

Statistics S1 Mark scheme

Question	Scheme	Marks
1(a)	$S_{ww} = 41252 - \frac{640^2}{10} =$ <u>292</u>	M1A1
	$S_{wp} = 27557.8 - \frac{640 \times 431}{10} =$ <u>-26.2</u>	A1
		(3)
(b)	$r = \frac{-26.2}{\sqrt{292 \times 2.72}}$	M1
	$= -0.9297$ awrt <u>-0.930</u>	A1
		(2)
(c)	As <u>weight</u> increases the percentage of <u>oil</u> content decreases o.e.	B1
		(1)
(d)	$b = \frac{-26.2}{292} = -0.0897...$ awrt <u>-0.09</u>	M1 A1
	$a = \frac{431}{10} - \left(\frac{-26.2}{292} \right) \times \left(\frac{640}{10} \right) = 48.842...$	M1
	<u>$p = 48.8 - 0.0897w$</u>	A1
		(4)
(e)	$p = 48.8 - 0.0897 \times 60$	M1
	$= 43.4/43.5$ awrt <u>43.4/43.5</u>	A1
		(2)
(12 marks)		
Notes:		
(a)		
M1: for a correct expression for S_{ww} or S_{wp} (may be implied by one correct answer)		
1st A1: for either $S_{ww} = 292$ or $S_{wp} = -26.2$		
2nd A1: for both $S_{ww} = 292$ <u>and</u> $S_{wp} = -26.2$		
(b)		
M1: for a correct expression (Allow ft of their S_{ww} or S_{wp} provided $S_{ww} \neq 41252$ and $S_{wp} \neq 27557.8$). Condone missing “-”		
A1: for awrt -0.930 (Condone -0.93 for M1A1 if correct expression is seen) (Answer only awrt -0.930 scores 2/2 but answer only -0.93 is M1A0)		
(c)		
B1: For a correct contextual description of negative correlation which must include <u>weight</u> and <u>oil</u> (but w increases as p decreases is not sufficient)		
(d)		
1st M1: for a correct expression for b (Allow ft)		
1st A1: for awrt -0.09		
2nd M1: for a correct method for a ft their value of b (Allow $a = 43.1 + b \times 64$)		
2nd A1: for a correct equation for p and w with $a =$ awrt 48.8 and $b =$ awrt -0.0897 No fractions. Equation in x and y is A0		
(e)		
M1: substituting $w = 60$ into their equation		
A1: awrt 43.4 or 43.5 (Answer only scores 2/2)		

Question	Scheme	Marks
2	$1.5 \times 12 = 18$ 20 people represented by 18 (cm ²) or 1 person is represented by 0.9 (cm ²)	M1
	$x = \frac{20 \times 94.5}{18}$ oe = 105 (people)	M1 A1 cao
(3 marks)		
Notes:		
M1: For an attempt to relate area to frequency (e.g. $\frac{20}{18}$ or $\frac{18}{20}$ seen)		
M1: For a correct expression/equation for total frequency e.g. $\frac{18}{20} = \frac{94.5}{x}$		
A1: For 105 cao		

Question	Scheme	Marks
3(a)	(Discrete) <u>Uniform</u>	B1
		(1)
(b)	$P(X=4) = \frac{1}{\underline{5}}$ oe	B1
		(1)
(c)	$F(3) = \frac{3}{\underline{5}}$ oe	B1
		(1)
(d)	$P(3X-3 > X+4) = P(X > 3.5)$	M1
	$= \frac{2}{\underline{5}}$ oe	A1
		(2)
(e)	$E(X) = \underline{3}$	
		B1
		(1)
(f)	$E(X^2) = \frac{1}{5}(1^2 + 2^2 + 3^2 + 4^2 + 5^2)$	M1
	$= \underline{11}$	A1
		(2)
(g)	$\text{Var}(X) = 11 - 3^2$ or $\frac{(5+1)(5-1)}{12}$	M1
	$= \underline{2}$	A1
		(2)
(h)	$11.4 = aE(X) - 3$ or $11.4 = 3a - 3$	M1
	$a = 4.8$	A1
	$\text{Var}(4.8X - 3) = '4.8'^2 \times '2'$	M1
	$= 46.08$ awrt <u>46.1</u>	A1
		(4)
(14 marks)		

