correct substitution ***(A1)***

eg 0.3×0.6

$\mathrm{P}(A \cap B) = 0.18$ ***A1 N2***

[2 marks]

20b. *[2 marks]*

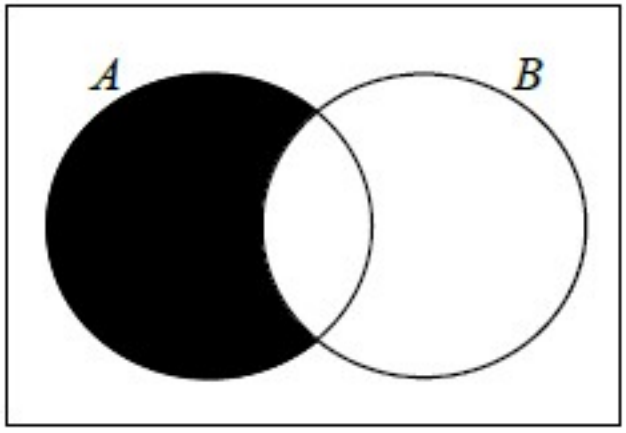
correct substitution ***(A1)***

eg $\mathrm{P}(A \cup B) = 0.3 + 0.6 - 0.18$

$\mathrm{P}(A \cup B) = 0.72$ ***A1 N2***

[2 marks]

20c. *[1 mark]*



A1 N1

20d. *[2 marks]*

Markscheme

appropriate approach ***(M1)***

eg $0.3 - 0.18,\ \mathrm{P}(A) \times \mathrm{P}(B')$

$\mathrm{P}(A \cap B') = 0.12$ (may be seen in Venn diagram) ***A1 N2***

[2 marks]

21a. *[2 marks]*

attempt to find number who took less than 45 minutes ***(M1)***

eg line on graph (vertical at approx 45, or horizontal at approx 70)

70 students (accept 69) ***A1*** ***N2***

[2 marks]

21b. *[3 marks]*

55 students completed task in less than 35 minutes ***(A1)***

subtracting **their** values ***(M1)***

eg 70 – 55

15 students ***A1*** ***N2***

[3 marks]

21c. *[2 marks]*

correct approach ***(A1)***

eg line from *y*-axis on 50

$k = 33$ ***A1*** ***N2***

[2 marks]

22a. *[2 marks]*

Note: There may be slight differences in answers, depending on whether candidates use tables or GDCs, or their 3 sf answers in subsequent parts. Do not penalise answers that are consistent with **their** working and check carefully for ***FT***.

attempt to standardize ***(M1)***

eg $z = \frac{21.8-20}{1.25},\ 1.44$

$\mathrm{P}(T < 21.8) = 0.925$ ***A1*** ***N2***

[2 marks]

22b. *[5 marks]*

Note: There may be slight differences in answers, depending on whether candidates use tables or GDCs, or their 3 sf answers in subsequent parts. Do not penalise answers that are consistent with **their** working and check carefully for ***FT***.

attempt to subtract probabilities ***(M1)***

eg $\mathrm{P}(T < 21.8) - \mathrm{P}(T < k) = 0.3,\ 0.925 - 0.3$

$\mathrm{P}(T < k) = 0.625$ ***A1***

EITHER

finding the z-value for 0.625 ***(A1)***

eg $z = 0.3186$ (from tables), $z = 0.3188$

attempt to set up equation using **their** z-value ***(M1)***

eg $0.3186 = \frac{k-20}{1.25},\ -0.524 \times 1.25 = k - 20$

$k = 20.4$ ***A1*** ***N3***

OR

$k = 20.4$ ***A3*** ***N3***

[5 marks]

23a. *[5 marks]*

(i) attempt to find $\mathrm{P}(\text{red}) \times \mathrm{P}(\text{red})$ ***(M1)***

eg $\frac{3}{8} \times \frac{2}{7}$, $\frac{3}{8} \times \frac{3}{8}$, $\frac{3}{8} \times \frac{2}{8}$

$\mathrm{P}(\text{none green}) = \frac{6}{56} \left(= \frac{3}{28}\right)$ ***A1*** ***N2***

(ii) attempt to find $\mathrm{P}(\text{red}) \times \mathrm{P}(\text{green})$ ***(M1)***

eg $\frac{5}{8} \times \frac{3}{7}$, $\frac{3}{8} \times \frac{5}{8}$, $\frac{15}{56}$

recognizing two ways to get one red, one green ***(M1)***

eg $2\mathrm{P}(R) \times \mathrm{P}(G)$, $\frac{5}{8} \times \frac{3}{7} + \frac{3}{8} \times \frac{5}{7}$, $\frac{3}{8} \times \frac{5}{8} \times 2$

$\mathrm{P}(\text{exactly one green}) = \frac{30}{56} \left(= \frac{15}{28}\right)$ ***A1 N2***

[5 marks]

