Subject – Math AA(Standard Level)
Topic - Statistics and Probability
Year - May 2021 – Nov 2022
Paper -2
Answers

Question 1

(a) attempt to use the symmetry of the normal curve *(M1)*

eg diagram, $0.5-0.1446$

$\mathrm{P}(24.15 < X < 25) = 0.3554$ *A1*

[2 marks]

(b) (i) use of inverse normal to find z score *(M1)*

$z = -1.0598$

correct substitution $\dfrac{24.15-25}{\sigma} = -1.0598$ *(A1)*

$\sigma = 0.802$ *A1*

(ii) $\mathrm{P}(X > 26) = 0.106$ *(M1)A1*

[5 marks]

(c) recognizing binomial probability *(M1)*

$\mathrm{E}(Y) = 10 \times 0.10621$ *(A1)*

$= 1.06$ *A1*

[3 marks]

(d) $\mathrm{P}(Y = 3)$ *(M1)*

$= 0.0655$ *A1*

[2 marks]

(e) recognizing conditional probability *(M1)*

correct substitution *A1*

$\dfrac{0.3554}{1-0.10621}$

$= 0.398$ *A1*

[3 marks]

Total [15 marks]

Question 2

(a) $a = 1.29$ and $b = -10.4$ *A1A1*

[2 marks]

(b) recognising both lines pass through the mean point *(M1)*

$p = 28.7$, $q = 30.3$ *A2*

[3 marks]

Total [5 marks]

Question 3

(a) recognition of binomial *(M1)*

$X \sim \mathrm{B}(5,\ 0.7)$

attempt to find $\mathrm{P}(X \le 3)$ ***M1***

$= 0.472 (= 0.47178)$ ***A1***

[3 marks]

(b) recognition of 2 sixes in 4 tosses *(M1)*

$\mathrm{P}(\text{3rd six on the 5th toss}) = \left[\binom{4}{2} \times (0.7)^2 \times (0.3)^2\right] \times 0.7 (= 0.2646 \times 0.7)$ ***A1***

$= 0.185 (= 0.18522)$ ***A1***

[3 marks]

Total [6 marks]

Question 4

Let X = mass of a bag of sugar

(a) evidence of identifying the correct area *(M1)*

$\mathrm{P}(X < 995) = 0.0765637\ldots$

$= 0.0766$ ***A1***

[2 marks]

(b) 0.0766×100

≈ 8 ***A1***

[1 mark]

(c) recognition that $\mathrm{P}(X > 1005 | X \ge 995)$ is required *(M1)*

$$\frac{\mathrm{P}(X \ge 995 \cap X > 1005)}{\mathrm{P}(X \ge 995)}$$

$$\frac{\mathrm{P}(X > 1005)}{\mathrm{P}(X \ge 995)}$$ *(A1)*

$$\frac{0.0765637\ldots}{1 - 0.0765637\ldots}\left(= \frac{0.0765637\ldots}{0.923436\ldots}\right)$$

$= 0.0829$ *A1*

[3 marks]

Total [6 marks]

Question 5

(a) $a = 0.433156\ldots,\ b = 4.50265\ldots$

$a = 0.433,\ b = 4.50$ **A1A1**

[2 marks]

