

# MARK SCHEME

Maximum Mark: 50

Q	Answer / Working	Marks	Guidance
<b>1(a)</b>	Sum of probabilities $= 1 \implies p + q = 1 - 0.15 - 0.2 - 0.1 \implies p + q = 0.55$	<b>M1</b>	Forms first equation.
	$E(X) = 1.75 \implies -0.15 + p + 0.4 + 3q + 0.4 = 1.75 \implies p + 3q = 1.1$	<b>M1</b>	Forms second equation.
	Subtracting equations: $2q = 0.55 \implies q = 0.275$ , so $p = 0.275$	<b>A1</b>	Both correct exact values.
		<b>[3]</b>	
<b>1(b)</b>	$P(X \neq 4) = 1 - 0.1 = 0.9$	<b>M1</b>	Identifies denominator.
	$P(X > 1 \text{ and } X \neq 4) = P(X = 2 \text{ or } 3) = 0.2 + 0.275 = 0.475$ $P(X > 1   X \neq 4) = \frac{0.475}{0.9}$	<b>M1</b>	Uses conditional probability formula.
	$= \frac{19}{36} \approx 0.528$	<b>A1</b>	Accept 0.528 or exact fraction.
		<b>[2]</b>	
<b>2(a)</b>	Correct branches and labels drawn (A then B)	<b>B1</b>	Shape of tree.
	Branches for A: R (5/8), B (3/8). Branches for B given R: R (5/7), B (2/7). Branches for B given B: R (4/7), B (3/7).	<b>B1</b>	All probabilities correct.
			<b>[2]</b>

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2(b)	$P(\text{same}) = P(\text{R, R}) + P(\text{B, B}) = \left(\frac{5}{8} \times \frac{5}{7}\right) + \left(\frac{3}{8} \times \frac{3}{7}\right)$ $= \frac{25}{56} + \frac{9}{56} = \frac{34}{56} = \frac{17}{28} \approx 0.607$	<b>M1</b>	Adds the two successful paths.
		<b>A1</b>	
		<b>[2]</b>	
2(c)	$P(R_B) = \left(\frac{5}{8} \times \frac{5}{7}\right) + \left(\frac{3}{8} \times \frac{4}{7}\right) = \frac{25}{56} + \frac{12}{56} = \frac{37}{56}$	<b>M1</b>	Finds total probability of Red from B.
	$P(B_A \cap R_B) = \frac{12}{56}$	<b>M1</b>	Identifies correct numerator.
	$P(B_A   R_B) = \frac{12/56}{37/56} = \frac{12}{37} \approx 0.324$	<b>A1</b>	
		<b>[3]</b>	
3(a)	$n = 25 \implies$ Median is the 13 <sup>th</sup> value: 21.8 kg  Lower quartile is median of bottom 12: avg of 6 <sup>th</sup> & 7 <sup>th</sup> = $\frac{20.4+20.7}{2} = 20.55$ Upper quartile is median of top 12: avg of 19 <sup>th</sup> & 20 <sup>th</sup> = $\frac{22.5+22.6}{2} = 22.55$  IQR = $22.55 - 20.55 = 2.0$ kg	<b>B1</b>	
		<b>M1</b>	Uses valid method for quartiles. (Accept 20.7 and 22.5 if $n/4$ rounded up method used).
		<b>A1</b>	Allow 1.8 if alternative method used consistently.
		<b>[3]</b>	
3(b)	Correct female extremes: 18.4 and 23.8, with box (19.7, 20.9, 22.4)	<b>B1</b>	Drawn against the provided scale.

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	Correct male extremes: 19.2 and 23.8	<b>B1</b>	
	Correct male box (20.55, 21.8, 22.55)	<b>B1</b>	Follow through on their IQR values.
		<b>[3]</b>	
<b>3(c)</b>	Valid comparison of centre (e.g. "Male dogs are generally heavier, median 21.8 > 20.9") OR spread (e.g. "Female dogs have a wider spread of masses, IQR 2.7 > 2.0")	<b>B1</b>	Must be in context of the data.
		<b>[1]</b>	
<b>4(a)</b>	Number of valid positions for the two T's: (1,5), (2,6), (3,7), (4,8), (5,9) $\implies$ 5 ways	<b>B1</b>	
	Number of ways to arrange the remaining 7 letters (E,E,E,M,O,R,I) = $\frac{7!}{3!}$	<b>M1</b>	Dividing by 3! for repeated E's.
	Total = $5 \times \frac{5040}{6} = 5 \times 840 = 4200$	<b>A1</b>	
		<b>[3]</b>	
<b>4(b)</b>	Treat EEE as one block. Total unrestricted with EEE together: Arrange [EEE], M, O, R, I, T, T $\implies \frac{7!}{2!} = 2520$	<b>M1</b>	
	Arrange with EEE together AND TT together: Arrange [EEE], [TT], M, O, R, I $\implies 6! = 720$	<b>M1</b>	
	EEE together but TT not together = $2520 - 720 = 1800$	<b>M1</b>	Subtracts restricted from total.
	Total arrangements of METEORITE = $\frac{9!}{3!2!} = 30240$	<b>A1</b>	
	Probability = $\frac{1800}{30240} = \frac{5}{84} \approx 0.0595$		
		<b>[4]</b>	

