

## Topic 3 Part 3 [215 marks]

1a. [2 marks]

### Markscheme

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

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

[2 marks]

### Examiners report

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

1b. [1 mark]

### Markscheme

$p \vee q$  (AI) (CI)

[1 mark]

### Examiners report

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

1c. [3 marks]

### Markscheme

$\neg q \Rightarrow p$  (AI)(AI)(AI) (C3)

**Notes:** Award (AI) for implication, (AI) for the

$\neg q$ , (AI) for both

$\neg q$  and

$p$  in the correct order. If correct converse seen in words only award (AI)(AI)(A0). Accept

$p \Leftarrow \neg q$ . Accept

$\neg q$  for

$\neg q$ .

[3 marks]

### Examiners report

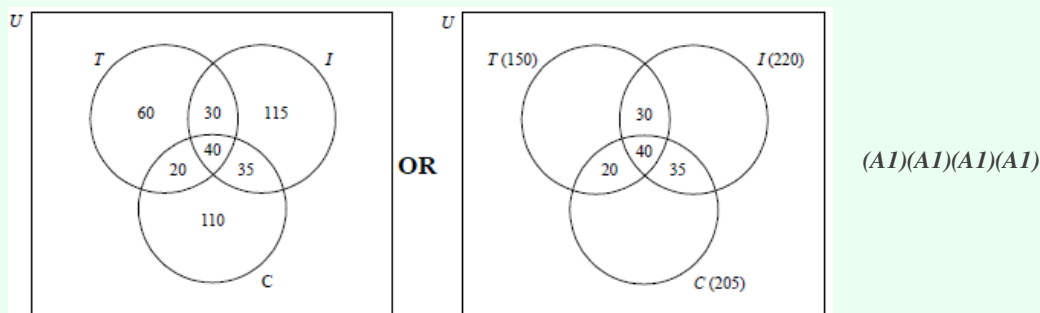
Finding the converse of a statement in part (c) proved to be difficult for a significant number of candidates and incorrect answers of the form

$q \Rightarrow \neg p$  were more frequently seen than the correct answer. Such incorrect answers lost two marks.

2a.

[4 marks]

## Markscheme



**Notes:** Award  $(AI)$  for labelled sets  $T$ ,  $C$ , and  $I$  included inside an enclosed universal set. (Label  $U$  is not essential.) Award  $(AI)$  for central entry 40.  $(AI)$  for 20, 30 and 35 in the other intersecting regions.  $(AI)$  for 60, 110 and 115 or  $T(150)$ ,  $C(205)$ ,  $I(220)$ .

[4 marks]

## Examiners report

The question was moderately well answered. The majority of candidates answered part (a) and at least parts of (b), and (d).

2b.

[2 marks]

## Markscheme

*In parts (b), (c) and (d) follow through from their diagram.*

(i) 110  $(AI)(ft)$

(ii) 35  $(AI)(ft)$

[2 marks]

## Examiners report

The question was moderately well answered. The majority of candidates answered part (a) and at least parts of (b), and (d).

2c.

[1 mark]

## Markscheme

*In parts (b), (c) and (d) follow through from their diagram.*

60  $(AI)(ft)$

[2 marks]

## Examiners report

The question was moderately well answered. Part (c) proved to be difficult, as it required understanding and interpreting set notation.

2d.

[2 marks]

## Markscheme

*In parts (b), (c) and (d) follow through from their diagram.*

$$450 - (60 + 20 + 40 + 30 + 115 + 35 + 110) \quad (M1)$$

**Note:** Award *(M1)* for subtracting all their values from 450.

$$= 40 \quad (A1)(ft)(G2)$$

[2 marks]

## Examiners report

The question was moderately well answered. The majority of candidates answered part (a) and at least parts of (b), and (d).

2e.

[6 marks]

## Markscheme

(i)

$$\frac{230}{450} \times \frac{229}{449} \quad (A1)(M1)$$

**Note:** Award *(A1)* for correct fractions, *(M1)* for multiplying their fractions.

$$\frac{52670}{202050} \left( \frac{5267}{20205}, 0.261, 26.1\% \right) (0.26067\dots) \quad (A1)(G2)$$

**Note:** Follow through from their Venn diagram in part (a).

(ii)

$$\frac{220}{450} \times \frac{230}{449} + \frac{230}{450} \times \frac{220}{449} \quad (A1)(A1)$$

**Note:** Award *(A1)* for addition of their products, *(A1)* for two correct products.

**OR**

$$\frac{230}{450} \times \frac{220}{449} \times 2 \quad (A1)(A1)$$

**Notes:** Award *(A1)* for their product of two fractions multiplied by 2, *(A1)* for correct product of two fractions multiplied by 2.

Award *(A0)(A0)* if correct product is seen not multiplied by 2.

$$\frac{2024}{4041} (0.501, 50.1\%) (0.50086\dots) \quad (A1)(G2)$$

**Note:** Follow through from their Venn diagram in part (a) and/or their 230 used in part (e)(i).

**Note:** For consistent use of replacement in parts (i) and (ii) award at most *(A0)(M1)(A0)* in part (i) and *(A1)(ft)(A1)(A1)(ft)* in part (ii).

[6 marks]

## Examiners report

The question was moderately well answered. Part (e) was rarely answered in its entirety.

2f.

[3 marks]

## Markscheme

(i)  $x + 9y = 13050$  (AI)

(ii)  $x = 900$  (AI)(ft)

$y = 1350$  (AI)(ft)

**Notes:** Follow through from their equation in (f)(i). Do not award (AI)(ft) if answer is negative. Award (MI)(A0) for an attempt at solving simultaneous equations algebraically but incorrect answer obtained.

[3 marks]

## Examiners report

The question was moderately well answered. Part (f) was answered by many candidates, but most of them offered a partial answer to part (g); a typical response was 36 instead of 37.

2g.

[3 marks]

## Markscheme

$49500 = 900 + 1350n$  (AI)(ft)

**Notes:** Award (AI)(ft) for setting up correct equation. Follow through from candidate's part (f).

$n = 36$  (AI)(ft)

The total number of months is 37. (AI)(ft)(G2)

**Note:** Award (GI) for 36 seen as final answer with no working. The value of  $n$  must be a positive integer for the last two (AI)(ft) to be awarded.

**OR**

$49500 = 900 + 1350(n - 1)$  (A2)(ft)

**Notes:** Award (A2)(ft) for setting up correct equation. Follow through from candidate's part (f).

$n = 37$  (AI)(ft)(G2)

**Note:** The value of  $n$  must be a positive integer for the last (AI)(ft) to be awarded.

[3 marks]

## Examiners report

The question was moderately well answered. Part (f) was answered by many candidates, but most of them offered a partial answer to part (g); a typical response was 36 instead of 37.

