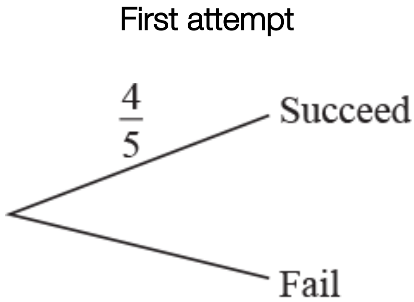
1. In a high jump competition, jumpers are allowed three attempts to succeed at each height. For one particular height Imran estimates his chances of succeeding as follows.

- The probability that he will succeed on his first attempt is $\frac{4}{5}$.
- If he fails on his first attempt, the probability that he will succeed on his second attempt is $\frac{3}{4}$.
- If he fails on his first two attempts, the probability that he will succeed on his third attempt is p.

Use Imran's estimates to answer the following.

(i) Complete the below probability tree diagram for this situation. [2]



(ii) Find the probability that Imran succeeds on either his first or his second attempt. [3]

(iii) Given that the probability that Imran succeeds at this particular height is $\frac{197}{200}$, find p. [3]

2. In a class of 30 students, each student studies exactly one modern language. 14 students study French, 9 students study Spanish and 7 students study German. A committee of 6 students is to be chosen from these 30 students. Find the number of ways of choosing the committee if it contains

(i) any 6 students from the class, [1]

(ii) 2 students studying each language, [2]

(iii) exactly 1 student studying French. [3]

3. Sandra makes repeated, independent attempts to hit a target. On each attempt, the probability that she succeeds is 0.1.

i. Find the probability that

a. the first time she succeeds is on her 5th attempt,

[2]

b. the first time she succeeds is after her 5th attempt,

[2]

c. the second time she succeeds is before her 4th attempt.

[4]

Jill also makes repeated attempts to hit the target. Each attempt of either Jill or Sandra is independent. Each time that Jill attempts to hit the target, the probability that she succeeds is 0.2. Sandra and Jill take turns attempting to hit the target, with Sandra going first.

ii. Find the probability that the first person to hit the target is Sandra, on her

a. 2nd attempt,

[2]

b. 10th attempt.

[3]

4. i. A bag contains 12 black discs, 10 white discs and 5 green discs. Three discs are drawn at random from the bag, without replacement. Find the probability that all three discs are of different colours.

[3]

ii. A bag contains 30 red discs and 20 blue discs. A second bag contains 50 discs, each of which is either red or blue. A disc is drawn at random from each bag. The probability that these two discs are of different colours is 0.54. Find the number of red discs that were in the second bag at the start.

[4]

5. The probability distribution of a random variable X is given in the table.

x	1	2	3
$P(X = x)$	0.6	0.3	0.1

Two values of X are chosen at random. Find the probability that the second value is greater than the first. [3]

6. A random variable X has probability distribution given by

$$P(X = x) = \frac{1}{860}(1 + x) \quad \text{for } x = 1, 2, 3, \ldots, 40.$$

(a) Find $P(X > 39)$. [2]

(b) Given that x is even, determine $P(X < 10)$. [6]

7. The probability distribution of a random variable X is given in the table.

x	0	2	4	6
$P(X = x)$	$\frac{3}{8}$	$\frac{5}{16}$	$4p$	p

(a) Find the value of p. [2]

(b) Two values of X are chosen at random. Find the probability that the product of these values is 0. [3]

8. The discrete random variable X takes values 1, 2, 3, 4 and 5, and its probability distribution is defined as follows.

$$P(X=x)=\begin{cases} a & x=1, \\ \frac{1}{2}P(X=x-1) & x=2,3,4,5, \\ 0 & \text{otherwise,} \end{cases}$$

where a is a constant.

(a) Show that $a=\frac{16}{31}$. [2]

The discrete probability distribution for X is given in the table.

x	1	2	3	4	5
$P(X=x)$	$\frac{16}{31}$	$\frac{8}{31}$	$\frac{4}{31}$	$\frac{2}{31}$	$\frac{1}{31}$

(b) Find the probability that X is odd. [1]

Two independent values of X are chosen, and their sum S is found.