(b) attempt to substitute $x = 18$ into their equation ***(M1)***

$y = 0.433 \times 18 + 4.50$

$= 12.2994\ldots$

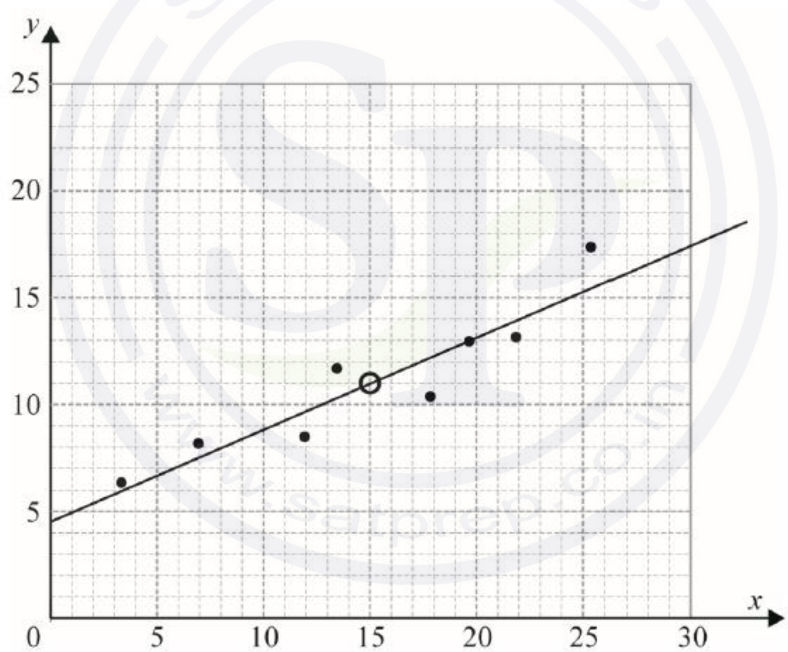
$= 12.3$ **A1**

[2 marks]

(c) $\bar{x} = 15$, $\bar{y} = 11$ **A1**

[1 mark]

(d)



A1A1

Note: Award marks as follows:

A1 for a straight line going through $(15,11)$

A1 for intercepting the y-axis between their $b \pm 1.5$ (when their line is extended), which includes all the data for $3.3 \le x \le 25.3$.

If the candidate does not use a ruler, award ***A0A1*** where appropriate.

[2 marks]

Total [7 marks]

Question 6

(a) considering that sum of probabilities is 1 *(M1)*

$0.85 + c + 0.03 + 0.002 + 0.0001 = 1$

0.1179 ***A1***

[2 marks]

(b) valid attempt to find $\mathrm{E}(D)$ *(M1)*

$\mathrm{E}(D) = (0 \times 0.85) + (2 \times 0.1179) + (10 \times 0.03) + (50 \times 0.002) + (1000 \times 0.0001)$

$\mathrm{E}(D) = 0.7358$ ***A1***

No, not a fair game ***A1***

for a fair game, $\mathrm{E}(D)$ would be \$2 OR players expected winnings are 1.264 ***R1***

[4 marks]

(c) recognition of GP with $r = 2$ *(M1)*

$1000 \times 2^{n-1}$ OR $500(2^n)$ ***A1***

[2 marks]

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(d) recognizing $\mathrm{E}(D) > 2$ *(M1)*

correct expression for w^{th} week (or n^{th} week) *(A1)*

$(0\times 0.85)+(2\times 0.1179)+(10\times 0.03)+(50\times 0.002)+(1000\times 2^{w-1}\times 0.0001)$

correct inequality (accept equation) *(A1)*

$0.6358+(1000\times 2^{w-1}\times 0.0001)>2$ OR $2^{n-1}>13.642$

EITHER

$n-1>3.76998$ OR $w=4.76998...$ *(A1)*

OR

$\mathrm{E}(D)=1.4358$ in week 4 or $\mathrm{E}(D)=2.2358$ in week 5 *(A1)*

THEN

$w=5$ ***A1***

expected profit per ticket $=$ their $\mathrm{E}(D)-2$ *(M1)*

$=0.2358$ ***A1***

[7 marks]

Total [15 marks]

Question 7

(a) use of inverse normal to find z-score **(M1)**

$z = 2.0537...$

$$2.0537... = \frac{82 - 75}{\sigma}$$ **(A1)**

$\sigma = 3.408401...$

$\sigma = 3.41$ **A1**

[3 marks]

(b) evidence of identifying the correct area under the normal curve **(M1)**

$\mathrm{P}(T > 80) = 0.071193...$

$\mathrm{P}(T > 80) = 0.0712$ **A1**

[2 marks]

(c) recognition that $\mathrm{P}(80 < T < 82)$ is required **(M1)**

$$P(T < 82 | T > 80) = \frac{\mathrm{P}(80 < T < 82)}{\mathrm{P}(T > 80)} = \left(\frac{0.051193...}{0.071193...}\right)$$ **(M1)(A1)**

$= 0.719075...$

$= 0.719$ **A1**

[4 marks]

