

b. If (both) the numbers x and y are not even (then) the sum of x and y is not an even number. ***(A1)(A1)*** ***(C2)***

Notes: Award ***(A1)*** for If…(then), ***(A1)*** for the correct not p, and not q in the correct order. Accept the word odd for the phrase “not even”.

[2 marks]

c. The inverse of a statement is not (necessarily) true, because two odd (not even) numbers, always have an even sum. ***(A1)(R1)*****(ft)** ***(C2)***

Notes: Award ***(A1)(R1)*** if a specific counter example given instead of a reason stated in general terms, *e.g.* the inverse is not true because, 5 and 7 have an even sum. Do not award ***(A1)(R0)***. Follow through from their statement in part (b).

[2 marks]

Examiners report

a. Although a few candidates did not seem to understand the meaning of the $\Rightarrow$ symbol, many scored a minimum of two marks on the first two parts of the question. Indeed, many correct statements were seen in part (a). Many candidates however confused converse with inverse in part (b) resulting in the incorrect statement "*if the sum of x and y are both even then the numbers x and y are both even*" appearing on many scripts earning ***(M1)(A0)***. Despite this incorrect compound statement, many candidates recovered with correct reasoning in part (c) from their correct (or incorrect) statement in part (b). Candidate's responses to part (c) of the question should have been given in the context of the question set and those that simply inferred their answer from truth tables only, earned no marks.

b. Although a few candidates did not seem to understand the meaning of the $\Rightarrow$ symbol, many scored a minimum of two marks on the first two parts of the question. Indeed, many correct statements were seen in part (a). Many candidates however confused converse with inverse in part (b) resulting in the incorrect statement "*if the sum of x and y are both even then the numbers x and y are both even*" appearing on many scripts earning ***(M1)(A0)***. Despite this incorrect compound statement, many candidates recovered with correct reasoning in part (c) from their correct (or incorrect) statement in part (b). Candidate's responses to part (c) of the question should have been given in the context of the question set and those that simply inferred their answer from truth tables only, earned no marks.

c. Although a few candidates did not seem to understand the meaning of the ⇒ symbol, many scored a minimum of two marks on the first two parts of the question. Indeed, many correct statements were seen in part (a). Many candidates however confused converse with inverse in part (b) resulting in the incorrect statement "*if the sum of x and y are both even then the numbers x and y are both even*" appearing on many scripts earning ***(M1)(A0)***. Despite this incorrect compound statement, many candidates recovered with correct reasoning in part (c) from their correct (or incorrect) statement in part (b). Candidate's responses to part (c) of the question should have been given in the context of the question set and those that simply inferred their answer from truth tables only, earned no marks.

---

a. Complete the truth table. [2]

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

b. Consider the propositions *p* and *q*: [2]

p: x is a number less than 10.

q: x2 is a number greater than 100.

Write in words the compound proposition $\neg p \vee q$.

c. Using part (a), determine whether $\neg p \vee q$ is true or false, for the case where x is a number less than 10 and x^2 is a number greater than 100. [1]

d. Write down a value of x for which $\neg p \vee q$ is false. [1]

Markscheme

a.

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

(A1) for third column and ***(A1)*****(ft)** for fourth column ***(A1)(A1)*****(ft)** ***(C2)***

b. x is greater than or equal to (not less than) 10 or x^2 is greater than 100. ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for “greater than or equal to (not less than) 10”, ***(A1)*** for “or x^2 is greater than 100”.

c. True ***(A1)*****(ft)** ***(C1)***

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

d. Any value of x such that $-10 \leqslant x < 10$. ***(A1)*****(ft)** ***(C1)***

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

Examiners report

a. 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.

b. 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.

c. 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.

d. 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.

---

p : x is a multiple of 12

q : x is a multiple of 6.

a. Write down in words $\neg p$. [1]

b. Write down in symbolic form the compound statement [2]

r : If x is a multiple of 12, then x is a multiple of 6.

c. Consider the compound statement [1]

s : If x is a multiple of 6, then x is a multiple of 12.

Identify whether s : is the inverse, the converse or the contrapositive of r.

d. Consider the compound statement [2]

s : If x is a multiple of 6, then x is a multiple of 12.

Determine the validity of s. Justify your decision.

Markscheme

a. x is not a multiple of 12 ***(A1)*** ***(C1)***

b. $p \Rightarrow q$ ***(A1)(A1)(C2)***

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

Accept $q \Leftarrow p$.

c. Converse ***(A1) (C1)***

d. 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

a. [N/A]
b. [N/A]
c. [N/A]
d. [N/A]

Consider the statement p:

"If a quadrilateral is a square then the four sides of the quadrilateral are equal".

a. Write down the inverse of statement *p* in words. [2]

b. Write down the converse of statement *p* in words. [2]

c. Determine whether the converse of statement *p* is always true. Give an example to justify your answer. [2]

Markscheme

a. If a quadrilateral is not a square (then) the four sides of the quadrilateral are not equal. ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for "if…(then)", ***(A1)*** for the correct phrases in the correct order.

[2 marks]

b. If the four sides of the quadrilateral are equal (then) the quadrilateral is a square. ***(A1)(A1)*****(ft)** ***(C2)***

Note: Award ***(A1)*** for "if…(then)", ***(A1)*****(ft)** for the correct phrases in the correct order.

Note: Follow through in (b) if the inverse and converse in (a) and (b) are correct and reversed.

[2 marks]

c. The converse is not always true, for example a rhombus (diamond) is a quadrilateral with four equal sides, but it is not a square. ***(A1)(R1)*** ***(C2)***

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

[2 marks]

Examiners report

a. There was confusion among some students about which was the inverse and converse of the given statement.

b. There was confusion among some students about which was the inverse and converse of the given statement.

c. There was confusion among some students about which was the inverse and converse of the given statement. Part (c) was poorly done with very few students able to provide an example that shows that the converse is not always true.

The truth table below shows the truth-values for the proposition

$p \veebar q \Rightarrow \neg p \veebar \neg q$

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

a. Explain the distinction between the compound propositions, $p \veebar q$ and $p \vee q$. [1]

b. Fill in the four missing truth-values on the table. [4]

c. State whether the proposition $p \veebar q \Rightarrow \neg p \veebar \neg q$ is a tautology, a contradiction or neither. [1]

Markscheme

a. Both are 'p or q', the first is 'but not both' ***(A1)***

Note: Award mark for clear understanding if wording is poor. ***(C1)***

[1 mark]

b.

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

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

Note: Follow through is for final column. ***(C4)***

[4 marks]

c. Tautology. ***(A1)*****(ft)** ***(C1)***

[1 mark]

Examiners report

a. a) The majority of candidates were able to explain the difference between inclusive and exclusive correctly but many used “and” and “or” to distinguish between the two.

b. b) Less than half were able to find the truth value of the two disjunctions in the table correctly. Most candidates did gain some marks but a number of them left at least one cell blank even though it was a 50% chance of getting the correct value.

c. c) Most candidates answered this part correctly with many receiving follow through for “neither” from an incorrect table.

Consider the propositions p and q.

p: *I take swimming lessons*

q: *I can swim 50 metres*

a. Complete the truth table below. [2]

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

b. Write the following compound proposition in symbolic form. [2]

“I cannot swim 50 metres and I take swimming lessons.”

c. Write the following compound proposition in words. [2]

$q \Rightarrow \neg q$

Markscheme

a.

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

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

Notes: Award ***(A1)*** for each correct column. Follow through in 4th column from their 3rd column.

[2 marks]

b. $\neg q \wedge p$ ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for $\neg q$ and p in any order, ***(A1)*** for $\wedge$.

[2 marks]

c. If I can swim 50 metres (then) I do not take swimming lessons. ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for If… (then), ***(A1)*** for correct propositions in the correct order.

[2 marks]

Examiners report

a. This question was well answered by most of the candidates who could complete the truth table, write the proposition in symbolic form and write the given proposition in words, although the '*If*' was sometimes omitted. Where marks were lost on Question 2, it was generally in the second column of the truth table.

b. This question was well answered by most of the candidates who could complete the truth table, write the proposition in symbolic form and write the given proposition in words, although the '*If*' was sometimes omitted. Where marks were lost on Question 2, it was generally in the second column of the truth table.

c. This question was well answered by most of the candidates who could complete the truth table, write the proposition in symbolic form and write the given proposition in words, although the '*If*' was sometimes omitted. Where marks were lost on Question 2, it was generally in the second column of the truth table.

Consider the universal set $U = \{x \in \mathbb{N} | 3 < x < 13\}$, and the subsets $A = \{\text{multiples of } 3\}$ and $B = \{4,\ 6,\ 12\}$.

a.i. List the elements of the following set. [1]

A

a.ii. List the elements of the following set. [1]

$A \cap B'$

b. Write down one element of $(A \cup B)'$. [2]

c. One of the statements in the table below is false. Indicate with an **X** which statement is false. Give a reason for your answer. [2]

$n(A \cup B) = 4$	
$15 \in A'$	
$A \subset A \cup B$	

Markscheme

a.i. 6, 9, 12 ***(A1)*** ***(C1)***

[1 mark]

a.ii. 9 ***(A1)*(ft)** ***(C1)***

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

[1 mark]

b. any element from {5, 7, 8, 10, 11} ***(A1)(A1)*(ft)** ***(C2)***

Note: Award ***(A1)*(ft)** for finding $(A \cup B)$, follow through from their *A*.

Award full marks if all correct elements of $(A \cup B)'$ are listed.

[2 marks]

c.

$n(A \cup B) = 4$	
$15 \in A'$	**X**
$A \subset A \cup B$	

$15 \notin U$ ***(R1)(A1)*** ***(C2)***

Notes: Accept correct reason in words.

If the reason is incorrect, both marks are lost.

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

[2 marks]

Examiners report

a.i. The question was not well answered by the majority of the candidates. Many did not identify the universal set correctly and so took 3 to be a member of this set. This affected their answers in a)(i) and a)(ii).

a.ii. The question was not well answered by the majority of the candidates. Many did not identify the universal set correctly and so took 3 to be a member of this set. This affected their answers in a)(i) and a)(ii).

b. Not many students answered (b) correctly. Some listed all correct elements of the given set instead of just one, which shows that they did not read the question carefully.

c. Although many candidates could indicate which statement in the table in c) was false, often they were unable either to identify or articulate a correct reason for it.

Consider the two propositions p and q.

p: The sun is shining q: I will go swimming

a. Write in words the compound proposition [2]

$p \Rightarrow q$;

b. Write in words the compound proposition [2]

$\neg p \vee q$.

c. The truth table for these compound propositions is given below. [1]

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

Complete the column for $\neg p$.

d. The truth table for these compound propositions is given below. [1]

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

State the relationship between the compound propositions $p \Rightarrow q$ and $\neg p \vee q$.

Markscheme

a. If the sun is shining then I will go swimming. ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for "if…then" and ***(A1)*** for correct order.

[2 marks]

b. Either the sun is not shining or I will go swimming. ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for both correct statements and ***(A1)*** for "either" "…or".

[2 marks]

c.

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

(A1) ***(C1)***

[1 mark]

d. They are (logically) equivalent. ***(A1)*** ***(C1)***

Note: Do not accept any other answers.

[1 mark]

Examiners report

a. The most common error was poor use of the "If...then" connective.

b. Confusion between "and" and "or" was rare, however, the use of implication in this part was a little too common.

c. Precise, correct terminology was expected in this part.

d. [N/A]

Two propositions p and q are defined as follows

p: Eva is on a diet
q: Eva is losing weight.

a. Write down the following statement **in words**. [2]

$$q \Rightarrow p$$

b. Write down, in words, the contrapositive statement of $q \Rightarrow p$. [2]

c. Determine whether your statement in part (a) is logically equivalent to your statement in part (b). Justify your answer. [2]

Markscheme

a. If Eva is losing weight then Eva is on a diet ***(A1)(A1)*** ***(C2)***

Notes: Award ***(A1)*** 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 ***(A1)*** for correct propositions in correct order.

[2 marks]

b. If Eva is not on a diet then she is not losing weight ***(A1)(A1)*** ***(C2)***

Notes: Award ***(A1)*** for “not on a diet” and “not losing weight” seen, ***(A1)*** for complete correct answer.

No follow through from part (a).

[2 marks]

c. The statements are logically equivalent ***(A1)*****(ft)**

The contrapositive is always logically equivalent to the original statement ***(R1)*****(ft)**

OR

A correct truth table showing the equivalence ***(R1)*****(ft)** ***(C2)***

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

[2 marks]

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

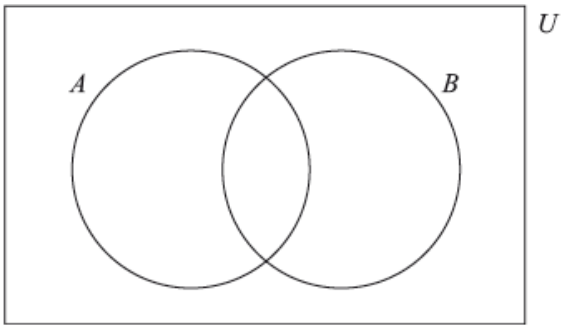
Aleph has an unbiased cubical (six faced) die on which are written the numbers

1 , 2 , 3 , 4 , 5 and 6.

Beth has an unbiased tetrahedral (four faced) die on which are written the numbers

2 , 3 , 5 and 7.

a. Complete the Venn diagram with the numbers written on Aleph’s die (A) and Beth’s die (B). [2]

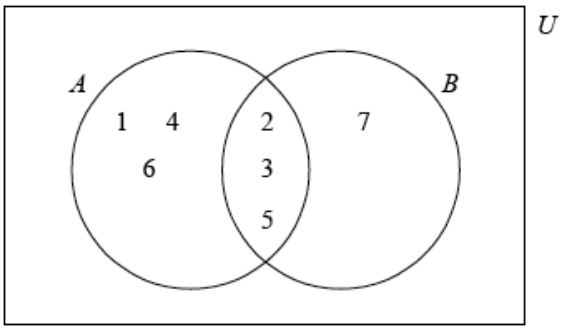


b. Find $n(B \cap A')$. [2]

c. Aleph and Beth are each going to roll their die once only. Shin says the probability that each die will show the same number is $\frac{1}{8}$. [2]

Determine whether Shin is correct. Give a reason.

Markscheme

a. 

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

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

b. 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).

c. 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

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

b. Many identified correctly the set B ∩ A′ , but listed the element instead of writing the number of elements in the set.

c. In part (c) the majority stated that Shin was incorrect giving probabilities of 3/8 (3/6 × 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.

Consider the following Venn diagrams. Each diagram is shaded differently.

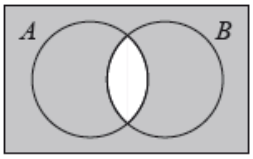


Diagram 1

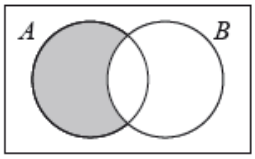


Diagram 2

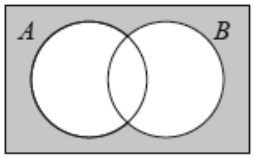


Diagram 3

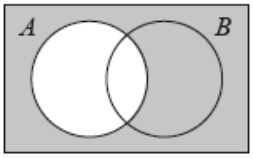


Diagram 4

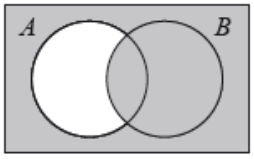


Diagram 5

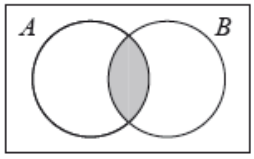


Diagram 6

In the following table there are six sets. Each of these sets corresponds to the shaded region of one of the Venn diagrams. In the correct space, write the number of the diagram that corresponds to that set.

Set	Diagram
$(A \cup B)'$	. . . . .
$A' \cup B'$	. . . . .
$A \cap B'$	. . . . .
$A \cap B$	. . . . .
$A' \cup B$	. . . . .
A'	. . . . .

Markscheme

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

(A6)(C6)

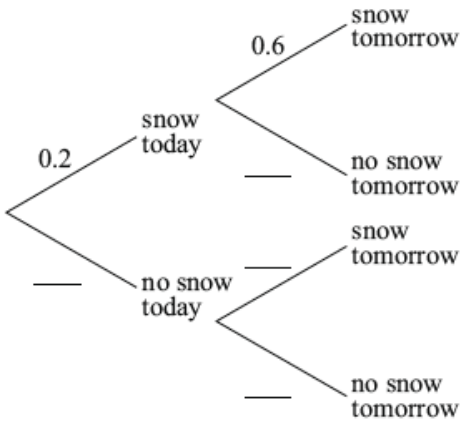
Note: Award ***(A1)*** for each correct entry.

Examiners report

[N/A]

The probability that it snows today is 0.2. If it does snow today, the probability that it will snow tomorrow is 0.6. If it does not snow today, the probability that it will not snow tomorrow is 0.9.

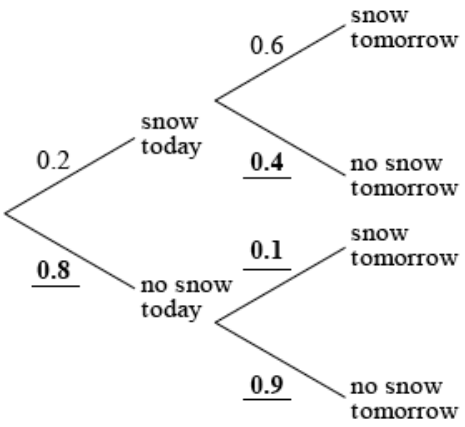
a. Using the information given, complete the following tree diagram. [3]



b. Calculate the probability that it will snow tomorrow. [3]

Markscheme

a.



(A1)(A1)(A1) ***(C3)***

Note: Award ***(A1)*** for each correct pair of probabilities.

[3 marks]

b. $0.2 \times 0.6 + 0.8 \times 0.1$ ***(A1)*****(ft)*****(M1)***

Note: Award ***(A1)*****(ft)** for two correct products of probabilities taken from their diagram, ***(M1)*** for the addition of their products.

$= 0.2 \left(\frac{1}{5},\ 20\%\right)$ ***(A1)*****(ft)** ***(C3)***

Note: Accept any equivalent correct fraction.

Follow through from their tree diagram.

[3 marks]

Examiners report

a. [N/A]
b. [N/A]

Consider two propositions p and q.

a. Complete the truth table below. [4]

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

b. Decide whether the compound proposition [2]

$$(p \Rightarrow \neg q) \Leftrightarrow (\neg p \Rightarrow q)$$

is a tautology. State the reason for your decision.

Markscheme

a.

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

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

Note: Award ***(A1)*** for each correct column (second column **(ft)** from first, fourth **(ft)** from third). Follow through from second column to fourth column for a consistent mistake in implication.

[4 marks]

b. Since second and fourth columns are not identical ***(R1)*****(ft)**

$\Rightarrow$ Not a tautology ***(A1)*****(ft)** ***(C2)***

Note: ***(R0)(A1)*** may **not** be awarded.

[2 marks]

Examiners report

a. The truth table was well done by the majority of candidates but significantly fewer could give the correct reason for whether the compound proposition was a tautology, so many lost 2 marks in this part of the question.

b. The truth table was well done by the majority of candidates but significantly fewer could give the correct reason for whether the compound proposition was a tautology, so many lost 2 marks in this part of the question.

Alan's laundry basket contains two green, three red and seven black socks. He selects one sock from the laundry basket at random.

a. Write down the probability that the sock is red. [1]

b. Alan returns the sock to the laundry basket and selects two socks at random. [2]

Find the probability that the first sock he selects is green and the second sock is black.

c. Alan returns the socks to the laundry basket and again selects two socks at random. [3]

Find the probability that he selects two socks of the same colour.

Markscheme

a. $\frac{3}{12}\left(\frac{1}{4}, 0.25, 25\%\right)$ ***(A1)*** ***(C1)***

b. $\left(\frac{2}{12}\right) \times \left(\frac{7}{11}\right)$ ***(M1)***

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

$= \frac{14}{132}\left(\frac{7}{66}, 0.10606..., 10.6\%\right)$ ***(A1)*** ***(C2)***

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

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

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

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

U is the set of **positive** integers less than or equal to 10.

A, B and C are subsets of U.

$A = \{\text{even integers}\}$

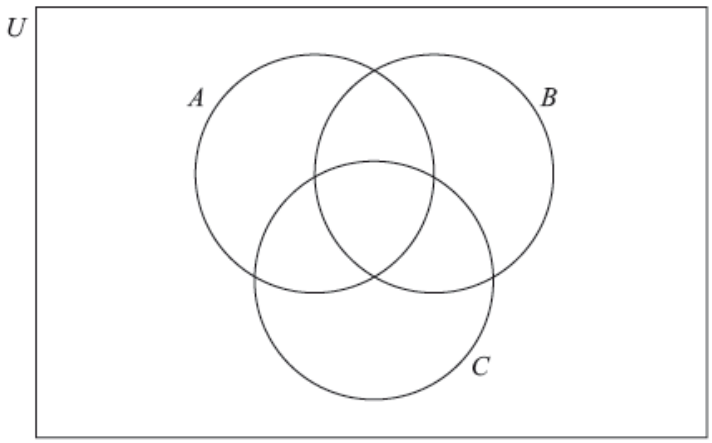
$B = \{\text{multiples of } 3\}$

$C = \{6,\ 7,\ 8,\ 9\}$

a. List the elements of A. [1]

b. List the elements of B. [1]

c. Complete the Venn diagram with **all** the elements of U. [4]



Markscheme

a. $2, 4, 6, 8, 10$ ***(A1)*** ***(C1)***

Note: Do not penalize the use of $\{\ \}$.

[1 mark]

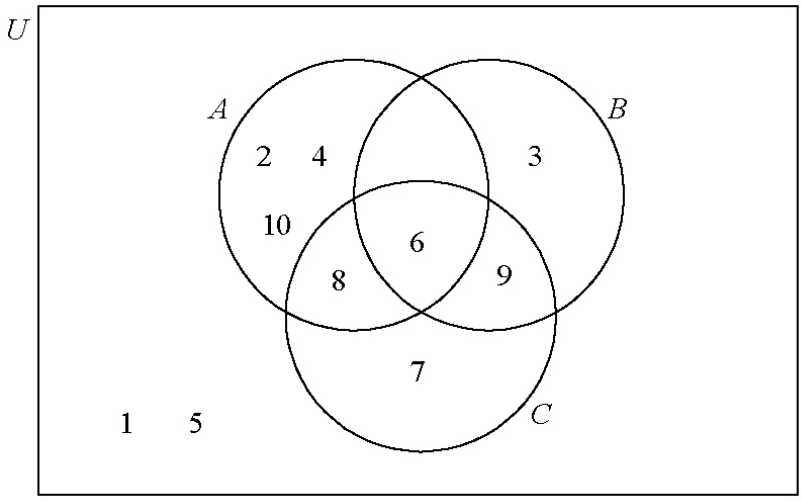
b. $3, 6, 9$ ***(A1)*** ***(C1)***

Note: Do not penalize the use of $\{\ \}$.

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

[1 mark]

c.



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

Notes: Award ***(A1)*(ft)** for the correct placement of 6.

Award ***(A1)*(ft)** for the correct placement of 8 and 9 and the empty region.

Award ***(A1)*(ft)** for the correct placement of 2, 4, 3, 7, and 10.

Award ***(A1)*(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

a. 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.

b. 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.

c. 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.

A survey was carried out at an international airport. A number of travellers were interviewed and asked for their flight destinations. The results are shown in the table below.

