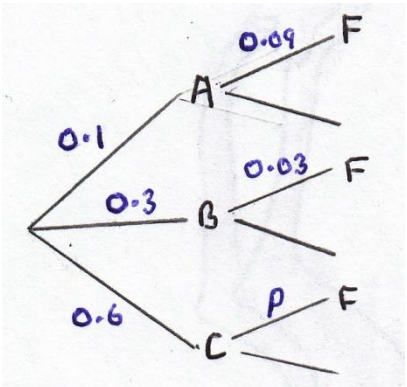
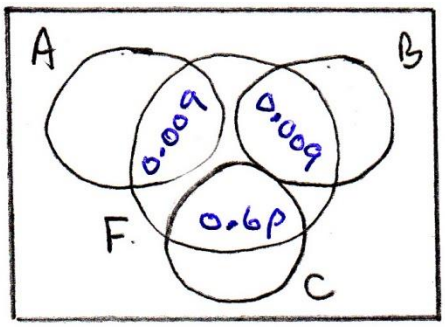
Qu	Scheme	Marks	AO
1 (a)	[$p = 1 - (0.2 + 0.2 + 0.1 + 0.2)] =$ **0.3**	B1 **(1)**	1.1b
(b)	A and C are mutually exclusive. [NOT P(A) and P(C)]	B1 **(1)**	1.2
		(2 marks)	
	Notes		
(a)	B1 for		
(b)	B1 for A and C [NB $A \cap C$ or $A \cap C = \varnothing$ is B0] If more than one case given they must all be correct e.g. $A \cap B$ and C		

Qu	Scheme	Marks	AO
2 (a)	[Let $p = \text{P}(F \mid C)$]		
	Tree diagram or some other method to find an equation for p	M1	2.1
	$0.1\times0.09+0.3\times0.03+0.6\times p=0.06$	A1	1.1b
	$p = 0.07$ i.e. **7%**	A1	1.1b
		(3)	
(b)	e.g. $\text{P}(B \text{ and } F) = 0.3\times0.03 = 0.009$ but		
	$\text{P}(B)\times\text{P}(F) = 0.3\times0.06 = 0.018$	B1	2.4
	These are not equal so not independent		
		(1)	
		(4 marks)	

	Notes
(a)	M1 for selecting a suitable method to find the missing probability e.g. sight of tree diagram with 0.1, 0.3, 0.6 and 0.09, 0.03, p suitably placed e.g. sight of VD with 0.009 for $A\cap F$ and $B\cap F$ and 0.6p suitably placed or attempt an equation with at least one correct numerical and one "p" product (not necessarily correct) on LHS or for sight of $0.06 - (0.009 + 0.009)$ (o.e. e.g. $6 - 1.8 = 4.2\%$) 1st A1 for a correct equation for p (May be implied by a correct answer) or for the expression $\dfrac{0.06-(0.009+0.009)}{0.6}$ (o.e.) 2nd A1 for 7% (accept 0.07) **Correct Ans:** Provided there is no incorrect working seen award 3/3 e.g. may just see tree diagram with 0.07 for p (probably from trial and improv')
(b)	B1 for a suitable explanation…may talk about 2nd branches on tree diagram and point out that $0.03 \neq 0.06$ but need some supporting calculation/words Can condone incorrect use of set notation (it is not on AS spec) provided the rest of the calculations and words are correct.