(d) recognition of binomial probability *(M1)*

$X \sim \mathrm{B}(64, 0.071193...)$ or $\mathrm{E}(X) = 64 \times 0.071193...$ *(A1)*

$\mathrm{E}(X) = 4.556353...$

$\mathrm{E}(X) = 4.56$ (flights) ***A1***

[3 marks]

(e) $\mathrm{P}(X > 6) = P(X \geq 7) = 1 - \mathrm{P}(X \leq 6)$ *(M1)*

$= 1 - 0.83088...$ *(A1)*

$= 0.1691196...$

$= 0.169$ ***A1***

[3 marks]

Total [15 marks]

Question 8

(a) **EITHER**

$\mathrm{P}(S) + \mathrm{P}(T) + \mathrm{P}(S' \cap T') - \mathrm{P}(S \cap T) = 1$ OR $\mathrm{P}(S \cup T) = \mathrm{P}((S' \cap T')')$ *(M1)*

$0.7 + 0.2 + 0.18 - \mathrm{P}(S \cap T) = 1$ OR $\mathrm{P}(S \cup T) = 1 - 0.18$

OR

a clearly labelled Venn diagram *(M1)*

THEN

$\mathrm{P}(S \cap T) = 0.08$ (accept 8%) ***A1***

Note: To obtain the ***M1*** for the Venn diagram all labels must be correct and in the correct sections. For example, do not accept 0.7 in the area corresponding to $S \cap T'$.

[2 marks]

(b) **EITHER**

$P(T \cap S') = P(T) - P(T \cap S) (= 0.2 - 0.08)$ OR

$P(T \cap S') = P(T \cup S) - P(S) (= 0.82 - 0.7)$

(M1)

OR

a clearly labelled Venn diagram including $P(S)$, $P(T)$ and $P(S \cap T)$ ***(M1)***

THEN

$= 0.12$ (accept 12%) ***A1***

[2 marks]

(c) $P(G \cap T) = P(T / G)P(G)$ (0.25×0.48) ***(M1)***

$= 0.12$ ***A1***

[2 marks]

(d) **METHOD 1**

$P(G) \times P(T) (= 0.48 \times 0.2) = 0.096$ ***A1***

$P(G) \times P(T) \neq P(G \cap T) \Rightarrow$ G and T are not independent ***R1***

METHOD 2

$P(T | G) = 0.25$ ***A1***

$P(T | G) \neq P(T) \Rightarrow$ G and T are not independent ***R1***

Note: Do not award ***A0R1.***

[2 marks]

Total [8 marks]

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Question 9

(a) (i) $a = 0.805084...$ and $b = 2.88135...$

$a = 0.805$ and $b = 2.88$ ***A1A1***

(ii) $r = 0.97777...$

$r = 0.978$ ***A1***

[3 marks]

(b) a represents the (average) increase in waiting time (0.805 mins) per additional customer (waiting to receive their coffee) ***R1***

[1 mark]

(c) attempt to substitute $x = 7$ into their equation ***(M1)***

$8.51693...$

8.52 (mins) ***A1***

[2 marks]

Total [6 marks]

Question 10

(a) $P\left(\frac{\mu - 1.5\sigma - \mu}{\sigma} < \frac{X - \mu}{\sigma} < \frac{\mu + 1.5\sigma - \mu}{\sigma}\right)$ ***(M1)***

$P(-1.5 < Z < 1.5)$ OR $1 - 2 \times P(Z < -1.5)$ ***(A1)***

$P(-1.5 < Z < 1.5) = 0.866385...$

$P(\mu - 1.5\sigma < X < \mu + 1.5\sigma) = 0.866$ ***A1***

Note: Do not award any marks for use of their answers from part (b).