Destination	America	Africa	Asia
Number of males	45	62	37
Number of females	35	46	25

a. One traveller is to be chosen at random from all those interviewed. [2]

Find the probability that this traveller was going to Africa.

b. One female traveller is to be chosen at random from all those interviewed. [2]

Find the probability that this female traveller was going to Asia.

c. One traveller is to be chosen at random from those **not** going to America. [2]

Find the probability that the chosen traveller is female.

Markscheme

a. $\frac{108}{250}$ $\left(\frac{54}{125}, 0.432, 43.2\%\right)$ ***(A1)(A1)*** ***(C2)***

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

[2 marks]

b. $\frac{25}{106}$ $(0.236, 23.6\%)$ ***(A1)(A1)*** ***(C2)***

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

[2 marks]

c. $\frac{71}{170}$ $(0.418, 41.8\%)$ ***(A1)(A1)*** ***(C2)***

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

[2 marks]

Examiners report

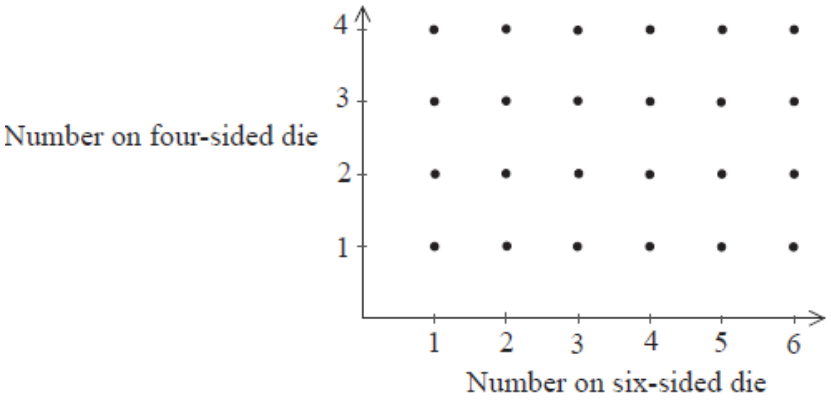
a. A reasonably well attempted question with parts (a) and (c) proving to provide many correct answers. A correct answer for part (b) however proved to be a little more elusive as, despite a correct numerator of 25 seen on many scripts, the total sample space was not reduced and a denominator of 250 lost the final mark in this part of the question. On a minority of scripts candidates simply wrote down decimal answers. Where these were correct, both marks for each part were earned. However, incorrect answers earned no marks – candidates would be well advised to at least write down the fraction answer first so that any part marks can be awarded. A case in question here was a predominance of incorrect answers of 0.10 or 10% for part (b). This, on its own earns no marks whereas $25/250$ earned A1, A0.

b. A reasonably well attempted question with parts (a) and (c) proving to provide many correct answers. A correct answer for part (b) however proved to be a little more elusive as, despite a correct numerator of 25 seen on many scripts, the total sample space was not reduced and a denominator of 250 lost the final mark in this part of the question. On a minority of scripts candidates simply wrote down decimal answers. Where these were correct, both marks for each part were earned. However, incorrect answers earned no marks – candidates would be well advised to at least write down the fraction answer first so that any part marks can be awarded. A case in question here was a predominance of incorrect answers of 0.10 or 10% for part (b). This, on its own earns no marks whereas $25/250$ earned A1, A0.

c. A reasonably well attempted question with parts (a) and (c) proving to provide many correct answers. A correct answer for part (b) however proved to be a little more elusive as, despite a correct numerator of 25 seen on many scripts, the total sample space was not reduced and a denominator of 250 lost the final mark in this part of the question. On a minority of scripts candidates simply wrote down decimal answers. Where these were correct, both marks for each part were earned. However, incorrect answers earned no marks – candidates would be well advised to at least write down the fraction answer first so that any part marks can be awarded. A case in question here was a predominance of incorrect answers of 0.10 or 10% for part (b). This, on its own earns no marks whereas $25/250$ earned A1, A0.

A fair six-sided die has the numbers 1, 2, 3, 4, 5, 6 written on its faces. A fair four-sided die has the numbers 1, 2, 3, and 4 written on its faces. The two dice are rolled.

The following diagram shows the possible outcomes.



a. Find the probability that the two dice show the same number. [2]

b. Find the probability that the difference between the two numbers shown on the dice is 1. [2]

c. Find the probability that the number shown on the four-sided die is greater than the number shown on the six-sided die, given that the difference between the two numbers is 1. [2]

Markscheme

a. $\frac{4}{24}$ $\left(\frac{1}{6}, 0.167, 16.7\ \%\right)$ ***(A1)(A1)*** ***(C2)***

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

[2 marks]

b. $\frac{7}{24}$ $(0.292, 29.2\ \%)$ ***(A1)(A1)*****(ft)** ***(C2)***

Note: Award ***(A1)*****(ft)** from the denominator used in (a).

[2 marks]

c. $\frac{3}{7}$ $(0.429, 42.9\ \%)$ ***(A1)(A1)*****(ft)** ***(C2)***

Note: Award ***(A1)*** for numerator ***(A1)*****(ft)** for denominator, **(ft)** from their numerator in (b).

[2 marks]

Examiners report

a. The diagram caused some difficulty for some candidates, however the majority of candidates were successful.

b. The diagram caused some difficulty for some candidates, however the majority of candidates were successful in (a).

The term "difference" was well understood by the candidature.

c. The diagram caused some difficulty for some candidates, however the majority of candidates were successful in (a).

---

a. Complete the following truth table. [2]

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

b. Consider the propositions [2]

p: *Cristina understands logic*

q: *Cristina will do well on the logic test.*

Write down the following compound proposition in symbolic form.

"If Cristina understands logic then she will do well on the logic test"

c. Write down in words the contrapositive of the proposition given in part (b). [2]

Markscheme

a.

p	q	$\ldots\ldots\neg q\ldots\ldots$	$p \Rightarrow \neg q$
T	T	F	....**F**....
T	F	T	....**T**....
F	T	F	....**T**....
F	F	T	....**T**....

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

Note: Award ***(A1)*** for $\neg q$, ***(A1)*** for last column.

[2 marks]

b. $p \Rightarrow q$ ***(A1)(A1)*** ***(C2)***

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

[2 marks]

c. If Cristina does not do well on the logic test then she does not understand logic. ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for If…(then), must be an implication, ***(A1)*** for the correct propositions in the correct order.

[2 marks]

Examiners report

a. This question was well answered with most candidates able to complete the truth table correctly in part a) and write the correct compound proposition in symbolic form in part b). A significant number of candidates could not write the correct contrapositive, although most were awarded one mark for writing an implication.

b. This question was well answered with most candidates able to complete the truth table correctly in part a) and write the correct compound proposition in symbolic form in part b). A significant number of candidates could not write the correct contrapositive, although most were awarded one mark for writing an implication.

c. This question was well answered with most candidates able to complete the truth table correctly in part a) and write the correct compound proposition in symbolic form in part b). A significant number of candidates could not write the correct contrapositive, although most were awarded one mark for writing an implication.

In a particular school, students must choose at least one of three optional subjects: art, psychology or history.

Consider the following propositions

a: I choose art,
p: I choose psychology,
h: I choose history.

a. Write, in words, the compound proposition [3]

$$\neg h \Rightarrow (p \vee a)$$

.

b. Complete the truth table for $\neg a \Rightarrow p$. [1]

a	p	$\neg a$	$\neg a \Rightarrow p$
T	T	F	
T	F	F	
F	T	T	
F	F	T	

c. State whether $\neg a \Rightarrow p$ is a tautology, a contradiction or neither. Justify your answer. [2]

Markscheme

a. If I do not choose history then I choose either psychology or I choose art ***(A1)(A1)(A1)*** ***(C3)***

Notes: Award ***(A1)*** for 'if… (then)…'

Award ***(A1)*** for 'not choose history.'

Award ***(A1)*** for 'choose (either) psychology or art (or both).'

If the order of the statements is wrong award at most ***(A1)(A1)(A0)***.

[3 marks]

b.

a	p	$\neg a$	$\neg a \Rightarrow p$
T	T	F	**T**
T	F	F	**T**
F	T	T	**T**
F	F	T	**F**

(A1) ***(C1)***

[1 mark]

c. Neither, because not all the entries in the last column are the same. ***(A1)*****(ft)*****(R1)*** ***(C2)***

Notes: Do not award ***(R0)(A1)***. Follow through from their answer to part (b). Reasoning must be consistent with their answer to part (b).

[2 marks]

Examiners report

a. Many correct answers were seen in part (a) with only a minority of candidates misinterpreting the symbol $\vee$ as 'and'. Some candidates left out the word 'if' and consequently lost the first mark.

b. Part (b) was not done as well as expected indicating that some work needs to be done by centres on the truth table for the logic symbol $\Rightarrow$.

c. Many correct answers of 'neither' were seen in part (c) but the justification was sometimes lacking definitive reasoning. Without sufficient reasoning, the answer mark was not awarded.

Two propositions are defined as follows:

p : *Quadrilateral ABCD has two diagonals that are equal in length.*
q : *Quadrilateral ABCD is a rectangle.*

a. Express the following in symbolic form. [2]

"A rectangle always has two diagonals that are equal in length."

b. Write down in symbolic form the converse of the statement in (a). [1]

c. Determine, **without** using a truth table, whether the statements in (a) and (b) are logically equivalent. [2]

d. Write down the name of the statement that is logically equivalent to the converse. [1]

Markscheme

a. $q \Rightarrow p$ ***(A1)(A1)*** ***(C2)***

Note: Award the first ***(A1)*** for seeing the implication sign, the second ***(A1)*** is for a correct answer only. Not using the implication earns **no** marks.

[2 marks]

b. $p \Rightarrow q$ ***(A1)*****(ft)** ***(C1)***

Note: Award ***(A1)*****(ft)** where the propositions in the implication in part (a) are exchanged.

[1 mark]

c. Not equivalent; a kite or an isosceles trapezium (for example) can have diagonals that are equal in length. ***(A1)(R1)*** ***(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 ***(R1)(A0)***.

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

Do not accept solutions based on truth tables.

[2 marks]

d. Inverse ***(A1)*** ***(C1)***

Note: Do not accept symbolic notation.

[1 mark]

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]
d. [N/A]

Consider the following propositions.

p: The car is under warranty
q: The car is less than 2 years old
r : The car has been driven more than 20 000 km

a. Write down in words $(q \vee \neg r) \Rightarrow p$. [3]

b. Complete the truth table. [2]

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

c. State whether the statement $\neg p \Rightarrow \neg(q \vee \neg r)$ is the inverse, the converse or the contrapositive of the statement in part (a). [1]

Markscheme

a. if the car is less than 2 years old or the car has not been driven more than $20\,000\ \text{km}$, then the car is under warranty ***(A1)(A1)(A1)*** ***(C3)***

Note: Award ***(A1)*** for if …, then …, ***(A1)*** for "or", ***(A1)*** for correct statements in correct order. Accept "If the car has not been driven more than $20\,000\ \text{km}$ or the car is less than 2 years old, then the car is under warranty". Accept logical equivalent wording for each proposition, *eg* "less than $20\,000\ \text{km}$".

[3 marks]

b.

p	q	r	$\neg r$	$q \vee \neg r$	$(q \vee \neg r) \Rightarrow p$
T	T	T	F	**T**	**T**
T	T	F	T	**T**	**T**
T	F	T	F	**F**	**T**
T	F	F	T	**T**	**T**
F	T	T	F	**T**	**F**
F	T	F	T	**T**	**F**
F	F	T	F	**F**	**T**
F	F	F	T	**T**	**F**

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

Note: Award ***(A1)*** for $q \vee \neg r$ column correct and ***(A1)*(ft)** for $(q \vee \neg r) \Rightarrow p$ column correct. Follow through from their $q \vee \neg r$ column.

[2 marks]

c. contrapositive ***(A1)*** ***(C1)***

[1 mark]

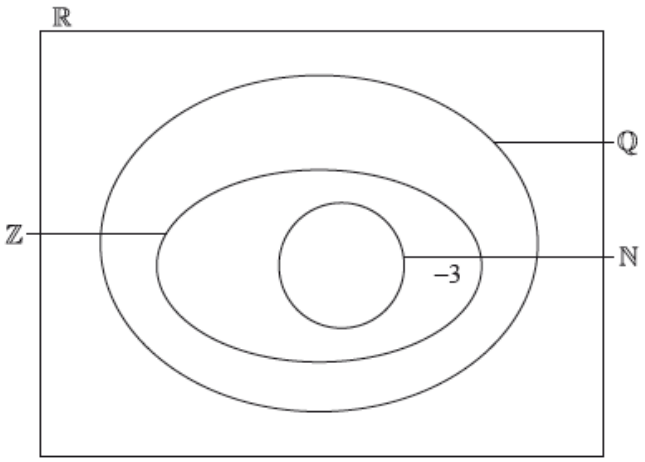
Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

The following Venn diagram shows the relationship between the sets of numbers

$$\mathbb{N},\ \mathbb{Z}, \mathbb{Q} \text{ and } \mathbb{R}.$$

The number –3 belongs to the set of $\mathbb{Z}$, $\mathbb{Q}$ and $\mathbb{R}$, but not $\mathbb{N}$, and is placed in the appropriate position on the Venn diagram as an example.



Write down the following numbers in the appropriate place in the Venn diagram.

a. 4 [1]

b. $\frac{1}{3}$ [1]

c. π [1]

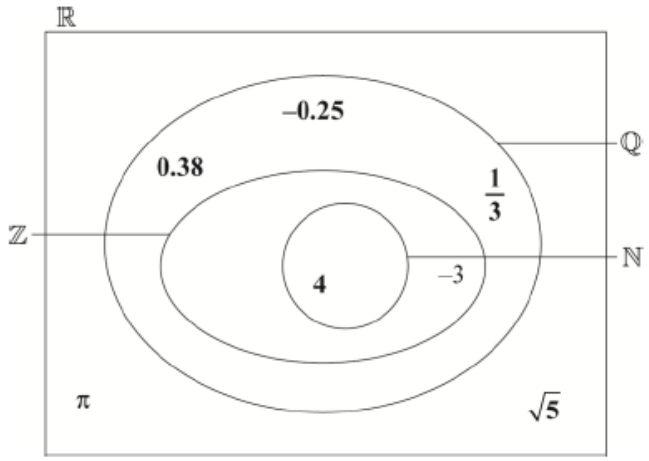
d. 0.38 [1]

e. $\sqrt{5}$ [1]

f. -0.25 [1]

Markscheme

a.



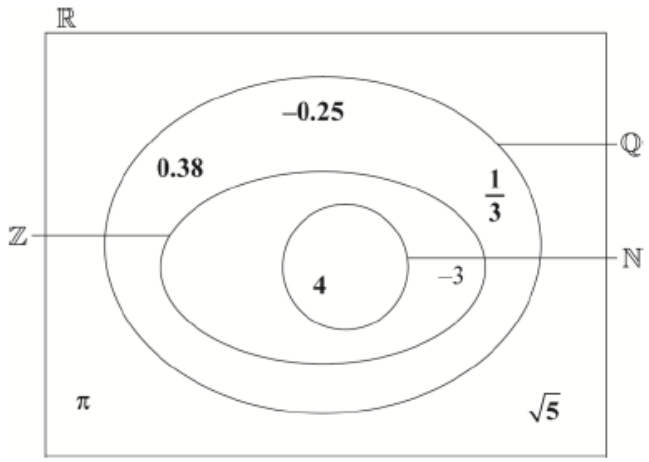
(A1)(A1)(A1)(A1)(A1)(A1) ***(C6)***

Note: Award ***(A1)*** for each number correctly placed.

Award ***(A0)*** for any entry in more than one region.

[1 mark]

b.



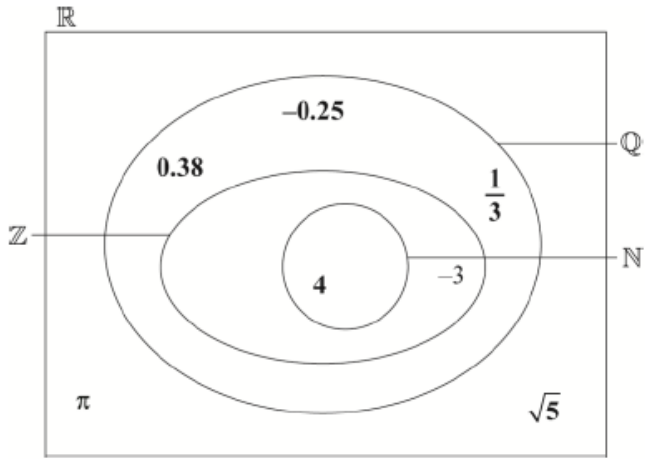
(A1)(A1)(A1)(A1)(A1)(A1) ***(C6)***

Note: Award ***(A1)*** for each number correctly placed.

Award ***(A0)*** for any entry in more than one region.

[1 mark]

c.



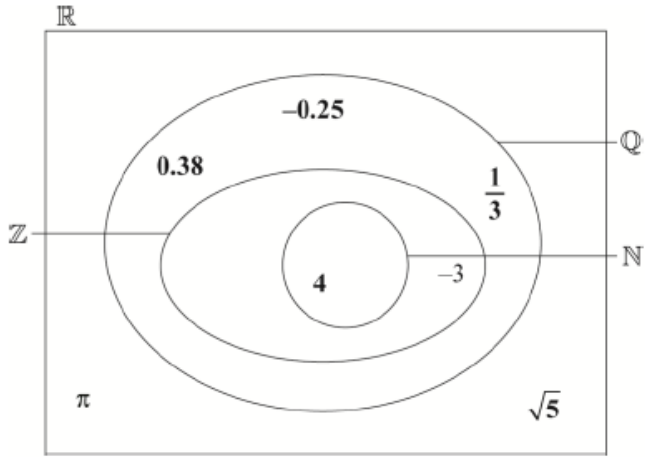
(A1)(A1)(A1)(A1)(A1)(A1) ***(C6)***

Note: Award ***(A1)*** for each number correctly placed.

Award ***(A0)*** for any entry in more than one region.

[1 mark]

d.



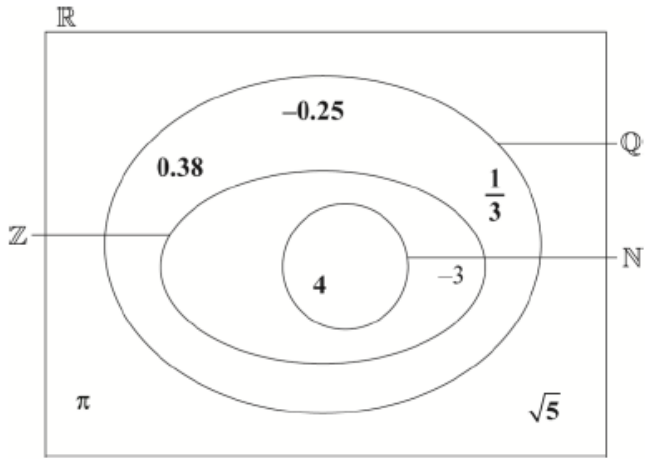
(A1)(A1)(A1)(A1)(A1)(A1) ***(C6)***

Note: Award ***(A1)*** for each number correctly placed.

Award ***(A0)*** for any entry in more than one region.

[1 mark]

e.



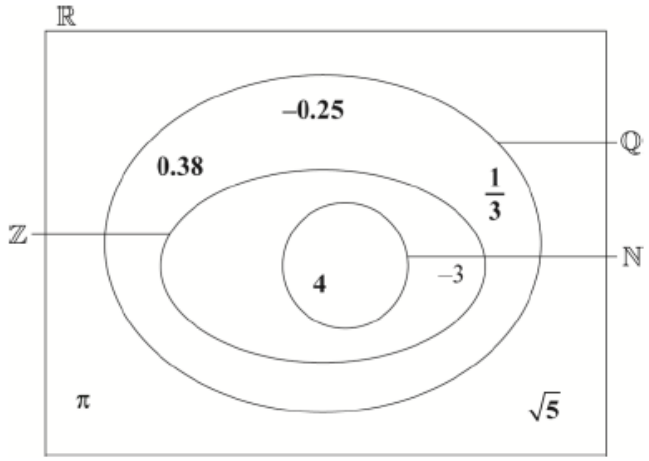
(A1)(A1)(A1)(A1)(A1)(A1) ***(C6)***

Note: Award ***(A1)*** for each number correctly placed.

Award ***(A0)*** for any entry in more than one region.

[1 mark]

f.



(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

a. [N/A]
b. [N/A]
c. [N/A]
d. [N/A]
e. [N/A]
f. [N/A]

Consider the following logic propositions:

p : Sean is at school

q : Sean is playing a game on his computer.

a. Write in words, $p \veebar q$. [2]

b. Write in words, the converse of $p \Rightarrow \neg q$. [2]

c. Complete the following truth table for $p \Rightarrow \neg q$. [2]

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

Markscheme

a. Either Sean is at school or Sean is playing a game on his computer but not both. ***(A1)(A1)*** ***(C2)***

Note: ***(A1)*** for 'either ... or but not both' ***(A1)*** for correct statements. 'Either' can be omitted.

[2 marks]

b. If Sean is not playing a game on his computer then Sean is at school. ***(A1)(A1)*** ***(C2)***

Note: ***(A1)*** for 'If ... then' ***(A1)*** for correct propositions in the correct order.

[2 marks]

c.

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

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

Note: ***(A1)*** for each correct column.

[2 marks]

Examiners report

a. The common error in part (a) was not to include "but not both" and for (b), to give the inverse rather than the converse. The first column in the table (not q) was well done but a number of candidates answered the implication incorrectly.

b. The common error in part (a) was not to include "but not both" and for (b), to give the inverse rather than the converse. The first column in the table (not q) was well done but a number of candidates answered the implication incorrectly.

c. The common error in part (a) was not to include "but not both" and for (b), to give the inverse rather than the converse. The first column in the table (not q) was well done but a number of candidates answered the implication incorrectly.

Consider the following logic propositions:

p : *Yuiko is studying French.*

q : *Yuiko is studying Chinese.*

a. Write down the following compound propositions in symbolic form. [3]

(i) Yuiko is studying French but not Chinese.

(ii) Yuiko is studying French or Chinese, but not both.

b. Write down in words the **inverse** of the following compound proposition. [3]

If Yuiko is studying Chinese, then she is not studying French.

Markscheme

a. (i) $p \wedge \neg q$ ***(A1)(A1)***

Note: Award ***(A1)*** for conjunction, ***(A1)*** for negation of *q*.

(ii) $p \veebar q$ **OR** $(p \vee q) \veebar (p \wedge q)$ ***(A1)*** ***(C3)***

b. If Yuiko is not studying Chinese, (then) she is studying French. ***(A1)(A1)(A1)*** ***(C3)***

Notes: Award ***(A1)*** for "if … (then)" seen, award ***(A1)*** for "not studying Chinese" seen, ***(A1)*** for correct propositions in correct order.

Examiners report

a. 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.

b. [N/A]

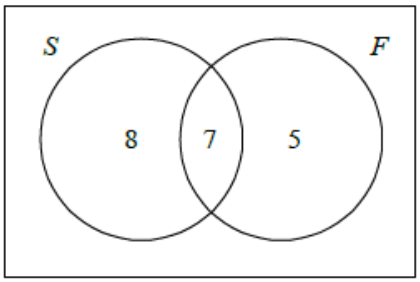
A class consists of students studying Spanish or French or both. Fifteen students study Spanish and twelve study French.

The probability that a student studies French given that she studies Spanish is $\frac{7}{15}$.

a. Draw a Venn diagram in the space below to illustrate this information. [3]

b. Find the probability that a student studies Spanish given that she studies one language only. [3]

Markscheme

a. 