(c) Find the probability that S is odd. [2]

(d) Find the probability that S is greater than 8, given that S is odd. [3]

Sheila sometimes needs several attempts to start her car in the morning. She models the number of attempts she needs by the discrete random variable Y defined as follows.

$$P(Y=y+1)=\frac{1}{2}P(Y=y) \quad \text{for all positive integers } y.$$

(e) Find $P(Y=1)$. [2]

(f) Give a reason why one of the variables, X or Y, might be more appropriate as a model for the number of attempts that Sheila needs to start her car. [1]

9. Bag A contains 3 black discs and 2 white discs only. Initially Bag B is empty. Discs are removed at random from bag A, and are placed in bag B, one at a time, until all 5 discs are in bag B.

(a) Write down the probability that the last disc that is placed in bag B is black. [1]

(b) Find the probability that the first disc and the last disc that are placed in bag B are both black. [2]

(c) Find the probability that, starting from when the first disc is placed in bag B, the number of black discs in bag B is always greater than the number of white discs in bag B. [4]

10. Each of the 30 students in a class plays at least one of squash, hockey and tennis.

- 18 students play squash
- 19 students play hockey
- 17 students play tennis
- 8 students play squash and hockey
- 9 students play hockey and tennis
- 11 students play squash and tennis

(a) Find the number of students who play all three sports. [3]

A student is picked at random from the class.

(b) Given that this student plays squash, find the probability that this student does not play hockey. [1]

Two different students are picked at random from the class, one after the other, without replacement.

(c) Given that the first student plays squash, find the probability that the second student plays hockey. [4]

11. Joanne has five cards, numbered 1, 1, 1, 2, 2. She picks two cards at random, without replacement. The variable X denotes the sum of the numbers on the two cards.

(a) Show that $\mathrm{P}(X=3)=\frac{3}{5}$. [2]

The table shows the probability distribution of X.

x	2	3	4
$P(X = x)$	$\frac{3}{10}$	$\frac{3}{5}$	$\frac{1}{10}$

Joanne replaces the two cards. Now Liam picks two cards at random from the five cards, without replacement. The variable Y denotes the sum of the numbers on the two cards that Liam picks.

(b) Find $P(X = Y)$. [2]

END OF QUESTION paper

Question			Answer/Indicative content	Marks	Part marks and guidance		
1		i	All correct lines & probs OR labels All correct lines & probs & labels	B1 B1 [2]	Allow extra lines with no probs given, or prob = 0 given, for B1B1 No need for labels "2nd attempt" and "3rd attempt" SC: One line omitted, all probs and labels given on other lines B1B0 **Examiner's Comments** Some candidates omitted some probabilities or some labels. A few gave extra branches, with probabilities on them.	"probs" includes $1 – p$ Ignore products at end, if shown Instead of *p* & $1 – p$, allow 0.7 & 0.3 or incorrect *p* & –p from (iii) NOT *q* instead of $1 – p$	