23b. *[3 marks]*

$\mathrm{P}(\text{both green}) = \frac{20}{56}$ (seen anywhere) ***(A1)***

correct substitution into formula for $\mathrm{E}(X)$ ***A1***

eg $0 \times \frac{6}{56} + 1 \times \frac{30}{56} + 2 \times \frac{20}{56}$, $\frac{30}{64} + \frac{50}{64}$

expected number of green marbles is $\frac{70}{56} \left(= \frac{5}{4}\right)$ ***A1 N2***

[3 marks]

23c. *[2 marks]*

(i) $\mathrm{P}(\text{jar B}) = \frac{4}{6} \left(= \frac{2}{3}\right)$ ***A1 N1***

(ii) $\mathrm{P}(\text{red}|\text{ jar B}) = \frac{6}{8} \left(= \frac{3}{4}\right)$ ***A1 N1***

[2 marks]

23d. *[6 marks]*

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

eg $\mathrm{P}(A|R)$, $\frac{\mathrm{P}(\text{jar A and red})}{\mathrm{P}(\text{red})}$, tree diagram

attempt to multiply along either branch (may be seen on diagram) ***(M1)***

eg $\mathrm{P}(\text{jar A and red}) = \frac{1}{3} \times \frac{3}{8} \left(= \frac{1}{8}\right)$

attempt to multiply along **other** branch ***(M1)***

eg $\mathrm{P}(\text{jar B and red}) = \frac{2}{3} \times \frac{6}{8} \left(= \frac{1}{2}\right)$

adding the probabilities of two mutually exclusive paths ***(A1)***

eg $\mathrm{P}(\text{red}) = \frac{1}{3} \times \frac{3}{8} + \frac{2}{3} \times \frac{6}{8}$

correct substitution

eg $\mathrm{P}(\text{jar A}|\text{red}) = \frac{\frac{1}{3} \times \frac{3}{8}}{\frac{1}{3} \times \frac{3}{8} + \frac{2}{3} \times \frac{6}{8}}, \frac{\frac{1}{8}}{\frac{5}{8}}$ ***A1***

$\mathrm{P}(\text{jar A}|\text{red}) = \frac{1}{5}$ ***A1 N3***

[6 marks]

24a. *[2 marks]*

valid approach ***(M1)***

eg $35 - 26, 26 + p = 36$

$p = 9$ ***A1 N2***

[2 marks]

24b. *[4 marks]*

(i) mean $= 26.7$ ***A2 N2***

(ii) recognizing that variance is $(\text{sd})^2$ ***(M1)***

eg $11.021\ldots^2, \sigma = \sqrt{\text{var}}, 11.158\ldots^2$

$\sigma^2 = 121$ ***A1 N2***

[4 marks]

25a. *[2 marks]*

evidence of valid approach ***(M1)***

e.g. $92 + 52$, line on graph at $x = 31$

$p = 144$ ***A1 N2***

[2 marks]

25b. *[5 marks]*

(i) evidence of valid approach ***(M1)***

e.g. line on graph, 0.8×160, using complement

$= 29.5$ ***A1 N2***

(ii) $Q_1 = 23$; $Q_3 = 29$ ***(A1)(A1)***

$\text{IQR} = 6$ (accept any notation that suggests an interval) ***A1 N3***

[5 marks]

26a. *[1 mark]*

$\text{median} = 174(\text{cm})$ ***A1 N1***

[1 mark]

26b. *[2 marks]*

attempt to find number shorter than 161 ***(M1)***

e.g. line on graph, 12 boys

$p = \frac{12}{200} (= 0.06)$ ***A1 N2***

[2 marks]

26c. *[3 marks]*

METHOD 1

18% have a height less than h ***(A1)***

$0.18 \times 200 = 36$ (36 may be seen as a line on the graph) ***(A1)***

$h = 166$ (cm) ***A1*** ***N2***

METHOD 2

$0.82 \times 200 = 164$ (164 may be seen as a line on the graph) ***(A1)***

$200 - 164 = 36$ ***(A1)***

$h = 166$ (cm) ***A1*** ***N2***

[3 marks]

27a. *[1 mark]*

$\mathrm{P}(X = 2) = \frac{4}{14} \left(= \frac{2}{7}\right)$ ***A1*** ***N1***

[1 mark]

27b. *[4 marks]*

$\mathrm{P}(X = 1) = \frac{1}{14}$ ***(A1)***

$\mathrm{P}(X = k) = \frac{k^2}{14}$ ***(A1)***

setting the sum of probabilities $= 1$ ***M1***

e.g. $\frac{1}{14} + \frac{4}{14} + \frac{k^2}{14} = 1$, $5 + k^2 = 14$

$k^2 = 9$ (accept $\frac{k^2}{14} = \frac{9}{14}$) ***A1***

$k = 3$ ***AG*** ***N0***

[4 marks]

27c. *[2 marks]*

correct substitution into $\mathrm{E}(X) = \sum xP(X = x)$ ***A1***

e.g. $1\left(\frac{1}{14}\right) + 2\left(\frac{4}{14}\right) + 3\left(\frac{9}{14}\right)$

$\mathrm{E}(X) = \frac{36}{14}\left(= \frac{18}{7}\right)$ ***A1*** ***N1***

[2 marks]