Question 3 *continued***Notes:****(a)****B1:** For uniform.**(d)****M1:** For identifying the correct probabilities i.e. $P(X > 3.5)$ or $P(X = 4) + P(X = 5)$ **(f)****M1:** For a correct expression.**(g)****M1:** For either 'their (f)' – 'their (e)'² or for a correct expression $\frac{(5+1)(5-1)}{12}$ **(h)****1st M1:** For setting up a correct linear equation using $aE(X) - 3 = 11.4$ **1st A1:** May be implied by a correct answer.**2nd M1:** For "their a^2 " × "their $\text{Var}(X)$ " (must see values substituted) (may be implied by a correct answer or correct ft answer)NB: 'their $\text{Var}(X)$ ' < 0 is M0 here.

Question	Scheme	Marks
4(a)	7.5 <u>and</u> 25	B1
		(1)
(b)	Mean = 10.3125 awrt 10.3	B1
		(1)
(c)	$\sigma = \sqrt{\frac{120125}{80} - 10.3125^2}$	M1
	= 6.6188.. ($s = 6.6605\dots$) awrt 6.62	A1
		(2)
(d)	Median = $\{5\} + \frac{20}{24} \times 5$ or $\{10\} - \frac{4}{24} \times 5$	M1
	= 9.16666 awrt 9.17	A1
		(2)
(e)	Mean > median $\therefore$ positive skew	M1A1
		(2)
(f)	$t = 10v + 5$	
	Mean = $10 \times 10.3125 + 5$	M1
	= 108.125 awrt 108	A1
	$\sigma = 10 \times 6.6188$	M1
	= 66.188.. (66.605 from s) awrt 66.2	A1
		(4)
(12 marks)		
Notes:		
(a)		
B1: Both values correct (may be seen in table)		
(b)		
B1: For awrt 10.3 (Do not allow improper fractions).		
(c)		
M1: For a correct expression including the square root (allow ft from their mean)		
A1: For awrt 6.62 (Allow $s =$ awrt 6.66)		
(d)		
M1: For a correct fraction: $\frac{20}{24} \times 5$ <u>or</u> if using $n + 1$ for $\frac{20.5}{24} \times 5$ may be scored from working down $-\frac{4}{24} \times 5$		
A1: For awrt 9.17 or (if using $n + 1$) for awrt 9.27		

Question 4 notes *continued*

(e)

M1: For a correct comparison of ‘their b’ and ‘their d’ (must have an answer to both (b) and (d))
Comparison may be part of bigger expression e.g. $3(\text{mean} - \text{median})/\text{s.d.}$

Allow use of $Q_3 - Q_2 > Q_2 - Q_1$ only if $Q_1 = 5$ and $Q_3 = 15$ are both seen

A1: For positive skew (which must follow from their values)

(f)

M1: **(1st M1)** For $10 \times \text{"their mean"} + 5$

M1: **(2nd M1)** or $10 \times \text{"their sd"}$

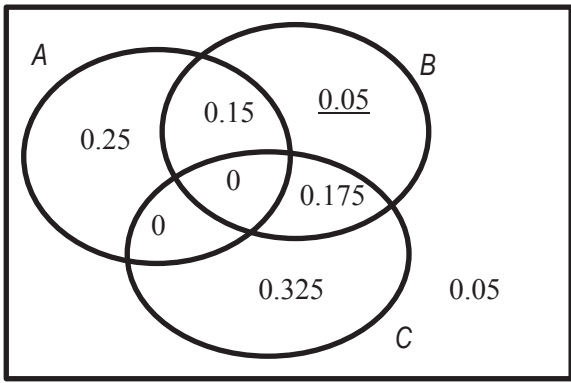
Use of decoded data to find mean must be fully correct,

i.e. $8650/80 = \text{awrt } 108$ (M1A1)

