1. (a) (i) $P(B) = \frac{3}{4}$ A1 N1

(ii) $P(R) = \frac{1}{4}$ A1 N1

(b) $p = \frac{3}{4}$ A1 N1

$s = \frac{1}{4}$, $t = \frac{3}{4}$ A1 N1

(c) (i) $P(X = 3)$

$= P$ (getting 1 and 2) $= \frac{1}{4} \times \frac{3}{4}$ A1

$= \frac{3}{16}$ AG N0

(ii) $P(X = 2) = \frac{1}{4} \times \frac{1}{4} + \frac{3}{4}$ $\left(\text{or } 1 - \frac{3}{16}\right)$ (A1)

$= \frac{13}{16}$ A1 N2

(d) (i)

X	2	3
$P(X = x)$	$\frac{13}{16}$	$\frac{3}{16}$

A2 N2

(ii) evidence of using $E(X) = \sum xP(X = x)$ (M1)

$E(X) = 2\left(\frac{13}{16}\right) + 3\left(\frac{3}{16}\right)$ (A1)

$= \frac{35}{16}$ $\left(= 2\frac{3}{16}\right)$ A1 N2

(e) win \$10 $\Rightarrow$ scores 3 one time, 2 other time (M1)

$P(3) \times P(2) = \frac{13}{16} \times \frac{3}{16}$ (seen anywhere) A1

evidence of recognizing there are different ways of winning \$10 (M1)

eg $P(3) \times P(2) + P(2) \times P(3)$, $2\left(\frac{13}{16} \times \frac{3}{16}\right)$,

$\frac{36}{256} + \frac{3}{256} + \frac{36}{256} + \frac{3}{256}$

P(win \$10) $= \frac{78}{256}$ $\left(= \frac{39}{128}\right)$ A1 N3

[16]

2. ***Note:*** *Candidates may be using tables in this question, which leads to a variety of values. Accept reasonable answers that are consistent with working shown.*

$W \sim N(2.5, 0.3^2)$

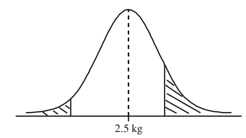
(a) (i) $z = -1.67$ (accept 1.67) (A1)

$P(W < 2) = 0.0478$ (accept answers between 0.0475 and 0.0485) A1 N2

(ii) $z = 1$ (A1)

$P(W > 2.8) = 0.159$ A1 N2

(iii)



A1A1 N2

Note: *Award A1 for a vertical line to left of mean and shading to left, A1 for vertical line to right of mean and shading to right.*

(iv) Evidence of appropriate calculation M1

eg $1 - (0.047790 + 0.15866)$, $0.8413 - 0.0478$

$P = 0.7936$ AG N0

Note: *The final value may vary depending on what level of accuracy is used.*
Accept their value in subsequent parts.

(b) (i) $X \sim B(10, 0.7935...)$

Evidence of calculation M1

eg $P(X = 10) = (0.7935...)^{10}$

$P(X = 10) = 0.0990$ (3 sf) A1 N1

(ii) **METHOD 1**

Recognizing $X \sim B(10, 0.7935...)$ (may be seen in (i)) (M1)

$P(X \le 6) = 0.1325...$ (or $P(X = 1) + ... + P(X = 6)$) (A1)

evidence of using the complement (M1)

eg $P(X \ge 7) = 1 - P(X \le 6)$, $P(X \ge 7) = 1 - P(X < 7)$

$P(X \ge 7) = 0.867$ A1 N3

METHOD 2

Recognizing $X \sim B(10, 0.7935...)$ (may be seen in (i)) (M1)

For adding terms from $P(X = 7)$ to $P(X = 10)$ (M1)

$P(X \ge 7) = 0.209235 + 0.301604 + 0.257629 + 0.099030$ (A1)

$= 0.867$ A1 N3

[13]

3. (a) For summing to 1 (M1)

eg $0.1 + a + 0.3 + b = 1$

$a + b = 0.6$ A1 N2

(b) evidence of correctly using $E(X) = \sum x f(x)$ (M1)

eg $0 \times 0.1 + 1 \times a + 2 \times 0.3 + 3 \times b$, $0.1 + a + 0.6 + 3b = 1.5$

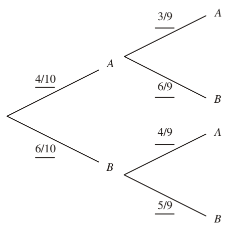
Correct equation $0 + a + 0.6 + 3b = 1.5$ $(a + 3b = 0.9)$ (A1)

Solving simultaneously gives

$a = 0.45$ $b = 0.15$ A1A1 N3

[6]

4. (a)



A1A1A1 N3

(b) $\left(\frac{4}{10}\times\frac{6}{9}\right)+\left(\frac{6}{10}\times\frac{4}{9}\right)$ M1M1