3a.

[6 marks]

## Markscheme

(i)

$$\frac{220}{500} \left( \frac{11}{25}, 0.44, 44\% \right) \quad (A1)(G1)$$

(ii)

$$\frac{180}{500} \left( \frac{9}{25}, 0.36, 36\% \right) \quad (A1)(G1)$$

(iii)

$$\frac{40}{500} \left( \frac{2}{25}, 0.08, 8\% \right) \quad (A1)(A1)(G2)$$

(iv)

$$\frac{55}{500} \left( \frac{11}{56}, 0.196, 19.6\% \right) \quad (A1)(A1)(G2)$$

**Note:** Award (A1) for numerator, (A1) for denominator. Award (A0)(A0) if answers are given as incorrect reduced fractions without working.

[6 marks]

## Examiners report

Part (a) was generally well answered by most of the students, except for part (a)(iv) which called for conditional probability.

3b.

[1 mark]

## Markscheme

“The size of the television screen is independent of gender.” (A1)

**Note:** Accept “not associated”, do not accept “not correlated”.

[1 mark]

## Examiners report

Most students correctly stated the null hypothesis in part (b), and answered parts (d), (e), (f) and (g).

3c.

[2 marks]

## Markscheme

$$\frac{180}{500} \times \frac{220}{500} \times 500 \text{ OR } \frac{180 \times 220}{500} \quad (M1)$$

$$= 79.2 \quad (A1)$$

$$= 79 \quad (AG)$$

**Note:** Both the unrounded and the given answer must be seen for the final (A1) to be awarded.

[2 marks]

## Examiners report

In some responses to part (c) it seemed that the difference between calculation of the expected value and showing that the value is 79 was not clear to the candidates. It is important that teachers explain to their students that in a “*show that*” question they are expected to demonstrate the mathematical reasoning through which the given answer is obtained.

3d. [1 mark]

## Markscheme

3 (AI)

[1 mark]

## Examiners report

Most students correctly stated the null hypothesis in part (b), and answered parts (d), (e), (f) and (g).

3e. [2 marks]

## Markscheme

$$\chi^2_{calc} = 104(103.957...) \quad (G2)$$

**Note:** Award (MI) if an attempt at using the formula is seen but incorrect answer obtained.

[2 marks]

## Examiners report

Most students correctly stated the null hypothesis in part (b), and answered parts (d), (e), (f) and (g).

3f. [1 mark]

## Markscheme

11.345 (AI)(ft)

**Notes:** Follow through from their degrees of freedom.

[1 mark]

## Examiners report

Most students correctly stated the null hypothesis in part (b), and answered parts (d), (e), (f) and (g).

3g. [2 marks]

## Markscheme

$$\chi^2_{calc} > \chi^2_{crit} \quad \text{OR} \quad p < 0.01 \quad (RI)$$

Do not accept  $H_0$ . (AI)(ft)

**Note:** Do not award (R0)(AI)(ft). Follow through from their parts (d), (e) and (f).

[2 marks]

## Examiners report

Most students correctly stated the null hypothesis in part (b), and answered parts (d), (e), (f) and (g).

4a.

[2 marks]

### Markscheme

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]

### Examiners report

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.

4b.

[2 marks]

### Markscheme

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]

### Examiners report

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.

4c.

[2 marks]

### Markscheme

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

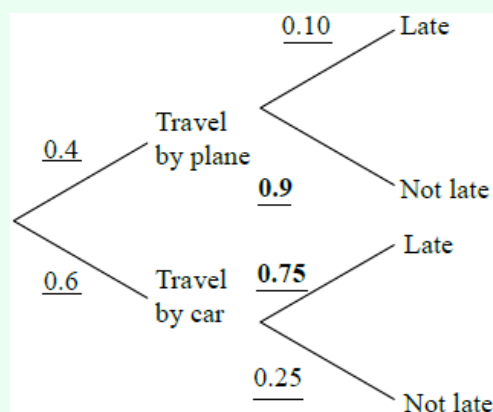
Although a few candidates did not seem to understand the meaning of the

$\Rightarrow$  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.

5a.

[1 mark]

## Markscheme



(A1) (C1)

**Note:** Award **(A1)** for 0.9 and 0.75.

[1 mark]

## Examiners report

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.

5b.

[3 marks]

## Markscheme

$$0.4 \times 0.9 + 0.6 \times 0.25 \quad (\text{M1})(\text{M1})$$

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

$$0.51 \left( \frac{51}{100}, 51\% \right) \quad (\text{A1})(\text{ft}) \quad (\text{C3})$$

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

[3 marks]

## Examiners report

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.



5c.

[2 marks]

## Markscheme

$$\frac{0.6 \times 0.25}{0.51} \quad (M1)$$

**Note:** Award (M1) for correctly substituted conditional probability formula.

$$0.294 \left( \frac{5}{17}, 0.294117... \right) \quad (A1)(ft) \quad (C2)$$

**Note:** Follow through from their tree diagram and their part (b).

[2 marks]

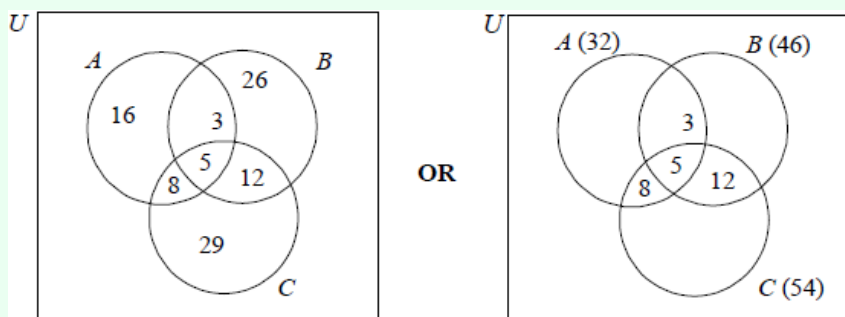
## Examiners report

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).

6a.

[4 marks]

## Markscheme



(A1) for three circles and a rectangle ( $U$  need not be seen)

(A1) for 5

(A1) for 3, 8 and 12

(A1) for 16, 26 and 29 **OR** 32, 46, 54 placed outside the circles. (A4)

**Note:** Accept answers given as decimals or fractions.

[4 marks]

## Examiners report

This question was accessible to the great majority of candidates. The common errors were:

- the lack of a bounding rectangle in (a);
- the lack of subtraction for the entries in the disjoint regions of the type  $A' \cap B' \cap C$  and the subsequent total exceeding 100%;
- the **incorrect** interpretation of “either ...or” as “exclusive or”. It is of the utmost importance to note that the ambiguity of the “or” statement will be removed and “exclusive or” signalled by the phrase “either ...or....**but not both**”. Otherwise, “inclusive or” must always be assumed.