(A1)(A1)(A1) ***(C3)***

Note: Award ***(A1)*** for a labeled Venn diagram with appropriate sets.

(A1) for 7, ***(A1)*** for 8 and 5.

[3 marks]

b. $\mathrm{P}\left(\text{Spanish} \mid \text{one language only}\right) = \frac{\frac{8}{20}}{\frac{8}{20}+\frac{5}{20}}$ ***(M1)(A1)*****(ft)**

Note: Award ***(M1)*** for substituted conditional probability formula, ***(A1)*** for correct substitution. Follow through from their Venn diagram.

$= \frac{8}{13}(0.615,\ 61.5\%)$ ***(A1)*****(ft)**

OR

$\mathrm{P}\left(\text{Spanish} \mid \text{one language only}\right) = \frac{8}{8+5}$ ***(A1)*****(ft)*****(M1)***

Note: Award ***(A1)*** for their correct numerator, ***(M1)*** for correct recognition of regions. Follow through from their Venn diagram.

$= \frac{8}{13}(0.615,\ 61.5\%)$ ***(A1)*****(ft)** ***(C3)***

[3 marks]

Examiners report

a. Part (a) was done well.

b. Very few were able to answer (b).

Consider the following logic propositions.

p: Sandi gets up before eight o'clock

q: Sandi goes for a run

r: Sandi goes for a swim

a. Write down in words the compound proposition [3]

$p \Rightarrow (q \veebar r)$.

b. Complete the following truth table. [2]

p	q	r	$q \veebar r$	$p \Rightarrow (q \veebar r)$
T	T	T		
T	T	F		
T	F	T		
T	F	F		
F	T	T		
F	T	F		
F	F	T		
F	F	F		

c. On a morning when Sandi does **not** get up before eight o'clock, use your truth table to determine whether $p \Rightarrow (q \veebar r)$ is a tautology, contradiction or neither. [1]

Markscheme

a. If Sandi gets up before eight o'clock then Sandi (either) goes for a run or goes for a swim, but not both. ***(A1)(A1)(A1)*** ***(C3)***

Note: Award ***(A1)*** for If …… then ……, ***(A1)*** for all propositions in the correct order, ***(A1)*** for "… or … but not both" (do not accept "either" as a replacement for "but not both").

[3 marks]

b.

p	q	r	$(q \veebar r)$	$p \Rightarrow (q \veebar r)$
T	T	T	**F**	**F**
T	T	F	**T**	**T**
T	F	T	**T**	**T**
T	F	F	**F**	**F**
F	T	T	**F**	**T**
F	T	F	**T**	**T**
F	F	T	**T**	**T**
F	F	F	**F**	**T**

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

Note: Award ***(A1)*** for correct $(q \veebar r)$ column, and ***(A1)*****(ft)** for their correct $p \Rightarrow (q \veebar r)$ column. Follow through from their $(q \veebar r)$ column.

[2 marks]

c. tautology ***(A1)*****(ft)** ***(C1)***

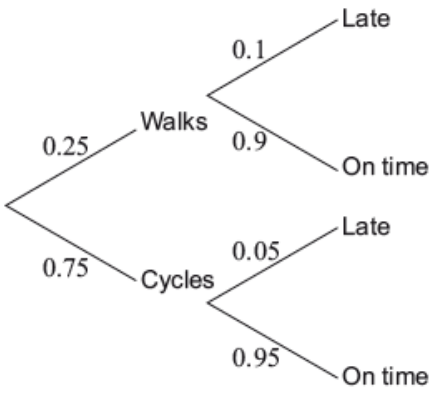
Note: Follow through from part (b).

[1 mark]

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

Peter either walks or cycles to work. The probability that he walks is 0.25. If Peter walks to work, the probability that he is late is 0.1. If he cycles to work, the probability that he is late is 0.05. The tree diagram for this information is shown.



a. On a day chosen at random, Peter walked to work. [1]

Write down the probability that he was on time.

b. For a different day, also chosen at random, [2]

find the probability that Peter cycled to work and was late.

c. For a different day, also chosen at random, [3]

find the probability that, given Peter was late, he cycled to work.

Markscheme

a. 0.9 ***(A1)*** ***(C1)***

b. 0.75×0.05 ***(M1)***

$= 0.0375 \quad \left(\frac{3}{80},\ 3{,}75\%\right)$ ***(A1)*** ***(C2)***

c. $\frac{0.75\times0.05}{0.75\times0.05+0.25\times0.1}$ ***(M1)(M1)***

Note: Award ***(M1)*** for their correct numerator, ***(M1)*** for their correct denominator, *ie*, $\left(\frac{\text{their (b)}}{\text{their (b)}+0.25\times0.1}\right)$.

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

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

Note: Follow through from part (b).

Examiners report

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

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

c. 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.

A bag contains 7 red discs and 4 blue discs. Ju Shen chooses a disc at random from the bag and removes it. Ramón then chooses a disc from those left in the bag.

a. Write down the probability that [3]

(i) Ju Shen chooses a red disc from the bag;

(ii) Ramón chooses a blue disc from the bag, given that Ju Shen has chosen a red disc;

(iii) Ju Shen chooses a red disc and Ramón chooses a blue disc from the bag.

b. Find the probability that Ju Shen and Ramón choose different coloured discs from the bag. [3]

Markscheme

a. (i) $\frac{7}{11}$ $(0.636, 63.6\%)$ $(0.636363\ldots)$ ***(A1)*** ***(C1)***

(ii) $\frac{4}{10}$ $\left(\frac{2}{5}, 0.4, 40\%\right)$ ***(A1)*** ***(C1)***

(iii) $\frac{28}{110}$ $\left(\frac{14}{55}, 0.255, 25.5\%\right)$ $0.254545\ldots$ ***(A1)*(ft)** ***(C1)***

Note: Follow through from the product of their answers to parts (a) (i) and (ii).

[3 marks]

b. $\frac{28}{110} + \left(\frac{4}{11} \times \frac{7}{10}\right)$ **OR** $2 \times \frac{28}{110}$ ***(M1)(M1)***

Notes: Award ***(M1)*** for using their $\frac{28}{110}$ as part of a combined probability expression. ***(M1)*** for either adding $\frac{4}{11} \times \frac{7}{10}$ **or** for multiplying by 2.

$= \frac{56}{110}$ $\left(\frac{28}{55}, 0.509, 50.9\%\right)$ $(0.509090\ldots)$ ***(A1)*(ft)** ***(C3)***

Note: Follow through applies from their answer to part (a) (iii) and only when their answer is between 0 and 1.

[3 marks]

Examiners report

a. The vast majority of candidates were able to pick up the first two marks by confidently identifying the *number of favourable outcomes/total number of outcomes*. Difficulties arose however when combining events and only the more able candidates were able to progress successfully with the remainder of the question. As usual in this type of question, there was an abundance of incorrect answers greater than 1 given.

b. The vast majority of candidates were able to pick up the first two marks by confidently identifying the number of favourable outcomes/total number of outcomes. Difficulties arose however when combining events and only the more able candidates were able to progress successfully with the remainder of the question. As usual in this type of question, there was an abundance of incorrect answers greater than 1 given.

The Home Shine factory produces light bulbs, 7% of which are found to be defective.

Francesco buys two light bulbs produced by Home Shine.

The Bright Light factory also produces light bulbs. The probability that a light bulb produced by Bright Light is not defective is a.

Deborah buys three light bulbs produced by Bright Light.

a. Write down the probability that a light bulb produced by Home Shine is not defective. [1]

b.i. Find the probability that both light bulbs are not defective. [2]

b.ii. Find the probability that at least one of Francesco's light bulbs is defective. [2]

c. Write down an expression, in terms of a, for the probability that at least one of Deborah's three light bulbs is defective. [1]

Markscheme

a. 0.93 (93%) ***(A1)*** ***(C1)***

[1 mark]

b.i. 0.93×0.93 ***(M1)***

Note: Award ***(M1)*** for squaring their answer to part (a).

0.865 (0.8649; 86.5%) ***(A1)*****(ft)** ***(C2)***

Notes: Follow through from part (a).

Accept 0.86 $\left(\text{unless it follows } \frac{93}{100} \times \frac{92}{99}\right)$.

[2 marks]

b.ii. $1 - 0.8649$ ***(M1)***

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

OR

$0.07 \times 0.07 + 2 \times (0.07 \times 0.93)$ ***(M1)***

Note: Follow through from part (a).

0.135 (0.1351; 13.5%) ***(A1)*****(ft)** ***(C2)***

[2 marks]

c. $1 - a^3$ ***(A1)*** ***(C1)***

Note: Accept $3a^2(1-a) + 3a(1-a)^2 + (1-a)^3$ or equivalent.

[1 mark]

Examiners report

a. [N/A]
b.i. [N/A]
b.ii. [N/A]
c. [N/A]

In a research project on the relation between the gender of 150 science students at college and their degree subject, the following set of data is collected.

		Degree Subject		
		Biology	Physics	Chemistry
Gender	Male	40	16	35
	Female	15	24	20

a. Find the probability that a student chosen at random is male. [2]

b. Find the probability that a student chosen at random is either male or studies Chemistry. [2]

c. Find the probability that a student chosen at random studies Physics, given that the student is male. [2]

Markscheme

a. $= \frac{91}{150}(0.607,\ 60.6\,\%,\ 60.7\,\%)$ ***(A1)(A1)*** ***(C2)***

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

[2 marks]

b. $= \frac{111}{150}\left(\frac{37}{50},\ 0.74,\ 74\,\%\right)$ ***(A1)*****(ft)*****(A1)*** ***(C2)***

Note: Award ***(A1)*****(ft)** for their numerator in (a) +20 provided the final answer is not greater than 1. ***(A1)*** for denominator.

[2 marks]

c. $\frac{16}{91}(0.176,\ 17.6\,\%)$ ***(A1)(A1)*****(ft)** ***(C2)***

Note: Award ***(A1)*** for numerator and ***(A1)*****(ft)** for denominator. Follow through from their numerator in (a) provided answer is not greater than 1.

[2 marks]

Examiners report

a. Parts (a) and (b) were well answered with many candidates gaining 4 marks there. The conditional probability in part (c) proved to be more challenging. Nearly all candidates attempted this question showing that time was not a factor in this paper. Many candidates gave their answers as incorrectly rounded decimals, which incurred an accuracy penalty and prevented them from gaining the maximum marks.

b. Parts (a) and (b) were well answered with many candidates gaining 4 marks there. The conditional probability in part (c) proved to be more challenging. Nearly all candidates attempted this question showing that time was not a factor in this paper. Many candidates gave their answers as incorrectly rounded decimals, which incurred an accuracy penalty and prevented them from gaining the maximum marks.

c. Parts (a) and (b) were well answered with many candidates gaining 4 marks there. The conditional probability in part (c) proved to be more challenging. Nearly all candidates attempted this question showing that time was not a factor in this paper. Many candidates gave their answers as incorrectly rounded decimals, which incurred an accuracy penalty and prevented them from gaining the maximum marks.

---

a. Complete the truth table shown below. [3]

p	q	$p \wedge q$	$p \vee (p \wedge q)$	$(p \vee (p \wedge q)) \Rightarrow p$
T	T			
T	F			
F	T			
F	F			

b. State whether the compound proposition $(p \vee (p \wedge q)) \Rightarrow p$ is a contradiction, a tautology or neither. [1]

c. Consider the following propositions. [2]

p: Feng finishes his homework

q: Feng goes to the football match

Write in symbolic form the following proposition.

If Feng does not go to the football match then Feng finishes his homework.

Markscheme

a.

p	q	$p \wedge q$	$p \vee (p \wedge q)$	$(p \vee (p \wedge q)) \Rightarrow p$
T	**T**	**T**	**T**	**T**
T	**F**	**F**	**T**	**T**
F	**T**	**F**	**F**	**T**
F	**F**	**F**	**F**	**T**

(A1)(A1)*(ft)*(A1)*(ft)** ***(C3)

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

[3 marks]

b. tautology ***(A1)*(ft)** ***(C1)***

Note: Follow through from their last column.

[1 mark]

c. $\neg q \Rightarrow p$ ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for $\neg q$ and p in correct order, ***(A1)*** for $\Rightarrow$ sign.

[2 marks]

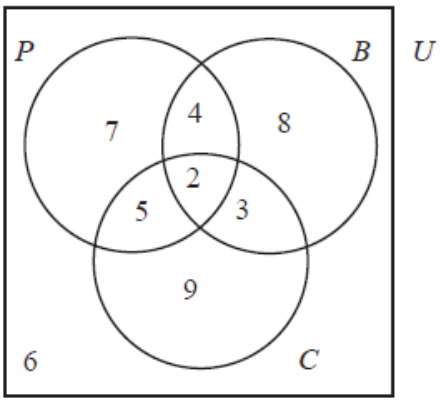
Examiners report

a. The truth table was very well answered and where the table was incorrect a follow through mark could be given for part (b) for a correct answer resulting from their final column. Some candidates appeared unsure of the concept of a tautology.

b. The truth table was very well answered and where the table was incorrect a follow through mark could be given for part (b) for a correct answer resulting from their final column. Some candidates appeared unsure of the concept of a tautology.

c. Nearly all candidates could write the proposition in part (c) in symbolic form.

The Venn diagram shows the numbers of pupils in a school according to whether they study the sciences Physics (P), Chemistry (C), Biology (B).



a. Write down the number of pupils that study Chemistry only. [1]

b. Write down the number of pupils that study **exactly** two sciences. [1]

c. Write down the number of pupils that do not study Physics. [2]

d. Find $n[(P \cup B) \cap C]$. [2]

Markscheme

a. 9 ***(A1)*** ***(C1)***

[1 mark]

b. 12 ***(A1)*** ***(C1)***

[1 mark]

c. $8 + 3 + 9 + 6$ ***(M1)***

$= 26$ ***(A1)*** ***(C2)***

Note: Award ***(A1)*** for 20 seen if answer is incorrect.

[2 marks]

d. $5 + 2 + 3$ ***(M1)***

$= 10$ ***(A1)*** ***(C2)***

Note: Award ***(A1)*** for 29 or 19 seen if answer is incorrect.

[2 marks]

Examiners report

a. This question was well attempted by the majority. The major error was the omission of the “6” in the candidates’ calculations. Perhaps better positioning would have helped in this regard.

b. This question was well attempted by the majority. The major error was the omission of the “6” in the candidates’ calculations. Perhaps better positioning would have helped in this regard.

c. This question was well attempted by the majority. The major error was the omission of the “6” in the candidates’ calculations. Perhaps better positioning would have helped in this regard.

d. This question was well attempted by the majority. The major error was the omission of the “6” in the candidates’ calculations. Perhaps better positioning would have helped in this regard.

Consider the following logic statements.

p: Carlos is playing the guitar

q: Carlos is studying for his IB exams

a. Write in words the compound statement $\neg p \wedge q$. [2]

b. Write the following statement in symbolic form. [1]

“Either Carlos is playing the guitar or he is studying for his IB exams but not both.”

c. Write the **converse** of the following statement in **symbolic form**. [3]

“If Carlos is playing the guitar then he is not studying for his IB exams.”

Markscheme

a. Carlos is not playing the guitar and he is studying for his IB exams. ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for “and”, ***(A1)*** for correct statements.

[2 marks]

b. $p \veebar q$ ***(A1)*** ***(C1)***

[1 mark]

c. $\neg q \Rightarrow p$ ***(A1)(A1)(A1)*** ***(C3)***

Notes: Award ***(A1)*** for implication, ***(A1)*** for the $\neg q$, ***(A1)*** for both $\neg q$ and p in the correct order. If correct converse seen in words only award ***(A1)(A1)(A0)***. Accept $p \Leftarrow \neg q$. Accept $-q$ for $\neg q$.

[3 marks]

Examiners report

a. In part (a) occasionally *'if...then...'* was not seen but generally this was well done.

b. Part (b) was also well done despite the dearth of previous testing of the *exclusive or* statement.

c. Finding the converse of a statement in part (c) proved to be difficult for a significant number of candidates and incorrect answers of the form $q \Rightarrow \neg p$ were more frequently seen than the correct answer. Such incorrect answers lost two marks.

In the Canadian city of Ottawa:

$$97\% \text{ of the population speak English,}$$
$$38\% \text{ of the population speak French,}$$
$$36\% \text{ of the population speak both English and French.}$$

The total population of Ottawa is $985\,000$.

a. Calculate the percentage of the population of Ottawa that speak English but not French. [2]

b. Calculate the number of people in Ottawa that speak both English and French. [2]

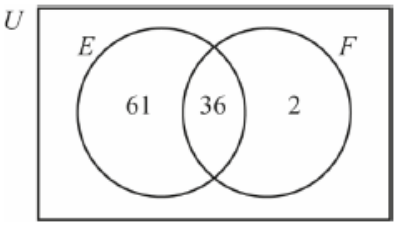
c. Write down your answer to part (b) in the form $a \times 10^k$ where $1 \leqslant a < 10$ and $k \in \mathbb{Z}$. [2]

Markscheme

a. $97 - 36$ ***(M1)***

Note: Award ***(M1)*** for subtracting 36 from 97.

OR



(M1)

Note: Award ***(M1)*** for 61 **and** 36 seen in the correct places in the Venn diagram.

$= 61\ (\%)$ ***(A1)*** ***(C2)***

Note: Accept 61.0 (%).

[2 marks]

b. $\frac{36}{100} \times 985\,000$ ***(M1)***

Note: Award ***(M1)*** for multiplying 0.36 (or equivalent) by $985\,000$.

$= 355\,000\ (354\,600)$ ***(A1)*** ***(C2)***

[2 marks]

c. $3.55 \times 10^5\ (3.546 \times 10^5)$ ***(A1)*****(ft)*****(A1)*****(ft)*** ***(C2)***

Note: Award ***(A1)(ft)*** for 3.55 (3.546) **must** match part (b), and ***(A1)(ft)*** $\times 10^5$.

Award ***(A0)(A0)*** for answers of the type: 35.5×10^4. Follow through from part (b).

[2 marks]

Examiners report

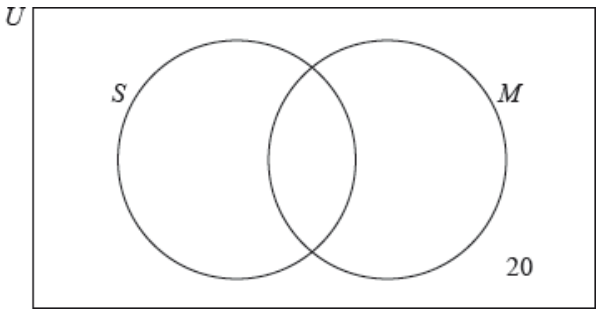
a. [N/A]
b. [N/A]
c. [N/A]

Rosewood College has 120 students. The students can join the sports club (S) and the music club (M).

For a student chosen at random from these 120, the probability that they joined both clubs is $\frac{1}{4}$ and the probability that they joined the music club is $\frac{1}{3}$.

There are 20 students that did not join either club.

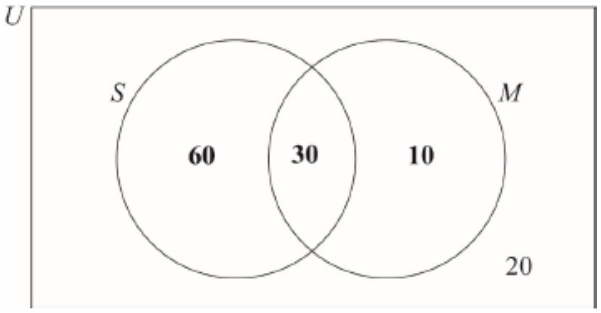
a. Complete the Venn diagram for these students. [2]



b. One of the students who joined the sports club is chosen at random. Find the probability that this student joined both clubs. [2]

c. Determine whether the events S and M are independent. [2]

Markscheme

a. 

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

Note: Award ***(A1)*** for 30 in correct area, ***(A1)*** for 60 and 10 in the correct areas.

[2 marks]

b. $\frac{30}{90}$ $\left(\frac{1}{3},\ 0.333333\ldots,\ 33.3333\ldots\%\right)$ ***(A1)*****(ft)*****(A1)*****(ft)*** ***(C2)***

Note: Award ***(A1)*****(ft)** for correct numerator of 30, ***(A1)*****(ft)** for correct denominator of 90. Follow through from their Venn diagram.

[2 marks]

c. $\mathrm{P}(S) \times \mathrm{P}(M) = \frac{3}{4} \times \frac{1}{3} = \frac{1}{4}$ ***(R1)***

Note: Award ***(R1)*** for multiplying their by $\frac{1}{3}$.

therefore the events are independent $\left(\text{as } \mathrm{P}(S \cap M) = \frac{1}{4}\right)$ ***(A1)*****(ft)** ***(C2)***

Note: Award ***(R1)(A1)*****(ft)** for an answer which is consistent with their Venn diagram.

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

Do not award final ***(A1)*** if $\mathrm{P}(S) \times \mathrm{P}(M)$ is not calculated. Follow through from part (a).

[2 marks]

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

Consider the propositions

p: *I have a bowl of soup.*
q: *I have an ice cream.*

a. Write down, in words, the compound proposition $\neg p \Rightarrow q$. [2]

b. Complete the truth table. [2]

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

c. Write down, in symbolic form, the converse of $\neg p \Rightarrow q$. [2]

Markscheme

a. 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]

b.

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]

c. $q \Rightarrow \neg p$ ***(A1)(A1)*** ***(C2)***

Notes: Award ***(A1)*** for $\Rightarrow$.

Award ***(A1)*** for q and $\neg p$ in correct order.

Accept $\neg p \Leftarrow q$.

[2 marks]

Examiners report

a. 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.

b. 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.

c. 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.

Consider the following propositions.

p: I completed the task
q: I was paid

a. Write down in words $\neg q$. [1]

b. Write down in symbolic form the compound statement: [1]

If I was paid then I completed the task.

c.i. Complete the following truth table. [2]

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

c.ii. State whether the statements $p \vee \neg q$ and $q \Rightarrow p$ are logically equivalent. Give a reason for your answer. [2]

Markscheme

a. I was not paid ***(A1)*** ***(C1)***

[1 mark]

b. $q \Rightarrow p$ ***(A1)*** ***(C1)***

[1 mark]

c.i.

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

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

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

[2 marks]

c.ii. yes ***(A1)*(ft)**

as the last two columns of the truth table are the same ***(R1)*(ft)** ***(C2)***

Note: Do not award ***(A1)(R0)***. Follow through from part (c)(i).

[2 marks]

Examiners report

a. [N/A]
b. [N/A]
c.i. [N/A]
c.ii. [N/A]

Let $\mathrm{P}(A) = 0.5$, $\mathrm{P}(B) = 0.6$ and $\mathrm{P}(A \cup B) = 0.8$.

a. Find $\mathrm{P}(A \cap B)$. [2]

b. Find $\mathrm{P}(A|B)$. [2]

c. Decide whether *A* and *B* are independent events. Give a reason for your answer. [2]

Markscheme

a. $0.8 = 0.5 + 0.6 - \mathrm{P}(A \cap B)$ ***(M1)***

$\mathrm{P}(A \cap B) = 0.3$ ***(A1)*** ***(C2)***

Note: Award ***(M1)*** for correct substitution, ***(A1)*** for correct answer.

[2 marks]

b. $\mathrm{P}(A|B) = \frac{0.3}{0.6}$ ***(M1)***

= 0.5 ***(A1)*(ft)** ***(C2)***

Note: Award ***(M1)*** for correct substitution in conditional probability formula. Follow through from their answer to part (a), provided probability is not greater than one.