Use of decoded data to find s.d. must be fully correct,

i.e. $\sqrt{\frac{1285750}{80} - \left(\frac{8650}{80}\right)^2} = \text{awrt } 66.2$ (M1A1)

Question	Scheme	Marks
5(a)	$P(T = 2) = 3 \times \frac{1}{6} \times \frac{1}{6} = \frac{1}{12}$ oe	M1 A1
		(2)
(b)	$P(T = 3) = [P(0, 3) + P(1, 2) + P(2, 1)] + P(3)$	
	$= \left(\frac{1}{6} \times \frac{1}{2}\right) + \left(\frac{1}{6} \times \frac{1}{6}\right) + \left(\frac{1}{6} \times \frac{1}{6}\right) + \frac{1}{2}$	M1 M1
	$= \frac{23}{36}$ oe	A1
		(3)
(c)	$P(T = 3 \mid \text{rolled twice}) = \frac{P((T = 3) \cap \text{die rolled twice})}{P(\text{die rolled twice})}$	M1
	$= \frac{\frac{5}{36}}{\frac{1}{2}}$	M1
	$= \frac{5}{18}$ oe	A1
		(3)
(8 marks)		
Notes:		
Correct answer only in (a), (b) or (c) scores full marks for that part.		
Methods leading to answers > 1 score 0 marks		
(a)		
M1: For a correct expression.		
A1: Allow exact equivalent ($\frac{1}{6} \times \frac{1}{2} = \frac{1}{12}$ is M0A0).		
(b)		
M1: For $\frac{1}{2}$ + at least one correct product.		
M1: For fully correct expression.		
A1: Allow exact equivalent.		
(c)		
M1: For correct conditional probability ratio (this mark may be implied by 2 nd M1) but going on to assume independence [using numerator $P(T = 3) \times P(\text{rolled twice})$] is M0M0A0.		
M1: For a correct numerical ratio of probabilities (allow ft of (their (b) – $\frac{1}{2}$) as numerator).		
A1: Allow exact equivalent.		

Question	Scheme	Marks	
6(a)	$[P(A \cup C) =] \underline{\frac{9}{10}}$ oe	B1	
		(1)	
(b)	$P(A \cup B) = P(A) + P(B) - P(A) \times P(B)$	M1	
	$\frac{5}{8} = \frac{2}{5} + P(B) - \frac{2}{5} P(B)$	M1 A1	
	$P(B) = \frac{3}{8} *$	A1cso	
		(4)	
(c)	$[P(A B) = P(A) =] \underline{\frac{2}{5}}$ oe	B1	
		(1)	
(d)		Diagram	B1
		0.15 <u>and</u> 0.25	M1
		0.05 <u>and</u> 0.05	M1
	0.175 <u>and</u> 0.325	M1 A1	
		(5)	
(11 marks)			
Notes:			
(b)			
M1: For use of $P(A \cup B) = P(A) + P(B) - P(A \cap B)$			
M1: For use of $P(A \cap B) = P(A) \times P(B)$ (But just seeing $\frac{2}{5} \times \frac{3}{8} = \frac{3}{20}$ on its own is M0M0)			
A1: A correct equation			
A1: (No wrong working seen dependent on all previous marks)			
(allow a full verification method, however, substitution of $P(B) = 3/8$ into only one $P(B)$ to find the other $P(B)$ (e.g. using $3/20$ to find $3/8$) can score M1M0A0A0)			

Question 6 notes continued

(d)

B1: 3 circles intersecting, see diagram above, (at least 2 labelled) with the two zeros showing A does not intersect C (Do not allow blank spaces for the two zeros)

or 3 circles, see diagram below, (at least 2 labelled) where B intersects A and C but A and C do not intersect.