Qu	Scheme	Marks	AO
5(a)	$P(X=4) = P(X=2)$ so $P(X=4) = 0.35$ $P(X=1) = P(X=3)$ and $P(X=1) + P(X=3) = 1 - 0.7$ So x | 1 | 2 | 3 | 4 $P(X=x)$ | 0.15 | 0.35 | 0.15 | [0.35]	M1 A1 (2)	2.1 1.1b
(b)	Let A = number of spins that land on 4 $A \sim B(60, "0.35")$	B1ft	3.3
	$[P(A > 30) =]\quad 1 - P(A \leqslant 30)$ $= 1 - 0.99411\ldots$ = **awrt 0.00589**	M1 A1 (3)	3.4 1.1b
(c)	$Y - X \leqslant 4 \Rightarrow \frac{12}{X} - X \leqslant 4$ <u>or</u> $12 - X^2 \leqslant 4X$ (since $X > 0$) o.e.	M1	3.1a
	i.e. $0 \leqslant X^2 + 4X - 12 \Rightarrow 0 \leqslant (X+6)(X-2)$ so $X \geqslant 2$	M1	1.1b
	$P(Y - X \leqslant 4) = P(X \geqslant 2) = 0.35 + 0.15 + 0.35$ = **<u>0.85</u>**	A1 (3)	3.2a
		(8 marks)	

Notes

(a) M1 for using the given information to obtain $P(X=4)$
Award for statement $P(X=4) = P(X=2)$ <u>or</u> writing $P(X=4) = 0.35$
A1 for getting fully correct distribution (any form that clearly identifies probs)
e.g. can be list $P(X=1) = 0.15$, $P(X=3) = \ldots$etc or as a probability function
$P(X=x) = \begin{cases} 0.15 & x = 1,3 \\ 0.35 & x = 2,4 \end{cases}$
[Condone missing $P(X=2)$ as this is given in QP]

(b) B1 for selecting a suitable model, sight of B(60, their 0.35) o.e. in words
f.t. their $P(X=4)$ from part (a).
Can be implied by $P(A \leqslant 30)$ = awrt 0.9941 or final answer = awrt 0.00589
M1 for using their model and interpreting "more than half"
Need to see $1 - P(A \leqslant 30)$. Can be implied by awrt 0.00589
Can ignore incorrect LHS such as $P(A \geqslant 30)$
A1 for awrt 0.00589

(c) 1st M1 for translating the prob. problem into a <u>correct</u> mathematical inequality
Just an inequality in 1 variable. May be inside a probability statement.
ALT **Table of values:**

X	1	2	3	4
Y	12	6	4	3

<u>or</u> values of $Y - X = 11, 4, 1, -1$

2nd M1 for solving the inequality leading to a range of values, allow 1 or 2 slips
May be a quadratic or cubic but must lead to a set of values of X or $Y - X$
ALT **Table or values:** They must state clearly which values are required
Both Ms can be implied by a correct answer (or correct ft of their distb'n)
A1 for interpreting the inequality and solving the problem i.e. 0.85 cao

Question	Scheme	Marks	AOs
2	$x = 0$	B1	2.2a
	$\text{P}(A) = 0.1 + z + y \quad \text{P}(C) = 0.39 + z[+x] \quad \text{P}(A \text{ and } C) = z$	M1	2.1
	$\text{P}(A \text{ and } C) = \text{P}(A) \times \text{P}(C) \rightarrow z = (0.1 + z + y) \times (0.39 + z[+x])$	M1	1.1b
	$\left[\sum p = 1\right]$ $0.06 + 0.3 + 0.39 + 0.1 + z + y[+x] = 1 \rightarrow \quad [z + y[+x] = 0.15]$	M1	1.1b
	Solving (simultaneously) leading to $\underline{z = 0.13} \quad \underline{y = 0.02}$	A1	1.1b
			(5 marks)

Notes

B1: for $x = 0$, may be seen on Venn diagram

M1: Identifying the probabilities required for independence and at least 2 correct
These must be labelled
If there are no labels, then this may be implied by $z = (0.1 + z + y)(0.39 + z\ [+x])$, allow one numerical slip

Allow e.g.
$\text{P}(A') = 0.39 + 0.30 + 0.06[+x] \quad \text{P}(C) = 0.39 + z[+x] \quad \text{P}(A' \text{ and } C) = 0.39$
[Not on spec. but you may see use of conditional probabilities]

