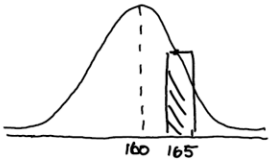
S1 Mock 2025 MS

1 It is known that, on average, 2 people in 5 in a certain country are overweight. A random sample of 400 people is chosen. Using a suitable approximation, find the probability that fewer than 165 people in the sample are overweight. [5]

$P(ow) = 0.4 \quad n = 400 \quad X \sim N(160, 96)$

$P(X < 165) = P\left(z < \frac{164.5 - 160}{\sqrt{96}}\right)$



$= P(z < 0.459)$
$= 0.6768$
$= 0.677 \quad$ to 3 s.f.

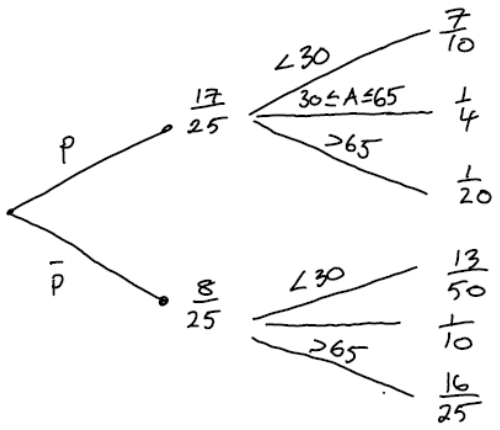
1 $\mu = 160$, $\sigma^2 = 96$	**B1**	For 160 and 96 seen or implied by 9.798
$P(\leq 165) = \Phi\left(\frac{164.5-160}{\sqrt{96}}\right) = \Phi(0.4593)$	**M1**	For standardising, must have square root
	M1	For continuity correction, either 165.5 or 164.5
	M1	For using tables and finding correct area (i.e.> 0.5)
$= 0.677$	**A1** **[5]**	For correct answer

3 It was found that 68% of the passengers on a train used a cell phone during their train journey. Of those using a cell phone, 70% were under 30 years old, 25% were between 30 and 65 years old and the rest were over 65 years old. Of those not using a cell phone, 26% were under 30 years old and 64% were over 65 years old.

(i) Draw a tree diagram to represent this information, giving all probabilities as decimals. [2]

(ii) Given that one of the passengers is 45 years old, find the probability of this passenger using a cell phone during the journey. [3]

i)

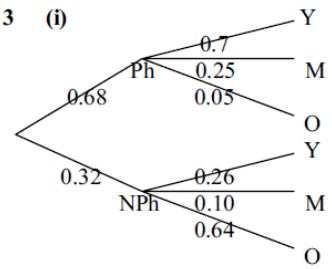


ii)

$$P(P \mid 45 \text{ years old}) = \frac{P(P \cap 45)}{P(45)}$$

$$= \frac{\frac{17}{25} \times \frac{1}{4}}{\frac{17}{25} \times \frac{1}{4} + \frac{8}{25} \times \frac{1}{10}}$$

$$= \frac{85}{101} = 0.84158$$

3 **(i)** 		Y = young, M = middle-aged, O = old
	M1	Correct shape with Ph, NPh first
	A1 [2]	All probabilities and correct
(ii) $P(\text{Ph} \mid \text{M}) = \frac{0.68 \times 0.25}{0.68 \times 0.25 + 0.32 \times 0.1}$	B1	For correct numerator using cond prob formula with numerator < denominator
	M1	For attempt at P(35 – 60 years old), involving the sum of two 2-factor probs, seen anywhere
= 0.842 (170/202)	A1 [3]	Correct answer

2 The random variable X is the daily profit, in thousands of dollars, made by a company. X is normally distributed with mean 6.4 and standard deviation 5.2.

(i) Find the probability that, on a randomly chosen day, the company makes a profit between \$10 000 and \$12 000. [3]

(ii) Find the probability that the company makes a loss on exactly 1 of the next 4 consecutive days. [4]

$X \sim N(6.4, 5.2^2)$

i) $P(10 < X < 12) = \left(\frac{10-6.4}{5.2} < z < \frac{12-6.4}{5.2} \right)$

$= \Phi(1.077) - \Phi(0.692)$
$= 0.8593 - 0.7556$
$= 0.1037$
$= 0.104$ to 3 s.f.

ii) $P(X < 0) = P\left(z < \frac{0-6.4}{5.2} \right)$

$= P(z < -1.231)$
$= 1 - \Phi(1.231)$
$= 1 - 0.8909$
$= 0.1091$
$= 0.109$ to 3s.f.