[3 marks]

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(b) $z_1 = -1.75068...$ and $z_2 = 1.30468...$ (seen anywhere) ***(A1)***

correct equations ***(A1)(A1)***

$\frac{106.2 - \mu}{\sigma} = -1.75068...$, $\mu + 1.30468...\sigma = 182.6$

attempt to solve their equations involving **z** values ***(M1)***

$\mu = 149.976..., \sigma = 25.0051...$

$\mu = 150, \sigma = 25.0$ ***A1***

[5 marks]

(c) (i) new sample space is 96% (may be seen in (ii) or (iii)) ***(M1)***

$P(\text{medium}|\text{not small})$ OR $\frac{0.576}{0.96}$

$P(\text{Medium}) = 0.6$ ***A1***

(ii) $P(\text{Large}) = 0.3$ ***A1***

(iii) $P(\text{Premium}) = 0.1$ ***A1***

[4 marks]

(d) attempt to express revenue from avocados ***(M1)***

$1.1 \times 0.6 + 1.29 \times 0.3 + 1.96 \times 0.1$ OR $1.243n$

correct inequality or equation for net profit in terms of n ***(A1)***

$1.1 \times 0.6n + 1.29 \times 0.3n + 1.96 \times 0.1n - 200 \geq 438$ OR $1.243n - 200 = 438$

attempt to solve the inequality ***(M1)***

sketch OR $n = 513.274...$

$n = 514$ ***A1***

> **Note:** Only award follow through in part (d) for 3 probabilities which add up to 1. FT of probabilities from c) that do not add up to 1 should only be awarded ***M*** marks, where appropriate, in d).

[4 marks]

Total [16 marks]

Question 11

(a) recognize that the variable has a Binomial distribution **(M1)**

$X \sim \mathrm{B}(30, 0.05)$

attempt to find $\mathrm{P}(X \geq 1)$ **(M1)**

$1-\mathrm{P}(X=0)$ OR $1-0.95^{30}$ OR $1-0.214638...$ OR $0.785361...$

Note: The two ***M*** marks are independent of each other.

$\mathrm{P}(X \geq 1) = 0.785$ ***A1***

[3 marks]

(b) recognition of conditional probability **(M1)**

$\mathrm{P}(X \leq 2 \mid X \geq 1)$ OR $\mathrm{P}(\text{at most 2 defective} \mid \text{at least 1 defective})$

Note: Recognition must be shown in context either in words or symbols but not just $\mathrm{P}(A \mid B)$.

$\frac{\mathrm{P}(1 \leq X \leq 2)}{\mathrm{P}(X \geq 1)}$ OR $\frac{\mathrm{P}(X=1)+\mathrm{P}(X=2)}{\mathrm{P}(X \geq 1)}$ **(A1)**

$\frac{0.597540...}{0.785361...}$ OR $\frac{0.812178...-0.214638...}{0.785361...}$ OR $\frac{0.338903...+0.258636...}{0.785361...}$ **(A1)**

$= 0.760847...$

$\mathrm{P}(X \leq 2 \mid X \geq 1) = 0.761$ ***A1***

[4 marks]

Total [7 marks]

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Question 12

(a) use of GDC to give *(M1)*

$r = 0.883529...$

$r = 0.884$ **A1**

Note: Award the ***(M1)*** for any correct value of r, a, b or $r^2 = 0.780624...$ seen in part (a) or part (b).

[2 marks]

(b) $a = 1.36609...$, $b = 64.5171...$

$a = 1.37$, $b = 64.5$ **A1**

[1 mark]

(c) attempt to find their difference *(M1)*

$5 \times 1.36609...$ OR $1.36609...(h+5) + 64.5171... - (1.36609...h + 64.5171...)$

$6.83045...$

$= 6.83$ $(6.85 \text{ from } 1.37)$

the student could have expected her score to increase by 7 marks. **A1**

Note: Accept an increase of 6, 6.83 or 6.85.

