<table>
<thead>
<tr>
<th>Code</th>
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<tr>
<td>M</td>
<td>Method mark</td>
</tr>
<tr>
<td>A</td>
<td>Accuracy mark</td>
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<tr>
<td>B</td>
<td>Working mark</td>
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<tr>
<td>cao</td>
<td>Correct answer only</td>
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<tr>
<td>oe</td>
<td>Or equivalent</td>
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<tr>
<td>ft</td>
<td>Follow through</td>
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<tr>
<td>Question</td>
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<tr>
<td>1 a</td>
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<td><strong>4 a</strong></td>
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<tr>
<td>b i</td>
<td>P(Anna, Chloe)+ P(Anna, Clara) + P(Chloe, Clara)</td>
</tr>
<tr>
<td>b ii</td>
<td>P(Ben, Ciaran) + P(Ben, Daniel) + P(Ciaran, Daniel)</td>
</tr>
<tr>
<td>b iii</td>
<td>P(Chloe, Clara) + P(Chloe, Ciaran) + P(Clara, Ciaran)</td>
</tr>
<tr>
<td>b iv</td>
<td>1 - ( \frac{3}{15} = \frac{12}{15} = \frac{4}{5} )</td>
</tr>
<tr>
<td>c i</td>
<td>Mutually exclusive as cannot select the same person twice.</td>
</tr>
<tr>
<td>c ii</td>
<td>Mutually exclusive as ‘two men’ cannot include a man and a women, and vice versa.</td>
</tr>
<tr>
<td>c iii</td>
<td>Mutually exclusive as no two men have the same initial.</td>
</tr>
<tr>
<td>M</td>
<td>3</td>
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<tr>
<td>A1</td>
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<td>A1</td>
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<td>M1</td>
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<tr>
<td>B1</td>
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<tr>
<td>iv</td>
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</tbody>
</table>
|---|---
| d | P(exhaustive outcomes) = 1  
P(same sex) + P (not the same sex) =  
P(F, F) + P(M, M) + P(M, F) = 1  
**OR**  
P(two women) = P(A, Ch) + P(A, Cl)  
+P(Ch, Cl) = $\frac{3}{15}$  
P(two men) = P(B, Ci) + P(C, D) + P(Cl, D)  
= $\frac{3}{15}$  
P(opposite sex) = P(A, B) + P(A, Ci) +  
P(A, D) + P(B, Ch) + P(B, Cl) + P(Ch, Ci) +  
P(Ch, D) + P(Cl, Ci) + P(Cl, D) = $\frac{9}{15}$  
$\frac{3}{15} + \frac{3}{15} + \frac{9}{15} = \frac{15}{15}$  

**Not** mutually exclusive as there are possible combinations where two women have the same initial, such as Chloe and Clara.  
Picking two people of the same sex and picking two people of opposite sex.  
This is mutually exclusive and mutually exhaustive because the total probabilities add up to 1.  

| B1 |  
|---|---
| B1 | B1 for mutually exclusive with correct explanation oe  
M1 | B1 for mutually exclusive with correct explanation oe  
M1 | M1 for full demonstration of exhaustive outcomes to support argument oe  

B1 |  
|---|---
| B1 |  
| M1 |  

13
Probabilities on all the branches at each split must sum to 1 because they are mutually exhaustive and exclusive (an outcome happens or another outcome happens until all possible outcomes are accounted for).

The probabilities at each stage may have the same denominator if they are independent (with replacement) or the denominator may change if they are dependent (without replacement). Final probabilities must sum to 1 because all possible outcomes have been considered.

The probabilities on all the branches at each split must sum to 1 because they are exhaustive and must describe all possible outcomes for that event.

Denominators for the same event at different stages will be different if the question specifies 'without replacement', for example, when choosing counters without replacement, there are fewer counters to choose from after each choice.

Check each set of branches sum to 1. Check whether choices are made with or without replacement. Make sure you know when to add \( P(A) \) and \( P(B) \) and when to multiply. Check that sum of the final probabilities after multiplication along the branches is 1.

\[
P(\text{rain, not rain}) + P(\text{not rain, rain}) = 0.25 \times 0.52 + 0.75 \times 0.48 = 0.49
\]

<table>
<thead>
<tr>
<th>5</th>
<th>a</th>
<th>B3</th>
<th>2 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td></td>
<td>B1</td>
<td></td>
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<tr>
<td>c</td>
<td></td>
<td>B1</td>
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<tr>
<td>d</td>
<td></td>
<td>B1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>M1</td>
<td></td>
</tr>
</tbody>
</table>

M1 for multiplication of rain and complement

A1 for clear, complete explanation

B1 for clear explanation of dependent events

B1 for clear explanation of exhaustive events

B1 for at least three checks that include final probabilities sum to 1 oe

M for explanation that includes mutually exclusive events

B1 for explanation that includes independent events

A1 for clear, complete explanation

M for multiplication of rain and complement
He can expect to win one in 36 times so should expect to have 36 goes to win at least once.