[2 marks]

c. $\mathrm{P}(A \cap B) = \mathrm{P}(A) \times \mathrm{P}(B)$ or 0.3 = 0.5 × 0.6 ***(R1)***

OR

$\mathrm{P}(A|B) = \mathrm{P}(A)$ ***(R1)***

they are independent. (Yes) ***(A1)*****(ft)** ***(C2)***

Note: Follow through from their answers to parts (a) or (b).

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

[2 marks]

Examiners report

a. Parts (a) and (b) were well answered but very few candidates could provide a reason for the independence of A and B. A number of candidates confused independent and mutually exclusive events.

b. Parts (a) and (b) were well answered but very few candidates could provide a reason for the independence of A and B. A number of candidates confused independent and mutually exclusive events.

c. Parts (a) and (b) were well answered but very few candidates could provide a reason for the independence of A and B. A number of candidates confused independent and mutually exclusive events.

---

a. Two friends, Sensen and Cruz, are conducting an investigation on probability. [2]

Sensen has a fair six-sided die with faces numbered $1,\ 2,\ 2,\ 4,\ 4$ and 4. Cruz has a fair disc with one red side and one blue side.

The die and the disc are thrown at the same time.

Find the probability that the number shown on the die is 1 **and** the colour shown on the disc is blue;

b. Find the probability that the number shown on the die is 1 **or** the colour shown on the disc is blue; [2]

c. Find the probability that the number shown on the die is even given that the colour shown on the disc is red. [2]

Markscheme

a. $\frac{1}{2} \times \frac{1}{6}$ ***(M1)***

$\frac{1}{12}\ (0.0833,\ 8.33\,\%,\ 0.08333...)$ ***(A1)*** ***(C2)***

b. $\frac{1}{2} + \left(\frac{1}{2} \times \frac{1}{6}\right)$ ***(M1)***

OR

$\frac{1}{6} + \frac{1}{2} - \frac{1}{12}$ ***(M1)***

$\frac{7}{12}\ (0.583,\ 58.3\,\%,\ 0.58333...)$ ***(A1)*** ***(C2)***

Note: Award ***(M1)(A0)*** for a **correct** attempt at a possibility/sample space diagram or tree diagram or $\frac{1}{6} + \left(\frac{5}{6} \times \frac{1}{2}\right)$, leading to an incorrect answer.

c. $\frac{1}{3} + \frac{1}{2}$ ***(M1)***

OR

$\frac{\frac{5}{6} \times \frac{1}{2}}{\frac{1}{2}}$ ***(M1)***

$\frac{5}{6}\ (0.833,\ 83.3\,\%,\ 0.83333...)$ ***(A1)*** ***(C2)***

Notes: Award ***(M1)(A0)*** for a **correct** attempt at a possibility/sample space diagram or tree diagram, leading to an incorrect answer.

Examiners report

a. Question 5: Probability.

Some candidates confused the probability of both events occurring with the probability that one or the other occurs. Many candidates were unable to find the conditional probability. Candidates should not answer a probability question with an answer that exceeds one. Only the very best candidates did very well on this question; many found this to be one of the most challenging questions in the paper.

b. Question 5: Probability.

Some candidates confused the probability of both events occurring with the probability that one or the other occurs. Many candidates were unable to find the conditional probability. Candidates should not answer a probability question with an answer that exceeds one. Only the very best candidates did very well on this question; many found this to be one of the most challenging questions in the paper.

c. Question 5: Probability.

Some candidates confused the probability of both events occurring with the probability that one or the other occurs. Many candidates were unable to find the conditional probability. Candidates should not answer a probability question with an answer that exceeds one. Only the very best candidates did very well on this question; many found this to be one of the most challenging questions in the paper.

Consider the propositions r, p and q.

a. Complete the following truth table. [4]

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

b. Determine whether the compound proposition $\neg\left((r \wedge p) \vee \neg q\right) \Leftrightarrow \neg(r \wedge p) \wedge q$ is a tautology, a contradiction or neither. [2]

Give a reason.

Markscheme

a.

r	p	q	$r \wedge p$	$\neg q$	$(r \wedge p) \vee \neg q$	$\neg\left((r \wedge p) \vee \neg q\right)$	$\neg(r \wedge p)$	$\neg(r \wedge p) \wedge q$
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**

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

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 "$\neg\left((r \wedge p) \vee \neg q\right)$" column, follow through from the preceding column.

b. tautology ***(A1)*****(ft)**

columns $\neg\left((r \wedge p) \vee \neg q\right)$ 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 $\neg\left((r \wedge p) \vee \neg q\right) \Leftrightarrow \neg(r \wedge p) \wedge q$ that is consistent with their table.

Examiners report

a. [N/A]
b. [N/A]

---

a. Consider the following statements [2]

z : x is an integer
q : x is a rational number
r : x is a real number.

i) Write down, in words, $\neg q$.

ii) Write down a value for x such that the statement $\neg q$ is true.

b. Write the following argument in symbolic form: [3]

"If x is a real number and x is not a rational number, then x is not an integer".

c. Phoebe states that the argument in part (b) can be shown to be valid, without the need of a truth table. [1]

Justify Phoebe's statement.

Markscheme

a. i) x is not a rational number ***(A1)***

Note: Accept "x is an irrational number".

ii) any non-rational number (for example: π, $\sqrt{2}$, ...) ***(A1) (C2)***

b. $(r \wedge \neg q) \Rightarrow \neg z$ ***(A1)(A1)(A1) (C3)***

Note: Award ***(A1)*** for "$\Rightarrow$" seen, ***(A1)*** for "$\neg z$" as the consequent and ***(A1)*** for "$(r \wedge \neg q)$" or "$(\neg q \wedge r)$" as the antecedent (the parentheses are required).

c. all integers are rational numbers (and therefore x cannot be an integer if it is not a rational number) ***(R1)***

Note: Accept equivalent expressions.

OR

if x is an integer, then x is a rational number, therefore if x is not a rational number, then x is not an integer (contrapositive) ***(R1) (C1)***

Note: Accept "If x is not in $\mathbb{Q}$, then x is not in $\mathbb{Z}$" with a Venn diagram showing $\mathbb{R}$, $\mathbb{Q}$ and $\mathbb{Z}$ correctly.

Examiners report

a. Question 5 Logic

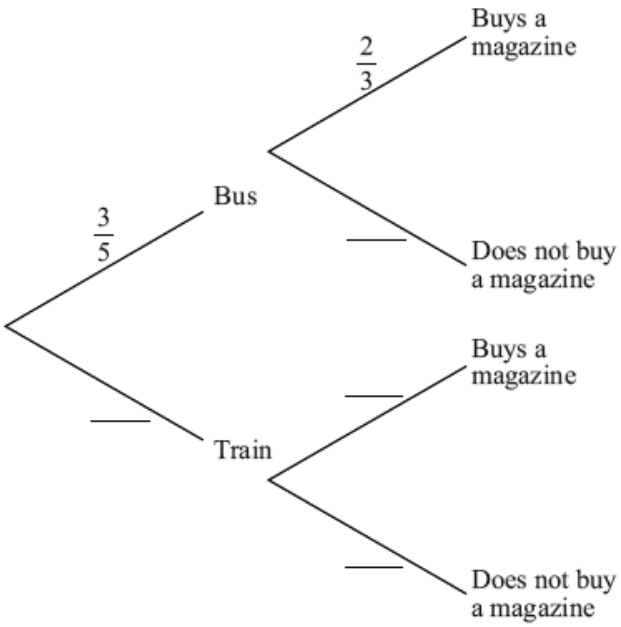
In part (a), the majority of candidates were able to state the negation, but surprisingly many were unable to give an example of a non-rational number.

b. In part (b), a common error was the lack of parentheses in the antecedent. A further error was the use of the "intersection" symbol rather than that for conjunction; care must be taken in this regard.

c. Part (c) proved problematic for all but the best candidates.

Ramzi travels to work each day, either by bus or by train. The probability that he travels by bus is $\frac{3}{5}$. If he travels by bus, the probability that he buys a magazine is $\frac{2}{3}$. If he travels by train, the probability that he buys a magazine is $\frac{3}{4}$.

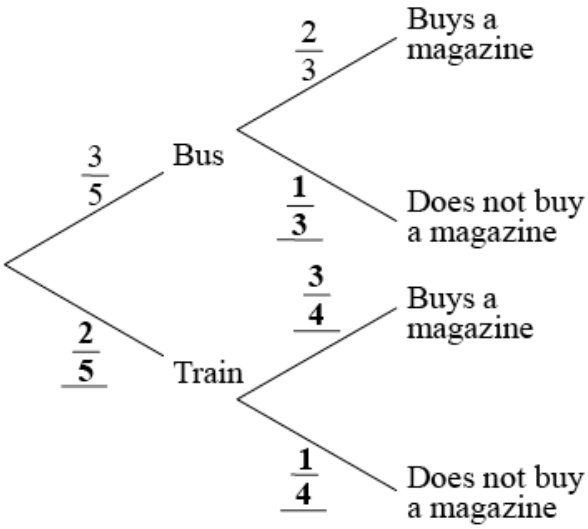
a. Complete the tree diagram. [3]



b. Find the probability that Ramzi buys a magazine when he travels to work. [3]

Markscheme

a.



(A1)(A1)(A1) ***(C3)***

Note: Award ***(A1)*** for each correct pair of branches.

[3 marks]

b. $\frac{3}{5} \times \frac{2}{3} + \frac{2}{5} \times \frac{3}{4}$ ***(A1)*****(ft)*****(M1)***

Notes: Award ***(A1)*****(ft)** for two consistent products from tree diagram, ***(M1)*** for addition of their products.

Follow through from their tree diagram provided all probabilities are between 0 and 1.

$\frac{7}{10}$ $\left(0.7, 70\%, \frac{42}{60}\right)$ ***(A1)*****(ft)** ***(C3)***

[3 marks]

Examiners report

a. 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.

b. 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.

B and C are subsets of a universal set U such that

$$U = \{x : x \in \mathbb{Z}, 0 \leqslant x < 10\},\ B = \{\text{prime numbers} < 10\},\ C = \{x : x \in \mathbb{Z}, 1 < x \leqslant 6\}.$$

a. List the members of sets [4]

(i) B

(ii) $C \cap B$

(iii) $B \cup C'$

b. Consider the propositions: [2]

p : x is a prime number less than 10.

q : x is a positive integer between 1 and 7.

Write down, in words, the contrapositive of the statement, "If x is a prime number less than 10, then x is a positive integer between 1 and 7."

Markscheme

a. (i) $B = 2, 3, 5, 7$ ***(A1)***

Brackets not required

(ii) $C \cap B = 2, 3, 5$ ***(A1)*****(ft)**

Follow through only from incorrect B

(iii) $C' = 0, 1, 7, 8, 9$ ***(A1)*****(ft)**

$B \cup C' = 0, 1, 2, 3, 5, 7, 8, 9$ ***(A1)*****(ft)**

*Note: Award **(A1)** for correct C' seen. The first **(A1)(ft)** in (iii) can be awarded only if C was listed incorrectly and a mark was lost as a result in (a)(ii). If C was not listed and C' is wrong, the first mark is lost. The second mark can **(ft)** within part (iii) as well as from (i).* ***(C4)***

[4 marks]

b. "If x is not a positive integer between 1 and 7, then x is not a prime number less than 10." ***(A1)(A1)***

*Award **(A1)** for **both** (not) statements, **(A1)** for correct order.* ***(C2)***

[2 marks]

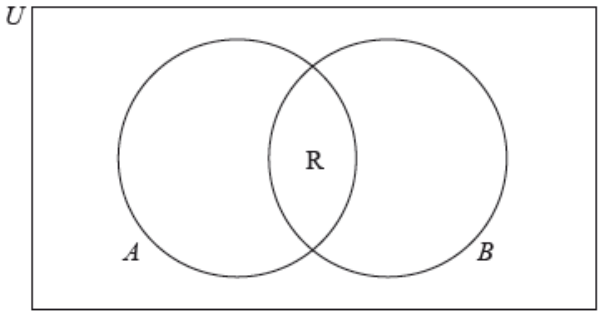
Examiners report

a. a) Many candidates included 1 as a prime number for set B. Most candidates were able to list the intersection of B and C correctly with many receiving a follow through for their incorrect B. Very few candidates were able to list $B \cup C'$ correctly with many listing the intersection. It was disappointing that only a few candidates listed C' separately – those that did often received a mark for this working.

b. b) The majority of candidates were able to write down the contrapositive correctly but many gave the inverse or the converse instead.

Tuti has the following polygons to classify: rectangle (R), rhombus (H), isosceles triangle (I), regular pentagon (P), and scalene triangle (T).

In the Venn diagram below, set A consists of the polygons that have at least one pair of parallel sides, and set B consists of the polygons that have at least one pair of equal sides.



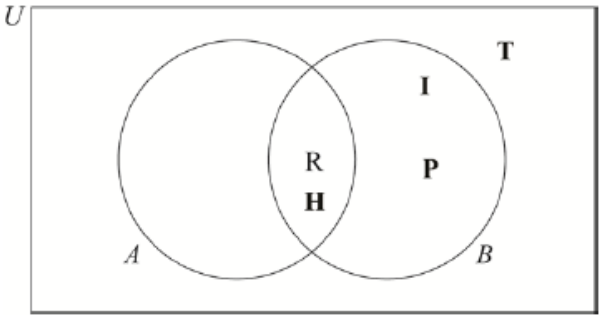
a. Complete the Venn diagram by placing the letter corresponding to each polygon in the appropriate region. For example, R has already been placed, and represents the rectangle. [3]

b. State which polygons from Tuti's list are elements of [3]

(i) $A \cap B$;

(ii) $(A \cup B)'$.

Markscheme

a. 

(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.

b. (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

a. [N/A]
b. [N/A]

Consider the following statements about the quadrilateral ABCD

q : ABCD has four equal sides s : ABCD is a square

a. Express in words the statement, $s \Rightarrow q$. [2]

b. Write down in words, the inverse of the statement, $s \Rightarrow q$. [2]

c. Determine the validity of the argument in (b). Give a reason for your decision. [2]

Markscheme

a. If ABCD is a square, then ABCD has four equal sides. ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for if… then, ***(A1)*** for propositions in the correct order.

b. If ABCD is not a square, then ABCD does not have four equal sides. ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for if… then, ***(A1)*** for propositions in the correct order.

c. Not a valid argument. ABCD may have 4 equal sides but will not **necessarily** be a square. (It may be a rhombus) ***(A1)(R1)*** ***(C2)***

Note: Award ***(R1)*** for correct reasoning, award ***(A1)*** for a consistent conclusion with their answer in part (b).

It is therefore possible that ***(R1)(A0)*** may be awarded, but ***(R0)(A1)*** can never be awarded.

Note: Simple examples of determining the validity of an argument without the use of a truth table may be tested.

Examiners report

a. [N/A]
b. [N/A]
[N/A]

c.

A survey was carried out in a group of 200 people. They were asked whether they smoke or not. The collected information was organized in the following table.

	Smoker	Non-smoker
Male	60	40
Female	30	70

One person from this group is chosen at random.

a. Write down the probability that this person is a smoker. [2]

b. Write down the probability that this person is male given that they are a smoker. [2]

c. Find the probability that this person is a smoker or is male. [2]

Markscheme

a. $\frac{90}{200}(0.45,\ 45\ \%)$ ***(A1)(A1)*** ***(C2)***

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

[2 marks]

b. $\frac{60}{90}(0.\bar{6},\ 0.667,\ 66.\bar{6}\ \%,\ 66.6\ldots\ \%,\ 66.7\ \%)$ ***(A1)(A1)*****(ft)** ***(C2)***

Notes: Award ***(A1)*** for numerator, ***(A1)*****(ft)** for denominator, follow through from their numerator in part (a). Last mark is lost if answer is not a probability.

[2 marks]

c. $\frac{90}{200}+\frac{100}{200}-\frac{60}{200}$ ***(M1)***

Note: Award ***(M1)*** for correct substitution in the combined events formula. Follow through from their answer to part (a).

$=\frac{130}{200}(0.65,\ 65\ \%)$ ***(A1)*****(ft)**

OR

$\frac{60}{200}+\frac{40}{200}+\frac{30}{200}$ ***(M1)***

Note: Award ***(M1)*** for adding the correct fractions.

$=\frac{130}{200}(0.65,\ 65\ \%)$ ***(A1)***

OR

$1 - \frac{70}{200}$ ***(M1)***

Note: Award ***(M1)*** for subtraction of correct fraction from 1.

$= \frac{130}{200} (0.65,\ 65\ \%)$ ***(A1)*** ***(C2)***

[2 marks]

Examiners report

a. This question was generally well answered by many of the candidates. Many found the conditional probability in part b) easier compared to previous sessions, since they were able to write it down directly from the table. A number of candidates found the final part difficult with a significant number unable to use the combined events probability formula correctly.

b. This question was generally well answered by many of the candidates. Many found the conditional probability in part b) easier compared to previous sessions, since they were able to write it down directly from the table. A number of candidates found the final part difficult with a significant number unable to use the combined events probability formula correctly.

c. This question was generally well answered by many of the candidates. Many found the conditional probability in part b) easier compared to previous sessions, since they were able to write it down directly from the table. A number of candidates found the final part difficult with a significant number unable to use the combined events probability formula correctly.

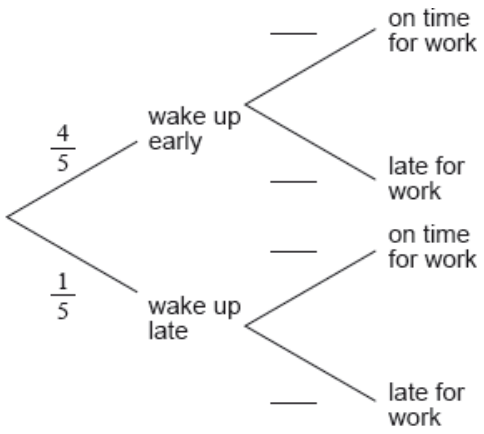
On a work day, the probability that Mr Van Winkel wakes up early is $\frac{4}{5}$.

If he wakes up early, the probability that he is on time for work is p.

If he wakes up late, the probability that he is on time for work is $\frac{1}{4}$.

The probability that Mr Van Winkel arrives on time for work is $\frac{3}{5}$.

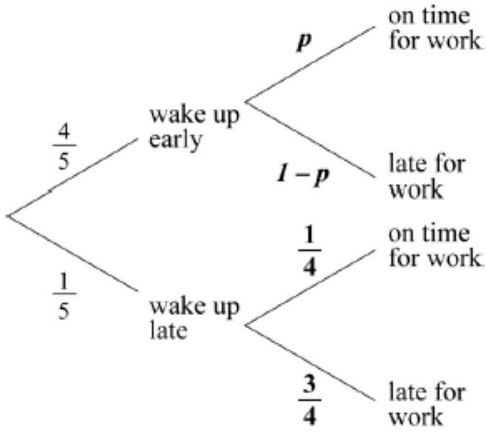
a. Complete the tree diagram below. [2]



b. Find the value of p. [4]

Markscheme

a.



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

Note: Award ***(A1)*** for each correct pair of probabilities.

[2 marks]

b. $\frac{4}{5}p + \frac{1}{5} \times \frac{1}{4} = \frac{3}{5}$ ***(A1)*****(ft)*****(M1)*****(M1)***

Note: Award ***(A1)*****(ft)** for two correct products from part (a), ***(M1)*** for adding their products, ***(M1)*** for equating the sum of any two probabilities to $\frac{3}{5}$.

$(p =) \frac{11}{16} (0.688,\ 0.6875)$ ***(A1)*****(ft)** ***(C4)***

Note: Award the final ***(A1)*****(ft)** only if $0 \leqslant p \leqslant 1$. Follow through from part (a).

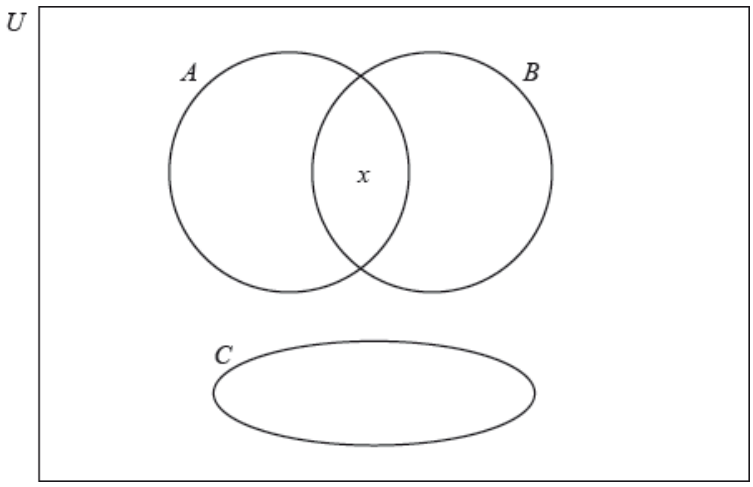
[4 marks]

Examiners report

a. [N/A]
b. [N/A]

The following Venn diagram shows the sets A, B, C and U.

x is an element of U.



a. In the table indicate whether the given statements are True or False. [5]

Statement	True or False
$x \in C$	
$x \subset B$	
$A \cup B \neq \varnothing$	
$A \cap B \subset C$	
$A \cap C = \varnothing$	

b. On the Venn diagram, shade the region $A \cap (B \cup C)'$. [1]

Markscheme

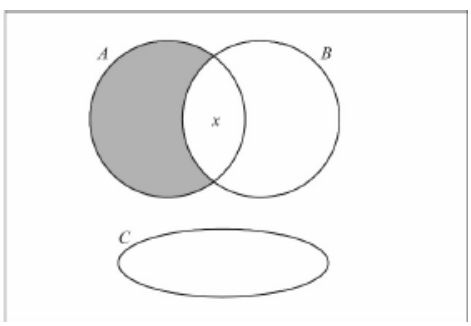
a.

Statement	True or False
$x \in C$	**False**
$x \subset B$	**False**
$A \cup B \neq \varnothing$	**True**
$A \cap B \subset C$	**False**
$A \cap C = \varnothing$	**True**

(A1)(A1)(A1)(A1)(A1) (C5)

[5 marks]

b.



(A1) (C1)

[1 mark]

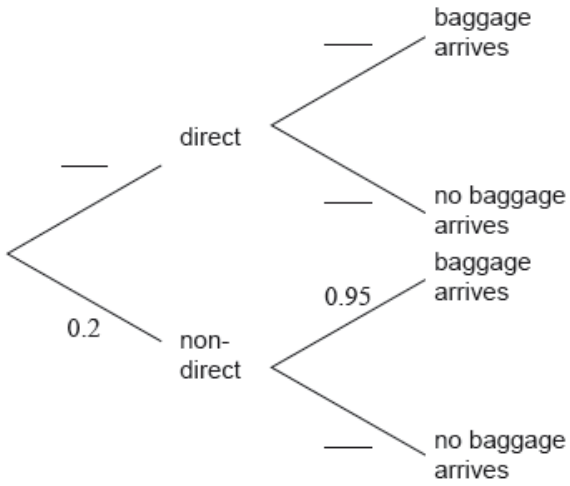
Examiners report

a. [N/A]
b. [N/A]

Sara regularly flies from Geneva to London. She takes either a direct flight or a non-directflight that goes via Amsterdam.

If she takes a direct flight, the probability that her baggage does not arrive in London is 0.01.
If she takes a non-direct flight the probability that her baggage arrives in London is 0.95.

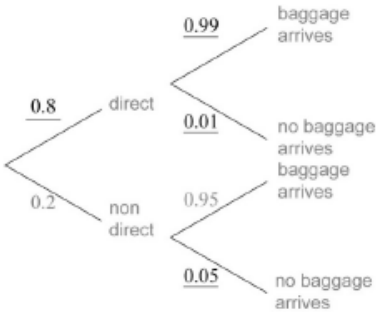
The probability that she takes a non-direct flight is 0.2.



a. Complete the tree diagram. [3]

b. Find the probability that Sara's baggage arrives in London. [3]

Markscheme

a. 