A number of candidates were unable to interpret the percentage error question correctly and scored 0/4. This was somewhat disappointing.

### Markscheme

$100 - (16 + 26 + 29) - (8 + 5 + 3 + 12) \quad (M1)$

$100 - 71 - 28$

**Note:** Award *(M1)* for correct expression. Accept equivalent expressions, for example  $100 - 71 - 28$  or  $100 - (71 + 28)$ .

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

**Note:** Follow through from their Venn diagram but only if working is seen.

[2 marks]

### Examiners report

This question was accessible to the great majority of candidates. The common errors were:

- the lack of a bounding rectangle in (a);
- the lack of subtraction for the entries in the disjoint regions of the type  $A' \cap B' \cap C$  and the subsequent total exceeding 100%;
- the **incorrect** interpretation of “either ...or” as “exclusive or”. It is of the utmost importance to note that the ambiguity of the “or” statement will be removed and “exclusive or” signalled by the phrase “either ...or....**but not both**”. Otherwise, “inclusive or” must always be assumed.

A number of candidates were unable to interpret the percentage error question correctly and scored 0/4. This was somewhat disappointing.

### Markscheme

$16 + 26 + 29 \quad (M1)$

**Note:** Award *(M1)* for 16, 26, 29 seen.

$= 71 \quad (A1)(ft)(G2)$

**Note:** Follow through from their Venn diagram but only if working is seen.

[2 marks]

### Examiners report

This question was accessible to the great majority of candidates. The common errors were:

- the lack of a bounding rectangle in (a);
- the lack of subtraction for the entries in the disjoint regions of the type  $A' \cap B' \cap C$  and the subsequent total exceeding 100%;
- the **incorrect** interpretation of “either ...or” as “exclusive or”. It is of the utmost importance to note that the ambiguity of the “or” statement will be removed and “exclusive or” signalled by the phrase “either ...or....**but not both**”. Otherwise, “inclusive or” must always be assumed.

A number of candidates were unable to interpret the percentage error question correctly and scored 0/4. This was somewhat disappointing.

6d.

[2 marks]

## Markscheme

$$16 + 3 + 26 \quad (M1)$$

**Note:** Award *(M1)* for their 16, 3, 26 seen.

$$= 45 \quad (A1)(ft)(G2)$$

**Note:** Follow through from their Venn diagram but only if working is seen.

[2 marks]

## Examiners report

This question was accessible to the great majority of candidates. The common errors were:

- the lack of a bounding rectangle in (a);
- the lack of subtraction for the entries in the disjoint regions of the type  $A' \cap B' \cap C$  and the subsequent total exceeding 100%;
- the **incorrect** interpretation of “either ...or” as “exclusive or”. It is of the utmost importance to note that the ambiguity of the “or” statement will be removed and “exclusive or” signalled by the phrase “either ...or....**but not both**”. Otherwise, “inclusive or” must always be assumed.

A number of candidates were unable to interpret the percentage error question correctly and scored 0/4. This was somewhat disappointing.

6e.

[2 marks]

## Markscheme

$$\text{True} \quad (A1)(ft)$$

$$100 - (1 - 16) = 83 \quad (R1)(ft)$$

**OR**

$$46 + 54 - 17 = 83 \quad (R1)(ft)$$

**Note:** Do not award *(A1)(R0)*. Follow through from their Venn diagram.

[2 marks]

## Examiners report

This question was accessible to the great majority of candidates. The common errors were:

- the lack of a bounding rectangle in (a);
- the lack of subtraction for the entries in the disjoint regions of the type  $A' \cap B' \cap C$  and the subsequent total exceeding 100%;
- the **incorrect** interpretation of “either ...or” as “exclusive or”. It is of the utmost importance to note that the ambiguity of the “or” statement will be removed and “exclusive or” signalled by the phrase “either ...or....**but not both**”. Otherwise, “inclusive or” must always be assumed.

A number of candidates were unable to interpret the percentage error question correctly and scored 0/4. This was somewhat disappointing.

6f.

[4 marks]

## Markscheme

28% of 120000 (*MI*)

= 33600 (*A1*)

% error =  $\frac{(34000-33600)}{33600} \times 100$  (*MI*)

**Note:** Award (*MI*) for 28 seen (may be implied by 33600 seen), award (*MI*) for correct substitution of **their** 33600 in the percentage error formula. If an error is made in calculating 33600 award a maximum of (*MI*)(*A0*)(*MI*)(*A0*), the final accuracy mark is lost.

**OR**

$\frac{34000}{120000} \times 100$  (*MI*)

= 28.3(28.3333...) (*A1*)

% error =  $\frac{(28.3333...-28)}{28} \times 100$  (*MI*)

= 1.19% (1.19047...) (*A1*)(ft)(*G3*)

**Note:** % sign not required. Accept 1.07 (1.0714...) with use of 28.3. 1.18 with use of 28.33 and 1.19 with use of 28.333. Award (*G3*) for 1.07, 1.18 or 1.19 seen without working.

[4 marks]

## Examiners report

This question was accessible to the great majority of candidates. The common errors were:

- the lack of a bounding rectangle in (a);
- the lack of subtraction for the entries in the disjoint regions of the type  $A' \cap B' \cap C$  and the subsequent total exceeding 100%;
- the **incorrect** interpretation of “either ...or” as “exclusive or”. It is of the utmost importance to note that the ambiguity of the “or” statement will be removed and “exclusive or” signalled by the phrase “either ...or....**but not both**”. Otherwise, “inclusive or” must always be assumed.

A number of candidates were unable to interpret the percentage error question correctly and scored 0/4. This was somewhat disappointing.

7a.

[2 marks]

## Markscheme

$p$	$q$	$\neg q$	$p \vee \neg q$
<b>T</b>	<b>T</b>	<b>F</b>	<b>T</b>
<b>T</b>	<b>F</b>	<b>T</b>	<b>T</b>
<b>F</b>	<b>T</b>	<b>F</b>	<b>F</b>
<b>F</b>	<b>F</b>	<b>T</b>	<b>T</b>

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

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

[2 marks]

## Examiners report

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.

7b. [2 marks]

### Markscheme

$\neg q \wedge p$  (A1)(A1) (C2)

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

[2 marks]

### Examiners report

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.

7c. [2 marks]

### Markscheme

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

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.