If he has 100 goes, then he can expect 3 wins.

\[
P(1, 1) = \frac{1}{36}
\]

\[
100 \div 36 = 2.7
\]

\[
P(B, B) = \frac{2}{3} \times \frac{2}{3} = \frac{4}{9}
\]

\[
P(R, B) = 1 - (P(B, B) + P(R, R)) = 1 - \left(\frac{4}{9} + \frac{1}{9}\right)
\]

\[
= \frac{4}{9}
\]

as required.
We want $g^2 = gy \times gy$

If you assume any value where $g = 2y$ then

$g^2 = (2y)^2 = 4y^2$

$gy \times gy = 2y^2 \times 2y^2 = 4y^2$

So the probabilities will be the same, as required.

No, the probabilities are not the same because:

$P(Y, Y) = \frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$

$P(G, G) = \frac{3}{4} \times \frac{3}{4} = \frac{9}{16}$

$P(Y, G) = 1 - (P(Y, Y) + P(G, G))$

$= 1 - \frac{10}{16} = \frac{6}{16} = \frac{3}{8}$

So the probability of scoring green twice is not the same as the probability of scoring yellow and green in this case.

Any spinner with twice as many greens as yellows, such as one divided into six equal sections, with two yellow and four greens in any position.

$P(Y) = \frac{2}{6}$; $P(Y, Y) = \frac{4}{36}$

$P(G) = \frac{4}{6}$; $P(G, G) = \frac{16}{36}$

$P(Y, G) = 1 - P(Y, Y) + P(G, G)$

$= 1 - \frac{20}{36} = \frac{16}{36}$

So $P(G, G) = P(Y, G)$
9 a

<table>
<thead>
<tr>
<th>b</th>
<th>P(P, P) = 0.4 \times 0.5 = 0.2</th>
<th>0.2</th>
<th>M1</th>
<th>3</th>
<th>M1 for correct construction of probability tree diagram A1 for probabilities and events identified clearly</th>
<th>M</th>
</tr>
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10

| P(6, 7 or 8) = \frac{12}{52} \times \frac{11}{51} | 0.050 | M1 | 2 | M1 for multiplication showing probabilities for two draws without replacement A1 cao | M |
|---|---|---|---|---|---|---|

11

| P(land on 1) = P(1, 2, 3 or 4) | \frac{4}{6} = \frac{2}{3} | M1 | 2 | M1 for multiplications to calculate P(1) and P(\text{\textendash}1) | M |
|---|---|---|---|---|---|---|

| P(land on –1) = P(5 or 6) | \frac{2}{6} = \frac{1}{3} | A1 |  | A1 for explanation that there are twice as many chances oe OR A1 for communicating that one probability is twice the other oe | |
|---|---|---|---|---|---|---|

Since \frac{2}{3} = 2 \times \frac{1}{3}, the counter is twice as likely to land on 1 as –1.

OR

There are twice as many possibilities for the dice to land on 1, 2, 3 or 4 than on 5 or 6 with a fair die.
12

\[ P(A \text{ and } B) = P(A) \times P(B) \text{ NOT } P(A) + P(B) \]

or

\[ P(A) \times P(B) \text{ means } P(A) \text{ and } P(B) \]

\[ P(A) + P(B) \text{ means } P(A) \text{ or } P(B) \]

\[
\begin{align*}
P(S) &= \frac{1}{6} \\
P(H) &= \frac{1}{2} \\
\text{P(5 and H)} &= \frac{1}{6} \times \frac{1}{2} = \frac{1}{12} \\
\text{P(5 or H)} &= \frac{1}{6} + \frac{1}{2} = \frac{2}{12} + \frac{6}{12} \\
&= \frac{8}{12} \\
\frac{1}{12} &\neq \frac{8}{12}
\end{align*}
\]

13

\[ P(\text{pass, pass}) = 0.9 \times 0.6 = 0.54 \]

The probability that she passes both parts on the first attempt is 0.54.

\[
\text{M1 } \quad \text{A1}
\]

M1 for use of probability notation
A1 for explanation that shows an understanding of the difference between ‘and’ and ‘or’
A1 for further explanation, example oe