$Y \sim B(4, 0.1091)$

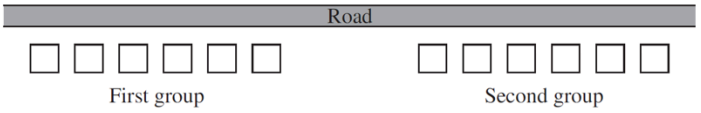
$P(Y = 1) = 4(0.8909)^3(0.1091)$
$= 0.30858...$
$= 0.309$ to 3 s.f.

2	**(i)** $z_1 = \frac{12-6.4}{5.2} = 1.077$	M1		Standardising, can be all in thousands, no mix, no cc no sq rt no sq
	$z_2 = \frac{10-6.4}{5.2} = 0.692$	M1		$\Phi_2 - \Phi_1$, Φ_2 must be $> \Phi_1$
	$\Phi(z_1) - \Phi(z_2) = 0.8593 - 0.7556$ $= 0.104$	A1	[3]	Correct answer
	(ii) P(loss) $= P(z < \frac{0-6.4}{5.2}) = P(z < -1.231)$ $= 1 - 0.8909$	M1		Standardising using $x = 0$, accept $\frac{0.5-6.4}{5.2}$
	$= 0.109$	A1		Correct prob
	P(1) $= (0.1091)^1(0.8909)^3 \times 4C1$	M1		Binomial term ${}_4C_x p^x(1-p)^{4-x}$ any p $x \neq 0$
	$= 0.309$ or 0.308	A1	[4]	Correct answer

4 A builder is planning to build 12 houses along one side of a road. He will build 2 houses in style A, 2 houses in style B, 3 houses in style C, 4 houses in style D and 1 house in style E.

(i) Find the number of possible arrangements of these 12 houses. [2]

(ii)



The 12 houses will be in two groups of 6 (see diagram). Find the number of possible arrangements if all the houses in styles A and D are in the first group and all the houses in styles B, C and E are in the second group. [3]

(iii) Four of the 12 houses will be selected for a survey. Exactly one house must be in style B and exactly one house in style C. Find the number of ways in which these four houses can be selected. [2]

i) Arrangements = $\frac{12!}{2!2!3!4!}$ = 831600

ii) First group = $\frac{6!}{2!4!}$

Second group = $\frac{6!}{3!2!}$

Total arrangements = 900

iii) B C _ _

$2 \times 3 \times {}_7C_2 = 126$

4 **(i)**	$\frac{12!}{2!2!3!4!} = 831600$	M1 A1 **[2]**	Dividing by 3! 4! and 2! once or twice o.e Correct final answer
(ii)	$\frac{6!}{4!2!} \times \frac{6!}{2!3!}$	B1	$\frac{6!}{4!2!}$ and $\frac{6!}{2!3!}$ seen o.e
		M1	multiplying their numbers for group 1 with their numbers for group 2
	= 900	A1 **[3]**	correct final answer
(iii)	$2 \times 3 \times {}_7C_2$ or $2 \times 3 \times 21$	M1	${}_7C_2$ seen multiplied or 5 options added
	= 126	A1 **[2]**	correct final answer

3 The mean and standard deviation of 20 values of x are 60 and 4 respectively.

(i) Find the values of Σx and Σx^2. [3]

Another 10 values of x are such that their sum is 550 and the sum of their squares is 40 500.

(ii) Find the mean and standard deviation of all these 30 values of x. [4]

$n = 20 \qquad \bar{x} = 60 \qquad \sigma = 4$

$\sigma = \sqrt{\frac{\Sigma x^2}{n} - \bar{x}^2}$

$16 = \frac{\Sigma x^2}{20} - 60^2$

$\Sigma x^2 = 72320$

$\Sigma x = 60 \times 20$

$= 1200$

$n = 30 \qquad \Sigma x = 550 \qquad \Sigma x^2 = 40500$

$\text{Mean} = \frac{550+1200}{30}$

$= \frac{175}{3}$

$= 58.33\ldots$

$= 58.3$ to 3 s.f.