Question			Answer/Indicative content	Marks	Part marks and guidance		
		ii	$\frac{4}{5} + \frac{1}{5} \times \frac{3}{4}$ or $1 - \frac{1}{5} \times \frac{1}{4}$ $= \frac{19}{20}$ or 0.95	M2 A1 [3]	$\frac{4}{5}$ + prod of 2 P's or 1– prod of 2 P's M1 No ft from tree diag.	eg $\frac{4}{5} + \frac{1}{5} \times \frac{4}{5}$ or $1 - \frac{1}{5} \times \frac{1}{5}$ or $\frac{4}{5} + \frac{1}{5} \times \frac{3}{5}$ or $1 - \frac{1}{5} \times \frac{2}{5}$ M1M0A0	
					Examiner's Comments Many candidates answered this q uestion correctly. A few omitted the probability of succeeding on the first attempt and just found□□$\frac{1}{5} \times \frac{4}{5}$. Others considered both first and second attempts, but incorrectly just added□□$\frac{4}{5} + \frac{3}{4}$.		
		iii	$1 - \frac{1}{5} \times \frac{1}{4} \times (1 - p) = \frac{197}{200}$ or $\frac{3}{200}$ seen $\frac{1-p}{20} = \frac{3}{200}$ any correct step, one fract each side	M1 M1d	or '0.95'+ $\frac{1}{5} \times \frac{1}{4} \times p = \frac{197}{200}$ or $\frac{7}{200}$ seen eg $\frac{19+p}{20} = \frac{197}{200}$ or $\frac{1}{20}p = \frac{7}{200}$ Dep 1st M1	or $\frac{4}{5} + \frac{1}{5} \times \frac{3}{4} + \frac{1}{5} \times \frac{1}{4} \times p = \frac{197}{200}$ eg $\frac{1}{20}p = \frac{7}{200}$ oe in decimals	

Question			Answer/Indicative content	Marks	Part marks and guidance		
			$p = \frac{7}{10}$	A1 [3]	$\frac{197}{200} - (\frac{4}{5} + \frac{1}{5} \times \frac{3}{4})$ (= $\frac{7}{200}$) M1 '$\frac{7}{200}$' ÷ ($\frac{1}{4} \times \frac{1}{5}$) or '$\frac{7}{200}$' × 20 oe M1 = $\frac{7}{10}$ A1 **Examiner's Comments** Many candidates gave a correct equation involving *p*, but some were unable to handle the ensuing algebra. Not many used the slightly more efficient method, using 1 – P(three failures). Some correctly saw that they could use their answer to part (ii) as part of the method, but many wrote $\frac{19}{20} + \frac{1}{4}p = \frac{197}{200}$. Others considered only the third attempt, giving $\frac{1}{5} \times \frac{1}{4} \times p = \frac{197}{200}$.	ft from tree diag for M1M1, not A1 or similar arithmetic methods	

Question			Answer/Indicative content	Marks	Part marks and guidance
			Total	8	

Question			Answer/Indicative content	Marks	Part marks and guidance	
2		i	If P used instead of C consistently in all parts attempted (at least two parts attempted) 593775	B0 M1A0 M1M1A0 B1 [1]	427518000 550368 7338240 or 594000 (3 sf) **Examiner's Comments** Some candidates misread this question to mean "Find the probability . . ." rather than "Find the number of ways . . .". These candidates could gain a maximum of 3 marks altogether for all three parts. The same maximum applied for those who used permutations instead of combinations. Most candidates answered this question correctly. A few just found 30!.	
		ii	$^{14}C_2 \times {}^{9}C_2 \times {}^{7}C_2$ alone = 68796	M1 A1 [2]	M1A0 MR: $\div {}^{30}C_6$ or 68800 (3 sf) **Examiner's Comments** A common error was addition of the three correct combinations, instead of multiplication.	

Question			Answer/Indicative content	Marks	Part marks and guidance		
		iii	14 (or $^{14}C_1$) × $^{16}C_5$ or 14 × 4368 alone = 61152	M2 A1 [3]	or M1 for either $^{16}C_5$ or 4368 seen or 14 (or $^{14}C_1$) × any no. seen or 61200 (3 sf)	$14×(^9C_5+^9C_4x7+^9C_3×^7C_2+^9C_2×^7C_3+9x^7C_4+^7C_5)$ M2 NOT 14 + ….. : M0M0 MR: ÷ $^{30}C_6$ (= $\frac{224}{2175}$ or 0.103) M2A0	
					Examiner's Comments Arithmetical errors were common in the otherwise correct, but very long, method of adding six products of combinations. Candidates who used the direct method ($^{14}C_1$ × $^{16}C_5$) were more likely to obtain the correct answer. Some candidates, incorrectly, found $^{14}C_1$ × $^{30}C_5$ or $^{14}C_1$ × $^{29}C_5$. Others added $^{14}C_1$ + $^{16}C_5$.		
			Total	6			