[2 marks]

Total [5 marks]

Question13

(a) $\mathrm{P}(C < 61)$ **(M1)**

$= 0.365112...$

$= 0.365$ **A1**

[2 marks]

(b) recognition of binomial eg $X \sim \mathrm{B}(12, 0.365...)$ **(M1)**

$\mathrm{P}(X = 5) = 0.213666...$

$= 0.214$ **A1**

[2 marks]

(c) (i) Let CM represent 'chocolate muffin' and BM represent 'banana muffin'

$\mathrm{P}(B < 61) = 0.0197555...$ **(A1)**

EITHER

$\mathrm{P}(CM) \times \mathrm{P}(C < 61 | CM) + \mathrm{P}(BM) \times \mathrm{P}(B < 61 | BM)$ (or equivalent in words) **(M1)**

OR

tree diagram showing two ways to have a muffin weigh < 61 **(M1)**

THEN

$(0.6 \times 0.365...) + (0.4 \times 0.0197...)$ **(A1)**

$= 0.226969...$

$= 0.227$ **A1**

(ii) recognizing conditional probability **(M1)**

Note: Recognition must be shown in context either in words or symbols, not just $\mathrm{P}(A \mid B)$.

$\dfrac{0.6 \times 0.365112...}{0.226969...}$ **(A1)**

$= 0.965183...$

$= 0.965$ **A1**

[7 marks]

(d) **METHOD 1**

$P(CM)\times P(C<61|CM)+P(BM)\times P(B<61|BM)=0.157$ ***(M1)***

$(0.6\times P(C<61))+(0.4\times 0.0197555...)=0.157$

$P(C<61)=0.248496...$ ***(A1)***

attempt to solve for σ using GDC ***(M1)***

Note: Award ***(M1)*** for a graph or table of values to show their $P(C<61)$ with a variable standard deviation.

$\sigma=1.47225...$

$\sigma=1.47$ (g) ***A2***

METHOD 2

$P(CM)\times P(C<61|CM)+P(BM)\times P(B<61|BM)=0.157$ ***(M1)***

$(0.6\times P(C<61))+(0.4\times 0.0197555...)=0.157$

$P(C<61)=0.248496...$ ***(A1)***

use of inverse normal to find z score of their $P(C<61)$ ***(M1)***

$z=-0.679229...$

correct substitution ***(A1)***

$\frac{61-62}{\sigma}=-0.679229...$

$\sigma=1.47225...$

$\sigma=1.47$ (g) ***A1***

[5 marks]

Total [16 marks]

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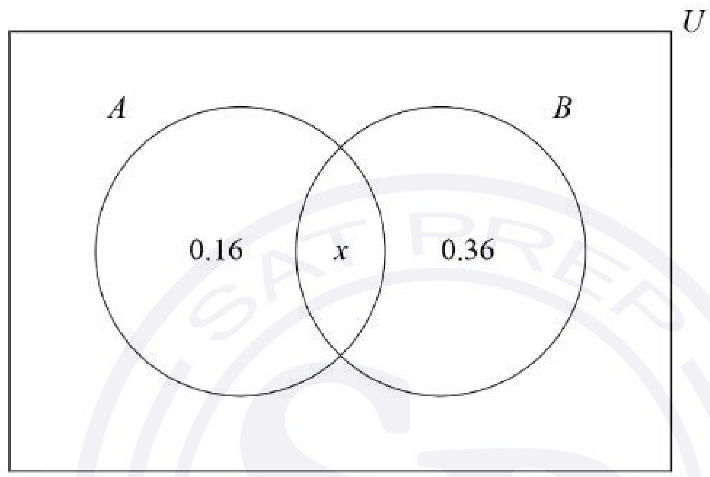
Question 14

(a) **METHOD 1**

EITHER

one of $\mathrm{P}(A) = x + 0.16$ OR $\mathrm{P}(B) = x + 0.36$ ***A1***

OR



A1

THEN

attempt to equate their $\mathrm{P}(A \cap B)$ with their expression for $\mathrm{P}(A) \times \mathrm{P}(B)$ ***M1***

$\mathrm{P}(A \cap B) = \mathrm{P}(A) \times \mathrm{P}(B) \Rightarrow x = (x + 0.16) \times (x + 0.36)$ ***A1***

$x = 0.24$ ***A1***

METHOD 2

attempt to form at least one equation in $\mathrm{P}(A)$ and $\mathrm{P}(B)$ using independence ***M1***

$\left(\mathrm{P}(A \cap B') = \mathrm{P}(A) \times \mathrm{P}(B') \Rightarrow\right)$ $\mathrm{P}(A) \times \left(1 - \mathrm{P}(B)\right) = 0.16$ OR