Q	Answer / Working	Marks	Guidance
5(a)	$P(\text{success}) = \frac{1}{3}, P(\text{fail}) = \frac{2}{3}.$ Requires exactly 1 success in first 6 throws, then success on 7th.	<b>M1</b>	Understanding of negative binomial setup.
	$P = \binom{6}{1} \left(\frac{1}{3}\right)^1 \left(\frac{2}{3}\right)^5 \times \left(\frac{1}{3}\right)$	<b>M1</b>	
	$= 6 \times \frac{1}{9} \times \frac{32}{243} = \frac{64}{729} \approx 0.0878$	<b>A1</b>	
		<b>[3]</b>	
5(b)	"Fewer than 6 throws" means obtaining at least 2 successes in the first 5 throws. Let $X \sim B(5, \frac{1}{3})$ .	<b>M1</b>	Alternatively: adds exact probabilities for 2nd, 3rd, 4th, 5th throws.
	$P(X \geq 2) = 1 - P(X = 0) - P(X = 1) = 1 - \left(\frac{2}{3}\right)^5 - 5 \left(\frac{1}{3}\right) \left(\frac{2}{3}\right)^4$	<b>M1</b>	Setup for Binomial calculation.
	$= 1 - \frac{32}{243} - \frac{80}{243} = \frac{131}{243} \approx 0.539$	<b>A1</b>	
		<b>[3]</b>	
6(a)	Mean = $40 + \frac{264}{120} = 42.2$	<b>B1</b>	
	Var = $\frac{3456}{120} - \left(\frac{264}{120}\right)^2 = 28.8 - 4.84 = 23.96$	<b>B1</b>	
			<b>[2]</b>
6(b)	$T \sim N(42.2, 23.96)$ . Find $P(T > 45)$ .	<b>M1</b>	Standardises using their mean and var.
	$z = \frac{45 - 42.2}{\sqrt{23.96}} = \frac{2.8}{4.8949} \approx 0.572$		
	$P(Z > 0.572) = 1 - \Phi(0.572) = 1 - 0.7163$	<b>M1</b>	Correct normal tail area.

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	$= 0.2837 \approx 0.284$	<b>A1</b>	
		<b>[3]</b>	
<b>6(c)</b>	$X \sim B(100, 0.32) \approx N(\mu, \sigma^2)$ $\mu = np = 32, \quad \sigma^2 = npq = 100 \times 0.32 \times 0.68 = 21.76$	<b>M1</b>	Correct approx parameters.
	$P(X < 30) \xrightarrow{\text{c.c.}} P(X < 29.5)$	<b>M1</b>	Applies continuity correction 29.5.
	$z = \frac{29.5-32}{\sqrt{21.76}} = \frac{-2.5}{4.66476} \approx -0.536$	<b>M1</b>	Standardises with CC.
	$P(Z < -0.536) = 1 - \Phi(0.536) = 1 - 0.7040$	<b>M1</b>	Correct area approach.
	$= 0.296$	<b>A1</b>	Accept in range [0.295, 0.297].
		<b>[5]</b>	
<b>7(a)</b>	Total ways to choose 5 from 12 = $\binom{12}{5} = 792$	<b>B1</b>	
	Ways for (3J, 2S): $\binom{6}{3} \times \binom{6}{2} = 20 \times 15 = 300$ Ways for (4J, 1S): $\binom{6}{4} \times \binom{6}{1} = 15 \times 6 = 90$ Ways for (5J, 0S): $\binom{6}{5} \times 1 = 6 \times 1 = 6$	<b>M1</b>	Evaluates all valid combinations. (OR notes symmetry of selecting 5 from 6S/6J implies exactly 0.5 probability).
	Total successful = 396 $\implies$ Prob = $\frac{396}{792} = 0.5$	<b>A1</b>	
		<b>[3]</b>	
<b>7(b)</b>	Ways = $\binom{12}{4} \times \binom{8}{4} \times \binom{4}{4}$	<b>M1</b>	

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	$= 495 \times 70 \times 1 = 34650$	<b>A1</b>	
		<b>[2]</b>	
<b>7(c)</b>	Choose category for all-S team: 3 options. Choose category for all-J team: 2 options. (The 3rd category gets the remaining 2S and 2J).	<b>M1</b>	Assigning categories to team compositions.
	Choose 4 Seniors from 6: $\binom{6}{4} = 15$ . Choose 4 Juniors from 6: $\binom{6}{4} = 15$ .	<b>M1</b>	Evaluating team compositions.
	Total = $3 \times 2 \times 15 \times 15 = 1350$	<b>A1</b>	
		<b>[3]</b>	
			<b>Total: 50 Marks</b>