Answer 1:

(a) use of symmetry *eg* diagram **(M1)**

$\mathrm{P}(X > \mu + 5) = 0.2$ **A1**

[2 marks]

(b) **EITHER**

$\mathrm{P}(X < \mu + 5 \mid X > \mu - 5) = \dfrac{\mathrm{P}(X > \mu - 5 \cap X < \mu + 5)}{\mathrm{P}(X > \mu - 5)}$ **(M1)**

$= \dfrac{\mathrm{P}(\mu - 5 < X < \mu + 5)}{\mathrm{P}(X > \mu - 5)}$ **(A1)**

$= \dfrac{0.6}{0.8}$ **A1A1**

Note: ***A1*** for denominator is independent of the previous ***A*** marks.

OR

use of diagram **(M1)**

Note: Only award ***(M1)*** if the region $\mu - 5 < X < \mu + 5$ is indicated and used.

$\mathrm{P}(X > \mu - 5) = 0.8 \quad \mathrm{P}(\mu - 5 < X < \mu + 5) = 0.6$ **(A1)**

Note: Probabilities can be shown on the diagram.

$= \dfrac{0.6}{0.8}$ **M1A1**

THEN

$= \dfrac{3}{4} = (0.75)$ **A1**

[5 marks]

Total [7 marks]

Answer 2:

3. (a) recognising to find $y(25)$ ***(M1)***

$y(25) = -0.6 \times 25^2 + 23 \times 25 + 110$

$= 310$ (children) ***A1***

[2 marks]

(b) recognizing x on y is required ***(M1)***

$0.0935114\ldots$ and $7.43053\ldots$ ***(A1)***

$x = 0.0935y + 7.43$ ***A1***

[3 marks]

(c) attempt to substitute their answer to part (a) into their regression equation for either x or y ***(M1)***

$x = 0.0935114... \times 310 + 7.43053...(= 36.4190...)$

36 (accept 37 or 36.4) ***A1***

Note:	Award ***(M1)A1FT*** for $x = 37$ found from using $y = 9.39x - 41.5$. Award ***(M1)A0FT*** for a correct ***FT*** answer that lies outside $[15, 46]$.

[2 marks]

Total [7 marks]

Answer 3:

3. (a) attempt to use definition of outlier

$1.5\times 20+Q_3$ ***(M1)***

$1.5\times 20+U\geq 75$ $(\Rightarrow U\geq 45$, accept $U>45)$ OR $1.5\times 20+Q_3=75$ ***A1***

minimum value of $U=45$ ***A1***

[3 marks]

(b) attempt to use interquartile range ***(M1)***

$U-L=20$ (may be seen in part (a)) OR $L\geq 25$ (accept $L>25$)

minimum value of $L=25$ ***A1***

[2 marks]

Total [5 marks]

Answer 4:

10. (a) recognizing probabilities sum to 1 ***(M1)***

$0.288 + \mathrm{P}(94.6 < X < 98.1) + 0.434 = 1$

$\mathrm{P}(94.6 < X < 98.1) = 0.278$ ***A1***

Note: If no working shown, award ***(M1)A0*** for $\mathrm{P}(94.6 < X < 98.1) = 0.28$ (2sf).

[2 marks]

(b) **METHOD 1**

recognizing the need to use inverse normal with 0.288, $(1-0.434)$ or 0.434 ***(M1)***

Note: Accept use of calculator notation eg $\mathrm{invNorm}(0.288)(= \ 0.559236...)$.

$\mu + \mathrm{invNorm}(0.288)\sigma = 94.6, \mu + \mathrm{invNorm}(1-0.434)\sigma = 98.1$ (or equivalent) ***(A1)(A1)***

attempt to solve their equations in two variables using the GDC (that involve either z-values or 'invNorm' rather than probabilities) ***(M1)***

$\mu = 97.2981...,\ \sigma = 4.82468...$

$\mu = 97.3,\ \sigma = 4.82$ ***A1***

Note: Condone use of different variables throughout, but do not award the final ***A1*** if they do not clearly identify which variable is their mean and standard deviation.

METHOD 2

use of inverse normal to find at least one z-score for $\mathrm{P}(Z < z) = 0.288$ or $\mathrm{P}(Z < z) = 1 - 0.434$ ***(M1)***

$z_1 = -0.559236...$ OR $z_2 = 0.166199...$

$\frac{94.6-\mu}{\sigma} = -0.559236...$, $\frac{98.1-\mu}{\sigma} = 0.166199...$ (or equivalent) ***(A1)(A1)***

attempt to solve their equations (that involve z-values rather than probabilities) ***(M1)***

$\mu = 97.2981...,\ \sigma = 4.82468...$

$\mu = 97.3,\ \sigma = 4.82$ ***A1***

Note: Award marks as appropriate for work seen in part (a).

