Answer 1:

(a) **METHOD 1**

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$ **M1**

$= P(A) + P(A \cap B) + P(A' \cap B) - P(A \cap B)$ **M1A1**

$= P(A) + P(A' \cap B)$ **AG**

METHOD 2

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$ **M1**

$= P(A) + P(B) - P(A|B) \times P(B)$ **M1**

$= P(A) + \left(1 - P(A|B)\right) \times P(B)$

$= P(A) + P(A'|B) \times P(B)$ **A1**

$= P(A) + P(A' \cap B)$ **AG**

[3 marks]

(b) **(i)**   use $P(A \cup B) = P(A) + P(A' \cap B)$ and $P(A' \cap B) = P(B \mid A')P(A')$ **(M1)**

$\dfrac{4}{9} = P(A) + \dfrac{1}{6}\left(1 - P(A)\right)$ **A1**

$8 = 18P(A) + 3\left(1 - P(A)\right)$ **M1**

$P(A) = \dfrac{1}{3}$ **AG**

(ii) **METHOD 1**

$P(B) = P(A \cap B) + P(A' \cap B)$ **M1**

$= P(B \mid A)P(A) + P(B \mid A')P(A')$ **M1**

$= \dfrac{1}{3} \times \dfrac{1}{3} + \dfrac{1}{6} \times \dfrac{2}{3} = \dfrac{2}{9}$ **A1**

METHOD 2

$P(A \cap B) = P(B \mid A)P(A) \Rightarrow P(A \cap B) = \dfrac{1}{3} \times \dfrac{1}{3} = \dfrac{1}{9}$ **M1**

$P(B) = P(A \cup B) + P(A \cap B) - P(A)$ **M1**

$P(B) = \dfrac{4}{9} + \dfrac{1}{9} - \dfrac{1}{3} = \dfrac{2}{9}$ **A1**

[6 marks]

Total [9 marks]

Answer 2:

12. (a)　$\dfrac{4}{18}\left(\dfrac{2}{9}\right)$　　　　　　　　　　　　　　　　　　　　　　　　**A1**

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　[1 mark]

(b)　$-3 \times \dfrac{1}{18} + (-1) \times \dfrac{4}{18} + 0 \times \dfrac{3}{18} + \ldots + 5 \times \dfrac{7}{18}$　　　　**(M1)**

Note: Award **(M1)** for their correct substitution into the formula for expected value.

　　　$= 1.83 \left(\dfrac{33}{18},\, 1.83333\ldots\right)$　　　　　　　　　　　　**A1**

　　　　　　　　　　　　　　　　　　　　　　　　　　　　[2 marks]

(c)　$2 \times \dfrac{1}{18} \times \dfrac{3}{18}$　　　　　　　　　　　　　　**(M1)(M1)**

Note: Award **(M1)** for $\dfrac{1}{18} \times \dfrac{3}{18}$, award **(M1)** for multiplying their product by 2.

　　　$= \dfrac{1}{54}\left(\dfrac{6}{324},\, 0.0185185\ldots,\, 1.85\%\right)$　　　　　　**A1**

　　　　　　　　　　　　　　　　　　　　　　　　　　[3 marks]

　　　　　　　　　　　　　　　　　　　　　　　Total [6 marks]

Answer 3:

5. (a)　$(\mathrm{E}(X) =)\ 10 \times 0.8$　　　　　　　　　　　　　　**(M1)**
　　　　8 (people)　　　　　　　　　　　　　　　　　　　**A1**
　　　　　　　　　　　　　　　　　　　　　　　　　[2 marks]

(b)　recognition of binomial probability　　　　　　　**(M1)**
　　　0.0881　(0.0880803…)　　　　　　　　　　　　　**A1**
　　　　　　　　　　　　　　　　　　　　　　　　　[2 marks]

(c)　0.8 and 6 seen　**OR**　0.2 and 3 seen　　　　　　**(A1)**
　　　attempt to use binomial probability　　　　　　　**(M1)**
　　　0.121　(0.120873…)　　　　　　　　　　　　　　**A1**
　　　　　　　　　　　　　　　　　　　　　　　　　[3 marks]
　　　　　　　　　　　　　　　　　　　　　Total [7 marks]

Answer 4:

9. (a) $X \sim \mathrm{N}(4, 0.25^2)$

EITHER
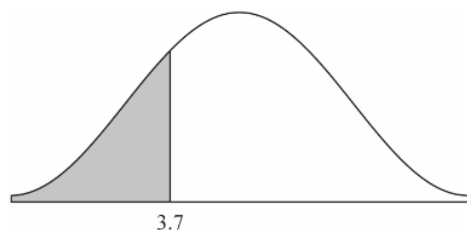correct probability expression   *(M1)*
$\mathrm{P}(X < 3.7)$

Note: Accept a weak or strict inequality, and any label instead of X, e.g. length or L.