M

\[
\text{M1 for correct construction of probability tree diagram } \quad \text{A1 for probabilities and events identified clearly}
\]

M

A1 cao
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Score</th>
<th>Mark Scheme</th>
<th></th>
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</table>
| 14 a | \( P(\text{late}) = 0.08 \)  
\( P(\text{not late}) = 0.92 \)  
\( P(\text{early}) = 0.02 \)  
\( P(\text{not early}) = 0.98 \)  
\( P(\text{raining}) = 0.3 \)  
\( P(\text{not raining}) = 0.7 \)  
\( P(\text{on time}) = 1 - P(\text{late}) - P(\text{early}) \)  
\( = 1 - 0.08 - 0.02 \)  
\( = 0.9 \)  
\( P(\text{on time, not raining}) = 0.9 \times 0.7 = 0.63 \) | B1    | 2   | B1 for correct multiplication for three different events oe | M |
| b | \( P(\text{raining}, \text{raining}, \text{raining}) = 0.3^3 \)  
\( = 0.027 \) | B1    |       | B1 for correct multiplication for three same events oe |   |
| c | \( P(\text{not late five days in a row}) = 0.92^5 \)  
\( = 0.6591 \) | B1    |       | B1 for correct multiplication for five same complement events oe |   |
| 15 | Let the number of students in the class be \( x \).  
Number who solve problem 1 = 0.5\( x \)  
Number who solve problem 2 = 0.8\( x \)  
So \( x \) is the two added together less 12 as this has been counted twice  
\( x = 0.8x + 0.5x = 12 \)  
\( x = 1.3x - 12 \)  
\( 12 = 0.3x \)  
\( x = 40 \)  
or  
\( 80\% + 50\% = 130\% \)  
so 12 represents the overcount by 30\%.  
\( \frac{30}{100}x = 12 \)  
\( x = 40 \)  
The number of students who took the exam is 40. | M1    | 2   | M1 for either solving the linear equation or calculating, using the percentages from the Venn diagram | H |
<p>|   |                                                                 | A1    |       | A1 for explanation as to why 12 is subtracted (or we have 30% too much) |   |
|   |                                                                 | A1    |       | A1 cao |   |</p>
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<tr>
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<th>Question</th>
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<th>Scheme</th>
<th>Marks</th>
<th>Comments</th>
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|   | 16 a     | \( x = 0.7x + 30 - 0.3x \)  
\( x - 0.7x + 0.3x = 30 \)  
\( 0.6x = 30 \)  
\( x = 50 \) | [Diagram of overlapping circles labeled Brown hair and Glasses with values 0.4x, 0.3x, 30] | M1 | 3 | M1 for equation set up |
|   | b        | Own problem | A1 B1 B1 | 4 | A1 cao  
B1 for clear, organised problem  
B1 for relevant mark scheme |
|   | 17       | You cannot use a sample space diagram because it is a two-way diagram, it is two-dimensional (horizontal and vertical) and it is impossible to draw the third and fourth dimensions. Also a probability tree diagram would be very complex. | B1 B1 | 3 | B1 for explanation of the fact that a two-way table describes two events only  
B1 for comment on the complexity or impracticality of a tree diagram |

**Diagram:**
- Overlapping circles labeled Brown hair and Glasses with values 0.4x, 0.3x, 30
- \( x = 50 \)
| 18 a | Example of a problem that can be solved by adding probabilities. | B1 | 3 | B1 for clearly structured question, for example: E.g. A bag contains 3 red, 2 yellow and 4 blue counters. One is drawn and replaced. A second is drawn. What is the probability of a red first or a blue first? 

\[ P(R \text{ first}) + P(B \text{ first}) = \frac{3}{9} + \frac{4}{9} = \frac{7}{9} \] |
| b | Example of a problem that can be solved by multiplying probabilities. | B1 | | |
| c | Example of a problem that involves both adding and multiplying probabilities. | B1 | | |
|   | | | B1 for clearly structured question, for example: What is the probability of drawing two yellows, replacing the counter each time? 

\[ P(YY) = P(Y) \times P(Y) = \frac{2}{9} \times \frac{2}{9} = \frac{4}{81} \] |
|   | | | B1 for clearly structured question, for example: What is the probability of drawing two counters the same colour, replacing the counter each time? 