(A1)(A1)(A1) ***(C3)***

Note: Award ***(A1)*** for each correct pair of probabilities.

[3 marks]

b. $0.8 \times 0.99 + 0.2 \times 0.95$ ***(A1)*****(ft)*****(M1)***

Note: Award ***(A1)*****(ft)** for two correct products of probabilities taken from their diagram, ***(M1)*** for the addition of their products.

$= 0.982 \left(98.2\%, \frac{491}{500}\right)$ ***(A1)*****(ft)** ***(C3)***

Note: Follow through from part (a).

[3 marks]

Examiners report

a. [N/A]
b. [N/A]

The IB grades attained by a group of students are listed as follows.

$$6 \quad 4 \quad 5 \quad 3 \quad 7 \quad 3 \quad 5 \quad 4 \quad 2 \quad 5$$

a. Find the median grade. [2]

b. Calculate the interquartile range. [2]

c. Find the probability that a student chosen at random from the group scored at least a grade 4. [2]

Markscheme

a. $2 \quad 3 \quad 3 \quad 4 \quad 4 \quad 5 \quad 5 \quad 5 \quad 6 \quad 7$ ***(M1)***

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

$(\text{Median} =)\ 4.5$ ***(A1)*** ***(C2)***

b. $5 - 3$ ***(M1)***

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

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

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

Examiners report

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

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

c. 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.

A **weighted** die has 2 red faces, 3 green faces and 1 black face. When the die is thrown, the black face is three times as likely to appear on top as one of the other five faces. The other five faces have equal probability of appearing on top.

The following table gives the probabilities.

Red 1	Red 2	Green 1	Green 2	Green 3	Black
$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{m}{8}$	$\frac{1}{8}$	$\frac{n}{8}$

a. Find the value of [2]

(i) m;

(ii) n.

b. The die is thrown once. [2]

Given that the face on top is not red, find the probability that it is black.

c. The die is now thrown twice. [2]

Calculate the probability that black appears on top both times.

Markscheme

a. (i) $m = 1$ ***(A1)***

(ii) $n = 3$ ***(A1)*** ***(C2)***

Note: Award ***(A0)(A1)*****(ft)** for $m = \frac{1}{8}, n = \frac{3}{8}$.

Award ***(A0)(A1)*****(ft)** for $m = 3$, $n = 1$.

[2 marks]

b. $\mathrm{P}(B/R') = \frac{\frac{3}{8}}{\frac{6}{8}} = \frac{3}{6}\left(\frac{1}{2}, 50\%, 0.5\right)$ ***(M1)(A1)*****(ft)** ***(C2)***

Note: Award ***(M1)*** for correctly substituted conditional probability formula or for 6 seen as part of denominator.

[2 marks]

c. $\mathrm{P}(B, B) = \frac{3}{8} \times \frac{3}{8} = \frac{9}{64}(0.141)$ ***(M1)(A1)*****(ft)** ***(C2)***

Note: Award ***(M1)*** for product of two correct fractions, decimals or percentages.

(ft) from their answer to part (a) (ii).

[2 marks]

Examiners report

a. The answers 1/8 and 3/8 were provided by many rather than 1 and 3. The conditional probability question was correctly answered more often when the formula was used. A common incorrect answer to part (c) was 3/8 × 2/7.

b. The answers 1/8 and 3/8 were provided by many rather than 1 and 3. The conditional probability question was correctly answered more often when the formula was used. A common incorrect answer to part (c) was 3/8 × 2/7.

c. The answers 1/8 and 3/8 were provided by many rather than 1 and 3. The conditional probability question was correctly answered more often when the formula was used. A common incorrect answer to part (c) was 3/8 × 2/7.

a. (i) Complete the truth table below. [4]

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

(ii) State whether the compound propositions $\neg(p \wedge q)$ and $\neg p \vee \neg q$ are equivalent.

b. Consider the following propositions. [2]

p : Amy eats sweets

q : Amy goes swimming.

Write, in symbolic form, the following proposition.

Amy either eats sweets or goes swimming, but not both.

Markscheme

a. (i)

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

(A3)

Note: Award ***(A1)*** for $p \wedge q$ column correct, ***(A1)*****(ft)** for $\neg(p \wedge q)$ column correct, ***(A1)*** for last column correct.

(ii) Yes. ***(R1)*(ft)** ***(C4)***

Note: (ft) from their second and the last columns. Must be correct from their table.

[4 marks]

b. $p \underline{\vee} q$. ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for $p \ldots q$, ***(A1)*** for $\underline{\vee}$. Accept $(p \vee q) \wedge \neg(p \wedge q)$ or $(p \vee q) \wedge (\neg p \vee \neg q)$.

[2 marks]

Examiners report

a. This question was well answered by many of the candidates. It is an area of the syllabus that is well taught and many managed to get a follow through mark even though one of the columns in the table might have been incorrect.

b. This question was well answered by many of the candidates. It is an area of the syllabus that is well taught and many managed to get a follow through mark even though one of the columns in the table might have been incorrect.

Consider each of the following statements

$$p : Alex\ is\ from\ Uruguay$$

$$q : Alex\ is\ a\ scientist$$

$$r : Alex\ plays\ the\ flute$$

a. Write the following argument in words [3]

$$\neg r \Rightarrow (q \vee p)$$

b. Complete the truth table for the argument in part (a) using the values below for p , q , r and $\neg r$. [2]

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

c. The argument $\neg r \Rightarrow (q \vee p)$ is invalid. State the reason for this. [1]

Markscheme

a. If Alex does not play the flute then he is **either** a scientist **or** from Uruguay. ***(A1)(A1)(A1)*** ***(C3)***

Note: Award ***(A1)*** if… then, correct ***(A1)*** antecedent, ***(A1)*** correct consequent.

b.

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

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

c. Not all entries in the final column are T. ***(R1)*** ***(C1)***

Examiners report

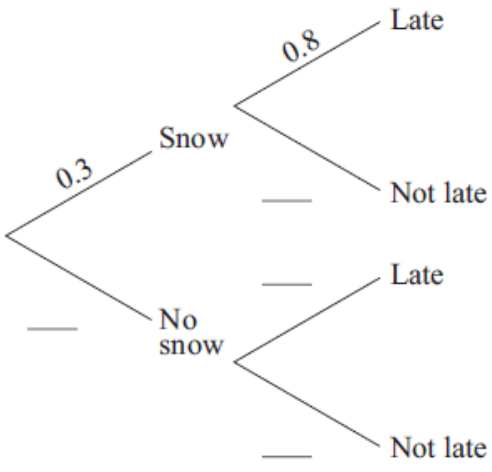
a. [N/A]
b. [N/A]
c. [N/A]

The probability that it will snow tomorrow is 0.3.

If it snows tomorrow the probability that Chuck will be late for school is 0.8.

If it does not snow tomorrow the probability that Chuck will be late for school is 0.1.

a. Complete the tree diagram below. [3]

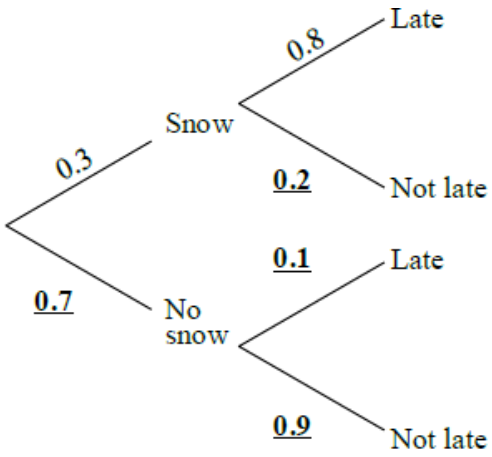


b. Find the probability that it does not snow tomorrow and Chuck is late for school. [1]

c. Find the probability that Chuck is late for school. [2]

Markscheme

a.



(A1)(A1)(A1) ***(C3)***

Note: Award ***(A1)*** for each correct pair.

[3 marks]

b. 0.7×0.1

$= 0.07(\frac{7}{100},\ 7\%)$ ***(A1)*****(ft)** ***(C1)***

[1 mark]

c. $0.3 \times 0.8 + 0.07$ ***(M1)***

$= 0.31(\frac{31}{100},\ 31\%)$ ***(A1)*****(ft)**

Note: In (b) and (c) follow through from sensible answers only i.e. not a probability greater than one. ***(C2)***

[2 marks]

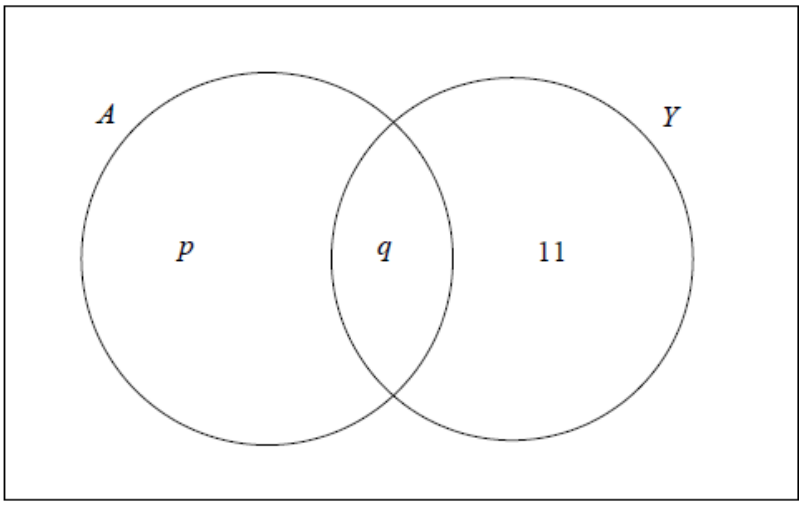
Examiners report

a. This question was answered well.

b. This question was answered well.

c. A few students were unable to do part (c).

A fitness club has 60 members. 35 of the members attend the club's aerobics course (A) and 28 members attend the club's yoga course (Y). 17 members attend both courses. A Venn diagram is used to illustrate this situation.



a. Write down the value of q. [1]

b. Find the value of p. [2]

c. Calculate the number of members of the fitness club who attend neither the aerobics course (A) nor the yoga course (Y). [2]

d. Shade, on your Venn diagram, $A' \cap Y$. [1]

Markscheme

a. 17 ***(A1)*** ***(C1)***

[1 mark]

b. 35 – 17 ***(M1)***

= 18 ***(A1)*** ***(C2)***

Note: Award ***(A1)*** for correct answer only.

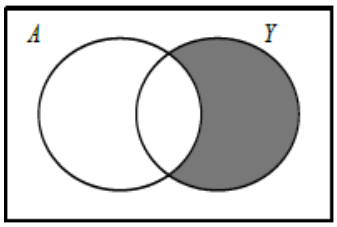
[2 marks]

c. $60 - (35 - 17) - (28 - 17) - 17$ ***(M1)***

= 14 ***(A1)*(ft)** ***(C2)***

Note: Follow through from (a) and (b).

[2 marks]

d. 

(A1) ***(C1)***

[1 mark]

Examiners report

a. This was probably the question that most candidates found the easiest. Nearly all candidates gained either 5 or 6 marks with the mark lost in shading the region on the Venn diagram.

b. This was probably the question that most candidates found the easiest. Nearly all candidates gained either 5 or 6 marks with the mark lost in shading the region on the Venn diagram.

c. This was probably the question that most candidates found the easiest. Nearly all candidates gained either 5 or 6 marks with the mark lost in shading the region on the Venn diagram.

d. This was probably the question that most candidates found the easiest. Nearly all candidates gained either 5 or 6 marks with the mark lost in shading the region on the Venn diagram.

---

a. Complete the truth table below. [4]

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

b.i. State whether the statement $(p \wedge q) \Rightarrow (\neg p \veebar q)$ is a logical contradiction, a tautology or neither. [1]

b.ii. Give a reason for your answer to part (b)(i). [1]

Markscheme

a.

p	q	$\neg p$	$(p \wedge q)$	$(\neg p \veebar q)$	$(p \wedge q) \Rightarrow (\neg p \veebar q)$
T	T	**F**	**T**	**T**	**T**
T	F	**F**	**F**	**F**	**T**
F	T	**T**	**F**	**F**	**T**
F	F	**T**	**F**	**T**	**T**

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

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

Award first ***(A1)*(ft)** from their third column in the table.

Award second ***(A1)*(ft)** from their fourth and fifth column in the table.

[4 marks]

b.i. Tautology ***(A1)*(ft)** ***(C1)***

Note: Answer must be consistent with last column in table.

[1 mark]

b.ii. All entries (in the final column) are true. ***(R1)*(ft)** ***(C1)***

Note: Answer must be consistent with their answer to part (b)(i).

Note: Special case ***(A1)(R0)*** may be awarded.

[1 mark]

Examiners report

a. Weaker candidates had some difficulty here with the majority scoring less than 2 marks on this question. The more confident candidates were able to score well with most marks being lost only on completing the truth table for $(\neg p \veebar q)$. As a consequence, the final column entries of the table were often incorrect but earned the (A1)(ft) mark. Many candidates went on to correctly identify the correct (ft) response to (b)(i) and were able to support their answer with a correct reason.

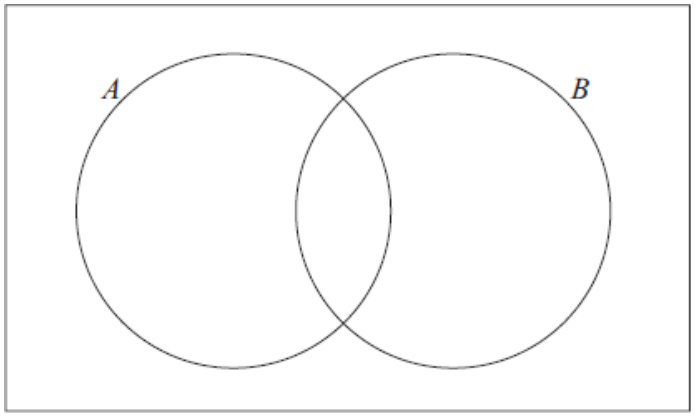
b.i. Weaker candidates had some difficulty here with the majority scoring less than 2 marks on this question. The more confident candidates were able to score well with most marks being lost only on completing the truth table for $(\neg p \veebar q)$. As a consequence, the final column entries of the table were often incorrect but earned the (A1)(ft) mark. Many candidates went on to correctly identify the correct (ft) response to (b)(i) and were able to support their answer with a correct reason.

b.ii. Weaker candidates had some difficulty here with the majority scoring less than 2 marks on this question. The more confident candidates were able to score well with most marks being lost only on completing the truth table for $(\neg p \veebar q)$. As a consequence, the final column entries of the table were often incorrect but earned the (A1)(ft) mark. Many candidates went on to correctly identify the correct (ft) response to (b)(i) and were able to support their answer with a correct reason.

A group of 30 students were asked about their favourite topping for toast.

18 liked peanut butter (A)
10 liked jam (B)
6 liked neither

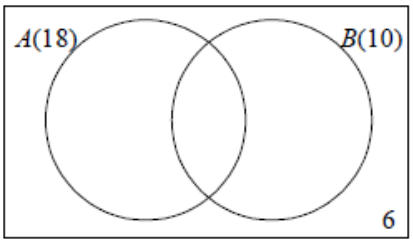
a. Show this information on the Venn diagram below. [2]

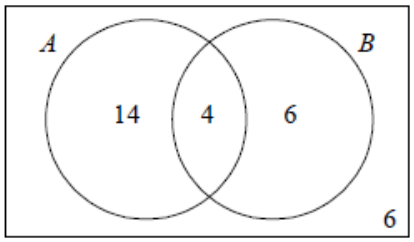


b. Find the number of students who like both peanut butter and jam. [2]

c. Find the probability that a randomly chosen student from the group likes peanut butter, given that they like jam. [2]

Markscheme

a. 

OR


(A2) ***(C2)***

Note: Award ***(A2)*** for 3 correctly placed values, and no extras (4 need not be seen), ***(A1)*** for 2 correctly placed values, ***(A0)*** for 1 or no correctly placed values.

[2 marks]

b. 18 + 10 + 6 = 30 ***(M1)***

= 4 ***(A1)*** ***(C2)***

[2 marks]

c. $\mathrm{P}(A|B) = \frac{4}{10}\left(\frac{2}{5},\ 0.4,\ 40\ \%\right)$ ***(A1)*****(ft)*****(A1)*** ***(C2)***

Note: Award ***(A1)*****(ft)** for their numerator from part (b), ***(A1)*** for denominator.

[2 marks]

Examiners report

a. The first two parts of this question were well answered with most candidates completing the Venn diagram correctly and finding the number in the intersection. The final part, requiring a conditional probability to be found, proved more difficult as many candidates tried to use the formula, when all that was required was to look at the values in the Venn diagram. Follow through marks were awarded in part (c) for values

correctly used from parts (a) and (b).

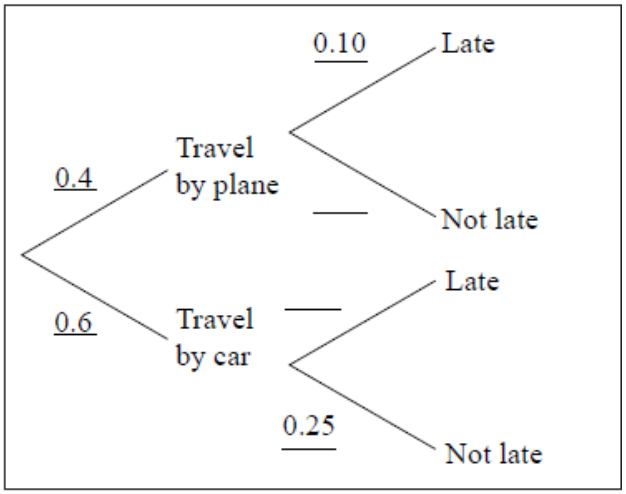
b. The first two parts of this question were well answered with most candidates completing the Venn diagram correctly and finding the number in the intersection. The final part, requiring a conditional probability to be found, proved more difficult as many candidates tried to use the formula, when all that was required was to look at the values in the Venn diagram. Follow through marks were awarded in part (c) for values correctly used from parts (a) and (b).

c. The first two parts of this question were well answered with most candidates completing the Venn diagram correctly and finding the number in the intersection. The final part, requiring a conditional probability to be found, proved more difficult as many candidates tried to use the formula, when all that was required was to look at the values in the Venn diagram. Follow through marks were awarded in part (c) for values correctly used from parts (a) and (b).

Merryn plans to travel to a concert tomorrow. Due to bad weather, there is a 60 % chance that all flights will be cancelled tomorrow. If the flights are cancelled Merryn will travel by car.

If she travels by plane the probability that she **will be late** for the concert is 10 %.
If she travels by car, the probability that she **will not be late** for the concert is 25 %.

a. Complete the tree diagram below. [1]



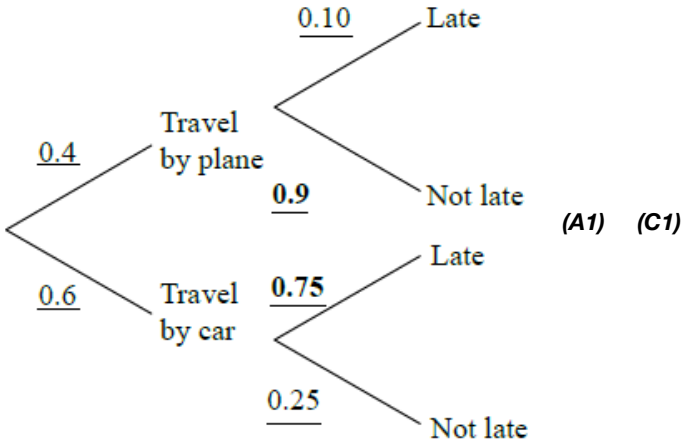
b. Find the probability that Merryn will not be late for the concert. [3]

c. Merryn was not late for the concert the next day. [2]

Given that, find the probability that she travelled to the concert by car.

Markscheme

a.



(A1) ***(C1)***

Note: Award ***(A1)*** for 0.9 and 0.75.

[1 mark]

b. $0.4 \times 0.9 + 0.6 \times 0.25$ ***(M1)(M1)***

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

$0.51 \left(\frac{51}{100},\ 51\%\right)$ ***(A1)*****(ft)** ***(C3)***

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

[3 marks]

c. $\frac{0.6 \times 0.25}{0.51}$ ***(M1)***

Note: Award ***(M1)*** for correctly substituted conditional probability formula.

$0.294 \left(\frac{5}{17}, 0.294117...\right)$ ***(A1)*****(ft)** ***(C2)***

Note: Follow through from their tree diagram and their part (b).

[2 marks]

Examiners report

a. It was pleasing to see many correct answers in parts (a) and (b) with many writing their answer to part (b) in the context of the question and writing down a percentage.

b. It was pleasing to see many correct answers in parts (a) and (b) with many writing their answer to part (b) in the context of the question and writing down a percentage.

c. Conditional probability is not an easy topic for candidates to understand and many simply wrote down $0.6 \times 0.25 = 0.15(15\%)$ for part (c).

$U = \{x | x \text{ is an integer}, 2 < x < 10\}$

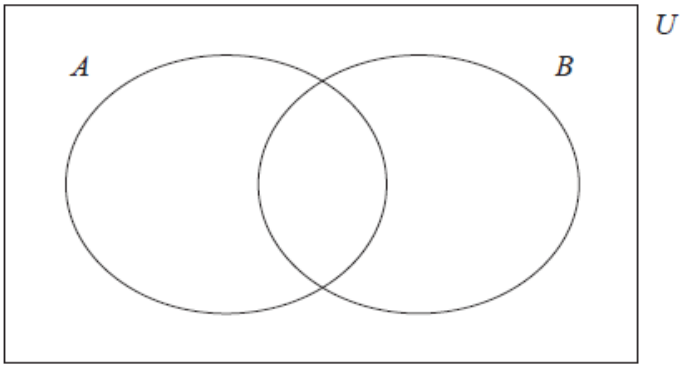
A and B are subsets of U such that $A = \{\text{multiples of } 3\}$, $B = \{\text{factors of } 24\}$.

a. List the elements of [2]

(i) U ;

(ii) B .

b. Write down the elements of U on the Venn diagram. [3]



c. Write down $n(A \cap B)$. [1]

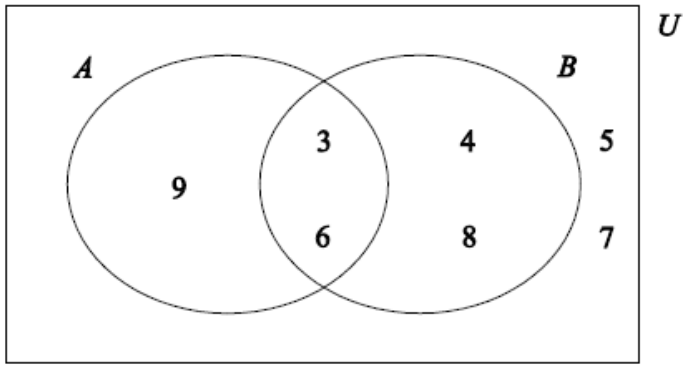
Markscheme

a. (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]

b. 

(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]

c. 2 ***(A1)*****(ft)** ***(C1)***

Note: Follow through from their Venn diagram.

[1 mark]

Examiners report

a. 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.