OR

normal curve with vertical line, left of mean, labelled 3.7, and shaded region *(M1)*

3.7

THEN
0.115 (0.115069…, 11.5%)   *A1*

Note: Award *M1A0* for 0.12 if no previous working.

[2 marks]

(b) **EITHER**
Correct probability expression   *(M1)*
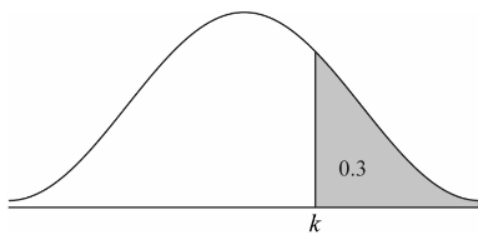$(\mathrm{P}(X < k) = 0.7$ **OR** $\mathrm{P}(X > k) = 0.3$

Note: Accept a weak or strict inequality, and any label instead of X *e.g.*, length or L.

OR
normal curve with vertical line to the right of the mean and shaded
region, correctly labelled either 0.3 or 0.7   *(M1)*

THEN
$(k =)$ 4.13 (4.13110...)   *A1*

Note: Award *M1A0* for 4.1 if no previous working.

[2 marks]

(c) **EITHER**
correct probability equation   *(M1)*
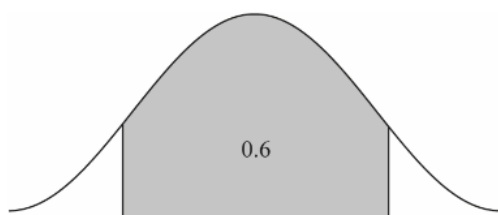$P(\text{length} < 4 + m) = 0.8$ **OR** $P(\text{length} < 4 - m) = 0.2$

Note: Accept any letter instead of "length" *e.g.*, X or L.

OR
normal curve with vertical lines symmetrical about the mean line with a correct
indication of an area of 0.6 or 0.2 or 0.8   *(M1)*

THEN
0.210 (0.210405...)   *A1*

Note: Award *(M1)A0* for an answer of 3.7895 or 4.2105 seen without working.

[2 marks]
Total [6 marks]

Answer 5:

1. (a) $\left(\dfrac{17+25}{130}=\right)\dfrac{42}{130}\left(\dfrac{21}{65},\ 0.323076...\right)$ *A1*

[1 mark]

(b) $\left(\dfrac{17}{17+25}=\right)\dfrac{17}{42}\ (0.404761...)$ *A1A1*

> **Note:** Award *A1* for correct numerator and *A1* for correct denominator.
> Award *A1A0* for working of $\dfrac{17/130}{\text{their answer to (a)}}$ if followed by an
> incorrect answer.

[2 marks]

(c) $\dfrac{41}{130}\times\dfrac{40}{129}$ *A1M1*

> **Note:** Award *A1* for two correct fractions seen, *M1* for multiplying their fractions.

$=\dfrac{1640}{16770}\approx 0.0978\left(0.0977936...,\ \dfrac{164}{1677}\right)$ *A1*

[3 marks]
Total [6 marks]

Answer 6:

8. (a)

t	1	2	3	4	5	6
$P(T=t)$	$\dfrac{1}{36}$ (0.027777…)	$\dfrac{3}{36}$ (0.083333…)	$\dfrac{5}{36}$ (0.138888…)	$\dfrac{7}{36}$ (0.194444…)	$\dfrac{9}{36}$ (0.25)	$\dfrac{11}{36}$ (0.305555…)

A2

> **Note:** Award *A1* if three to five probabilities are correct.

[2 marks]

(b) (i) $\dfrac{32}{36}$ $\left(\dfrac{8}{9}, \ 0.888888…, \ 88.9\%\right)$ *(A1)*

    (ii)   use of conditional probability   *(M1)*
        e.g. denominator of 32 **OR** denominator of 0.888888…, etc.

        $\dfrac{11}{32}$ $\left(0.34375, \ 34.4\%\right)$ *A1*

[3 marks]

(c) $\dfrac{1\times1+3\times2+5\times3+…+11\times6}{36}$ *(M1)*

    $=\dfrac{161}{36}$ $\left(4\tfrac{17}{36}, \ 4.47, \ 4.47222…\right)$ *A1*
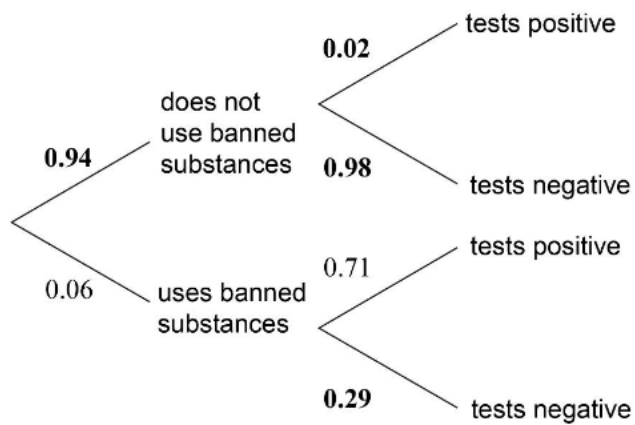
[2 marks]

