Statistics S1 Mark scheme

Question	Scheme	Marks
1(a)	$S_{ww} = 41252 - \dfrac{640^2}{10} =$ **292**	M1A1
	$S_{wp} = 27557.8 - \dfrac{640 \times 431}{10} =$ **−26.2**	A1
		(3)
(b)	$r = \dfrac{-26.2}{\sqrt{292 \times 2.72}}$	M1
	$= -0.9297$ awrt **−0.930**	A1
		(2)
(c)	As <u>weight</u> increases the percentage of <u>oil</u> content decreases o.e.	B1
		(1)
(d)	$b = \dfrac{-26.2}{292} = -0.0897...$ awrt **−0.09**	M1 A1
	$a = \dfrac{431}{10} - \left(\dfrac{-26.2}{292}\right) \times \left(\dfrac{640}{10}\right) = 48.842...$	M1
	$p = 48.8 - 0.0897w$	A1
		(4)
(e)	$p = 48.8 - 0.0897 \times 60$	M1
	$= 43.4/43.5$ awrt **43.4/43.5**	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
	$x = \dfrac{20 \times 94.5}{18}$ 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) **Uniform**	B1
		(1)
(b)	$P(X = 4) = \dfrac{1}{5}$ oe	B1
		(1)
(c)	$F(3) = \dfrac{3}{5}$ oe	B1
		(1)
(d)	$P(3X - 3 > X + 4) = P(X > 3.5)$	M1
	$= \dfrac{2}{5}$ oe	A1
		(2)
(e)	$E(X) = \underline{\mathbf{3}}$	
		B1
		(1)
(f)	$E(X^2) = \dfrac{1}{5}\left(1^2 + 2^2 + 3^2 + 4^2 + 5^2\right)$	M1
	$= \underline{\mathbf{11}}$	A1
		(2)
(g)	$\text{Var}(X) = 11 - 3^2 \qquad$ or $\qquad \dfrac{(5+1)(5-1)}{12}$	M1
	$= \underline{\mathbf{2}}$	A1
		(2)
(h)	$11.4 = a\,E(X) - 3$ **or** $11.4 = 3a - 3$	M1
	$a = 4.8$	A1
	$\text{Var}(4.8X - 3) = {}^{\prime}4.8^{\prime 2} \times {}^{\prime}2^{\prime}$	M1
	$= 46.08 \qquad\qquad\qquad\qquad\qquad$ awrt **46.1**	A1
		(4)
		(14 marks)

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

Question	Scheme	Marks
4(a)	7.5 <u>and</u> 25	B1
		(1)
(b)	Mean = 10.3125 awrt <u>**10.3**</u>	B1
		(1)
(c)	$\sigma = \sqrt{\dfrac{120125}{80} - '10.3125^2}$	M1
	$= 6.6188..$ $(s = 6.6605\ldots)$ awrt <u>**6.62**</u>	A1
		(2)
(d)	Median $= \{5\} + \dfrac{20}{24} \times 5$ or $\{10\} - \dfrac{4}{24} \times 5$	M1
	$= 9.16666$ awrt <u>**9.17**</u>	A1
		(2)
(e)	Mean > median $\therefore$ positive skew	M1A1
		(2)
(f)	$t = 10v + 5$	
	Mean $= 10 \times 10.3125 + 5$	M1
	$= 108.125$ awrt <u>**108**</u>	A1
	$\sigma = 10 \times 6.6188$	M1
	$= 66.188..$ (66.605 from s) awrt <u>**66.2**</u>	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: $\dfrac{20}{24} \times 5$ <u>or</u> if using $n + 1$ for $\dfrac{20.5}{24} \times 5$ may be scored from working

down $-\dfrac{4}{24} \times 5$

A1: For awrt 9.17 or (if using $n + 1$) for awrt 9.27

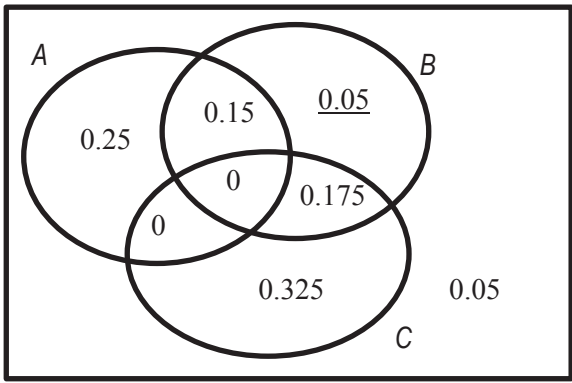| **Question 4 notes** *continued* |
| --- |
| **(e)**
 M1: For a correct comparison of 'their b' and 'their d' (must have an answer to both (b) and (d))
 Comparison may be part of bigger expression e.g. 3(mean – median)/s.d.
 Allow use of $Q_3 - Q_2 > Q_2 - Q_1$ only if $Q_1 = 5$ and $Q_3 = 15$ are both seen
 A1: For positive skew (which must follow from their values) |
| **(f)**
 M1: (1st **M1)** For $10 \times$ "their mean" $+5$
 M1: (2nd **M1)** or $10 \times$ "their sd"
 Use of decoded data to find mean must be fully correct,
 i.e. $8650/80 =$ awrt 108 (M1A1)
 Use of decoded data to find s.d. must be fully correct,
 i.e. $\sqrt{\dfrac{1285750}{80} - \left(\dfrac{8650}{80}\right)^2} =$ awrt 66.2 (M1A1) |