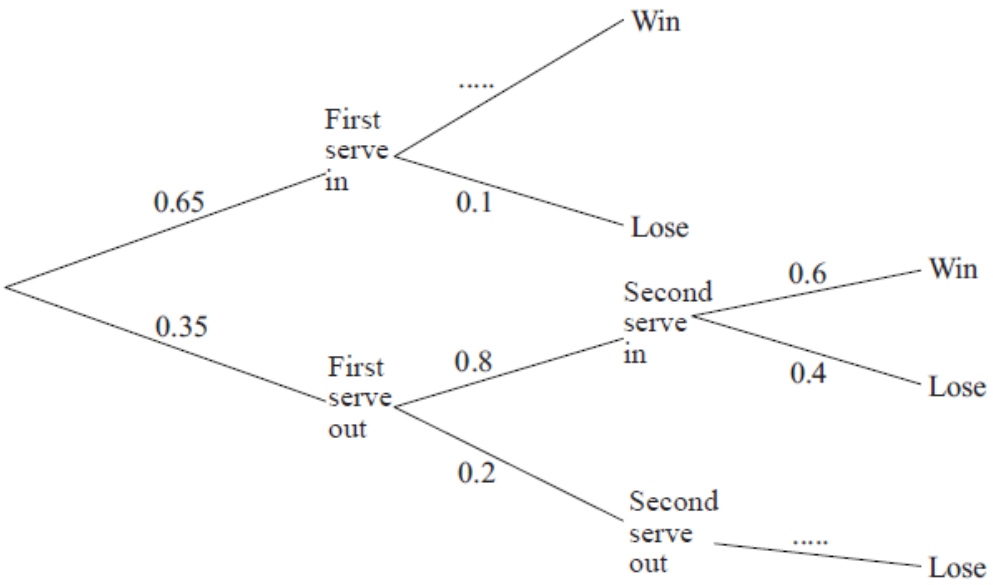
b. Many candidates were unable to write down correctly the universal set which was integers between 2 and 10. Some candidates did not read the direction “on the Venn diagram” so complained of lack of space for their answer. It is important candidates read the directions carefully. Many candidates listed 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.

c. 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.

When Andy plays tennis, 65% of his first serves go into the correct area of the court.

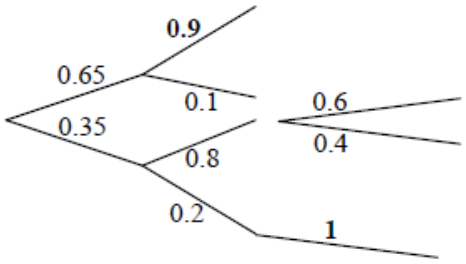
If the first serve goes into the correct area, his chance of winning the point is 90%.
If his first serve does not go into the correct area, Andy is allowed a second serve and, of these, 80% go into the correct area.
If the second serve goes into the correct area, his chance of winning the point is 60%.
If neither serve goes into the correct area, Andy loses the point.

a. Complete the tree diagram below. [2]



b. Find the probability that Andy loses the point. [4]

Markscheme

a. 

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

[2 marks]

b. $0.65 \times 0.1 \ (= 0.065)$ ***(A1)***

$0.35 \times 0.8 \times 0.4 \ (= 0.112)$ ***(A1)***

$0.35 \times 0.2 \times 1$ *the 1 can be implied* $(= 0.07)$ ***(A1)*****(ft)**

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

Note: No **(ft)** for any probabilities greater than 1.

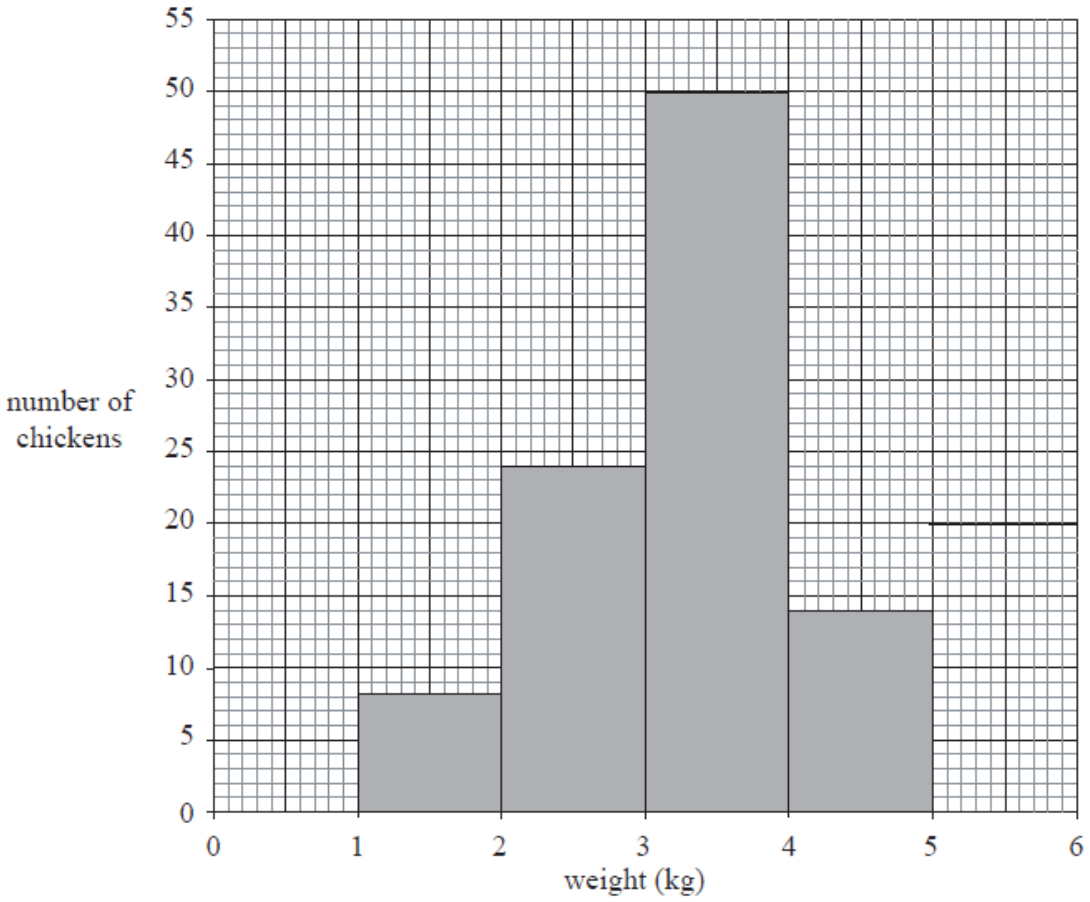
[4 marks]

Examiners report

a. This question proved to be the easiest question (along with question 1) with many candidates gaining full marks. The probability tree diagram was completed correctly and then most could go on to find the required probability. Very few added the probabilities instead of multiplying them.

b. This question proved to be the easiest question (along with question 1) with many candidates gaining full marks. The probability tree diagram was completed correctly and then most could go on to find the required probability. Very few added the probabilities instead of multiplying them.

The following histogram shows the weights of a number of frozen chickens in a supermarket. The weights are grouped such that $1 \leqslant \text{weight} < 2$, $2 \leqslant \text{weight} < 3$ and so on.



b. Find the total number of chickens. [1]

c. Write down the modal group. [1]

d. Gabriel chooses a chicken at random. [2]

Find the probability that this chicken weighs less than 4 kg.

Markscheme

b. 96 ***(A1)*** ***(C1)***

[1 mark]

c. $3 \leqslant \text{weight} < 4$ kg . *Accept* $3 - 4$ kg ***(A1)*** ***(C1)***

[1 mark]

d. For adding three heights or subtracting 14 from 96 ***(M1)***

$\frac{82}{96}$ $(0.854$ or $\frac{41}{48}, 85.4\%)$ **(ft)** *from (b).* ***(A1)*(ft)** ***(C2)***

[2 marks]

Examiners report

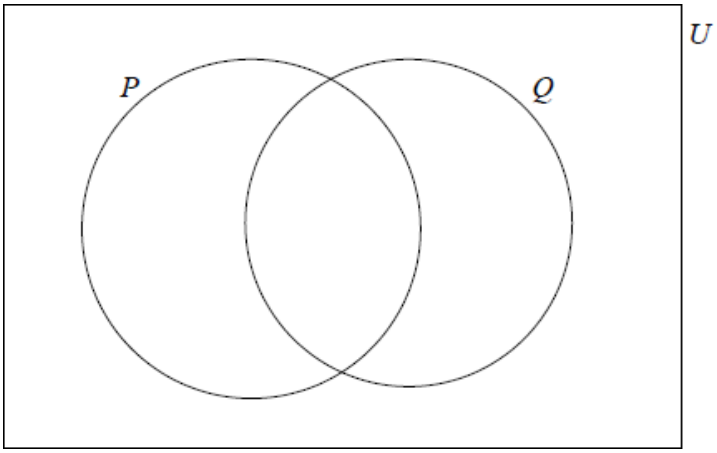
b. Very few candidates could draw a frequency polygon correctly. The word 'Draw' means that a ruler should be used. Many managed to draw from the mid-point of the bar but did not extend it to 0.5 or 5.5. Most could answer the probability part of the question.

c. Very few candidates could draw a frequency polygon correctly. The word ‘Draw’ means that a ruler should be used. Many managed to draw from the mid-point of the bar but did not extend it to 0.5 or 5.5. Most could answer the probability part of the question.

d. Very few candidates could draw a frequency polygon correctly. The word ‘Draw’ means that a ruler should be used. Many managed to draw from the mid-point of the bar but did not extend it to 0.5 or 5.5. Most could answer the probability part of the question.

The sets P, Q and U are defined as

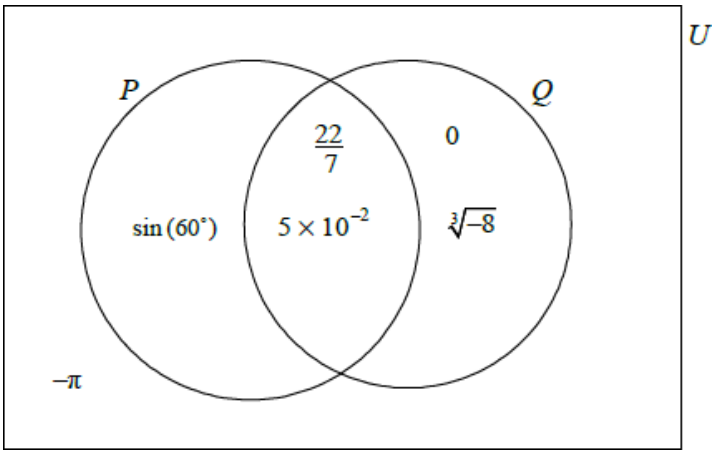
U = {Real Numbers} , P = {Positive Numbers} and Q = {Rational Numbers}.



Write down in the correct region on the Venn diagram the numbers

$\frac{22}{7}$, 5×10^{-2} , $\sin(60°)$, 0 , $\sqrt[3]{-8}$, $-\pi$.

Markscheme



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

Note: Award ***(A1)*** for each number placed once in the correct region. Accept equivalent forms for numbers.

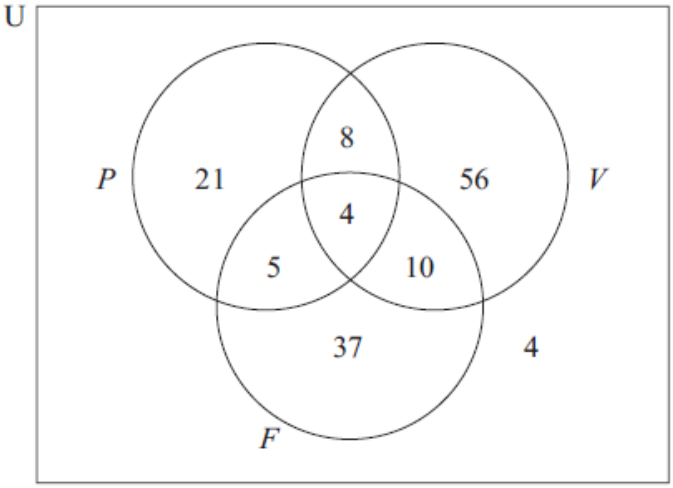
[6 marks]

Examiners report

Very few candidates gained full marks in this question. A common error turned out to be that $\frac{22}{7}$ and 5×10^{-2} were not considered rational numbers. Also, 0 and $\sin(60^\circ)$ were often placed incorrectly. However, it was encouraging that very few candidates placed values in more than one region.

Music lessons in Piano (P), Violin (V) and Flute (F) are offered to students at a school.

The Venn diagram shows the number of students who learn each kind of instrument.



a. Write down the total number of students in the school. [1]

b. Write down the number of students who [3]

(i) learn violin only;

(ii) learn piano or flute or both;

(iii) do not learn flute.

c. Explain, in words, the meaning of the part of the diagram that represents the set $P \cap F'$. [2]

Markscheme

a. 145 ***(A1)*** ***(C1)***

[1 mark]

b. (i) 56 ***(A1)***

(ii) 85 ***(A1)***

(iii) 89 ***(A1)*** ***(C3)***

[3 marks]

c. The students who learn the piano and do not learn the flute. ***(A1)(A1)*** ***(C2)***

Notes: Award ***(A1)*** for students who learn piano, not flute, ***(A1)*** for and (accept but). Accept correct alternative statements. Accept "The number of students who learn the piano and do not learn the flute".

[2 marks]

Examiners report

a. The most common error in Question 4 was to omit counting the four non-music students. Explaining in words the meaning of the set notation was difficult for some candidates.

b. The most common error in Question 4 was to omit counting the four non-music students. Explaining in words the meaning of the set notation was difficult for some candidates.

c. The most common error in Question 4 was to omit counting the four non-music students. Explaining in words the meaning of the set notation was difficult for some candidates.

In an international competition, participants can answer questions in **only one** of the three following languages: Portuguese, Mandarin or Hindi. 80 participants took part in the competition. The number of participants answering in Portuguese, Mandarin or Hindi is shown in the table.

		Languages			
		Portuguese	Mandarin	Hindi	**Total**
Participants	Boys	20	18	5	**43**
	Girls	18	7	12	**37**
	Total	**38**	**25**	**17**	**80**

A boy is chosen at random.

a. State the number of boys who answered questions in Portuguese. [1]

b. Find the probability that the boy answered questions in Hindi. [2]

c. Two girls are selected at random. [3]

Calculate the probability that one girl answered questions in Mandarin and the other answered questions in Hindi.

Markscheme

a. 20 ***(A1) (C1)***

[1 mark]

b. $\frac{5}{43}$ $(0.11627\ldots,\ 11.6279\ldots\%)$ ***(A1)(A1) (C2)***

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

[2 marks]

c. $\frac{7}{37} \times \frac{12}{36} + \frac{12}{37} \times \frac{7}{36}$ ***(A1)(M1)***

Note: Award ***(A1)*** for first or second correct product seen, ***(M1)*** for adding their two products or for multiplying their product by two.

$= \frac{14}{111}$ $(0.12612\ldots,\ 12.6126\,\%)$ ***(A1) (C3)***

[3 marks]

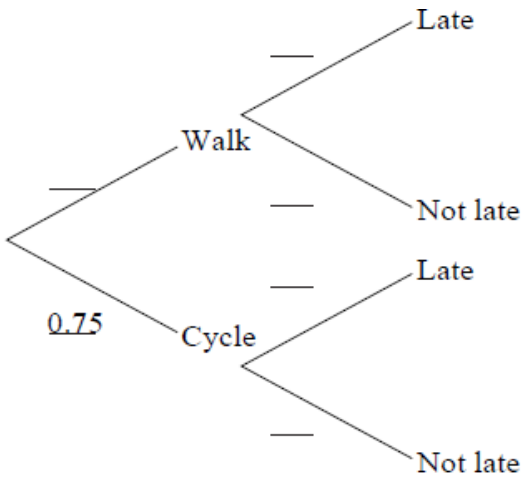
Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

Maria travels to school either by walking or by bicycle. The probability she cycles to school is 0.75.

If she walks, the probability that she is late for school is 0.1.
If she cycles, the probability that she is late for school is 0.05.

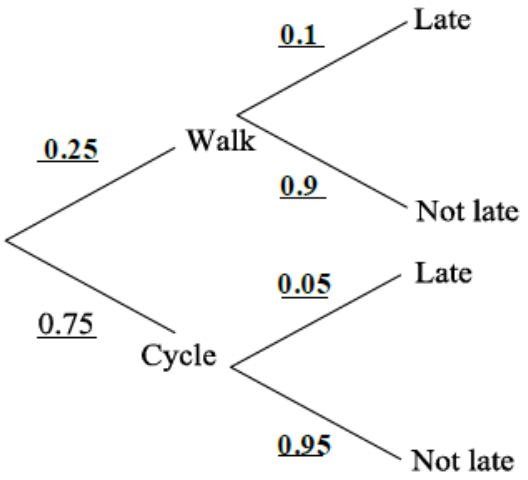
a. Complete the tree diagram below, showing the appropriate probabilities. [3]



b. Find the probability that Maria is late for school. [3]

Markscheme

a.



(A1)(A1)(A1) ***(C3)***

Note: Award ***(A1)*** for 0.25, ***(A1)*** for 0.1 and 0.9, ***(A1)*** for 0.05 and 0.95

[3 marks]

b. $\mathrm{P}(\text{late}) = 0.25 \times 0.1 + 0.75 \times 0.05$ ***(A1)*****(ft)*****(M1)***

Note: Award ***(A1)*****(ft)** for two correct products from their diagram and award ***(M1)*** for addition of their two products.

$= 0.0625 \left(\frac{1}{16},\ 6.25\%\right)$ ***(A1)*****(ft)** ***(C3)***

[3 marks]

Examiners report

a. Part (a) of this question was very well answered with many candidates gaining the maximum marks. Many candidates were less successful in part (b) and it seemed as if many of them either gained 3 marks or 0 marks. This shows that students who knew how to approach part (b) were also able to correctly substitute in the formula they used and reach the correct answer. Very few of those students lost the last mark for wrong rounding.

b. Part (a) of this question was very well answered with many candidates gaining the maximum marks. Many candidates were less successful in part (b) and it seemed as if many of them either gained 3 marks or 0 marks. This shows that students who knew how to approach part (b) were also able to correctly substitute in the formula they used and reach the correct answer. Very few of those students lost the last mark for wrong rounding.

Consider the following propositions.

p: my Mathematical Studies homework is due tomorrow
q: today is Wednesday

a. Write down in words the compound proposition $\neg p \Rightarrow q$. [2]

b. Complete the truth table. [3]

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

c. State whether the compound proposition $(\neg p \Rightarrow q) \vee (\neg p \wedge q)$ is a tautology, contradiction or neither. [1]

Markscheme

a. If my Mathematical Studies homework is not due in tomorrow then today is Wednesday. ***(A1)(A1) (C2)***

Note: Award ***(A1)*** for If… then…
Award ***(A1)*** for correct propositions, *my Mathematical Studies homework is* ***not*** *due in tomorrow and today is Wednesday*, in the correct order.
Award ***(A1)(A0)*** for "*If ¬p then q*".

[2 marks]

b.

p	q	$\neg p$	$\neg p \Rightarrow q$	$\neg p \wedge q$	$(\neg p \Rightarrow q) \vee (\neg p \wedge q)$
T	T	F	**T**	**F**	**T**
T	F	F	**T**	**F**	**T**
F	T	T	**T**	**T**	**T**
F	F	T	**F**	**F**	**F**

(A1)(A1)(A1)**(ft)** ***(C3)***

[3 marks]

c. neither ***(A1)*****(ft)** ***(C1)***

Note: Follow through from the final column of their truth table.

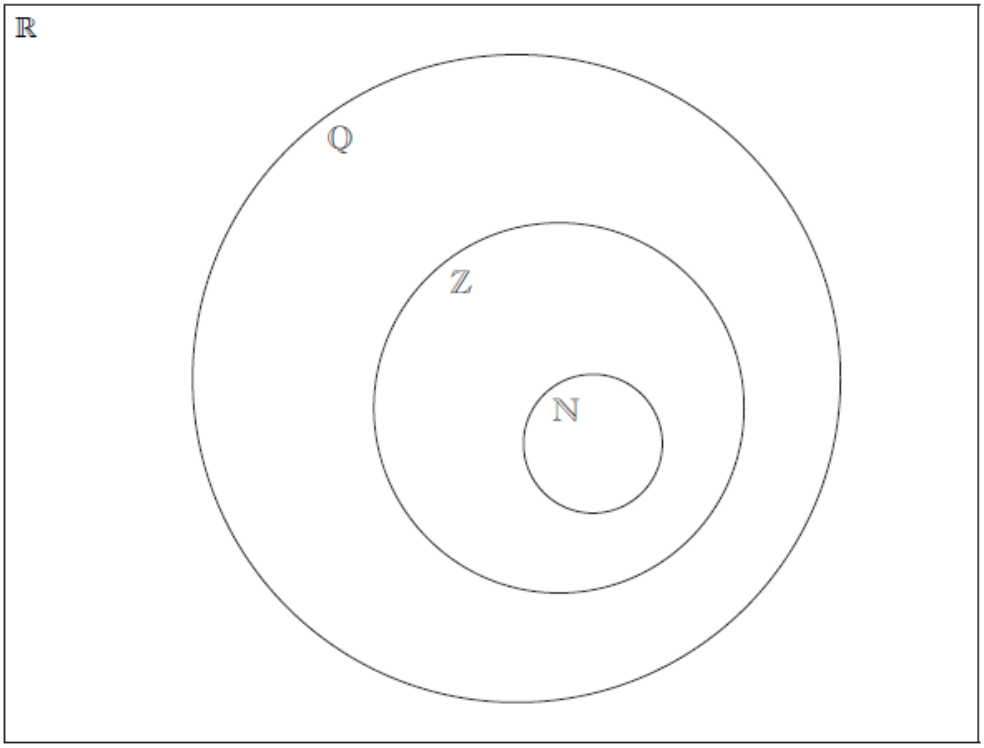
[1 mark]

Examiners report

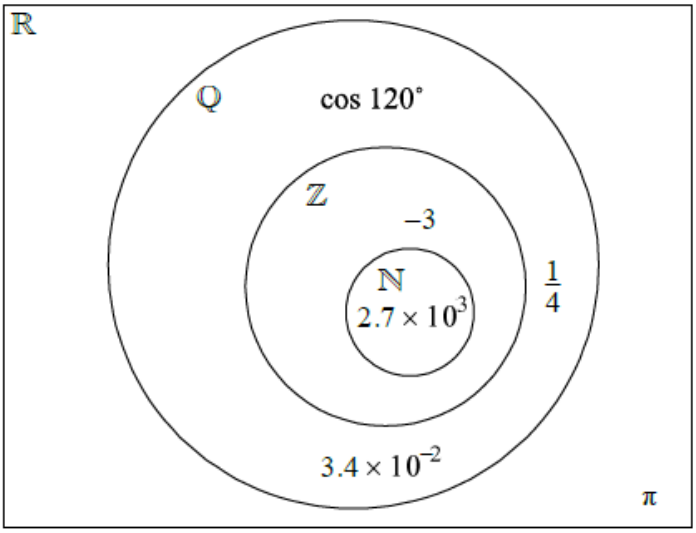
a. [N/A]
b. [N/A]
c. [N/A]

The Venn diagram shows the number sets $\mathbb{N}$, $\mathbb{Z}$, $\mathbb{Q}$ and $\mathbb{R}$. Place each of the following numbers in the appropriate region of the Venn diagram.

$\frac{1}{4}$, –3, π, cos 120°, 2.7×10^3, 3.4×10^{-2}



Markscheme



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

Note: Award ***(A1)*** for each number placed once in the correct section. Accept equivalent forms for numbers.