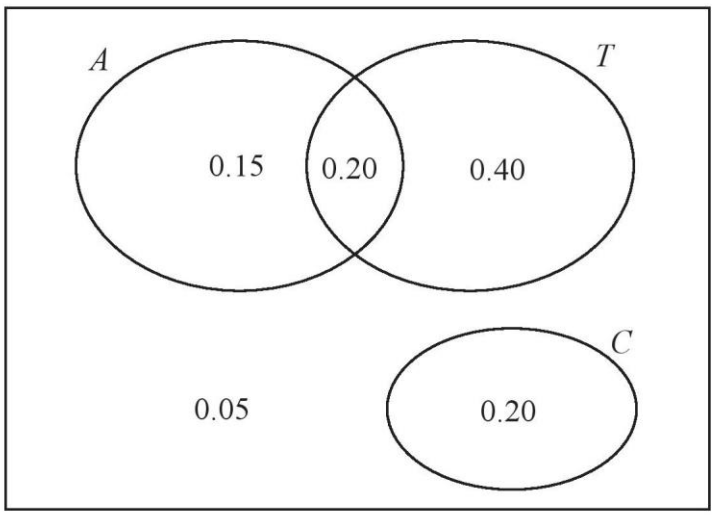
M1: Use of independence equation with their labelled probabilities in terms y, z [and x]
All their probabilities must be substituted into a correct formula
Sight of a correct equation e.g. $z = (0.1 + z + y)(0.39 + z\ [+x])$ scores M1M1

M1: Using $\Sigma p = 1$
Implied by $[x +]\ y + z = 0.15$
or their $x + y + z = 0.15$ where x, y, and z are all probabilities
or e.g. $\text{P}(A) = 0.25$

A1: both $y = 0.02$ and $z = 0.13$

Question	Scheme	Marks	AOs
3	Overall method	M1	2.1
	$a+b=2c+0.5$ oe **or** $a+b=2(1-a-b)$	B1	2.2a
	$a+b+c=0.75$ oe	B1	1.1b
	$3c=0.25 \quad \left[c=0.0833... \text{ or } \frac{1}{12}\right]$	M1	1.1b
	P(scoring 2,4 or 4,2 or 3,3) = $2\times"\frac{1}{12}"\times 0.15+0.1^2$	M1	3.1b
	$= 0.035$ oe	A1cso	1.1b
		(6)	
			(6 marks)

Notes		
3	**M1:**	A fully correct method with all the required steps. For gaining 2 correct equations with at least one correct(allow if unsimplified). Attempting to solve to find a value of c followed by **correct method** to find the probability
	B1:	Forming a correct equation from the information given in the question
	B1:	A correct equation using the sum of the probabilities equals 1
	M1:	Correct method for solving 2 equations to find c Implied by $c=\frac{1}{12}$
	M1:	Recognising the ways to get a total of 6. Condone missing arrangments or repeats. Do not ignore extras written unless ignored in the calculation. May be implied by $m\times"\frac{1}{12}"\times 0.15+n\times 0.1^2$ where m and n are positive integers
	A1cso:	Cao 0.035, $\frac{7}{200}$ oe

Question	Scheme	Marks	AOs
3(a)	$p = [1 - 0.75 - 0.05 =]$ **0.20**	B1	1.1b
		(1)	
(b)	$q =$ **0.15**	B1ft	1.1b
	P(A) = 0.35 P(T) = 0.6 P(A and T) = 0.20 P(A) × P(T) = 0.21	M1	2.1
	Since 0.20 ≠ 0.21 therefore A and T are **not** independent	A1	2.4
		(3)	
			
(c)	P(not [A or C]) = **0.45**	B1	1.1b
		(1)	
			(5 marks)

Notes:

(a)
B1: cao for $p = 0.20$

(b)
B1: Ft for use of their p and P(A or T) to find q i.e. 0.75 – "p" – 0.40 **or** $q = 0.15$
M1: For the statement of all probabilities required for a suitable test and sight of any appropriate calculations required

(c)
A1: All probabilities correct, correct comparison and suitable comment
B1: cao for 0.45