$\sigma^2 = \frac{72320+40500}{30} - \left(\frac{175}{3}\right)^2$

$\sigma = 18.917\ldots$

$= 18.9$ to 3 s.f.

Question	Answer	Marks	Guidance
3(i)	$\Sigma x = 60 \times 20 \qquad = 1200$	**B1**	
	$\frac{\Sigma x^2}{20} - 60^2 = 4^2$	**M1**	Correct variance formula used, condone = 4
	$\Sigma x^2 = 3616 \times 20 \qquad = 72320$	**A1**	Exact value
		3	

3(ii)	$\Sigma x = 1200 + 550 = 1750$ $\Sigma x^2 = 72320 + 40500 = 112800$	**M1**	Summing both values of Σx and Σx^2
	Mean $= \frac{\textit{their}\,1750}{30} = 58.3$	**B1FT**	FT *their* 1750 (not 550 or 1200)/*their*(20+10), accept unsimplified
	Variance $= \frac{\textit{their}\,112820}{30} - \left(\frac{\textit{their}\,1750}{30}\right)^2 \quad (= 357.89)$	**M1**	substitute *their* Σx and Σx^2 into correct variance formula
	s.d. = 18.9	**A1**	
		4	

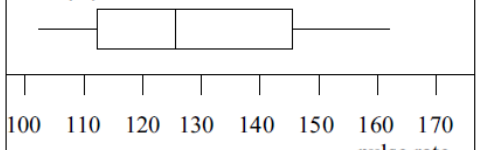
5 The pulse rates, in beats per minute, of a random sample of 15 small animals are shown in the following table.

115	120	158	132	125
104	142	160	145	104
162	117	109	124	134

(i) Draw a stem-and-leaf diagram to represent the data. [3]

(ii) Find the median and the quartiles. [2]

(iii) On graph paper, using a scale of 2 cm to represent 10 beats per minute, draw a box-and-whisker plot of the data. [3]

5 (i)	10 | 4 4 9 11 | 5 7 12 | 0 4 5 13 | 2 4 14 | 2 5 15 | 8 16 | 0 8 key 10 | 4 represents 104	B1 B1 B1 **[3]**	Correct stem Correct leaves, must be sorted and in columns and give correct overall shape Key, must have vertical line in both
(ii)	median = 125 LQ = 115 UQ = 145	B1 B1 **[2]**	Any 2 correct values seen third correct value
(iii)	 	B1 B1ft B1 **[3]**	correct uniform scale from at least 110 to 160 with room for end points, and label or title correct median and quartiles on diagram ft their values (must be box ends) correct whiskers, no line through box, touching box in the middle not the top or bottom

7 A box contains 2 green apples and 2 red apples. Apples are taken from the box, one at a time, without replacement. When both red apples have been taken, the process stops. The random variable X is the number of apples which have been taken when the process stops.

(i) Show that $P(X = 3) = \frac{1}{3}$. [3]

(ii) Draw up the probability distribution table for X. [3]

Another box contains 2 yellow peppers and 5 orange peppers. Three peppers are taken at random from the box without replacement.

(iii) Given that at least 2 of the peppers taken from the box are orange, find the probability that all 3 peppers are orange. [5]

i) $P(X=3) = 2 \times P(R)P(G)P(R)$
$= 2 \times \frac{2}{4} \times \frac{2}{3} \times \frac{1}{2}$
$= \frac{1}{3}$

ii)

x	2	4	4
$P(x=x)$	$\frac{1}{6}$	$\frac{1}{3}$	$\frac{1}{2}$

iii) $P(\text{3 and 0 at least 2 are orange}) = \frac{P(\text{3 0 and at least 2 are orange})}{P(\text{at least 2})}$

$P(\text{at least 2}) = 1 - P(X=1)$
$= 1 - [3P(Y)P(Y)P(O)]$
$= 1 - \left[3 \times \frac{2}{7} \times \frac{1}{6} \times \frac{5}{5}\right]$
$= \frac{6}{7}$

$= \frac{\frac{5}{7} \times \frac{4}{6} \times \frac{3}{5}}{\frac{6}{7}} = \frac{\frac{2}{7}}{\frac{6}{7}} = \frac{1}{3}$