8a. [1 mark]

### Markscheme

145 (A1) (C1)

[1 mark]

### Examiners report

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.

8b. [3 marks]

### Markscheme

(i) 56 (A1)

(ii) 85 (A1)

(iii) 89 (A1) (C3)

[3 marks]

## Examiners report

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.

8c. [2 marks]

## Markscheme

The students who learn the piano and do not learn the flute. (AI)(AI) (C2)

**Notes:** Award (AI) for students who learn piano, not flute, (AI) for and (accept but). Accept correct alternative statements. Accept “The number of students who learn the piano and do not learn the flute”.

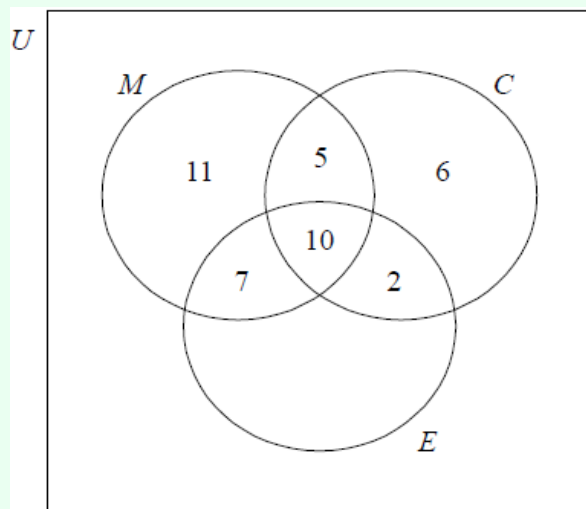
[2 marks]

## Examiners report

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.

9a. [4 marks]

## Markscheme



(AI) for rectangle and three labelled circles ( $U$  need not be seen)

(AI) for 10 in the correct region

(AI) for 2, 7 and 5 in the correct regions

(AI) for 6 and 11 in the correct regions (A4)

## Examiners report

This question divided the candidates into two parts: those who knew how to interpret the information in a manner the led to a consistent Venn diagram and those who did not. The use of the word “only” is crucial in this regard.

Follow through to the probability part of the question was contingent on the use of the given

$n(E) = 22$ ; given information should be used in subsequent parts. As ever, conditional probability proves a trial for many.

It is recommended that candidates write probabilities as unsimplified fractions as this increase their chances of gaining follow through from previous parts.

### Markscheme

16    *(A1)(ft)*

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

### Examiners report

This question divided the candidates into two parts: those who knew how to interpret the information in a manner the led to a consistent Venn diagram and those who did not. The use of the word “only” is crucial in this regard.

Follow through to the probability part of the question was contingent on the use of the given  $n(E) = 22$  ; given information should be used in subsequent parts. As ever, conditional probability proves a trial for many.

It is recommended that candidates write probabilities as unsimplified fractions as this increase their chances of gaining follow through from previous parts.

### Markscheme

(i)  
 $10 + 7 + 2$     *(M1)*

**Note:** Award *(M1)* for summing their 10, 7 and 2.

$22 - 19$   
 $= 3$     *(A1)(ft)(G2)*

**Note:** Follow through from their diagram. Award *(M1)(A1)(ft)* for answers consistent with their diagram irrespective of whether working seen. Award a maximum of *(M1)(A0)* for a negative answer.

(ii)  
 $22 + 11 + 5 + 6$     *(M1)*

**Note:** Award *(M1)* for summing 22, and their 11, 5 and 6.

$100 - 44$   
 $= 56$     *(A1)(ft)(G2)*

**Note:** Follow through from their diagram. Award *(M1)(A1)(ft)* for answers consistent with their diagram **and** the use of 22 irrespective of whether working seen. If negative values are used or implied award *(M0)(A0)*.

### Examiners report

This question divided the candidates into two parts: those who knew how to interpret the information in a manner the led to a consistent Venn diagram and those who did not. The use of the word “only” is crucial in this regard.

Follow through to the probability part of the question was contingent on the use of the given  $n(E) = 22$  ; given information should be used in subsequent parts. As ever, conditional probability proves a trial for many.

It is recommended that candidates write probabilities as unsimplified fractions as this increase their chances of gaining follow through from previous parts.

9d.

[7 marks]

## Markscheme

(i)

$$\frac{22}{100} \left( \frac{11}{50}, 0.22, 22\% \right) \quad (AI)(GI)$$

(ii)

$$\frac{5}{100} \left( \frac{1}{20}, 0.05, 5\% \right) \quad (AI)(ft)(AI)(G2)$$

**Note:** Award  $(AI)(ft)$  for their 5 in numerator,  $(AI)$  for denominator.

Follow through from their diagram.

(iii)

$$\frac{62}{100} \left( \frac{31}{50}, 0.62, 62\% \right) \quad (AI)(ft)(AI)(G2)$$

**Note:** Award  $(AI)(ft)$  for

$100 - (22 + 11 + \text{their } 5)$ ,  $(AI)$  for denominator.

Follow through from their diagram.

(iv)

$$\frac{62}{78} \left( \frac{31}{39}, 0.795, 79.5\% \right) (0.794871...) \quad (AI)(ft)(AI)(G2)$$

**Note:** Award  $(AI)(ft)$  for numerator,  $(AI)$  for denominator. Follow

through from part (d)(iii) for numerator.

## Examiners report

This question divided the candidates into two parts: those who knew how to interpret the information in a manner the led to a consistent Venn diagram and those who did not. The use of the word “only” is crucial in this regard.

Follow through to the probability part of the question was contingent on the use of the given

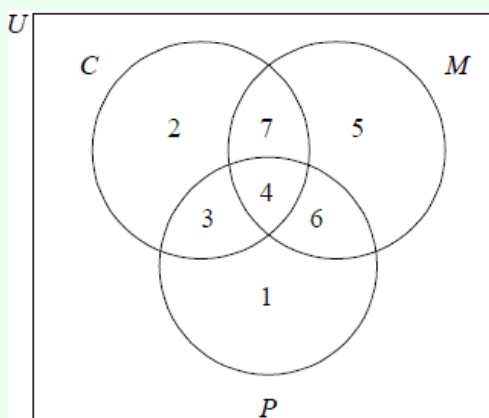
$n(E) = 22$ ; given information should be used in subsequent parts. As ever, conditional probability proves a trial for many.

It is recommended that candidates write probabilities as unsimplified fractions as this increase their chances of gaining follow through from previous parts.

10a.

[4 marks]

## Markscheme



$(AI)(AI)(AI)(AI)$

Award  $(AI)$  for 3 intersecting circles and rectangle,  $(AI)$  for 1, 3, 4 and 7,  $(AI)$  for 2,  $(AI)$  for 6 and 5.