$\left(\mathrm{P}(A' \cap B) = \mathrm{P}(A') \times \mathrm{P}(B) \Rightarrow\right)$ $\left(1 - \mathrm{P}(A)\right) \times \mathrm{P}(B) = 0.36$

$\mathrm{P}(A) = 0.4$ AND $\mathrm{P}(B) = 0.6$ ***A1***

$\mathrm{P}(A \cap B) = \mathrm{P}(A) \times \mathrm{P}(B) = 0.4 \times 0.6$ ***(A1)***

$x = 0.24$ ***A1***

[4 marks]

(b) **METHOD 1**

recognising $\mathrm{P}(A' \mid B') = \mathrm{P}(A')$ ***(M1)***

$= 1 - 0.16 - 0.24$

$= 0.6$ ***A1***

METHOD 2

$\mathrm{P}(B) = 0.36 + 0.24 (= 0.6)$

$\mathrm{P}(A' \mid B') = \dfrac{\mathrm{P}(A' \cap B')}{\mathrm{P}(B')} \quad \left(= \dfrac{0.24}{0.4}\right)$ ***(A1)***

$= 0.6$ ***A1***

[2 marks]

Total [6 marks]

Question 15

(a) $0.41 + k - 0.28 + 0.46 + 0.29 - 2k^2 = 1$ OR $k - 2k^2 + 0.01 = 0.13$ (or equivalent) ***A1***

$2k^2 - k + 0.12 = 0$ ***AG***

[1 mark]

(b) one of 0.2 OR 0.3 ***(M1)***

$k = 0.3$ ***A1***

reasoning to reject $k = 0.2$ eg $\mathrm{P}(1) = k - 0.28 \geq 0$ therefore $k \neq 0.2$ ***R1***

[3 marks]

(c) attempting to use the expected value formula ***(M1)***

$\mathrm{E}(X) = 0 \times 0.41 + 1 \times (0.3 - 0.28) + 2 \times 0.46 + 3 \times (0.29 - 2 \times 0.3^2)$

$= 1.27$ ***A1***

[2 marks]

Total [6 marks]

Question 16

(a) **EITHER**

recognising that half the total frequency is 10 (may be seen in an ordered list or indicated on the frequency table) ***(A1)***

OR

$5+1+4=3+x$ ***(A1)***

OR

$\sum f=20$ ***(A1)***

THEN

$x=7$ ***A1***

[2 marks]

(b) **METHOD 1**

1.58429…

1.58 ***A2***

METHOD 2

EITHER

$$\sigma^2=\frac{5\times(2-4.3)^2+1\times(3-4.3)^2+4\times(4-4.3)^2+3\times(5-4.3)^2+7\times(6-4.3)^2}{20}\ (=2.51)$$ ***(A1)***

OR

$$\sigma^2=\frac{5\times2^2+1\times3^2+4\times4^2+3\times5^2+7\times6^2}{20}-4.3^2\ (=2.51)$$ ***(A1)***

THEN

$\sigma=\sqrt{2.51}=1.58429...$

$=1.58$ ***A1***

[2 marks]

Total [4 marks]

Question 17

(a) **METHOD 1**

$T \sim N(35, \sigma^2)$

$P(T > 40) = 0.25$ or $P(T < 40) = 0.75$ ***(M1)***

attempt to solve for σ graphically or numerically using the GDC ***(M1)***

graph of normal curve $T \sim N(35, \sigma^2)$ for $P(T > 40)$ and $y = 0.25$ OR $P(T < 40)$ and $y = 0.75$ OR table of values for $P(T < 40)$ or $P(T > 40)$

$\sigma = 7.413011...$

$\sigma = 7.41$ (min) ***A2***

METHOD 2

$T \sim N(35, \sigma^2)$

$P(T > 40) = 0.25$ or $P(T < 40) = 0.75$ ***(M1)***

$z = 0.674489...$ ***(A1)***

valid equation using their z-score (clearly identified as z-score and not a probability) ***(M1)***

$\frac{40-35}{\sigma} = 0.674489...$ OR $5 = 0.674489...\sigma$

$7.413011...$

$\sigma = 7.41$ (min) ***A1***

[4 marks]