Question			Answer/Indicative content	Marks	Part marks and guidance	
3		i	**(a)** 0.9× 0.8 × 0.1	M1		
		i	$= \frac{6561}{100000}$ or 0.0656 (3sf)	A1	**Examiner's Comments** Most candidates answered this correctly, although a few gave $0.9^5 \times 0.1$.	
		i	**(b)** 0.9^5	M1	Allow 0.9^4 or $1 – 0.9^5$: M1 but $1 – 0.9^n$ ($n \neq 5$) or 0.1×0.9^n: M0	$1 – (0.1 \times +0.9 \times 0.1 + 0.9^2 \times 0.1 + …0.9^4 \times 0.n$ or 0.59 (2 sf)
		i	$= \frac{59049}{100000}$ or 0.59 (2 sf)	AI	**Examiner's Comments** Geometric distribution questions involving "before" or "after" often cause problems. Candidates are confused as to whether a "1 –" is needed. Others think that since it is a geometric situation, "× *p*" must be included. Also sometimes there is confusion over the power. In fact most candidates answered this question correctly, with a few giving 0.9^4 or $1 – 0.9^5$ or $0.9^5 \times 0.1$. Some used the long method (ie the complement method), but (as usual) a few of these omitted a term or added an extra term.	Allow without "1 –" OR omit last term NB $0.9^5 \times 0.1 = 0.0590$ MOAO
		i	**(c)** 0.1 × 0.1 or [0.1 × 0.1 × 0.9 + 0.1 × 0.1 × 0.1] oe	M1		$3 \times 0.1^2 \times 0.9 + 0.r$ <u>no incorrect multiples</u>
		i	+ 0.1 × 0.9 × 0.1 oe	M1	M1M1 two correct terms, <u>no incorrect multiples</u>	M2 for 1st term; M1 for 2nd
		i	+ 0.9 × 0.1 × 0.1 oe	M1	M1 all correct	

Question			Answer/Indicative content	Marks	Part marks and guidance	
		i	= 0.028	A1	Ans 0.027 probably M0M1M1A0 but check working	This method only scores using "1 – ": 0.9^3; $3 \times 0.9^2 \times 0.1$ <u>no incorrect multiples</u> MI; MI 1 – one or both terms with no further wking: M1(dep M1) eg $1 - 0.9^3$ alone M1M0M1
		i			SC if no M-mks scored: SSF, SSS, FSS, SFS or SS, FSS, SFS seen or implied: B1 **Examiner's Comments** Only a few candidates used the simplest method which involves SS, FSS, SFS. Few candidates answered this question totally correctly although many gave partially correct answers. Some gave only $0.1^2 \times 0.9$. Many gave $3 \times 0.1^2 \times 0.9$ but omitted + 0.1^3. Many included terms such as 0.1×0.9^2. Some used the complement method, but most of these only gave $1 - 0.9^3$, omitting to subtract $3 \times 0.9^2 \times 0.1$ also.	
		ii	(a) $0.9 \times 0.8 \times 0.1$	M1	alone or allow × 0.8 (ie girls in wrong order)	NOT $0.9 \times 0.8 \times 0.1 \times 0.2 = 0.0144$: MOAO
		ii	$= \frac{9}{125}$ or 0.072	A1	(= 0.0576) **Examiner's Comments** This question was well answered by most candidates. A few misread and thought Jill went first. Others included success for the wrong girl or for both girls.	NOT $0.9 \times 0.8 \times 0.2 = 0.144$: MOAO