## Examiners report

[N/A]



10b. [4 marks]

## Markscheme

(i) 2 (AI)(ft)

(ii) 6 (AI)(ft)

(iii)  $40 - (1 + 6 + 2 + 3 + 4 + 7 + 5)$  (MI)

**Note:** Award (MI) for subtracting all their values from 40.

= 12 (AI)(ft)(G2)

**Note:** Follow through from their Venn diagram for parts (i), (ii) and (iii).

## Examiners report

[N/A]

10c. [8 marks]

## Markscheme

(i)  
 $\frac{16}{40} \left( \frac{2}{5}, 0.4, 40\% \right)$  (AI)(AI)(G2)

**Note:** Award (AI) for numerator, (AI) for denominator. Answer must be less than 1 otherwise award (A0)(A0). Award (A0)(A0) if answer is given as incorrect reduced fraction without working.

(ii)  
 $\frac{20}{40} \left( \frac{1}{2}, 0.5, 50\% \right)$  (AI)(ft) (AI) (G2)

**Note:** Award (AI)(ft) for numerator, (AI) for denominator. Follow through from their Venn diagram. Answer must be less than 1 otherwise award (A0)(A0). Award (A0)(A0) if answer is given as incorrect reduced fraction without working.

(iii)  
 $\frac{6}{40} \left( \frac{3}{20}, 0.15, 15\% \right)$  (AI)(ft)(AI)(G2)

**Note:** Award (AI)(ft) for numerator, (AI) for denominator. Follow through from their Venn diagram. Answer must be less than 1 otherwise award (A0)(A0). Award (A0)(A0) if answer is given as incorrect reduced fraction without working.

(iv)  
 $\frac{11}{16} (0.6875, 68.75\%)$  (AI)(ft)(AI)(G2)

**Note:** Award (AI)(ft) for numerator, (AI) for denominator. Follow through from their Venn diagram. Answer must be less than 1 otherwise award (A0)(A0). Award (A0)(A0) if answer is given as incorrect reduced fraction without working.

## Examiners report

[N/A]

10d.

[3 marks]

Markscheme

$\frac{16}{40} \times \frac{15}{39}$  (AI)(AI)(ft)

Note: Award (AI) for multiplication of their probabilities, (AI)(ft) for their correct probabilities.

$\frac{240}{1560} \left( \frac{2}{13}, 0.153846..., 15.4\% \right)$  (AI)(ft)(G2)

Note: Follow through from their answer to part (c)(i). Answer must be less than 1 otherwise award at most (AI)(AI)(A0)(ft).

Examiners report

[N/A]

11a.

[4 marks]

Markscheme

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

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

Notes: Award (AI) for each correct column.

Award first (AI)(ft) from their third column in the table.

Award second (AI)(ft) from their fourth and fifth column in the table.

[4 marks]

Examiners report

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  $(\neg p \vee q)$ . 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.

11b.

[1 mark]

Markscheme

Tautology (AI)(ft) (CI)

Note: Answer must be consistent with last column in table.

[1 mark]

Examiners report

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  $(\neg p \vee q)$ . 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.

11c. [1 mark]

## Markscheme

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

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  $(\neg p \vee q)$ . 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.

12a. [2 marks]

## Markscheme

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

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

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

[2 marks]

## Examiners report

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.

12b. [2 marks]

## Markscheme

(i)  $q = 6$  **(A1)(ft)**

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

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

[2 marks]

## Examiners report

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.

12c. [2 marks]

## Markscheme

$15 + 6 + 3$  (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

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.

13a. [3 marks]

## Markscheme

(i)

$\frac{7}{11}$  (

0.636,

63.6%) (

0.636363...) (A1) (C1)

(ii)

$\frac{4}{10}$

$(\frac{2}{5}, 0.4, 40\%)$  (A1) (C1)

(iii)

$\frac{28}{110}$

$(\frac{14}{55}, 0.255, 25.5\%)$

0.254545... (A1)(ft) (C1)

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

[3 marks]

## Examiners report

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.

13b. [3 marks]

### Markscheme

$$\frac{28}{110} + \left(\frac{4}{11} \times \frac{7}{10}\right) \quad \text{OR} \\ 2 \times \frac{28}{110} \quad (MI)(MI)$$

**Notes:** Award *(MI)* for using their

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

$$= \frac{56}{110} \\ \left(\frac{28}{55}, 0.509, 50.9\%\right) ( \\ 0.509090\dots) \quad (AI)(ft) \quad (C3)$$

**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

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.

14a. [1 mark]

### Markscheme

$H_0$  : Gender and choice of afterschool sport are independent. *(AI)*

**Note:** Accept “not associated”, do not accept “not related”, “not correlated”, or “not linked”. Accept “the relation between gender and sport is independent”.

[1 mark]

## Examiners report

This question was successfully attempted by the great majority. However, the test is for the mathematical independence of the two variables; it does not address “correlation” or whether there is “no relation” between them. Further, the result of the test should be determined by the comparison of the **numerical values** of either the chi-squared calculated and critical values or the associated *p*-value and the significance level of the test. The creeping use of *k* as the critical value is the notation used in one text book; it is **not** standard notation and its use is not accepted. Comments were made on the G2 forms as to whether the null hypothesis should be “accepted” or not rejected; both forms are acceptable.

In the compound probability questions, the lack of an explicit tree diagram determined that many candidates were not able to proceed. Determining an appropriate technique is a skill that should be taught.

14b. [2 marks]

## Markscheme

$$\frac{85}{120} \times \frac{48}{120} \times 120 \left( \frac{85 \times 48}{120} \right) \quad (M1)$$

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

$$= 34 \quad (A1)(G2)$$

[2 marks]

## Examiners report

This question was successfully attempted by the great majority. However, the test is for the mathematical independence of the two variables; it does not address “correlation” or whether there is “no relation” between them. Further, the result of the test should be determined by the comparison of the **numerical values** of either the chi-squared calculated and critical values or the associated  $p$ -value and the significance level of the test. The creeping use of  $k$  as the critical value is the notation used in one text book; it is **not** standard notation and its use is not accepted. Comments were made on the G2 forms as to whether the the null hypothesis should be “accepted” or not rejected; both forms are acceptable.

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14c. [1 mark]

## Markscheme

$$2 \quad (A1)$$

[1 mark]

## Examiners report

This question was successfully attempted by the great majority. However, the test is for the mathematical independence of the two variables; it does not address “correlation” or whether there is “no relation” between them. Further, the result of the test should be determined by the comparison of the **numerical values** of either the chi-squared calculated and critical values or the associated  $p$ -value and the significance level of the test. The creeping use of  $k$  as the critical value is the notation used in one text book; it is **not** standard notation and its use is not accepted. Comments were made on the G2 forms as to whether the the null hypothesis should be “accepted” or not rejected; both forms are acceptable.