$=\frac{48}{90}\left(\frac{8}{15}, 0.533\right)$ A1 N1

[6]

5. (a) $\frac{19}{120}\ (=0.158)$ A1 N1

(b) $35-(8+5+7)(=15)$ (M1)

Probability = $\frac{15}{120}\left(=\frac{3}{24}=\frac{1}{8}=0.125\right)$ A1 N2

(c) Number studying = 76 (A1)

Number not studying = 120 − number studying = 44 (M1)

Probability = $\frac{44}{120}\left(=\frac{11}{30}=0.367\right)$ A1 N3

[6]

6. (a) $P(F\cup S)=1-0.14\ (=0.86)$ (A1)

Choosing an appropriate formula (M1)

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

Correct substitution

eg $P(F\cap S)=0.93-0.86$ A1

$P(F\cap S)=0.07$ AG N0

Notes: *There are several valid approaches. Award (A1)(M1)A1 for relevant working using any appropriate strategy eg formula, Venn Diagram, or table.*

Award no marks for the incorrect solution

$P(F\cap S)=1-P(F)+P(S)=1-0.93=0.07$

(b) Using conditional probability (M1)

eg $P(F\mid S)\left(=\frac{P(F\cap S)}{P(S)}\right)$

$P(F\mid S)=\frac{0.07}{0.62}$ (A1)

$=0.113$ A1 N3

(c) F and S are **not** independent A1 N1

EITHER

If independent $P(F\mid S)=P(F)$, $0.113\neq 0.31$ R1R1 N2

OR

If independent $P(F\cap S)=P(F)\,P(S)$, $0.07\neq 0.31\times 0.62\ (=0.1922)$ R1R1 N2

(d) Let $P(F)=x$

$P(S)=2P(F)\ (=2x)$ (A1)

For independence $P(F\cap S)=P(F)P(S)\ (=2x^2)$ (R1)

Attempt to set up a quadratic equation (M1)

eg $P(F\cup S)=P(F)P(S)-P(F)P(S)$, $0.86=x+2x-2x^2$

$2x^2-3x+0.86=0$ A2

$x=0.386$, $x=1.11$ (A1)

$P(F)=0.386$ (A1) N5

[16]

7. $X\sim N(\mu,\sigma^2)$, $P(X<3)=0.2$, $P(X>8)=0.1$

$P(X<8)=0.9$ (M1)

Attempt to set up equations (M1)

$\frac{3-\mu}{\sigma}=-0.8416,\ \frac{8-\mu}{\sigma}=1.282$ A1A1

$3-\mu=-0.8416\sigma$

$8-\mu=1.282\sigma$

$5=2.1236\sigma$

$\sigma=2.35,\quad \mu=4.99$ A1A1 N4

[6]

8. (a) For attempting to use the formula $(P(E\cap F)=P(E)P(F))$ (M1)

Correct substitution or rearranging the formula A1

eg $\frac{1}{3}=\frac{2}{3}P(F)$, $P(F)=\frac{P(E\cap F)}{P(E)}$, $P(F)=\frac{\frac{1}{3}}{\frac{2}{3}}$

$P(F)=\frac{1}{2}$ A1 N2

(b) For attempting to use the formula $(P(E\cup F)=P(E)+P(F)-(P(E\cap F))$ (M1)

$P(E\cup F)=\frac{2}{3}+\frac{1}{2}-\frac{1}{3}$ A1

$=\frac{5}{6}\ (=0.833)$ A1 N2

[6]

9. (a) $X\sim B(100,0.02)$

$E(X)=100\times 0.02=2$ A1 1

(b) $P(X=3)=\binom{100}{3}(0.02)^3(0.98)^{97}$ (M1)

$=0.182$ A1 2

(c) **METHOD 1**

$P(X > 1) = 1 - P(X \le 1) = 1 - (P(X = 0) + P(X = 1)$ M1

$= 1 - ((0.98)^{100} + 100(0.02)(0.98)^{99})$ (M1)

$= 0.597$ A1 2

METHOD 2

$P(X > 1) = 1 - P(X \le 1)$ (M1)

$= 1 - 0.40327$ (A1)

$= 0.597$ A1 2

Note*: Award marks as follows for finding P(X > 1), if working shown.*

$P(X \ge 1)$ A0

$= 1 - P(X<2) = 1 - 0.67668$ M1(ft)

$= 0.323$ A1(ft) 2

[6]

10. (a) Independent (I) (C2)

(b) Mutually exclusive (M) (C2)

(c) Neither (N) (C2)

Note: *Award part marks if the candidate shows understanding of I and/or M*

eg I $P(A \cap B) = P(A)P(B)$ *(M1)*

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

[6]