\[ P(Y, Y) + P(B, B) + P(R, R) = \left( \frac{2}{9} \times \frac{2}{9} \right) + \left( \frac{4}{9} \times \frac{4}{9} \right) + \left( \frac{3}{9} \times \frac{3}{9} \right) = \frac{29}{81} \] |
19 a \[ \frac{3}{10} \times \frac{2}{9} \times \frac{1}{8} = \frac{1}{120} \]

b \[ \frac{3}{10} \times \frac{2}{9} \times \frac{1}{8} = \frac{1}{120} \]

c The number of ‘plays’ in a year is \( 45 \times 50 = 2250 \). The income is \( 2250 \times 20p = £450 \).
The probability of a win on each play is \( \frac{1}{120} \).
The expected number of wins is \( \frac{1}{120} \times 2250 = 18.75 \)

\( = 19 \) (nearest whole number)
The expected pay-out is \( 19 \times £5 = £95 \)
The expected profit in one year is £450 – £95 = £355

\[
P(\text{win}) = \frac{1}{120}
\]

He is incorrect; every set of three numbers has the same chance of being chosen.

\[
\] 

M1 2

M1 for multiplication of three probabilities without replacement

A1

A1 for explanation that all numbers have the same chance of being drawn

M1

M1 for multiplication \( 45 \times 50 \) oe

M1

M1 for multiplication \( 2250 \times 20p \) oe

M1

M1 for \( \frac{1}{120} \times 2250 \) oe

M1

M1 for \( 19 \times 5 \) oe

M1

£355

A1

A1 £450 – £95 (ft)

20 It will help to show all nine possible outcomes and which ones give two socks of the same colour. Then the probabilities on the branches can be used to work out the chance of each outcome.

B1 2

B1 for clear explanation that shows awareness of nine possible outcomes (3 possible colours and then a further choice of 3), together with a comment about the diagram finding all possible combinations

B1

B1 for use of technical notation and possible use of a probability tree diagram to aid explanation

H

21 He forgot there were now only 49 cards left in the pack. The probability of being dealt the final ace is \( \frac{1}{49} \).

B1 2

B1 for comment that shows understanding that the cards had not been replaced, leaving the final ace to be chosen from 49 cards, not 52

H
### Question 22

P(picture card) = \( \frac{16}{52} \)

\[
P(\text{four in a row}) = \frac{16}{52} \times \frac{15}{51} \times \frac{14}{50} \times \frac{13}{49}
\]

= \( \frac{4}{595} \)

= 0.0067...

**M1**

A1

2

**H**

### Question 23

Work out P(Y), P(G) and P(O).

Then P(Y) \( \times \) P(yellow second), remembering both the numerator and denominator will be 1 less.

Then P(G) \( \times \) P(green second), remembering both the numerator and denominator will be 1 less. Then P(O) \( \times \) P(orange second), remembering both the numerator and denominator will be 1 less. Then add together these three probabilities.

She is most likely to forget to reduce the denominator by one for the second jelly baby.

**B1**

2

3

**B1** for stating the need to find the probabilities of each first
de

**B1** for reminding about the change in numerator and denominator
de

**B1** for final addition of probabilities oe

**B1** for example or relevant diagram

**H**

### Question 24

Work out the probability that no two friends choose the same random number.

P(no match) = \( \frac{8}{9} \times \frac{7}{9} \times \frac{6}{9} \times \frac{5}{9} \)

= \( \frac{6561}{9} \)

= \( \frac{560}{2187} \)

P(match) = 1 – P(no match)

So P(match) = \( \frac{1 - \frac{560}{2187}}{2187} \)

= \( \frac{0.743 941 472 3}{2187} \)

= 0.74

**M1**

3

**M1** for multiplication \( \frac{16}{52} \times \frac{15}{51} \times \frac{14}{50} \times \frac{13}{49} \)

**H**

**M1** for (1 – probability of no match)

**A1**

3

**A1** for rounding and ft
### 25

**a** Probability that they don’t have their birthday on the same day is:

\[
\frac{364 \times 363 \times 362 \ldots (365 - 24)}{365^{25}}
\]

Probability that they do is:

\[
1 - \frac{364 \times 363 \times 362 \ldots (365 - 24)}{365^{25}}
\]

**b** Alison is incorrect, a choice of \( \frac{25}{365} \) would only give you the probability of choosing 25 days from the year and they would not be the same day.

### 26

**a**

Assumptions made in order to start the question:

- All letters are equally likely to be initial letters.
- All 10 people are using the same alphabet for naming.

**b**

Probability that they don’t is:

\[
\frac{25 \times 24 \times 23 \ldots \ldots (26 - 9)}{26^{10}}
\]  

= 0.005 25

Probability that they do is:

\[
1 - \frac{25 \times 24 \times 23 \ldots \ldots (17)}{26^{10}}
\]  

= 0.994 75

0.994 75