Question			Answer/Indicative content	Marks	Part marks and guidance	
		ii	(b) $0.9^{9 \text{ or } 10} \times 0.8^{\text{yorlu}} \times 0.1$ (or × 0.2, not × 0.1 × 0.2)	M1	allow $0.9^{9 \text{ or } 10} \times 0.8^{9 \text{ 0r } 10} \times 0.1 \times {}^{18,19,20}C_1$ If ans = 0.00360 or 0.0150 see SC below	
		ii	$(0.9 \times 0.8)^9 \times 0.1$ oe	M1	fully correct	
		ii	$= 5.2 \times 10^{-3}$ or 0.0052 (2 sf)	A1	SC Consistent use of 0.8 for both girls: **(ii)(a)** 0.128 **(ii)(b)** 0.00360 or 0.9 for both girls: **(ii)(a)** 0.081 **(ii)(b)** 0.0150 If both these ans seen, allow (a) 0 (b) B1 **Examiner's Comments** Many candidates were confused as to how many failures were necessary for each girl. Others included success for the wrong girl or for both girls.	
			Total	13		

Question			Answer/Indicative content	Marks	Part marks and guidance	
4		i	12 × 10 × 5 (in numerators or alone) OR any prod of 3 probs×6(or ×3! or ${}^3P_3$)	M1	or ${}^{12}C_1 \times {}^{10}C_1 \times {}^{5}C_1$ or 600 (in numerators or alone)	or $\frac{4}{117}$ or 0.0342 oe
		i	$\frac{12}{27}\times\frac{10}{26}\times\frac{5}{25}\times 6$ or $\frac{12\times10\times5}{{}^{27}C_3}$	M1	or eg ($\frac{12}{27}\times\frac{10}{26}\times\frac{5}{25}+\frac{12}{27}\times\frac{5}{26}\times\frac{10}{25}$) ☐ 3	Fully correct method
		i	$=\frac{8}{39}$oe or 0.205 (3 sfs)	A1	**Examiner's Comments** Many candidates correctly found $\frac{12}{27}\times\frac{10}{26}\times\frac{5}{25}$ but either failed to multiply by 6 or multiplied by an incorrect number, such as 3 or 4 or 12. Some added the three fractions instead of multiplying. A few added 12, 10 and 5 incorrectly, and so started with a denominator of, eg, 25 instead of 27. Some did the question "with replacement".	Examples: $\frac{12}{27}\times\frac{10}{27}\times\frac{5}{27}\times 6$ or $\frac{12}{25}\times\frac{10}{24}\times\frac{5}{23}$ M1M0A0 or $\frac{1}{27}\times\frac{1}{26}\times\frac{1}{25}\times 6$ M1M0A0
		ii	$0.4\times\frac{x}{50}$ OR $0.6\times\frac{50-x}{50}$ oe or $0.4\times\frac{?}{50}$	M1	0.4 × p OR 0.6 × (1 – p) or similar	$0.4\times\frac{x}{50}$ or etc $0.4\times a$ etc M1
		ii	$0.4\times\frac{x}{50}+0.6\times\frac{50-x}{50}=0.54$	M1	0.4 × p + 0.6 × (1 – p) = 0.54	$0.4\times\frac{x}{50}+0.6\times\frac{y}{50}=0.54$ $0.4a+0.6b=0.54$
		ii	$4x$ = 60 oe, two terms	A1	p = 0.3	AND $x+y=50$ AND $a+b=1$ M1 $4x=60$ or $4y=140$ $a=0.3$ or $b=0.7$ A1

Question			Answer/Indicative content	Marks	Part marks and guidance	
		ii	no. of red = 15 T & I: $0.4 \times \frac{x}{50}$or etc OR one trial ($n \neq 15$) M1 Trial of $n = 15$ M1A1 Answer stated A1	A1	no. of red = 15 Allow $x = 15$ as answer, but not if contradicted later If $x \leftrightarrow (50 - x)$ or $p \leftrightarrow (1 - p)$: similar mks including 1st A1 for $p = 0.7$ or $x = 35$ Correct answer scores full marks unless clearly from incorrect method. __Examiner's Comments__ Many candidates were able to form an algebraic term such as $0.4 \times \frac{x}{50}$ or $\frac{2}{5} \times p$, but most then either equated this term alone to 0.54 or added it to a term such as $0.6 \times \frac{x}{50}$ or $\frac{3}{5} \times p$, using the same letter for both unknowns. Some realised that the second unknown was not the same as the first and wrote, for example, $0.4 \times \frac{x}{50} + 0.6 \times \frac{y}{50} = 0.54$. However, few realised that there was a second simultaneous equation, namely x + y = 50. The better scoring candidates wrote an equation such as A few candidates muddled red and blue, writing a correct equation such as $0.6 \times \frac{x}{50} + 0.4 \times \frac{50-x}{50} = 0.54$	no. of red = 15 no. of red = 15 A1