In the compound probability questions, the lack of an explicit tree diagram determined that many candidates were not able to proceed. Determining an appropriate technique is a skill that should be taught.

14d. [1 mark]

## Markscheme

$$5.99 \text{ (5.991)} \quad (A1)(ft)$$

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

[1 mark]

## Examiners report

This question was successfully attempted by the great majority. However, the test is for the mathematical independence of the two variables; it does not address “correlation” or whether there is “no relation” between them. Further, the result of the test should be determined by the comparison of the **numerical values** of either the chi-squared calculated and critical values or the associated  $p$ -value and the significance level of the test. The creeping use of  $k$  as the critical value is the notation used in one text book; it is **not** standard notation and its use is not accepted. Comments were made on the G2 forms as to whether the the null hypothesis should be “accepted” or not rejected; both forms are acceptable.

In the compound probability questions, the lack of an explicit tree diagram determined that many candidates were not able to proceed. Determining an appropriate technique is a skill that should be taught.

14e. [2 marks]

## Markscheme

2.42 (2.42094...) (G2)

[2 marks]

## Examiners report

This question was successfully attempted by the great majority. However, the test is for the mathematical independence of the two variables; it does not address “correlation” or whether there is “no relation” between them. Further, the result of the test should be determined by the comparison of the **numerical values** of either the chi-squared calculated and critical values or the associated  $p$ -value and the significance level of the test. The creeping use of  $k$  as the critical value is the notation used in one text book; it is **not** standard notation and its use is not accepted. Comments were made on the G2 forms as to whether the null hypothesis should be “accepted” or not rejected; both forms are acceptable.

In the compound probability questions, the lack of an explicit tree diagram determined that many candidates were not able to proceed. Determining an appropriate technique is a skill that should be taught.

14f. [2 marks]

## Markscheme

Since  $2.42 < 5.99$  therefore accept (do not reject)  $H_0$  (RI)(AI)(ft)

**Note:** The numerical values need not be seen, but must be consistent with their parts (d) and (e).

OR

$p$ -value  $0.298 > 0.05$  therefore accept (do not reject)  $H_0$  (RI)(AI)

**Note:**  $p$ -value comparison may **not** be used as part of a follow through solution. Do not award (AI)(R0). Follow through from parts (c), (d) and (e).

[2 marks]

## Examiners report

This question was successfully attempted by the great majority. However, the test is for the mathematical independence of the two variables; it does not address “correlation” or whether there is “no relation” between them. Further, the result of the test should be determined by the comparison of the **numerical values** of either the chi-squared calculated and critical values or the associated  $p$ -value and the significance level of the test. The creeping use of  $k$  as the critical value is the notation used in one text book; it is **not** standard notation and its use is not accepted. Comments were made on the G2 forms as to whether the null hypothesis should be “accepted” or not rejected; both forms are acceptable.

In the compound probability questions, the lack of an explicit tree diagram determined that many candidates were not able to proceed. Determining an appropriate technique is a skill that should be taught.

14g. [2 marks]

$$\frac{35}{120} \left( \frac{7}{24}, 0.292, 29.2\% \right)$$

$$\frac{25}{120} \left( \frac{5}{24}, 0.208, 20.8\% \right)$$

## Examiners report

This question was successfully attempted by the great majority. However, the test is for the mathematical independence of the two variables; it does not address “correlation” or whether there is “no relation” between them. Further, the result of the test should be determined by the comparison of the **numerical values** of either the chi-squared calculated and critical values or the associated  $p$ -value and the significance level of the test. The creeping use of  $k$  as the critical value is the notation used in one text book; it is **not** standard notation and its use is not accepted. Comments were made on the G2 forms as to whether the null hypothesis should be “accepted” or not rejected; both forms are acceptable.

In the compound probability questions, the lack of an explicit tree diagram determined that many candidates were not able to proceed. Determining an appropriate technique is a skill that should be taught.

14h. [5 marks]

## Markscheme

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

**Note:** Award **(AI)** for two correct fractions, **(MI)** for multiplying their two fractions.

$$= \frac{94}{595} (0.158, 15.8\%) (0.157983...) \quad (AI)(G2)$$

(ii)  
 $\frac{73}{120} \times \frac{72}{119} \quad (MI)$

**Note:** Award **(MI)** for multiplying correct fractions. If sampling with replacement has been used in both parts (h)(i) and (h)(ii) do not penalise in part (h)(ii). Award a maximum of **(MI)(AI)(ft)**.

$$= \frac{219}{595} (0.368, 36.8\%) (0.368067...) \quad (AI)(G2)$$

[5 marks]

## Examiners report

This question was successfully attempted by the great majority. However, the test is for the mathematical independence of the two variables; it does not address “correlation” or whether there is “no relation” between them. Further, the result of the test should be determined by the comparison of the **numerical values** of either the chi-squared calculated and critical values or the associated  $p$ -value and the significance level of the test. The creeping use of  $k$  as the critical value is the notation used in one text book; it is **not** standard notation and its use is not accepted. Comments were made on the G2 forms as to whether the null hypothesis should be “accepted” or not rejected; both forms are acceptable.

In the compound probability questions, the lack of an explicit tree diagram determined that many candidates were not able to proceed. Determining an appropriate technique is a skill that should be taught.

15a. [1 mark]

## Markscheme

90 **(AI)**

[1 mark]

## Examiners report

(a) Most candidates found this correctly although a few wrote 180 instead of 90.



15b.

[7 marks]

## Markscheme

(i)

$$\frac{3}{90}(0.\bar{03}, 0.0333, 0.0333..., 3.\bar{3}\%, 3.33\%) \quad (AI)(ft)$$

**Note:** For the denominator follow through from their answer in part (a).

(ii)

$$\frac{53}{90}(0.5\bar{8}, 0.588..., 0.589, 58.\bar{8}\%, 58.9\%) \quad (AI)(AI)(ft)(G2)$$

**Notes:** Award (AI) for the numerator. (AI)(ft) for denominator. For the denominator follow through from their answer in part (a).

(iii)

$$\frac{72}{90}(0.8, 80\%) \quad (AI)(ft)(AI)(ft)(G2)$$

**Notes:** Award (AI)(ft) for the numerator, (their part (a) –18) (AI)(ft) for denominator. For the denominator follow through from their answer in part (a).