[6 marks]

Examiners report

About half of the students answered this question correctly. The placement of cos120 and π appeared to cause the most problems.

The grades obtained by a group of 20 IB students are listed below:

6	2	5	3	5	5	6	2	6	1
7	6	2	4	2	4	3	4	5	6

a. Complete the following table for the grades obtained by the students. [2]

Grade	Frequency
1	
2	
3	2
4	
5	4
6	
7	1

b. Write down the modal grade obtained by the students. [1]

c. Calculate the median grade obtained by the students. [2]

d. One student is chosen at random from the group. [1]

Find the probability that this student obtained either grade 4 or grade 5.

Markscheme

a.

Grade	Frequency
1	**1**
2	**4**
3	(2)
4	**3**
5	(4)
6	**5**
7	(1)

(A2) ***(C2)***

Notes: Award ***(A1)*** for three correct. Award ***(A0)*** for two or fewer correct.

[2 marks]

b. $\text{Mode} = 6$ ***(A1)*****(ft)** ***(C1)***

[1 mark]

c. $\text{Median} = 4.5$ ***(M1)(A1)*****(ft)** ***(C2)***

Note: ***(M1)*** for attempt to order raw data (if frequency table not used) or ***(M1)*** halfway between 10^{th} and 11^{th} result.

[2 marks]

d. $\frac{7}{20}$ $(0.35, 35\%)$ ***(A1)*****(ft)** ***(C1)***

[1 mark]

Examiners report

a. Parts (a) and (b) were well done by the vast majority of candidates.

b. Parts (a) and (b) were well done by the vast majority of candidates.

c. Part (c) caused problems to many – with (1) the mean of the two grades not being taken (2) the mean being calculated instead of the median.

d. Part (d) was successfully completed by those candidates who did the question by counting. Those who tried to use the probability laws were not successful.

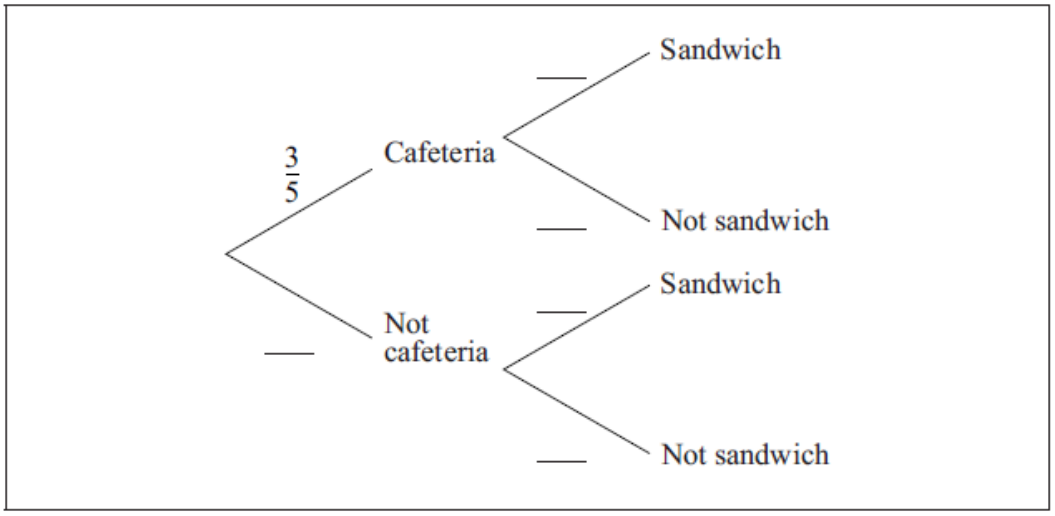
Much of the question could have been checked by inputting the data into the GDC.

The probability that Tanay eats lunch in the school cafeteria is $\frac{3}{5}$.

If he eats lunch in the school cafeteria, the probability that he has a sandwich is $\frac{3}{10}$.

If he does not eat lunch in the school cafeteria the probability that he has a sandwich is $\frac{9}{10}$.

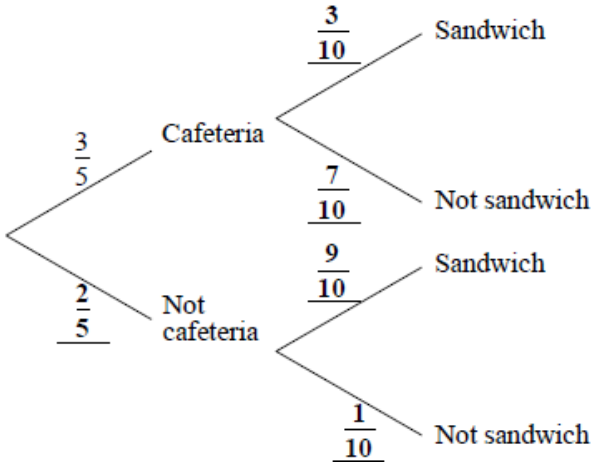
a. Complete the tree diagram below. [3]



b. Find the probability that Tanay has a sandwich for his lunch. [3]

Markscheme

a.



(A1)(A1)(A1) ***(C3)***

Note: Award ***(A1)*** for each correct pair of branches.

b. $\frac{3}{5} \times \frac{3}{10} + \frac{2}{5} \times \frac{9}{10}$ ***(A1)*****(ft)*****(M1)***

Notes: Award ***(A1)*****(ft)** for their two correct products, ***(M1)*** for addition of their products. Follow through from their tree diagram.

$= \frac{27}{50} (0.54, 54\%)$ ***(A1)*****(ft)** ***(C3)***

Examiners report

a. [N/A]
b. [N/A]

U is the set of all the **positive** integers less than or equal to 12.

A , B and C are subsets of U .

$$A = \{1, 2, 3, 4, 6, 12\}$$

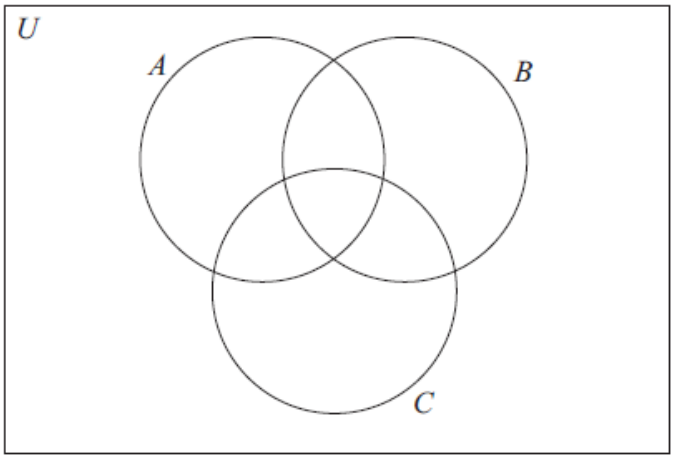
$$B = \{\text{odd integers}\}$$

$$C = \{5, 6, 8\}$$

a. Write down the number of elements in $A \cap C$. [1]

b. List the elements of B . [1]

c. Complete the following Venn diagram with **all** the elements of U . [4]



Markscheme

a. 1 (one) ***(A1)*** ***(C1)***

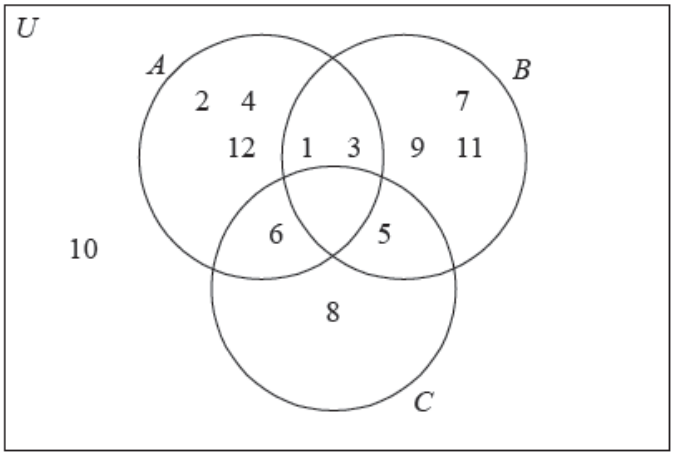
Note: 6, $\{6\}$ or $\{1\}$ earns no marks.

[1 mark]

b. $1, 3, 5, 7, 9, 11$ ***(A1)*** ***(C1)***

Note: Do not penalise if braces, parentheses or brackets are seen.

[1 mark]

c. 

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

Notes: Award ***(A1)*** for the empty set $A \cap B \cap C$.

Award ***(A1)*(ft)** for the correct placement of 6, 5, 1 and 3.

Award ***(A1)*(ft)** for the correct placement of 2, 4, 12, 7, 9, 11, 8.

Award ***(A1)*(ft)** for the correct placement of 10.

Follow through from part (b).

[4 marks]

Examiners report

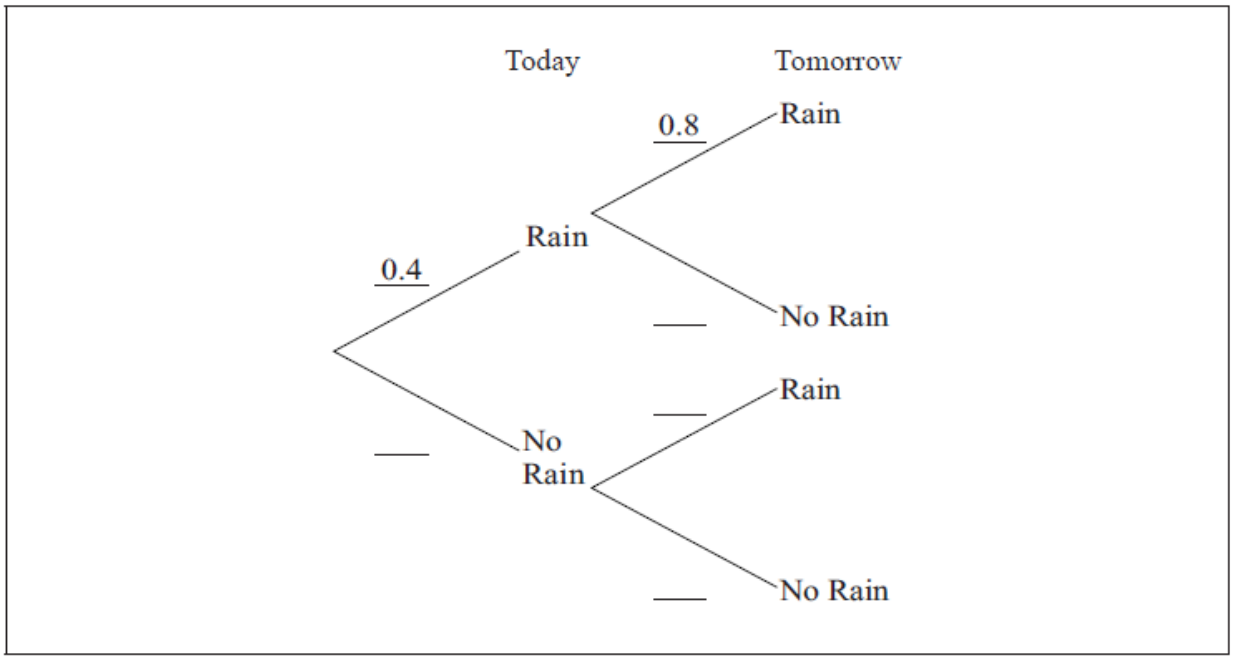
a. There was much confusion amongst candidates as to the understanding of the words *number of elements*. Many candidates simply wrote down 6 or $\{6\}$ and consequently lost the first mark.

b. There was much confusion amongst candidates as to the understanding of the words *number of elements*. Many candidates simply wrote down 6 or $\{6\}$ and consequently lost the first mark. Part (b) was done well and many successful attempts were made at completing the Venn diagram in part (c). The most common error in the last part of the question was the omission of the element 10.

c. Part (b) was done well and many successful attempts were made at completing the Venn diagram in part (c). The most common error in the last part of the question was the omission of the element 10.

The probability that it rains today is 0.4 . If it rains today, the probability that it will rain tomorrow is 0.8 . If it does not rain today, the probability that it will rain tomorrow is 0.7 .

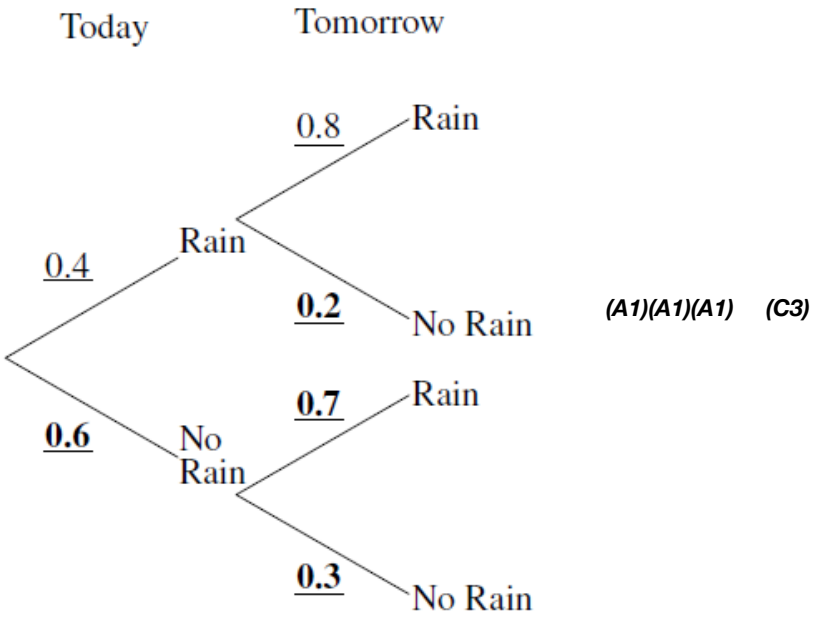
a. Complete the tree diagram below. [3]



b. Calculate the probability of rain tomorrow. [3]

Markscheme

a.



(A1)(A1)(A1) ***(C3)***

Note: Award ***(A1)*** for each correct pair.

[3 marks]

b. $0.4 \times 0.8 + 0.6 \times 0.7$ ***(A1)*****(ft)*****(M1)***

Notes: Award ***(A1)*****(ft)** for two consistent products from tree diagram, ***(M1)*** for addition of their products. Follow through from their tree diagram provided all probabilities are between 0 and 1.

$= 0.74$ ***(A1)*****(ft)** ***(C3)***

[3 marks]

Examiners report

a. Part a of this question was well answered, however part b caused many problems. Candidates did not seem to know how to find the probability of the combined events.

b. Part a of this question was well answered, however part b caused many problems. Candidates did not seem to know how to find the probability of the combined events.

A school offers three activities, basketball (B), choir (C) and drama (D). Every student must participate in at least one activity.

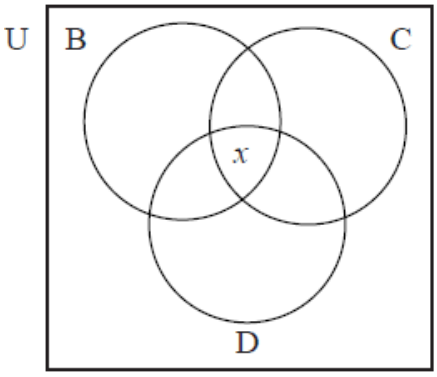
16 students play basketball only.

18 students play basketball and sing in the choir but do not do drama.

34 students play basketball and do drama but do not sing in the choir.

27 students are in the choir and do drama but do not play basketball.

a. Enter the above information on the Venn diagram below. [2]



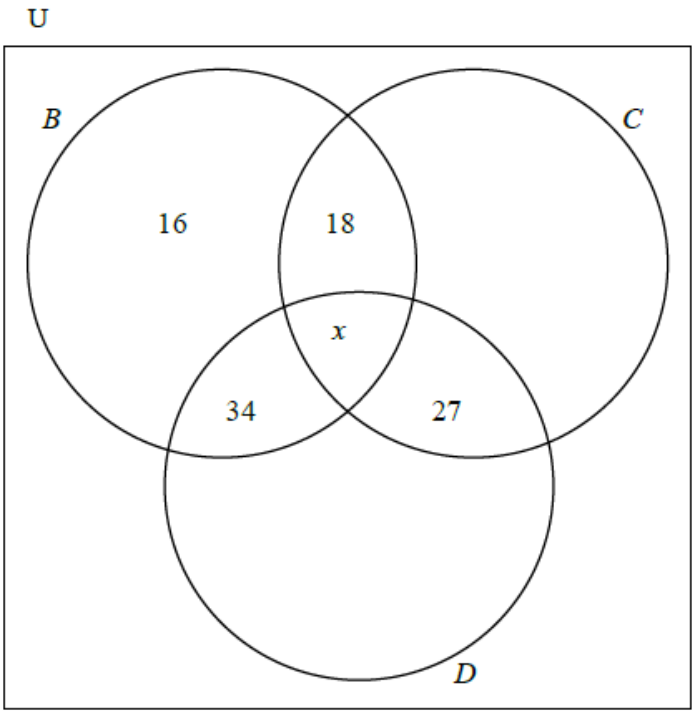
b. 99 of the students play basketball, 88 sing in the choir and 110 do drama. [1]

Calculate the number of students x participating in all three activities.

c. 99 of the students play basketball, 88 sing in the choir and 110 do drama. [3]

Calculate the total number of students in the school.

Markscheme

a. 

(A2)

(A1) *only if 1 error*

(A0) *otherwise* ***(C2)***

[2 marks]

b. $x + 16 + 18 + 34 = 99$

$x = 31$ ***(A1)*** ***(C1)***

[1 mark]

c. Choir only $= 88 - (18 + 27 + 31) = 12$ ***(A1)*****(ft)**

Drama only $= 110 - (27 + 34 + 31) = 18$ ***(A1)*****(ft)**

Total $= 16 + 34 + 18 + 31 + 12 + 27 + 18 = 156$ ***(A1)*****(ft)** ***(C3)***

[3 marks]

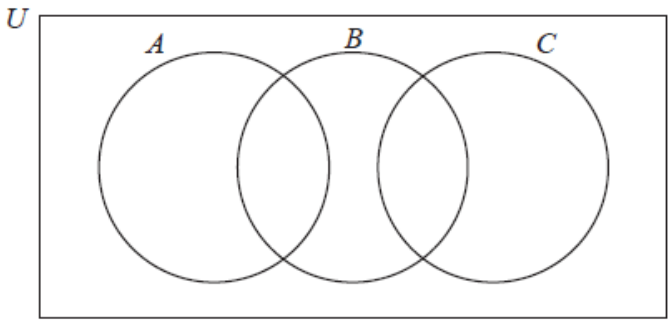
Examiners report

a. Venn diagrams continue to be a problem area. Quite a good number of candidates managed to fill in the information on the Venn diagram accurately. However, finding the correct value for *x* and calculating the number of students in the school posed a big problem for many candidates.

b. Venn diagrams continue to be a problem area. Quite a good number of candidates managed to fill in the information on the Venn diagram accurately. However, finding the correct value for *x* and calculating the number of students in the school posed a big problem for many candidates.

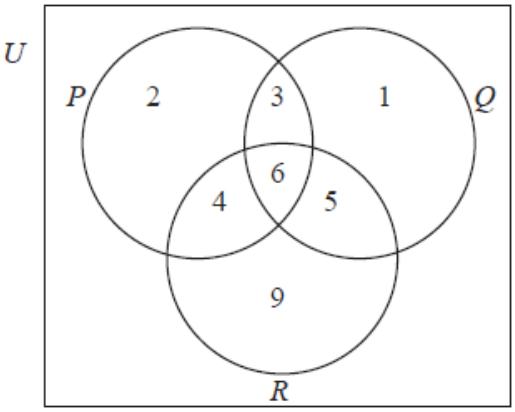
c. Venn diagrams continue to be a problem area. Quite a good number of candidates managed to fill in the information on the Venn diagram accurately. However, finding the correct value for *x* and calculating the number of students in the school posed a big problem for many candidates.

a. Shade $(A \cup B) \cap C'$ on the diagram below. [2]



b. In the Venn diagram below, the number of elements in each region is given. [2]

Find $n((P \cap Q) \cup R)$.



c. U is the set of positive integers, $\mathbb{Z}^+$. [2]

E is the set of even numbers.

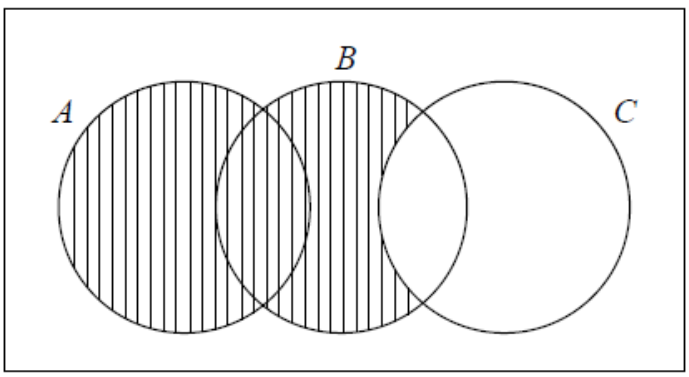
M is the set of multiples of 3.

(i) List the first six elements of the set M.

(ii) List the first six elements of the set $E' \cap M$.

Markscheme

a.



not shading C or shading $A \cup B$ ***(A1)***

correct shading ***(A1)*** ***(C2)***

[2 marks]

b. Identifying the correct 5 numbers $3, 4, 5, 6, 9$ ***(A1)***

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

[2 marks]

c. (i) $M = \{3, 6, 9, 12, 15, 18\}$ *brackets not required.* ***(A1)***

(ii) $E' \cap M = \{3, 9, 15, 21, 27, 33\}$ **(ft)** *from (i).* ***(A1)*****(ft)** ***(C2)***

[2 marks]

Examiners report

a. This question proved to be one of the easier questions with a number of candidates able to shade in the required region and finding values in a set. They still had problems with part (b).

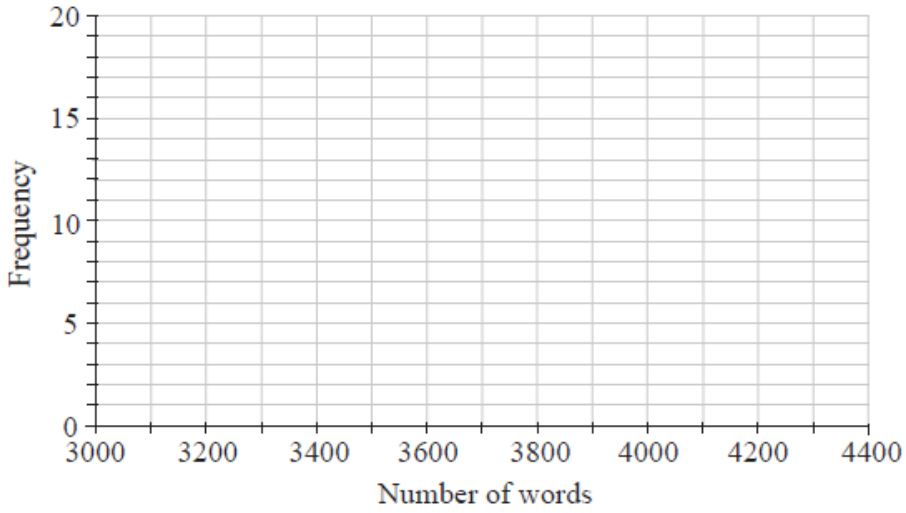
b. This question proved to be one of the easier questions with a number of candidates able to shade in the required region and finding values in a set. They still had problems with part (b).

c. This question proved to be one of the easier questions with a number of candidates able to shade in the required region and finding values in a set. They still had problems with part (b).