Question			Answer/Indicative content	Marks	Part marks and guidance	
					and correctly finding x = 35, but then gave their answer as 35 red discs, rather than 15. A few candidates used a trial and improvement method, some with success. Several gave an incorrect answer of 16 red discs, being deceived by the fact that this value does give a probability of 0.54, although only when rounded to 2 significant figures.	
			Total	7		
5			0.6 × 0.3 or 0.6 × 0.1 or 0.3 × 0.1 0.6 × 0.3 + 0.6 × 0.1 + 0.3 × 0.1 oe = 0.27	**M1** (AO3.1a) **M1** (AO1.1) **A1** (AO1.1) [3]	Any correct product seen, oe Fully correct method	**OR M1** $0.6^2 + 0.3^2 + 0.1^2$ (= 0.46) **M1** 0.5 × (1-'0.46')
			Total	3		

Question			Answer/Indicative content	Marks	Part marks and guidance		
6		a	$P(X>39)=P(X=40)$ $=\frac{1}{860}(1+40)$ $=\frac{41}{860}$	M1(AO1.1) A1(AO1.1) [2]	Attempt at evaluating P (X = 40)		
		b	$P(X \text{ even})=\frac{1}{860}(20+(2+4+6+...+40))$ oe $=\frac{1}{860}\left(20+\frac{2+40}{2}\times 20\right)$ $=\frac{22}{43}$ $P(X=2,4,6,8)=\frac{1}{860}(4+2+4+6+8)$ $=\frac{12}{430}$ oe $\frac{P(X=2,4,6,8 \text{ and } X \text{ even})}{P(X \text{ even})}=\frac{P(X=2,4,6,8)}{P(X \text{ even})}$ $=\frac{12}{430}\div\frac{22}{43}=\frac{3}{55}$ oe or 0.0545 (3 s.f.)	M1(AO3.1a) A1(AO1.1) A1(AO1.1) M1(AO1.1) A1(AO3.2a) B1(AO2.1) [6]	Attempt Σ probabilities of all even values Correct expression Attempt Σ probabilities for X = 2, 4,6,8 $\frac{\text{their } P(X=2,4,6,8)}{\text{their } P(X \text{ even})}$ For a clear solution allowing the line of reasoning to be followed, with each component of the conditional probability found clearly	Numerical sums may be evaluated BC throughout	
			Total	8			

Question			Answer/Indicative content	Marks	Part marks and guidance
7		a	$\frac{3}{8}+\frac{5}{16}+4p+p=1$ $p=\frac{1}{16}$ or 0.0625	M1 (AO1.1a) A1 (AO1.1) [2]	oe eg $5p=1-(\frac{3}{8}+\frac{5}{16})$ **Examiner's Comments** Most candidates answered this question correctly. A few tried to use Σxp instead of Σp.
		b	$\frac{3}{8}\times\frac{5}{8}$ or $\frac{3}{8}\times\frac{3}{8}$ seen oe $\frac{3}{8}\times\frac{5}{8}+\frac{5}{8}\times\frac{3}{8}+\frac{3}{8}\times\frac{3}{8}$ oe $=\frac{39}{64}$ or 0.609 (3 sf))	M1 (AO1.1a) M1 (AO2.1) A1 (AO1.1) [3]	or eg $\frac{3}{8}\times\frac{5}{16}+\frac{3}{8}\times\frac{4}{16}+\frac{3}{8}\times\frac{1}{16}$ ft their p or $1-(\frac{5}{16}+\frac{1}{4}+\frac{1}{16})^2$ M2 ft their p or Allow0.61 $1-(\frac{5}{8})^2$ M2 **Examiner's Comments** Most candidates scored only one mark because they omitted one or two of the three possible routes to obtaining a product of 0.
			Total	5	