(b) $P(T > 45)$ ***(M1)***

$= 0.0886718...$

$= 0.0887$ ***A1***

[2 marks]

(c) recognizing binomial probability *(M1)*

$L \sim \mathrm{B}(5,\ 0.0886718...)$

$\mathrm{P}(L \geq 1) = 1 - \mathrm{P}(L = 0)$ OR

$\mathrm{P}(L \geq 1) = \mathrm{P}(L = 1) + \mathrm{P}(L = 2) + \mathrm{P}(L = 3) + \mathrm{P}(L = 4) + \mathrm{P}(L = 5)$ *(M1)*

$0.371400\ldots$

$\mathrm{P}(L \geq 1) = 0.371$ ***A1***

[3 marks]

(d) recognizing conditional probability in context *(M1)*

finding $\{L < 3\} \cap \{L \geq 1\} = \{L = 1,\ L = 2\}$ (may be seen in conditional probability) *(A1)*

$\mathrm{P}(L = 1) + \mathrm{P}(L = 2) = 0.36532...$ (may be seen in conditional probability) *(A1)*

$\mathrm{P}(L < 3 \mid L \geq 1) = \dfrac{0.36532...}{0.37140...}$ *(A1)*

$0.983636\ldots$

0.984 ***A1***

[5 marks]

(e) **METHOD 1**

recognizing that Suzi can be late no more than once (in the remaining six days) *(M1)*

$\mathrm{X} \sim \mathrm{B}(6,\ 0.0886718...)$, where X is the number of days late *(A1)*

$\mathrm{P}(X \leq 1) = \mathrm{P}(X = 0) + \mathrm{P}(X = 1)$ *(M1)*

$= 0.907294...$

$\mathrm{P}(\text{Suzi gets a bonus}) = 0.907$ ***A1***

METHOD 2

recognizing that Suzi must be on time at least five times (of the remaining six days) *(M1)*

$\mathrm{X} \sim \mathrm{B}(6,\ 0.911328...)$, where X is the number of days on time *(A1)*

$\mathrm{P}(X \geq 5) = 1 - \mathrm{P}(X \leq 4)$ OR $1 - 0.0927052...$OR $\mathrm{P}(X = 5) + (X = 6)$ OR
$0.334434... + 0.572860...$ *(M1)*

$= 0.907294...$

$\mathrm{P}(\text{Suzi gets a bonus}) = 0.907$ ***A1***

[4 marks]

Total [18 marks]

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Question 18

(a) 0.28 (s) ***A1***

[1 mark]

(b) $\text{IQR} = 0.35 - 0.27\ (= 0.08)$ (s) ***(A1)***

substituting **their** IQR into correct expression for upper fence ***(A1)***

$0.35 + 1.5 \times 0.08\ (= 0.47)$ (s)

$0.46 < 0.47$ ***R1***

so 0.46 (s) is not an outlier ***AG***

[3 marks]

Question 19

$\mathrm{P}(A \cup B) = \mathrm{P}(A) + \mathrm{P}(B) - \mathrm{P}(A \cap B) = 0.68$

substitution of $\mathrm{P}(A) \cdot \mathrm{P}(B)$ for $\mathrm{P}(A \cap B)$ in $\mathrm{P}(A \cup B)$ ***(M1)***

$\mathrm{P}(A) + \mathrm{P}(B) - \mathrm{P}(A)\mathrm{P}(B)\ (= 0.68)$

substitution of $3\mathrm{P}(B)$ for $\mathrm{P}(A)$ ***(M1)***

$3\mathrm{P}(B) + \mathrm{P}(B) - 3\mathrm{P}(B)\mathrm{P}(B) = 0.68$ (or equivalent) ***(A1)***

Note: The first two ***M*** marks are independent of each other.

attempts to solve their quadratic equation ***(M1)***

$\mathrm{P}(B) = 0.2, 1.133\ldots \left(\frac{1}{5}, \frac{17}{15}\right)$

$\mathrm{P}(B) = 0.2 \left(= \frac{1}{5}\right)$ ***A2***

Note: Award ***A1*** if both answers are given as final answers for $\mathrm{P}(B)$.