The table below shows the number of words in the extended essays of an IB class.

Number of words	$3200 \leq w < 3400$	$3400 \leq w < 3600$	$3600 \leq w < 3800$	$3800 \leq w < 4000$	$4000 \leq w < 4200$
Frequency	2	5	8	17	3

a. Draw a histogram on the grid below for the data in this table. [3]

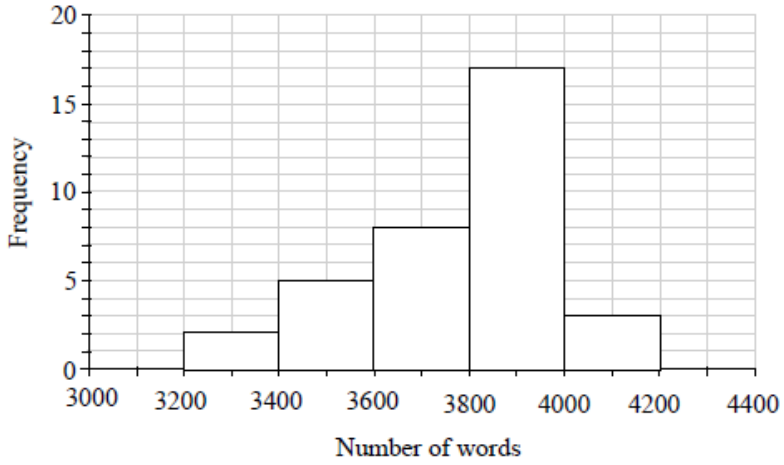


b. Write down the modal group. [1]

c. The maximum word count is 4000 words. [2]

Write down the probability that a student chosen at random is on or over the word count.

Markscheme

a. 

(A3) ***(C3)***

Notes: ***(A3)*** for correct histogram, ***(A2)*** for one error, ***(A1)*** for two errors, ***(A0)*** for more than two errors.
Award maximum ***(A2)*** if lines do not appear to be drawn with a ruler.
Award maximum ***(A2)*** if a frequency polygon is drawn.

[3 marks]

b. $\text{Modal group} = 3800 \leqslant w < 4000$ ***(A1)*** ***(C1)***

[1 mark]

c. $\text{Probability} = \frac{3}{35}\ (0.0857, 8.57\%)$ ***(A1)(A1)*** ***(C2)***

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

[2 marks]

Examiners report

a. A surprising number of the candidates did not appear to have brought a ruler/straight edge and so lost a mark in this question as they were asked to **draw** a histogram which means the lines must be drawn using a ruler/straight edge. Some candidates drew a frequency polygon. Parts (b) and (c) were generally answered well though $20/35$ was seen occasionally in part (c).

b. A surprising number of the candidates did not appear to have brought a ruler/straight edge and so lost a mark in this question as they were asked to **draw** a histogram which means the lines must be drawn using a ruler/straight edge. Some candidates drew a frequency polygon. Parts (b) and (c) were generally answered well though $20/35$ was seen occasionally in part (c).

c. A surprising number of the candidates did not appear to have brought a ruler/straight edge and so lost a mark in this question as they were asked to **draw** a histogram which means the lines must be drawn using a ruler/straight edge. Some candidates drew a frequency polygon. Parts (b) and (c) were generally answered well though $20/35$ was seen occasionally in part (c).

Consider the following Venn diagrams.

Diagram 1

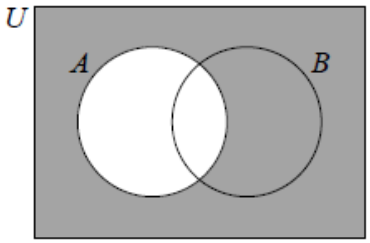


Diagram 2

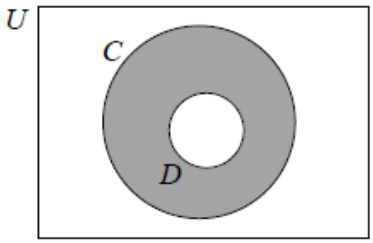
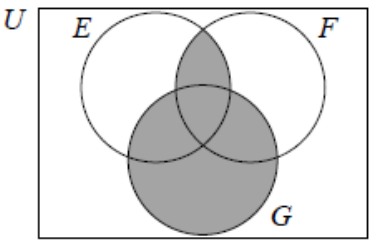


Diagram 3

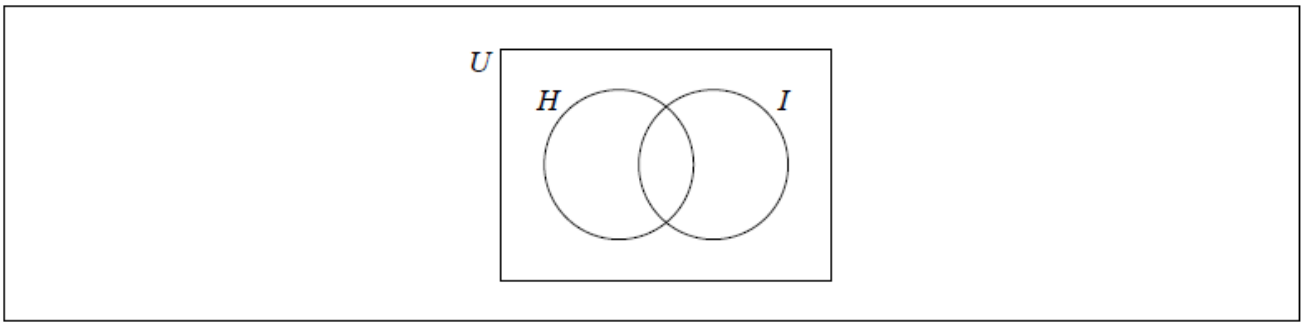


a.i. Write down an expression, in set notation, for the **shaded** region represented by Diagram 1. [1]

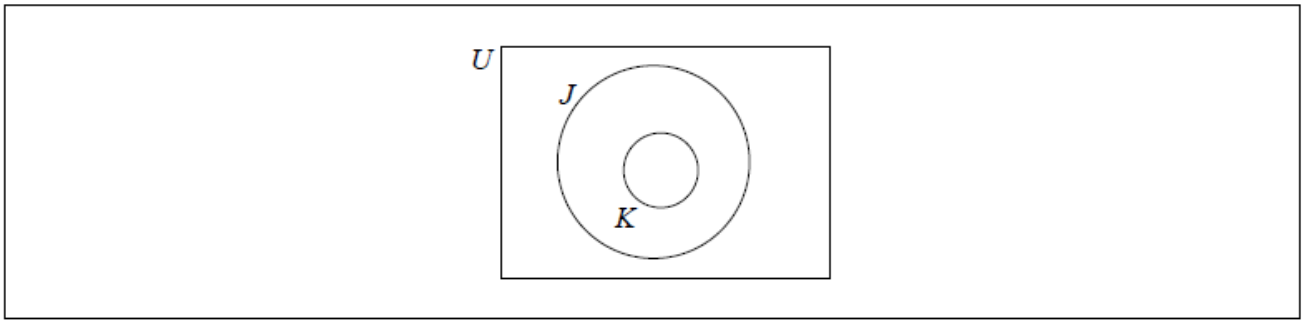
a.ii. Write down an expression, in set notation, for the **shaded** region represented by Diagram 2. [1]

a.iii Write down an expression, in set notation, for the shaded region represented by Diagram 3. [2]

b.i. Shade, on the Venn diagram, the region represented by the set $(H \cup I)'$. [1]



b.ii. Shade, on the Venn diagram, the region represented by the set $J \cap K$. [1]



Markscheme

a.i. A' ***(A1)***

Note: Accept alternative set notation for complement such as $U - A$.

[1 mark]

a.ii. $C \cap D'$ **OR** $D' \cap C$ ***(A1)***

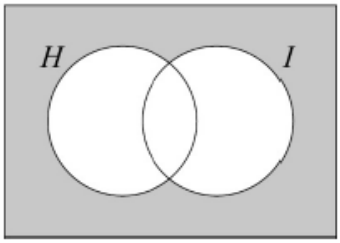
Note: Accept alternative set notation for complement.

[1 mark]

a.iii $(E \cap F) \cup G$ **OR** $G \cup (E \cap F)$ ***(A2) (C4)***

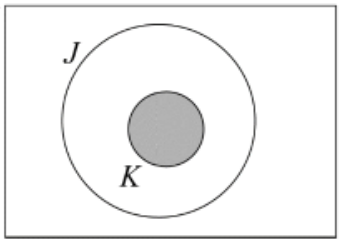
Note: Accept equivalent answers, for example $(E \cup G) \cap (F \cup G)$.

[2 marks]

b.i. 

(A1)

[1 mark]

b.ii. 

(A1) (C2)

[1 mark]

Examiners report

a.i. [N/A]
a.ii. [N/A]
a.iii. [N/A]
b.i. [N/A]
b.ii. [N/A]

All the children in a summer camp play at least one sport, from a choice of football (F) or basketball (B). 15 children play both sports.

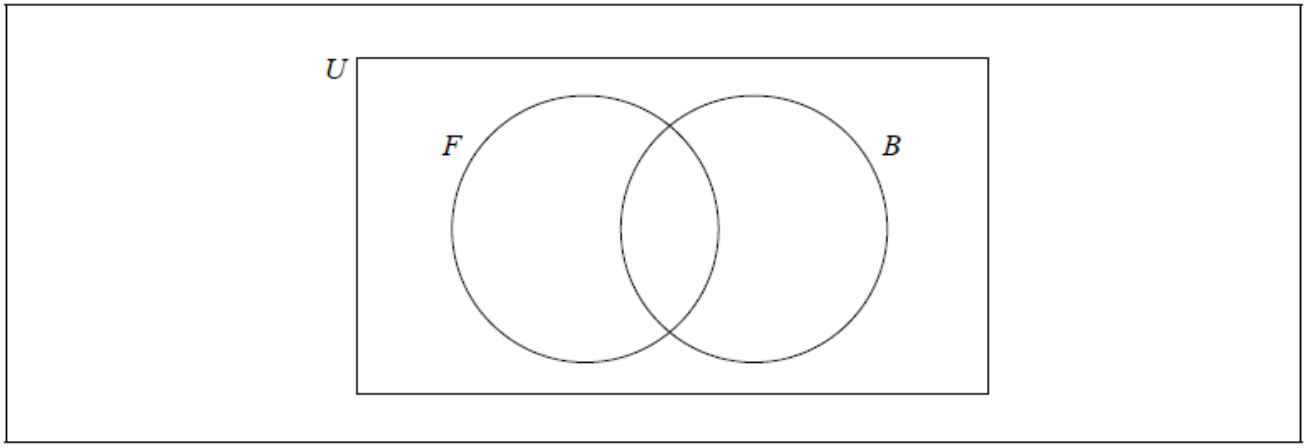
The number of children who play only football is double the number of children who play only basketball.

Let x be the number of children who play only football.

There are 120 children in the summer camp.

a. Write down an expression, in terms of x, for the number of children who play only basketball. [1]

b. Complete the Venn diagram using the above information. [2]



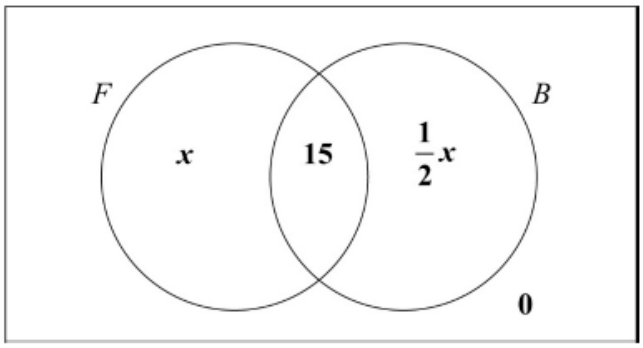
c. Find the number of children who play only football. [2]

d. Write down the value of $n(F)$. [1]

Markscheme

a. $\frac{1}{2}x$ ***(A1)*** ***(C1)***

[1 mark]

b. 

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

Notes: Award ***(A1)*** for 15 placed in the correct position, award ***(A1)*****(ft)** for x and their $\frac{1}{2}x$ placed in the correct positions of diagram. Do not penalize the absence of 0 inside the rectangle and award at most ***(A1)(A0)*** if any value other than 0 is seen outside the circles. Award at most ***(A1)(A0)*** if 35 and 70 are seen instead of x and their $\frac{1}{2}x$.

[2 marks]

c. $x + \frac{1}{2}x + 15 = 120$ or equivalent ***(M1)***

Note: Award ***(M1)*** for adding the values in their Venn and equating to 120 (or equivalent).

$(x =)\ 70$ ***(A1)*****(ft)** ***(C2)***

Note: Follow through from their Venn diagram, but only if the answer is a positive integer and x is seen in their Venn diagram.

[2 marks]

d. 85 ***(A1)*(ft)** ***(C1)***

Note: Follow through from their Venn diagram and their answer to part (c), but only if the answer is a positive integer and less than 120.

[1 mark]

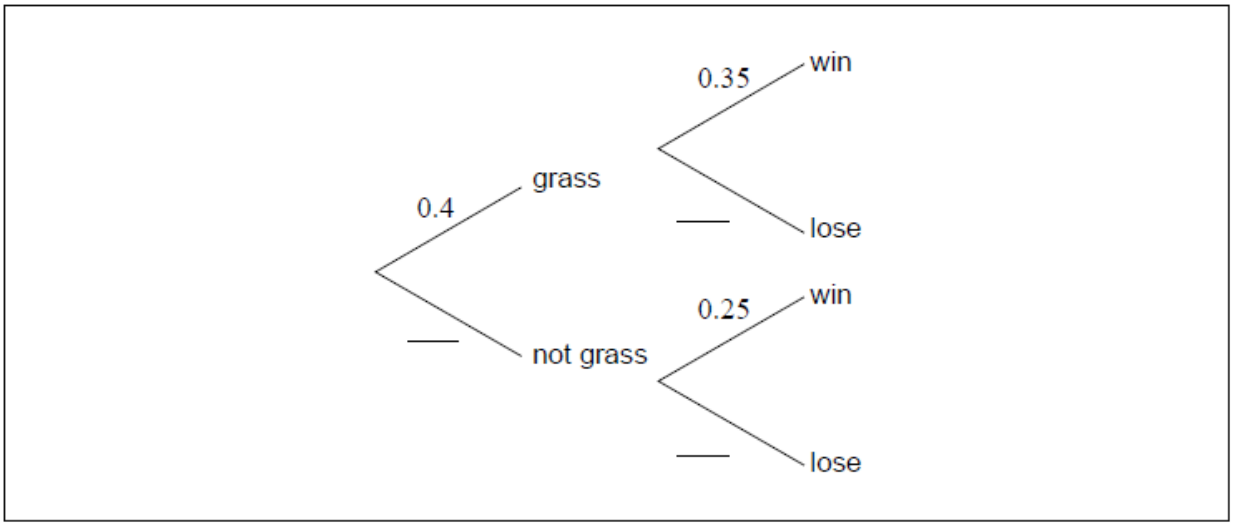
Examiners report

a. [N/A]
b. [N/A]
c. [N/A]
d. [N/A]

---

a. The probability that Nikita wins a tennis match depends on the surface of the tennis court on which she is playing. The probability that she plays on a grass court is 0.4. The probability that Nikita wins on a grass court is 0.35. The probability that Nikita wins when the court is not grass is 0.25. [3]

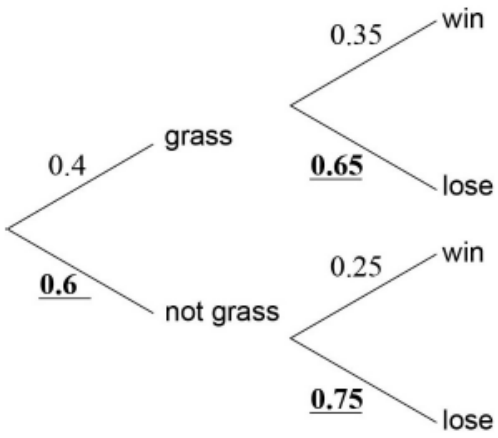
Complete the following tree diagram.



b. Find the probability that Nikita wins a match. [3]

Markscheme

a.



(A1)(A1)(A1) (C3)

Note: Award ***(A1)*** for each correct entry.

[3 marks]

b. $0.4 \times 0.35 + 0.6 \times 0.25$ ***(A1)*****(ft)*****(M1)***

Note: Award ***(A1)*****(ft)** for two correct products from their tree diagram seen, and ***(M1)*** for the addition of their products.

$= 0.29$ ***(A1)*****(ft)** ***(C3)***

Note: Follow through from part (a).

[3 marks]

Examiners report

a. Question 1: Tree diagram

This was a good starting question and answered correctly by the majority of the candidates. However, some candidates were unable to interpret part (b). The weakest seemed not to be aware that the sum of the probabilities on the branches should equal 1.

b. Question 1: Tree diagram

This was a good starting question and answered correctly by the majority of the candidates. However, some candidates were unable to interpret part (b). The weakest seemed not to be aware that the sum of the probabilities on the branches should equal 1.

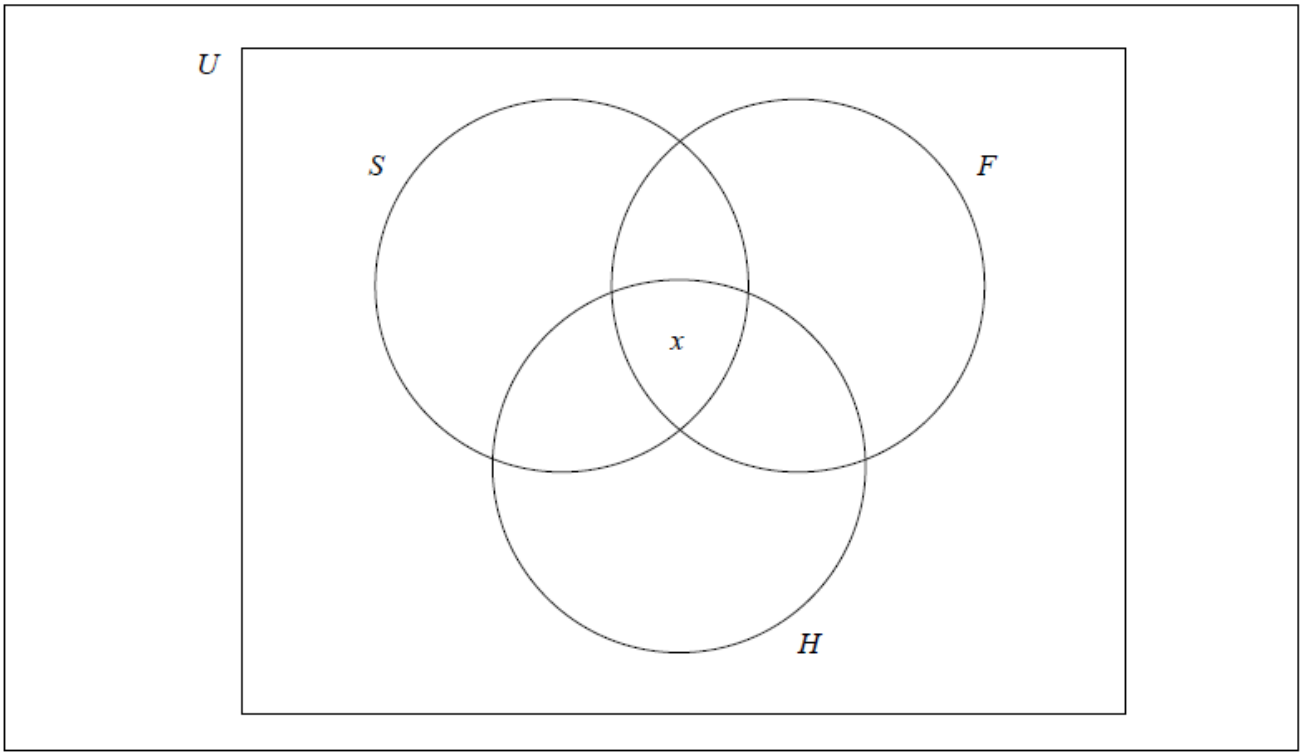
A group of 60 sports enthusiasts visited the PyeongChang 2018 Winter Olympic games to watch a variety of sporting events.

The most popular sports were snowboarding (*S*), figure skating (*F*) and ice hockey (*H*).

For this group of 60 people:

4 did not watch any of the most popular sports,
x watched all three of the most popular sports,
9 watched snowboarding only,
11 watched figure skating only,
15 watched ice hockey only,
7 watched snowboarding and figure skating,
13 watched figure skating and ice hockey,
11 watched snowboarding and ice hockey.

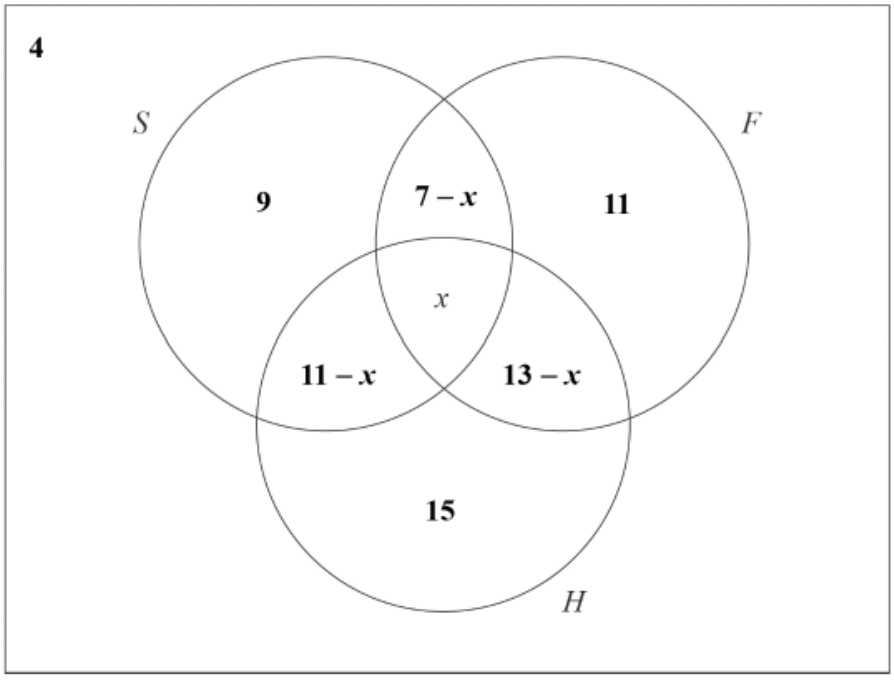
a. Complete the Venn diagram using the given information. [3]



b. Find the value of x. [2]

c. Write down the value of $n((F \cup H) \cap S')$. [1]

Markscheme

a. 

(A1)(A1)(A1) (C3)

Note: Award ***(A1)*** for 4 in correct place.

Award ***(A1)*** for 9, 11, 15 in correct place.

Award ***(A1)*** for $7 - x$, $13 - x$, $11 - x$ in correct place.

Accept 2, 8 and 6 in place of $7 - x$, $13 - x$, $11 - x$.

[3 marks]

b. $4 + 9 + 11 + 15 + x + (7 - x) + (11 - x) + (13 - x) = 60$ ***(M1)***

Note: Award ***(M1)*** for equating the sum of at least seven of the entries in their Venn diagram to 60.

$(x =)\ 5$ ***(A1)*****(ft)** ***(C2)***

Note: Follow through from part (a), but only if answer is positive.

[2 marks]

c. 34 ***(A1)*****(ft)** ***(C1)***

Note: Follow through from their Venn diagram.

[1 mark]

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]