Question	Scheme	Marks
4.(a)	[P(both blue) $= \frac{1}{20} \times \frac{1}{20} =] \frac{1}{400}$ oe	B1
		(1)
(b)	P(exactly 1 red) $= 2 \times \frac{1}{20} \times \frac{19}{20}, = \frac{19}{200}$ oe	M1, A1
		(2)
(c)	P(2 yellow and 1 green)$=3 \times \frac{4}{9} \times \frac{5}{8} \times \frac{4}{7} = \frac{10}{21}$ oe	B1 M1 A1
		(3)
(d)	P(All beads are yellow) $= \frac{5}{9} \times \frac{4}{8} \times \frac{3}{7} \times \frac{2}{6}$	M1
	P(At least 1 bead is green) = 1 – P(All beads are yellow)	
	$1 - \frac{5}{9} \times \frac{4}{8} \times \frac{3}{7} \times \frac{2}{6} = \frac{121}{126}$	M1A1
		(3)
		Total 9

	Notes
(a)	B1 $\frac{1}{400}$ or 0.0025
(b)	M1 for a correct equivalent expression $\frac{1}{20} \times \frac{19}{20} + \frac{19}{20} \times \frac{1}{20}$
	A1 $\frac{19}{200}$ or 0.095
(c)	B1 for 3 × … or for the sum of exactly 3 identical products attempted M1 for any one product correct
	A1 $\frac{10}{21}$ (allow awrt 0.476 from correct working)
(d)	1st M1 $\frac{5}{9} \times \frac{4}{8} \times \frac{3}{7} \times \frac{2}{6}$
	2nd M1 Use of $1 - p$ (where p is a product of 4 probabilities)
	A1 $\frac{121}{126}$ (condone awrt 0.960 must be at least 3sf from correct working)
	OR
	1st M1 List **all** 15 favourable outcomes and at least one correct product (YYYG)×4 [(YYGY), (YGYY), (GYYY)] (YYGG)×6 [(YGYG), (YGGY), (GYYG), (GYGY), (GGYY)] (GGYG)×4 [(GGGY), (YGGG), (GYGG)] (GGGG)
	2nd M1 Sum all 15 correct probabilities
	A1 $\frac{121}{126}$ (condone awrt 0.960 must be at least 3sf from correct working)

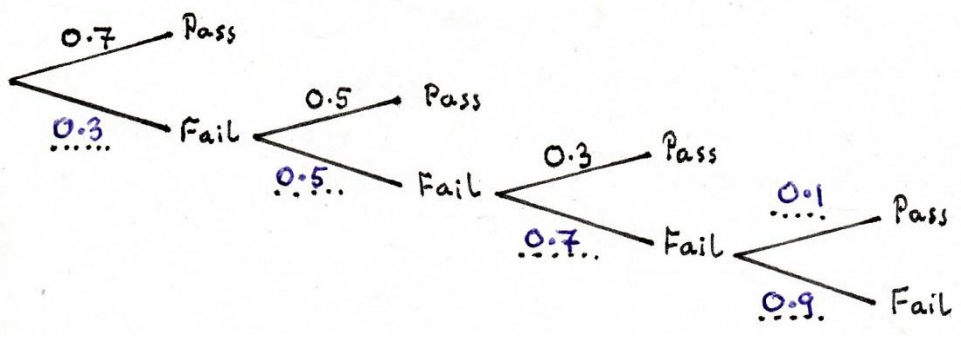
Question Number	Scheme	Marks
2. (a)	(The event that) the integer selected is prime **and** ends in a 3 (and is between 1 and 50 inclusive)	**B1** **(1)**
(b)	$\frac{15}{50}$ (or equivalent e.g. 0.30) [condone 30%]	**B1** **(1)**
(c)	$\frac{12}{50}$ (or equivalent e.g. 0.24) [condone 24%]	**B1** **(1)**
(d)	$\left[\mathrm{P}(A\mid C)=\right]\frac{\mathrm{P}(A\cap C)}{\mathrm{P}(C)}=\frac{\frac{7}{50}}{\frac{30}{50}}=,\ \frac{7}{30}$	**M1, A1** **(2)**
(e)	$\frac{15}{50}\neq\frac{7}{30}$, so not independent.	**M1, A1** **(2)**
(f)	$\left[\mathrm{P}(B\mid(A\cap C))=\right]\frac{\mathrm{P}(B\cap A\cap C)}{\mathrm{P}(A\cap C)}=\frac{\frac{2}{50}}{\frac{7}{50}}=,\ \frac{2}{7}$	**M1, A1** **(2)** **[9 marks]**