Question			Answer/Indicative content	Marks	Part marks and guidance	
8		a	$a(1+\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+\frac{1}{16})=1$ soi $a=\frac{16}{31}$	M1 (AO 3.1a) A1 (AO 1.1) [2]	or $\frac{16}{31}(1+\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+\frac{1}{16})=1$ oe seen correctly obtained **Examiner's Comments** This question was well answered on the whole, although a few candidates used the probabilities in the table, just finding $1-(\frac{8}{31}+\frac{4}{31}+\frac{2}{31}+\frac{1}{31})$.	
		b	$P(X=1, 3 \text{ or } 5)=\frac{21}{31}$ or 0.677 or 0.68 (2 sf)	B1 (AO 1.1a) [1]	**Examiner's Comments** This question was well answered.	

Question			Answer/Indicative content	Marks	Part marks and guidance		
		c	P(sum odd) = P(OE) + P(EO) $= 2 \times \frac{21}{31} \times (1 - \frac{21}{31})$ $= \frac{420}{961}$ or 0.437 or 0.44 (2 sf)	M1 (AO 2.1) A1 (AO 1.1) [2]	or correct "long" method	Allow without "2 ×"	
					Examiner's Comments Some candidates did not see that their answer to part (b) could be used, and started from scratch using the probabilities in the table. Many of these omitted at least one possible pair, and others included all possible pairs, but omitted to double their answer. A few candidates ignored the probabilities (and their answer to part (b)) and assumed the each value of *X* is equally likely.		

Question			Answer/Indicative content	Marks	Part marks and guidance	
		d	P(Sum > 8 & odd) = P(Sum = 9) = P(4, 5) + P(5, 4) $= \frac{2}{31} \times \frac{1}{31} + \frac{1}{31} \times \frac{2}{31} (= \frac{4}{961})$ $\frac{\text{P(Sum} > 8 \text{ \& odd)}}{P\text{(Sum odd)}}$ $= '\frac{4}{961}' \div '\frac{420}{961}'$ $= \frac{1}{105}$ or 0.00952 or 0.0095 (2 sf)	M1 (AO 1.1a) M1 (AO 2.4) A1 (AO 1.1) [3]	or P(> 8) × P(O | > 8) $= \frac{5}{961} \times \frac{4}{5}$ Attempt ft their (c) and their P(Sum > 8 & odd) cao NB $\frac{2}{961} \div \frac{210}{961} = \frac{1}{105}$ M0M1A0 **Examiner's Comments** Most candidates recognised the need to find P(S = 9), but some omitted to include both 4, 5 and 5, 4 . Many then correctly divided by their answer to part (d).	Correct method Attempt	
		e	$S_\infty = \frac{p}{1-0.5} = 1$ P(X = 1) = 0.5	M1 (AO 3.4) A1 (AO 3.4) [2]	Correct ans, no working M1A1 **Examiner's Comments** Some candidates recognised the need for an infinite series, but most could not cope with the fact that the first term is unknown. Many candidates thought that Y cannot be 0, hence P(Y = 0) = 0 and hence P(Y = 1) = 0.5 – 0 = 0		