Total [7 marks]

Answer 7:

3. (a) (i) Let X be the random variable "distance from O".
$X \sim \mathrm{N}(10, 3^2)$
$\mathrm{P}(X < 13) = 0.841 \ (0.841344...)$ **(M1)A1**

(ii) $\left(\mathrm{P}(X > 15) =\right) \ 0.0478 \ (0.0477903)$ **A1**

                                                                     [3 marks]

(b) $\mathrm{P}(X > 15) \times \mathrm{P}(X > 15)$ **(M1)**
$= 0.00228 \ (0.00228391...)$ **A1**

                                                                     [2 marks]

(c) $1 - (0.8143)^3$ **(M1)**
$= 0.460 \ (0.460050...)$ **A1**

                                                                     [2 marks]

(d) (i) let Y be the random variable "number of points scored"
evidence of use of binomial distribution   **(M1)**
$Y \sim \mathrm{B}(10, 0.539949...)$ **(A1)**
$\left(\mathrm{E}(Y) =\right) 10 \times 0.539949...$ **(M1)**
$= 5.40$ **A1**

(ii) $\left(\mathrm{P}(Y \geq 5) =\right) \ 0.717 \ (0.716650...)$ **A1**

(iii) $\mathrm{P}(5 \leq Y < 8)$ **(M1)**
$= 0.628 \ (0.627788...)$ **A1**

> **Note:** Award **M1** for a correct probability statement or indication of correct lower and upper bounds, 5 and 7.

(iv) $\dfrac{\mathrm{P}(5 \leq Y < 8)}{\mathrm{P}(Y \geq 5)} \left(= \dfrac{0.627788...}{0.716650...} \right)$ **(M1)**
$= 0.876 \ (0.876003...)$ **A1**

                                                                     [9 marks]
                                                   Total: [16 marks]

Answer 8:

4. **(a)**

tests positive

0.02

does not use banned substances

0.94

0.98

tests negative

tests positive

0.71

0.06

uses banned substances

0.29

tests negative

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**

Note: Do not accept the 2sf value for the final **A1**.

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

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

Note: Accept an answer of 0.848 (0.848241) from use of 3 sf answer from part (b)(i).

[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**

| Note:accept the 2 sf value of 47 for the final **A1** |

                                                                                    [5 marks]

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

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

      $P(X = 0)$ **OR** $P(X = 20)$ *(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…) is awarded full marks. |

                                                                                [4 marks]

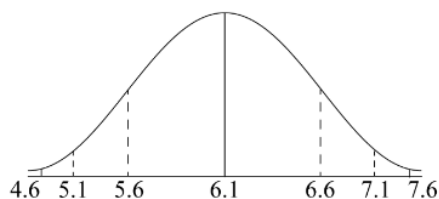(e) $P(X \geq 3)$ **OR** $P(X \leq 17)$ *(M1)*

      0.00707 (0.00706869…)   **A1**

| Note: Award *(M1)A0* for an answer of 0.00706.
    FT from their value of p in part (d) |

                                                                                [2 marks]

                                                                       [Total: 17 marks]

Answer 9:

4. **(a)**

| | 4.6 | 5.1 | 5.6 | | 6.1 | | 6.6 | 7.1 | 7.6 |

A1A1

> **Note:** Award **A1** for a normal curve with mean labelled 6.1 or μ, **A1** for indication of SD (0.5): marks on horizontal axis at 5.6 and/or 6.6 **OR** $\mu - 0.5$ and/or $\mu + 0.5$ on the correct side and approximately correct position.

[2 marks]

(b) $X \sim N(6.1, \, 0.5^2)$

$P(5.5 < X < 6.5)$ **OR** labelled sketch of region

(M1)

$= 0.673 \ (0.673074...)$ **A1**

[2 marks]

(c) $(P(X < 5.3) =) \ 0.0547992...$ **(A1)**

$0.0547992... \times 80$ **(M1)**

$= 4.38 \ (4.38393...)$ **A1**

[3 marks]

(d) 0.15 **OR** 0.85 **(A1)**

$P(X > x) = 0.15$ **OR** $P(X < x) = 0.85$ **OR** labelled sketch of region **(M1)**

$6.62 \ (6.61821...)$ **A1**

[3 marks]

(e) $(P(X > 6.25) =) \ 0.382088...$ **(A1)**

recognition of binomial **(M1)**

e.g. $B(10, \, 0.382088...)$

$0.0502 \ (0.0501768...)$ **A2**

[4 marks]

Total [14 marks]