(d) M1 for a correct ratio expression (may be in words) with at least one correct probability substituted or correct ratio expression and $\frac{7}{n}$ or $\frac{m}{30}$ where $7 < n$ or $m < 30$
or fully correct ratio of probabilities.
A1 for $\frac{7}{30}$ or any exact equivalent e.g. $0.2\dot{3}$ but 0.233 is M1A0 (Correct ans only = M1A1)

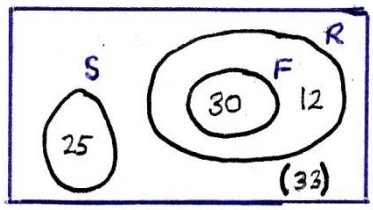
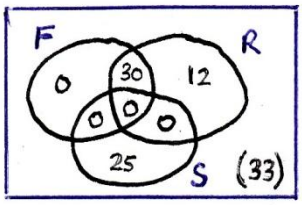
(e) M1 for correctly comparing 'their (b)' with 'their (d)', can be in words or symbols e.g. $\mathrm{P}(A)\neq\mathrm{P}(A\mid C)$ in symbols.
A1 dependent on a correct (b) and (d) (or awrt 0.233 in (d)) and for concluding not independent

SC For a correct test using correctly labelled $\mathrm{P}(A)=\frac{15}{50}$, $\mathrm{P}(C)=\frac{30}{50}$ and $\mathrm{P}(A\cap C)=\frac{7}{50}$ with all correct probabilities and $\frac{15}{50}\times\frac{30}{50}=\frac{9}{50}\neq\frac{7}{50}$ (o.e.) seen leading to "not independent" score M0A1

(f) M1 for a correct ratio expression (may be in words) with at least one correct probability substituted or correct ratio expression and $\frac{r}{7}$ or $\frac{2}{t}$ where $r < 7$ or $2 < t$
or fully correct ratio of probabilities
A1 for $\frac{2}{7}$ or an exact equivalent. **Allow** awrt 0.286 here as well.(Correct ans. only = M1A1)

Question Number	Scheme	Marks
4.(a)		B1 B1 (2)
(b)	$1-0.3\times0.5\times0.7\times0.9$ or $0.7+(0.3\times0.5)+(0.3\times0.5\times0.3)+(0.3\times0.5\times0.7\times0.1)$ $=$ **0.9055**	M1 A1 (2)
(c)	$[\mathrm{P}(P_1\cup P_2 \mid \text{Pass})=]\ \dfrac{0.7+"0.3"\times0.5}{(b)},\ =\dfrac{0.85}{"0.9055"}$ $=0.938707\ldots=$ awrt **0.939**	M1, A1ft A1 (3)
(d)	$p+(1-p)(p-0.2)$ or $1-(1-p)(1.2-p)$ (o.e.) e.g. $p+p-p^2+0.2p-0.2=0.95\ \rightarrow p^2-2.2p+1.15=0$ (*)	M1 dM1A1cso (3)
(e)	$p=\dfrac{2.2\pm\sqrt{2.2^2-4\times1.15}}{2}$ or Complete the sq: $(p-1.1)^2-1.1^2+1.15=0$ $=\dfrac{2.2\pm0.4898...}{2}$ or $\dfrac{2.2\pm\sqrt{0.24}}{2}$ or $1.1\pm\sqrt{0.06}$ or (1.34…), 0.855… $p=0.85505102\ldots$ $p=$ **0.855**	M1 A1 A1 (3)