Note: If no working shown, award ***(M1)(A0)(A0)(M1)A0*** for $\mu = 97,\ \sigma = 4.8$ (2sf).

[5 marks]

(c) (i) recognition of Binomial distribution ***(M1)***

$X \sim \mathrm{B}(100, 0.434)$

$\mathrm{P}(X = 34) = 0.0133198...$

$= 0.0133$ ***A1***

Note: If no working shown, award ***(M1)A0*** for $\mathrm{P}(X = 34) = 0.013$ (2sf).

(ii) $\mathrm{P}(X < 49) = 0.848218...$ (seen anywhere) ***(A1)***

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

Note: recognition must be shown in context, either in symbols eg $\mathrm{P}(X = 34 \mid X < 49)$, or in words eg $\mathrm{P}(34 \text{ plants} \mid \text{less than } 49 \text{ plants})$, not only as $\mathrm{P}(A \mid B)$.

$\left(\mathrm{P}(X = 34 \mid X < 49) =\right) \dfrac{\mathrm{P}(X = 34)}{\mathrm{P}(X < 49)}$ OR $\dfrac{\mathrm{P}(X = 34)}{\mathrm{P}(X \le 48)}$ $\left(= \dfrac{0.0133198...}{0.848218...}\right)$ ***(A1)***

$= 0.0157033...$

$\mathrm{P}(X = 34 \mid X < 49) = 0.0157$ ***A1***

Note: Exception to ***FT***: If the candidate finds $\mathrm{P}(X \le 49)$ $(= 0.890474...)$ and uses that to calculate $\mathrm{P}(X = 34 \mid X \le 49) = 0.0149581...$ award ***(A0)(M1)(A1)A0***.

Note: If no working shown, award ***(A0)(M1)(A0)A0*** for $\mathrm{P}(X = 34 \mid X < 49) = 0.016$ (2sf).

[6 marks]

(d) $Q_1 = 96.19$ OR $Q_3 = 101.01$ (may be seen on a labelled diagram with areas indicated) ***(A1)***

$P(96.19 < F < 101.01) = 0.5$ OR $P(F < 96.19) = 0.25$ OR $P(F < 101.01) = 0.75$ (or equivalent)

EITHER

attempt to find d using graph or table ***(M1)***

OR

$1 - 2P\left(Z < -\frac{2.41}{d}\right) = 0.5$ OR $P(Z < -\frac{2.41}{d}) = 0.25$ OR $P(Z < \frac{2.41}{d}) = 0.75$

OR $P(-\frac{2.41}{d} < Z < \frac{2.41}{d}) = 0.5$ (or equivalent) ***(M1)***

$-\frac{2.41}{d} = -0.674489...$ OR $\frac{2.41}{d} = 0.674489...$

THEN

$3.57307...$

$d = 3.57$ ***A1***

Note: Accept 3.56 using 96.2 or 101.

Note: If no working shown, award ***(A0)(M1)A0*** for $d = 3.6$ (2sf).

[3 marks]

Total [16 marks]

Answer 5:

(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]

(c) substitution into **their** x on y equation **_(M1)_**

$x = 1.29082(29) - 10.3793$

$x = 27.1$ **_A1_**

Note: Accept 27.

[2 marks]

Total [7 marks]

Answer 6:

1. (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]

(d) Lucy is incorrect in suggesting there is a causal relationship.
This might be true, but the data can only indicate a correlation. ***R1***

Note: Accept 'Lucy is incorrect as correlation does not imply causation' or equivalent.

[1 mark]

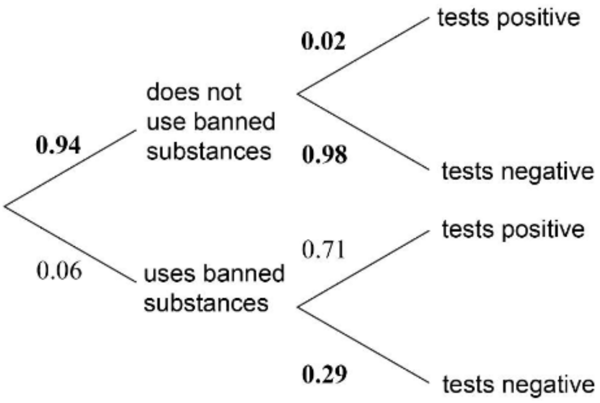
(e) no effect ***A1***

[1 mark]

Total [7 marks]

Answer 7:

3. (a)



A1A1

Note:	Award ***A1*** for any one value correct, ***A1*** for other three values correct. Accept percentage responses as equivalent forms on **all** branches.