(iv)

$$\frac{24}{48}(0.5, 50\%) \quad (AI)(AI)(G2)$$

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

[7 marks]

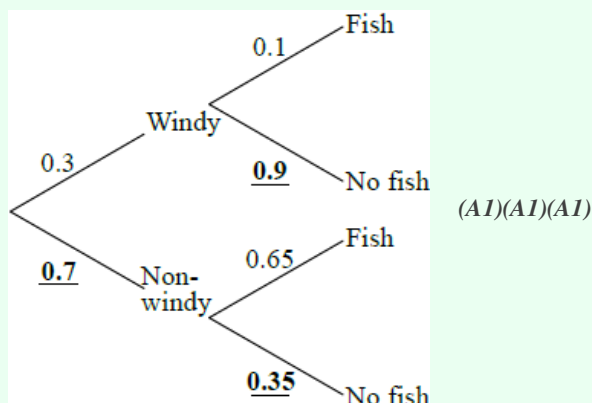
## Examiners report

(b) This was also answered well. The main errors were putting 65/90 in part (ii) and 24/90 in part (iv).

15c.

[3 marks]

## Markscheme



**Notes:** Award (AI) for each correct entry. Tree diagram must be seen for marks to be awarded.

[3 marks]

## Examiners report

(c) The tree diagram was completed correctly in most scripts. It appears that some candidates may have answered this on their question paper and this was not sent to the scanning centre with the answer papers.

15d. [2 marks]

## Markscheme

$$0.3 \times 0.1 = 0.03 \left( \frac{3}{100} \right) \quad (M1)(A1)(G2)$$

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

[2 marks]

## Examiners report

(d) Many answered this correctly. Some added instead of multiplying.

15e. [3 marks]

## Markscheme

$$0.3 \times 0.1 + 0.7 \times 0.65 \quad (M1)(M1)$$

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

$0.7 \times 0.65$  (or 0.455) seen, *(M1)* for adding their 0.03. Follow through from their answers to parts (c) and (d).

$$= 0.485 \left( \frac{485}{1000}, \frac{97}{200} \right) \quad (A1)(ft)(G2)$$

**Note:** Follow through from their tree diagram and their answer to part (d).

[3 marks]

## Examiners report

(e) Surprisingly well answered. Again some added and multiplied in the wrong place.

15f. [2 marks]

## Markscheme

$$0.485 \times 0.485 \quad (M1)$$

$$0.235 \left( \frac{9409}{40000}, 0.235225 \right) \quad (A1)(ft)(G2)$$

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

[2 marks]

## Examiners report

(f) Most candidates added here and then divided by 2 rather than multiplying.

15g. [3 marks]

## Markscheme

$$\frac{0.03}{0.485} \quad (M1)(A1)(ft)$$

**Notes:** Award *(M1)* for substituted conditional probability formula, *(A1)(ft)* for their (d) as numerator and their (e) as denominator.

$$0.0619 \left( \frac{6}{97}, 0.0618556... \right) \quad (A1)(ft)(G2)$$

**Note:** Follow through from their parts (d) and (e).

[3 marks]

## Examiners report

(g) This was badly done with very few correct answers seen.

16a. [8 marks]

## Markscheme

$$(i) \quad \frac{100}{400} \left( \frac{1}{4}, 0.25, 25\% \right) \quad (A1)$$

$$(ii) \quad \frac{90}{400} \left( \frac{9}{40}, 0.225, 22.5\% \right) \quad (A1)$$

$$(iii) \quad \frac{20}{400} \left( \frac{1}{20}, 0.05, 5\% \right) \quad (A1)(A1)$$

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

$$(iv) \quad \frac{120}{400} \left( \frac{3}{10}, 0.3, 30\% \right) \quad (A1)(A1)$$

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

$$(v) \quad \frac{30}{110} \left( \frac{3}{11}, 0.273, 27.3\% \right) (0.272727... ) \quad (A1)(A1)$$

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

0.27, do not accept

0.272, do not accept

0.3.

[8 marks]

## Examiners report

The simple probabilities beginning this question were successfully attempted by the great majority. Most errors in the latter parts occurred due to candidates trying to use the algebraic form of laws of probability, rather than by interpreting the contingency table. Probability questions in this course are, in the main, contextual and the reliance of formulas is not always beneficial to the candidates. Only the best candidates realized the significance of part (b) as a link to the chi-squared test.

This was well attempted by the majority, the weakness being the sole reliance of the calculator to calculate expected value. However, there still remains confusion between critical and *p*-values as the basis for accepting the null hypothesis.

## Markscheme

$$\frac{1}{20} \neq \frac{1}{4} \times \frac{9}{40} \quad (RI)(ft)$$

**Note:** The fractions must be used as part of the reason. Follow through from (a)(i), (a)(ii) and (a)(iii).

Pam is not correct.  $(AI)(ft)$

**Notes:** Do not award  $(R0)(AI)$ . Accept the events are not independent (dependent).

[2 marks]

## Examiners report

The simple probabilities beginning this question were successfully attempted by the great majority. Most errors in the latter parts occurred due to candidates trying to use the algebraic form of laws of probability, rather than by interpreting the contingency table. Probability questions in this course are, in the main, contextual and the reliance of formulas is not always beneficial to the candidates. Only the best candidates realized the significance of part (b) as a link to the chi-squared test.

This was well attempted by the majority, the weakness being the sole reliance of the calculator to calculate expected value. However, there still remains confusion between critical and  $p$ -values as the basis for accepting the null hypothesis.

## Markscheme

(i) The mathematics course and language of examination are independent.  $(AI)$

**Notes:** Accept “There is no association between Mathematics course and language”. Do not accept “not related”, “not correlated”, “not influenced”.

$$(ii) \quad \frac{110}{400} \times \frac{150}{400} \times 400 \quad \left( = \frac{110 \times 150}{400} \right) \quad (MI)$$

$$= 41.25 \quad (AI)$$

$$= 41.3 \quad (AG)$$

**Note:**

41.25 and

41.3 must be seen to award final  $(AI)$ .

[3 marks]

## Examiners report

The simple probabilities beginning this question were successfully attempted by the great majority. Most errors in the latter parts occurred due to candidates trying to use the algebraic form of laws of probability, rather than by interpreting the contingency table. Probability questions in this course are, in the main, contextual and the reliance of formulas is not always beneficial to the candidates. Only the best candidates realized the significance of part (b) as a link to the chi-squared test.

This was well attempted by the majority, the weakness being the sole reliance of the calculator to calculate expected value. However, there still remains confusion between critical and  $p$ -values as the basis for accepting the null hypothesis.

16d.