	Notes
(a)	1st B1 for correctly placing 0.3 and 0.5 2nd B1 for correctly placing 0.7, 0.1 and 0.9
	Apart from (d), a correct answer with no incorrect working scores full marks.
(b)	M1 for a correct expression (ft from their tree diagram) A1 for 0.9055 or exact equivalent e.g. $\frac{1811}{2000}$ Accept 0.906 only if correct expr' seen
(c)	M1 for a correct ratio of probs ft their 0.3 and their answer to (b)[if < 1]. Num > Den M0 A1ft for correct numerator and their part (b) on denominator A1 for awrt 0.939 or accept exact fraction eg $\frac{1700}{1811}$
(d)	1st M1 for a correct expression for P(pass) in terms of p[condone $p-(p-1)(p-0.2)$ etc] 2nd dM1 dep. on 1st M1 for expanding brackets and forming an equation in p Allow one slip A1cso correct processing leading to printed answer. No incorrect working seen.
(e)	M1 for attempt to solve **given** equation, correct expression. Condone just + not ± 1st A1 for correct expression and simplified square root or 1.34… and 0.855… 2nd A1 for $p=0.855$ only (penalise any extra value > 1) Correct ans only scores 3/3
Ans. only	For $\frac{1}{10}\left(11-\sqrt{6}\right)$ or 0.855... score M1A1A0 (not to 3dp) but for 0.855 can score M1A1A1

Question Number	Scheme	Marks
5. (a)	 or 	B1 B1 B1 B1 (4)
(b)	F and S or R and S	B1 (1)
(c)	$\mathrm{P}\left(\left[F \cup R \cup S\right]'\right) = \frac{33}{100}$ or **0.33**	B1 (1)
(d)	$\mathrm{P}(R) = \frac{30+12}{100} = \frac{21}{50}$ or **0.42**	B1 (1)
(e)	$\mathrm{P}\left(F \cup S\right) = \frac{30+25}{100} = \frac{11}{20}$ or **0.55**	B1 (1)
(f)	$\left[\mathrm{P}\left(F \mid R\right)\right] = \frac{\mathrm{P}\left(F \cap R\right)}{\mathrm{P}(R)} = \frac{"0.30"}{"0.42"}$ $= \frac{30}{42}$ or $\frac{5}{7}$ (o.e.)	M1 A1 (2) **Total 10**

	Notes
(a)	**In the diagram do not treat a blank space as zero. Allow probabilities or integers** 1st B1 for 3 labelled loops and a box. The 33 is not required for any marks in (a) 2nd B1 for $F \subset R$ or indicated by zeros 3rd B1 for 30 and 12 correctly placed and n(F) = 30 and $\mathrm{n}\left(F' \cap R\right) = 12$ 4th B1 for S a separate loop, or indicated by zeros, and the 25
(b)	B1 for a correct pair. If there is more than one pair then each pair must be correct. Do not allow P(F) etc or e.g. P($R \cap S$) = 0
(c),(d),(e)	B1 cao for each answer. Accept any exact equivalent (fractions or decimals) for the probabilities
(f)	M1 ft their "30" and their answer to (d). For a correct ratio of their probabilities or a correct ratio expression and at least one correct probability. If num > den score M0 A1 for $\frac{5}{7}$ or any exact equivalent. Must be proper fraction not $\frac{0.3}{0.42}$ NB $\frac{0.3}{0.42} = 0.714$ is A0 since it is not a proper fraction and the answer is not exact Condone P(R|F) = $\frac{30}{42}$ and allow M1A1 for the correct answer but $\mathrm{P}(R \mid F) = \frac{\mathrm{P}(R \cap F)}{P(F)} = \frac{0.30}{0.42} = \frac{30}{42}$ is M0A0