7 (a) (i)	$P(X=3) = P(GRR) + P(RGR)$ $\frac{2}{4}\times\frac{2}{3}\times\frac{1}{2} + \frac{2}{4}\times\frac{2}{3}\times\frac{1}{2}$ $\frac{1}{3}$ **AG**	M1 M1 A1 **3**	Mult 3 probs Summing 2 options Correct working with appropriate justification and fraction sequencing
(ii)	$P(X=2) = P(RR) = \frac{2}{4}\times\frac{1}{3} = \frac{1}{6}$ $P(X=4) = 1 - \left(\frac{1}{6}+\frac{1}{3}\right) = \frac{1}{2}$ Or P(GGRR) + P(RGGR) + P(GRGR) $= \left(\frac{2}{4}\times\frac{1}{3}\times\frac{2}{2}\times\frac{1}{1}\right)\times 3 = \frac{1}{2}$	B1 B1 B1√ **3**	Values 2, 3, 4 only in table Condone X=0,1 if P(X)=0 stated One correct prob other than (i) Second correct prob ft 1 – their previous 2 probs

X	2	3	4
Prob	$\frac{1}{6}$	$\frac{1}{3}$	$\frac{1}{2}$

(iii) P(3 orange | at least 2 O) = $\frac{P(3O)}{P(at\ least\ 2O)}$			
P(3 orange) = P(OOO)	M1		Atttempt at P(OOO) one three-factor option, not added
$= \frac{5}{7}\times\frac{4}{6}\times\frac{3}{5}=\frac{2}{7}$	A1		Correct unsimplified num of a fraction
P(at least 2O) = P(YOO) + P(OYO) + P(OOY) + $\frac{2}{7}$			
$=\frac{2}{7}\times\frac{5}{6}\times\frac{4}{5}+\frac{5}{7}\times\frac{2}{6}\times\frac{4}{5}+\frac{5}{7}\times\frac{4}{6}\times\frac{2}{5}+\frac{2}{7}$	M1		Attempt at P(at least 2O) sum 3 or 4 three-factor options
$=\frac{6}{7}$	A1		Correct unsimplified answer seen anywhere
P(30 | at least 2O) = $\frac{2}{7}\div\frac{6}{7}=\frac{1}{3}(0.333)$	A1	**5**	Correct answer evaluated
<u>Alternative 1</u>			
3 Orange = ${}^5C_3$	M1		Attempt at combinations for 3 orange oe, not added
	A1		Correct unsimplified num of a fraction
At least 2 Orange = ${}^5C_2\times{}^2C_1+{}^5C_3$	M1		Attempt at combinations for at least 2 orange condone omission of $+{}^5C_3$
	A1		Correct unsimplified answer seen anywhere
P(3O | at least 2O) = $\frac{{}^5C_3}{{}^5C_2\times{}^2C_1+{}^5C_3}=\frac{1}{3}$	A1	**5**	Correct answer evaluated
<u>Alternative 2</u>			
No Yellow = ${}^2C_0$	M1		Attempt at combinations for 0 yellow oe, not added
	A1		Correct unsimplified num of a fraction
No more than 1 Yellow = ${}^2C_1+{}^2C_0$	M1		Attempt at combinations for no more than 1 yellow. Condone omission of +2C0
	A1		Correct unsimplified answer seen anywhere
P(3O | at least 2O) = $\frac{{}^2C_0}{{}^2C_1+{}^2C_0}=\frac{1}{3}$	A1	**5**	Correct answer evaluated
<u>Misread – with replacement</u>			
MR–1 applied to first Accuracy Mark earned	M1		Attempt at P(OOO) one three factor option oe not added
P(3O) = $\frac{5}{7}\times\frac{5}{7}\times\frac{5}{7}=\frac{125}{343}$	A1		Correct unsimplified num of a fraction
P(at least 2O) = $\frac{5}{7}\times\frac{5}{7}\times\frac{2}{7}\times{}^3C_2+\left(\frac{5}{7}\right)^3$	M1		Attempt at P(at least 2O) sum of 3 or 4 three factor options
	A1		Correct unsimplified seen anywhere
P(3O | at least 2O) = $\frac{5}{11}$	A1	**4 max**	Answer evaluated