[4 marks]

## Markscheme

(i)

7.67 (

7.67003...) (G2)

**Note:** Accept

7.7, do not accept

8 or

7.6. Award (G1) if formula with all nine terms seen but their answer is not one of those above.

(ii)

4 (G1)

(iii)

9.488 (A1)(ft)

**Notes:** Accept

9.49 or

9.5, do not accept

9.4 or

9. Follow through from their degrees of freedom.

[4 marks]

## Examiners report

The simple probabilities beginning this question were successfully attempted by the great majority. Most errors in the latter parts occurred due to candidates trying to use the algebraic form of laws of probability, rather than by interpreting the contingency table. Probability questions in this course are, in the main, contextual and the reliance of formulas is not always beneficial to the candidates. Only the best candidates realized the significance of part (b) as a link to the chi-squared test.

This was well attempted by the majority, the weakness being the sole reliance of the calculator to calculate expected value. However, there still remains confusion between critical and  $p$ -values as the basis for accepting the null hypothesis.

16e.

[2 marks]

## Markscheme

 $7.67 < 9.488$  (R1)

OR

 $p = 0.104\dots, p > 0.05$  (R1)

Accept (Do not reject)

 $H_0$  (Pam's belief is correct) (A1)(ft)**Notes:** Follow through from part (d). Do not award (R0)(A1).

[2 marks]

## Examiners report

The simple probabilities beginning this question were successfully attempted by the great majority. Most errors in the latter parts occurred due to candidates trying to use the algebraic form of laws of probability, rather than by interpreting the contingency table. Probability questions in this course are, in the main, contextual and the reliance of formulas is not always beneficial to the candidates. Only the best candidates realized the significance of part (b) as a link to the chi-squared test.

This was well attempted by the majority, the weakness being the sole reliance of the calculator to calculate expected value. However, there still remains confusion between critical and  $p$ -values as the basis for accepting the null hypothesis.

17a.

[1 mark]

### Markscheme

−4,  
−3,  
−2,  
−1,  
0,  
1,  
2 (AI) (CI)

**Note:** Award (AI) for correct numbers, do not penalise if braces, brackets or parentheses seen.

[1 mark]

## Examiners report

Most candidates were able to answer part a correctly, although many did not realise that 0 is an integer.

17b.

[2 marks]

### Markscheme

$\frac{4}{7}$  (0.571, 57.1%) (AI)(ft)(AI)(ft) (C2)

**Notes:** Award (AI)(ft) for numerator, (AI)(ft) for denominator. Follow through from part (a).

**Note:** There is no further penalty in parts (c) and (d) for use of denominator consistent with that in part (b).

[2 marks]

## Examiners report

Most candidates were able to answer part a correctly, although many did not realise that 0 is an integer. The award of follow through marks was common in parts b, c and d.

17c.

[1 mark]

### Markscheme

$\frac{1}{7}$  (0.143, 14.3%) (AI)(ft) (CI)

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

[1 mark]

## Examiners report

Most candidates were able to answer part a correctly, although many did not realise that 0 is an integer. The award of follow through marks was common in parts b, c and d.

17d. [2 marks]

## Markscheme

$\frac{1}{7}$  (0.143, 14.3%) (AI)(ft)(AI)(ft) (C2)

**Note:** Award (AI)(ft) for numerator, (AI)(ft) for denominator. Follow through from part (a).

[2 marks]

## Examiners report

Most candidates were able to answer part a correctly, although many did not realise that 0 is an integer. The award of follow through marks was common in parts b, c and d.

18a. [3 marks]

## Markscheme

$r \wedge p \wedge \neg q$  (AI)(AI)(AI) (C3)

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

[3 marks]

## Examiners report

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'.

18b. [3 marks]

## Markscheme

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

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

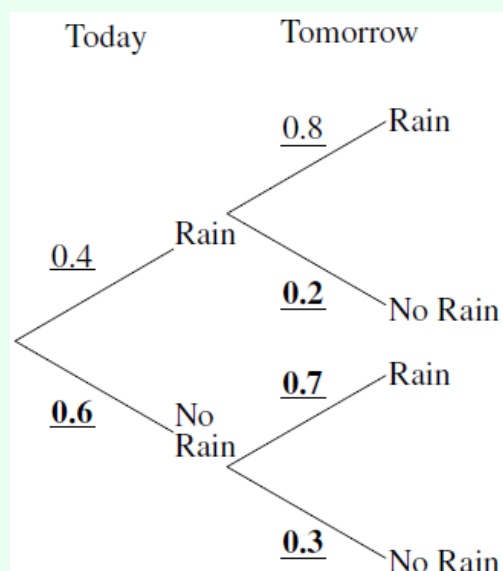
[3 marks]

## Examiners report

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'.

19a. [3 marks]

## Markscheme



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

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

[3 marks]

## Examiners report

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.

19b. [3 marks]

## Markscheme

$$0.4 \times 0.8 + 0.6 \times 0.7 \quad (A1)(ft)(M1)$$

**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.

$$= 0.74 \quad (A1)(ft) \quad (C3)$$

[3 marks]

## Examiners report

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.

20a. [1 mark]

## Markscheme

1 (one) (A1) (C1)

**Note:**

6,

{6} or

{1} earns no marks.

[1 mark]



## Examiners report

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.

20b.

[1 mark]

## Markscheme

1,

3,

5,

7,

9,

11 (AI) (CI)

**Note:** Do not penalise if braces, parentheses or brackets are seen.

[1 mark]

## Examiners report

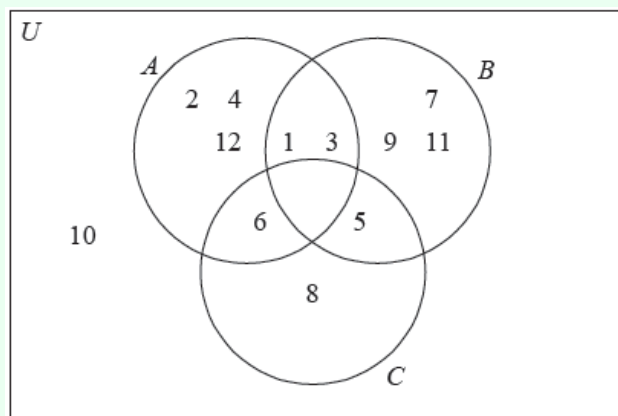
There was much confusion amongst candidates as to the understanding of the words *number of elements*. Many candidates simply wrote down

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.

## Markscheme



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

**Notes:** Award (AI) for the empty set

$A \cap B \cap C$ .

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

6,  
5,  
1 and  
3.

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

2,  
4,  
12,  
7,  
9,  
11,  
8.

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

10.

Follow through from part (b).

[4 marks]

## Examiners report

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.