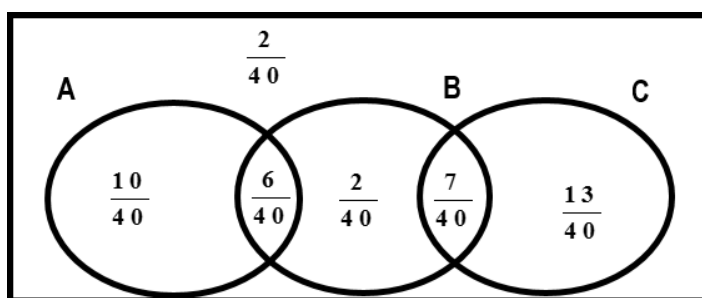
M1: 0.15 placed in $(A \cap B \cap C')$ and 0.25 placed in $(A \cap B' \cap C')$

M1: 0.3 – ‘their 0.25’ and 1 – (‘their 0.15’ + ‘their 0.25’ + ‘their 0.05’ + $\frac{1}{2}$)

M1: $\frac{3}{8}$ – (“their 0.15” + “their 0.05”), i.e. $P(B) = \frac{3}{8}$ and $\frac{1}{2}$ – “their 0.175”, i.e. $P(C) = \frac{1}{2}$

For the 3rd M mark, blank regions inside $P(B)$ and $P(C)$ are not treated as 0s and score M0

A1: fully correct with box



Question	Scheme	Marks
7(a)(i)	$P(X > 505) = P\left(Z > \frac{505 - 503}{1.6}\right)$	M1
	$= 1 - P(Z < 1.25) = 1 - 0.8944$	M1
	$= 0.1056$ awrt <u>0.106</u>	A1
		(3)
(ii)	$P(501 < X < 505) = 1 - 2 \times 0.1056$ or $0.8944 - 0.1056$	M1
	$= 0.7888$ awrt <u>0.789</u>	A1
		(2)
(b)	$P(X < w) = 0.9713$ or $P(X > w) = 0.0287$ (may be implied by $z = \pm 1.9$)	M1
	$\frac{w - 503}{1.6} = 1.9$ or $\frac{(1006 - w) - 503}{1.6} = -1.9$	M1
	$w = 506.04\dots$ awrt <u>506</u>	A1
		(3)
(c)	$\frac{r - 503}{q} = -2.3263$	M1A1
	$\frac{r + 6 - 503}{q} = 1.6449$	M1A1
	$1.6449q - 6 = -2.3263q$	ddM1
	$q = 1.51\dots$ awrt <u>1.51</u>	A1
	$r = 499.48\dots\dots$ awrt <u>499</u>	A1
		(7)
(15 marks)		
Notes:		
(a) (i) M1: Standardising with 505, 503 and 1.6. May be implied by use of 1.25 (Allow $\pm$) M1: For $1 - P(Z < 1.25)$ i.e. a correct method for finding $P(Z > 1.25)$, e.g. $1 - p$ where $0.5 < p < 0.99$ (ii) M1: $1 - 2 \times \text{their(i)}$		
(b) M1: For using symmetry to find the area of one tail (may be seen in a diagram) M1: A single standardisation with 503, 1.6 and w (or $1006 - w$) <u>and</u> set $= \pm z$ value ($1.8 < z < 2$) A1: For awrt 506 which must come from correct working. (Answer only: 506 scores 0/3, but 506.0...with no working send to review)		

Question 7 notes continued**(c)**

M1: $\frac{r-503}{q} = z \text{ value where } |z| > 2$

A1: $\frac{r-503}{q} = \text{awrt } -2.3263 \text{ (signs must be compatible)}$

M1: $\frac{r+6-503}{q} = z \text{ value where } |z| > 1$

A1: $\frac{r+6-503}{q} = \text{awrt } 1.6449 \text{ (signs must be compatible)}$

Special Case:

Less than 4dp z-values: use of awrt 2.32/2.33/2.34 **and** awrt 1.64/1.65 could score M1 A0 M1 and then A1 provided both equations have compatible signs.

3rd M1: (dep on both Ms) attempt to solve simultaneous equations leading to a value for q or r

3rd A1: Or awrt 1.51

4th A1: For awrt 499 (allow 499.5)