Question			Answer/Indicative content	Marks	Part marks and guidance	
		f	Eg *Y*. (*Y* takes all values, but) *X* cannot be > 5 Eg *X* because > 5 is very unlikely	**B1 (AO 3.5b)** **[1]**	oe, eg *Y*. It may take more than 5 attempts or "limited no." oe instead of 5 <u>Examiner's Comments</u> A choice of either *X* or *Y* with a reasonable justification was acceptable. Some candidates felt that it was unrealistic for Sheila to go on trying after five attempts, so *X* is the better model. Others said that she might well need more than five attempts so *Y* is the better model. One ingenious answer was that *X* is better, because it gives a higher chance of the car starting first time! Unfortunately, this answer did not deal with the question as to which model is more <u>appropriate</u>. A common incorrect response was that *Y* is a good model because according to *Y* the probability that the car starts decreases, rather than increases, with each attempt. Others stated that *Y* is <u>not</u> a good model, quoting exactly the same reason. Some answers did not include a choice of either *X* or *Y*. Another answer was that model *Y* implies that the car never starts. Many answers	

Question			Answer/Indicative content	Marks	Part marks and guidance	
					seemed to imply that using model *X*, the probabilities do not decrease.	
			Total	11		
9		a	$\frac{3}{5}$	B1 (AO1.1) [1]		
		b	$\frac{3}{5}\times\frac{2}{4}$ $=\frac{3}{10}$	M1 (AO1.1a) A1 (AO1.1) [2]	or $\frac{3}{5}\times(\frac{2}{4}\times\frac{2}{3}\times\frac{1}{2}\times 3)$ or $\frac{3}{5}\times\frac{{}^2C_2\times{}^2C_1}{{}^4C_3}$	
		c	BBB, BBWB $\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}+\frac{3}{5}\times\frac{2}{4}\times\frac{2}{3}\times\frac{1}{2}$ $=\frac{1}{5}$ oe	M1 (AO3.1b) M1 (AO2.1) M1 (AO1.1a) A1 (AO1.1) [4]	With no extras M1 for each correct product of probs or $\frac{2}{\frac{5!}{3!2!}}$	
			Total	7		

Question			Answer/Indicative content	Marks	Part marks and guidance		
10		a	Attempt to represent information e.g. by Venn diagram with *x* in centre and 3 other correct values in terms of *x* Attempt total (in terms of *x*) = 30 $x = 4$ so $n(S \cap H \cap T) = 4$	B1(AO3.3) M1(AO3.4) E1(AO1.1) [3]	Any equivalent method Or the number doing all three is 4. **E0** for just $x = 4$	**OR** **B1** $\frac{18}{30}+\frac{19}{30}+\frac{17}{30}-\left(\frac{8}{30}+\frac{9}{30}+\frac{11}{30}\right)\left(=\frac{26}{30}\right)$ **M1** $1-\text{"}\frac{26}{30}\text{"}\left(=\frac{4}{30}\right)$	
		b	$\frac{5}{9}$ oe	B1FT(AO2.2a) [1]	FT their (a)		
		c	$\frac{5}{9}\times\frac{19}{29}$ $\frac{4}{9}\times\frac{18}{29}$ $\frac{5}{9}\times\frac{19}{29}+\frac{4}{9}\times\frac{18}{29}$ $=\frac{167}{261}$ oe or 0.640 (3 s.f.)	B1(AO2.2a) B1(AO2.2a) M1(AO2.2a) A1(AO1.1) [4]	All correct		
			Total	8			

Question			Answer/Indicative content	Marks	Part marks and guidance	
11		a	$\frac{3}{5}\times\frac{1}{2}$ or $\frac{2}{5}\times\frac{3}{4}$	M1(AO1.1)	or $\frac{3}{5}\times\frac{1}{2}\times 2$ or $\frac{2}{5}\times\frac{3}{4}\times 2$	
			$\frac{3}{5}\times\frac{1}{2}+\frac{2}{5}\times\frac{3}{4}$	A1(AO1.1)	Must see this step	
			$(=\frac{3}{5}$ AG)	[2]		
		b	$\left(\frac{3}{5}\right)^2+\left(\frac{3}{10}\right)^2+\left(\frac{1}{10}\right)^2$	M1(AO1.1a)		
			$=\frac{23}{50}$ or 0.46	A1(AO1.1)		
				[2]		
			Total	4		