Statistics S1 Mark scheme

Question	Scheme		Marks
1(a)	$S_{ww} = 41252 - \frac{640^2}{10} =$	**292**	M1A1
	$S_{wp} = 27557.8 - \frac{640 \times 431}{10} =$	**–26.2**	A1
			(3)
(b)	$r = \frac{-26.2}{\sqrt{292 \times 2.72}}$		M1
	$= -0.9297$	awrt **–0.930**	A1
			(2)
(c)	As weight increases the percentage of oil content decreases o.e.		B1
			(1)
(d)	$b = \frac{-26.2}{292} = -0.0897...$	awrt **–0.09**	M1 A1
	$a = \frac{431}{10} - \left(\frac{-26.2}{292}\right) \times \left(\frac{640}{10}\right) = 48.842\ldots$		M1
		$\boldsymbol{p = 48.8 - 0.0897w}$	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** $S_{ww} = 292$ and $S_{wp} = -26.2$

(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 weight and oil (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)	$P(X = 4) = \frac{1}{5}$ oe	B1
		(1)
(c)	$F(3) = \frac{3}{5}$ oe	B1
		(1)
(d)	$P(3X - 3 > X + 4) = P(X > 3.5)$	M1
	$= \frac{2}{5}$ oe	A1
		(2)
(e)	$E(X) =$ **3**	
		B1
		(1)
(f)	$E(X^2) = \frac{1}{5}\left(1^2 + 2^2 + 3^2 + 4^2 + 5^2\right)$	M1
	= **11**	A1
		(2)
(g)	Var $(X) = 11 - 3^2$ or $\frac{(5+1)(5-1)}{12}$	M1
	= **2**	A1
		(2)
(h)	$11.4 = aE(X) - 3$ **or** $11.4 = 3a - 3$	M1
	$a = 4.8$	A1
	Var $(4.8X - 3) =$ '4.8'$^2 \times$ '2'	M1
	= 46.08 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 $\frac{(5+1)(5-1)}{12}$
(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 Var(X)" (must see values substituted) (may be implied by a correct answer or correct ft answer) NB: 'their Var(X)' < 0 is M0 here.

Question	Scheme	Marks
4(a)	7.5 and 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…) 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 ∴ 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: $\frac{20}{24} \times 5$ or 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(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. $\sqrt{\frac{1285750}{80} - \left(\frac{8650}{80}\right)^2}$ =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.

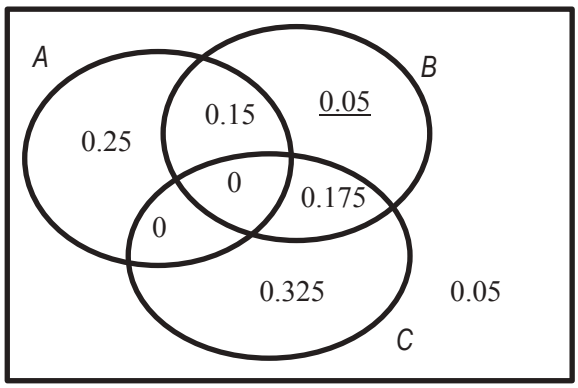
A1: Allow exact equivalent.

(c)

M1: For correct conditional probability ratio (this mark may be implied by 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) $-\frac{1}{2}$) as numerator).

A1: Allow exact equivalent.

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

Notes:

(b)

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

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 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.

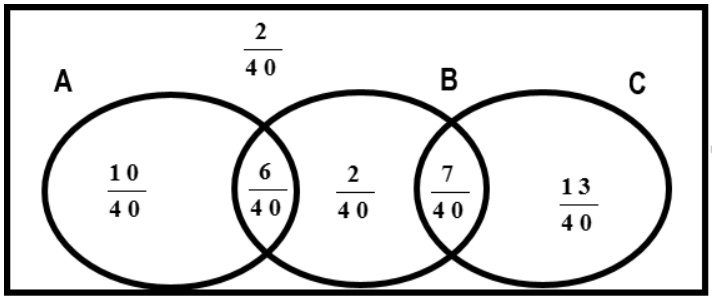
M1: 0.15 placed in $(A \cap B \cap C')$ and 0.25 placed in $(A \cap B' \cap C')$

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 **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
	$\frac{w-503}{1.6} = 1.9$ or $\frac{(1006-w)-503}{1.6} = -1.9$	M1
	$w = 506.04\ldots$ awrt **506**	A1
		(3)
(c)	$\frac{r-503}{q} = -2.3263$	M1A1
	$\frac{r+6-503}{q} = 1.6449$	M1A1
	$1.6449q - 6 = -2.3263q$	ddM1
	$q = 1.51...$ 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 $1006 - w$) and set = ± 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: $\frac{r-503}{q} = z$ value where $|z| > 2$

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

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

A1: $\frac{r+6-503}{q} =$ 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)