Question	Scheme	Marks
5(a)	$P(T = 2) = 3 \times \dfrac{1}{6} \times \dfrac{1}{6} = \dfrac{1}{12}$ oe	M1 A1
		(2)
(b)	$P(T = 3) = [P(0, 3) + P(1, 2) + P(2, 1)] + P(3)$	
	$= \left(\dfrac{1}{6} \times \dfrac{1}{2} \right) + \left(\dfrac{1}{6} \times \dfrac{1}{6} \right) + \left(\dfrac{1}{6} \times \dfrac{1}{6} \right) + \dfrac{1}{2}$	M1 M1
	$= \dfrac{23}{36}$ oe	A1
		(3)
(c)	$P(T = 3 \mid \text{rolled twice}) = \dfrac{P((T = 3) \cap \text{die rolled twice})}{P(\text{die rolled twice})}$	M1
	$= \dfrac{\dfrac{5}{36}}{\dfrac{1}{2}}$	M1
	$= \dfrac{5}{18}$ 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 $\dfrac{1}{2}$ + 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 2nd 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) $- \dfrac{1}{2}$) as numerator).

A1: Allow exact equivalent.

Question	Scheme	Marks
6(a)	$[\,\mathrm{P}(A\cup C)=\,]\dfrac{9}{10}$ oe	B1
		(1)
(b)	$\mathrm{P}(A\cup B)=\mathrm{P}(A)+\mathrm{P}(B)-\mathrm{P}(A)\times\mathrm{P}(B)$	M1
	$\dfrac{5}{8}=\dfrac{2}{5}+\mathrm{P}(B)-\dfrac{2}{5}\mathrm{P}(B)$	M1 A1
	$\mathrm{P}(B)=\dfrac{3}{8}\,*$	A1cso
		(4)
(c)	$[\,\mathrm{P}(A\,|\,B)=\ \mathrm{P}(A)\ =\,]\dfrac{2}{5}$ oe	B1
		(1)
(d)	Diagram	B1
	0.15 <u>and</u> 0.25	M1
	0.05 <u>and</u> <u>0.05</u>	M1
	0.175 <u>and</u> 0.325	M1
		A1
		(5)
		(11 marks)

Notes:

(b)

M1: For use of $\mathrm{P}(A\cup B)=\mathrm{P}(A)+\mathrm{P}(B)-\mathrm{P}(A\cap B)$

M1: For use of $\mathrm{P}(A\cap B)=\mathrm{P}(A)\times\mathrm{P}(B)$ (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 $\mathrm{P}(B)=3/8$ into only one $\mathrm{P}(B)$ to find the other $\mathrm{P}(B)$ (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)

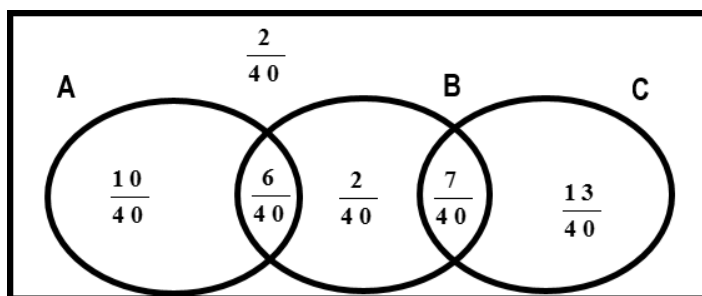**or** 3 circles, see diagram below, (at least 2 labelled) where B intersects A and C but A and C do not intersect.

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)	$P(X > 505) = P\left(Z > \dfrac{505 - 503}{1.6} \right)$	M1
	$= 1 - P(Z < 1.25)$ $= 1 - 0.8944$	M1
	$= 0.1056$ awrt **0.106**	A1
		(3)
(ii)	$P(501 < X < 505) = 1 - 2 \times 0.1056$ or $0.8944 - 0.1056$	M1
	$= 0.7888$ awrt **0.789**	A1
		(2)
(b)	$P(X < w) = 0.9713$ or $P(X > w) = 0.0287$ (may be implied by $z = \pm 1.9$)	M1
	$\dfrac{w - 503}{1.6} = 1.9$ or $\dfrac{(1006 - w) - 503}{1.6} = -1.9$	M1
	$w = 506.04\ldots$ awrt **506**	A1
		(3)
(c)	$\dfrac{r - 503}{q} = -2.3263$	M1A1
	$\dfrac{r + 6 - 503}{q} = 1.6449$	M1A1
	$1.6449q - 6 = -2.3263q$	ddM1
	$q = 1.51\ldots$ awrt **1.51**	A1
	$r = 499.48\ldots\ldots$ awrt **499**	A1
		(7)
		(15 marks)

Notes:

(a)

(i)

M1: Standardising with 505, 503 and 1.6. May be implied by use of 1.25 (Allow ±)

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: $1 - 2 \times$ 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: $\dfrac{r-503}{q} = z$ value   where $|z| > 2$

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

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

A1: $\dfrac{r+6-503}{q} = $ awrt 1.6449 (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

3rdA1: Or awrt 1.51

4thA1: For awrt 499 (allow 499.5)