[2 marks]

(b) (i) multiplication of two probabilities along the tree diagram ***(M1)***

0.94×0.98

$= 0.921 \ (0.9212, 92.1\%, 92.12\%)$ ***A1***

(ii) $(0.9212)^2$ ***(A1)***

$= 0.849 \ (0.848609\ldots, 84.9\%, 84.8609...\%)$ ***A1***

[4 marks]

(c) (i) $0.94 \times 0.02 + 0.06 \times 0.29$ ***(A1)(M1)***

Note: Award ***A1*** for two correct products from their tree diagram seen, ***M1*** for the addition of their two products.

$0.0362 \ (3.62\%)$ ***A1***

(ii) multiplying their part (c)(i) by 1300

0.0362×1300 ***(M1)***

$47.1 \ (47.06)$ ***A1***

[5 marks]

(d) $p = 0.02$ **OR** $p = 0.98$ ***(A1)***

recognition of binomial probability with $n = 20$ ***(M1)***

$\mathrm{P}(X = 0)$ **OR** $\mathrm{P}(X = 20)$ ***(M1)***

$0.668 \ (0.667607...)$ ***A1***

Note: Award ***(A1)(M1)(M1)A0*** for an answer of 0.667. $0.98^{20} = 0.668 \ (0.667607\ldots)$ is awarded full marks.

[4 marks]

(e) $\mathrm{P}(X \geq 3)$ **OR** $\mathrm{P}(X \leq 17)$ ***(M1)***

$0.00707 \ (0.00706869...)$ ***A1***

Note: Award ***(M1)A0*** for an answer of 0.00706. Award ***(M1)A0*** for an answer of 0.0599 $(0.0598989\ldots)$, obtained from the use of $\mathrm{P}(X \geq 2)$. ***FT*** from their value of p in part (d)

[2 marks]

[Total: 17 marks]

Answer 8:

16. (a) Let X be the random variable number of shots taken in a 12 minute period

$X \sim \mathrm{Po}(5)$ ***(A1)***

$\mathrm{P}(X \le 6) = 0.762 \quad (= 0.762183...)$ ***A1***

[2 marks]

(b) $\mathrm{P}(\text{less than 4 shots } \cap \text{success at least once})$

METHOD 1

$= \mathrm{P}(\text{less than 4 shots}) - \mathrm{P}(\text{less than 4 shots } \cap \text{zero success})$ ***(M1)***

Note: Might be communicated in Venn diagram.

attempt to multiply by different powers of 0.6 ***(M1)***

$= \mathrm{P}(X \le 3) - (\mathrm{P}(X=0)\times(0.6)^0 + \mathrm{P}(X=1)\times(0.6)^1 + \mathrm{P}(X=2)\times(0.6)^2 + \mathrm{P}(X=3)\times(0.6)^3)$

(A1)

$= 0.414 \quad (= 0.413845...)$ ***A1***

METHOD 2

attempt to multiply by different powers of 0.4 ***(M1)***

$= \mathrm{P}(X=1)\times(0.4)^1 + \mathrm{P}(X=2)\times\left((0.4)^2 + 2\times0.4\times0.6\right) + \mathrm{P}(X=3)\times\left((0.4)^3 + 3\times0.4^2\times0.6 + 3\times0.4\times0.6^2\right)$

(M1)(A1)

Note: Award ***M1*** for recognizing the six different cases, e.g. $2\times0.4\times0.6$ (etc.) or equivalent seen, ***A1*** for completely correct expression.

$= 0.414 \quad (= 0.413845...)$ ***A1***

[4 marks]

[Total 6 marks]

Answer 9:

10. **EITHER**

let $y_i = x_i - 12$

$\bar{x} = 10 \Rightarrow \bar{y} = -2$ ***M1A1***

$\sigma_x = \sigma_y = 3$ ***A1***

$\dfrac{\sum_{i=1}^{10} y_i^2}{10} - \bar{y}^2 = 9$ ***M1A1***

$\sum_{i=1}^{10} y_i^2 = 10(9+4) = 130$ ***A1***

OR

$\sum_{i=1}^{10}(x_i - 12)^2 = \sum_{i=1}^{10} x_i^2 - 24\sum_{i=1}^{10} x_i + 144\sum_{i=1}^{10} 1$ ***M1A1***

$\bar{x} = 10 \Rightarrow \sum_{i=1}^{10} x_i = 100$ ***A1***

$\sigma_x = 3$, $\dfrac{\sum_{i=1}^{10} x_i^2}{10} - \bar{x}^2 = 9$ ***(M1)***

$\Rightarrow \sum_{i=1}^{10} x_i^2 = 10(9+100)$ ***A1***

$\sum_{i=1}^{10}(x_i - 12)^2 = 1090 - 2400 + 1440 = 130$ ***A1***

[6 marks]