[6 marks]

Question 20

(a) recognising to find $\mathrm{P}(T > 40)$ ***(M1)***

$\mathrm{P}(T > 40) = 0.574136...$

$\mathrm{P}(T > 40) = 0.574$ ***A1***

[2 marks]

(b) attempt to multiply four independent probabilities using their $\mathrm{P}(T > 40)$ and $\mathrm{P}(T < 40)$ ***(M1)***

$(1-p)^3 \cdot p$ OR $(1-0.574136...)^3 \cdot 0.574136...$ OR $(0.425863...)^3 \cdot 0.574136...$ ***(A1)***

0.0443430...

0.0443 , 0.0444 from 3 sf values ***A1***

[3 marks]

(c) (i) recognizing conditional probability ***(M1)***

$\mathrm{P}(T < 55 \mid T > 40)$

$\dfrac{\mathrm{P}(40 < T < 55)}{\mathrm{P}(T > 40)}$ ***(A1)***

$\dfrac{0.461944...}{0.574136...}$ ***(A1)***

$\mathrm{P}(T < 55 \mid T > 40) = 0.804590...$

$= 0.805$ ***A1***

(ii) recognizing binomial probability ***(M1)***

$X \sim \mathrm{B}(n,\ p)$

$n = 10$ and $p = 0.804589...$ ***(A1)***

$0.0242111..., 0.0240188...$ using $p = 0.805$

$\mathrm{P}(X = 5) = 0.0242$ ***A1***

[7 marks]

(d) Let $\mathrm{P}(T < a) = x$

recognition that probabilities sum to 1 (seen anywhere) ***(M1)***

EITHER

expressing the three regions in one variable ***(M1)***

$x + 0.904 + 2x$ OR $\mathrm{P}(T < a) + 0.904 + 2\mathrm{P}(T < a)$ OR $\frac{1}{2}\mathrm{P}(T > b) + 0.904 + \mathrm{P}(T > b)$

OR x and $2x$ correctly indicated on labelled bell diagram

$\mathrm{P}(T < a) + 0.904 + 2\mathrm{P}(T < a) = 1$ OR $\frac{1}{2}\mathrm{P}(T > b) + 0.904 + \mathrm{P}(T > b) = 1$ (or equivalent) ***(A1)***

OR

expressing either $\mathrm{P}(T < a)$ or $\mathrm{P}(T > b)$ only in terms of $\mathrm{P}(a \le T \le b)$ ***(M1)***

$\left(\mathrm{P}(T < a) =\right)\frac{1}{3}\left(1 - \mathrm{P}(a \le T \le b)\right)$ OR $\left(\mathrm{P}(T > b) =\right)\frac{2}{3}\cdot\left(1 - \mathrm{P}(a \le T \le b)\right)$

$x = \frac{1}{3}(1 - 0.904)(= 0.032)$ OR $\mathrm{P}(T > b) = \frac{2}{3}(1 - 0.904)(= 0.064)$ ***(A1)***

THEN

$\mathrm{P}(T < a) = 0.032$

$a = 22.18167...$

$a = 22.2$ accept 22.1 ***A1***

[4 marks]

Total [16 marks]

Question 20

(a) 1.01206…, 2.45230…

$a = 1.01$, $b = 2.45$ $(1.01x + 2.45)$ ***A1A1***

[2 marks]

(b) 0.981464…

$r = 0.981$ ***A1***

Note: A common error is to enter the data incorrectly into the GDC, and obtain the answers $a = 1.01700...$, $b = 2.09814...$ and $r = 0.980888...$ Some candidates may write the 3 sf answers, ie. $a = 1.02$, $b = 2.10$ and $r = 0.981$ or 2 sf answers, ie. $a = 1.0$, $b = 2.1$ and $r = 0.98$. In these cases award ***A0A0*** for part (a) and ***A0*** for part (b). Even though some values round to an accepted answer, they come from incorrect working.

[1 mark]

(c) correct substitution of 78 into **their** regression equation ***(M1)***

81.3930… 81.23 from 3 sf answer

81 ***A1***

[2 marks]

Total [5 marks]

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