Q1.

(a) $(A=)\ 112$ ***A1***

[1 mark]

(b) $112\,e^{5k}=360$ ***(M1)***

Note: Award ***(M1)*** for their correct equation.

EITHER

graph of $y=112\,e^{5x}$ and $y=360$ with indication of point of intersection ***(M1)***

OR

$(k=)\ \frac{1}{5}\ln\left(\frac{360}{112}\right)$ ***(M1)***

Note: Award ***(M1)*** for correct rearranging and use of $\log$.

THEN

$(k=)\ 0.234\ (0.233521...)$ ***A1***

Note: Award ***(M1)(M1)(A0)*** for 0.233.

[3 marks]

Total: [4 marks]

Q2.

(a) $m=\frac{6-0}{4-2}=3$ ***(M1)A1***

[2 marks]

(b) $(m=)\ -\frac{1}{3}\ (-0.333, -0.333333...)$ ***A1***

[1 mark]

(c) an equation of line with a correct intercept and either of their gradients from (a) or (b) ***(M1)***

e.g. $y=-\frac{1}{3}x+4$ **OR** $y-4=-\frac{1}{3}(x-0)$

Note: Award ***(M1)*** for substituting either of their gradients from parts (a) or (b) and point B or $(3, 3)$ into equation of a line.

$x+3y-12=0$ or any integer multiple ***A1***

[2 marks]

(d) $(x=)\ 12$ ***A1***

[1 mark]

Total: [6 marks]

Q3.

(a) $h(4)=\frac{640}{4^2}+0.5$ **OR** $h(14)=\frac{640}{14^2}+0.5$ ***(M1)***

Note: Award ***(M1)*** for substituting 4 or 14 into h. This can be implicit from seeing 3.77 $(3.76530\ldots)$ or 40.5.

$3.77 \le h(x) \le 40.5$ $(3.76530... \le h(x) \le 40.5)$ ***A1A1***

Note: Award ***A1*** for both correct endpoints seen, ***A1*** for the endpoints in a correct interval.

[3 marks]

(b) (i) $h(x)=10$ **OR** $h^{-1}(x)=\sqrt{\frac{640}{x-0.5}}$ **OR** $h^{-1}(10)=\sqrt{\frac{640}{10-0.5}}$ ***(M1)***

$(x=)$ 8.21 cm $(8.20782...)$ ***A1***

(ii) a tin that is 10 cm high will have a diameter of 8.21 cm $(8.20782...)$ ***A1***

Note: Condone a correct answer expressed as the converse.

(iii) $4 \le h^{-1} \le 14$ ***A1***

Note: Accept $4 \le y \le 14$. Do not ***FT*** in this part.

[4 marks]
Total: [7 marks]

Q4.

(a) attempt at using trapezoidal rule formula ***(M1)***

$\frac{1}{2}\left(\frac{2-0}{5}\right)\left(30+50+2(50+60+40+20)\right)$ ***(A1)***

(total carbon $=$) 84 tonnes ***A1***

[3 marks]

(b) $\left|\frac{84-72}{72}\right| \times 100\%$ ***(M1)***

Note: Award ***(M1)*** for correct substitution of final answer in part (a) into percentage error formula.

$=16.7\%$ $(16.6666...\%)$ ***A1***

[2 marks]
Total: [5 marks]

Q5.

(a) $(\text{pH} =)\ -\log_{10}(1.3\times10^{-5})$ ***(M1)***

$4.89\quad(4.88605\ldots)$ ***A1***

[2 marks]

(b) **EITHER**

calculating pH

$(\text{pH} =)\ -\log_{10}(10\times1.3\times10^{-5})$ ***(M1)***

$3.89\quad(3.88605\ldots)$ ***A1***

($3.89 < 4.89$, therefore) the unknown liquid is more acidic (than coffee). ***A1***

Note: Follow through within the part for the final ***A1***. A correct conclusion must be supported by a mathematical justification linking the C-value to the pH level to earn the final ***A1***; a comparison of C-values only earns ***M0A0A0***.

OR

referencing the graph

The graph of $y = -\log_{10}(x)$ shows that as the value of x increases, the value of y decreases. ***M1***

Since the C-value (x-value) of the unknown liquid is larger than that of the coffee, the pH level (y-value) is lower. ***R1***

The unknown liquid is more acidic (than coffee). ***A1***

Note: Follow through within the part for the final ***A1***. A correct conclusion must be supported by a mathematical justification linking the C-value to the pH level to earn the final ***A1***; a comparison of C-values only earns ***M0R0A0***.

[3 marks]

Total [5 marks]

Q6.

(a) $(88 - 62) \times 1.5$ **OR** 26×1.5 seen anywhere **OR** 39 seen anywhere ***(M1)***

$62 - 39$

23 ***A1***

$25 > 23$ ***R1***

so is not an outlier ***AG***

[3 marks]

(b) The median score for the evening class is higher than the median score for the morning class. ***A1***

THEN

but the scores are more spread out in the evening class than in the morning class ***A1***

OR

the scores are more inconsistent in the evening class ***A1***

OR

the lowest scores are in the evening class ***A1***

OR

the interquartile range is lower in the morning class ***A1***

OR

the lower quartile is lower in the evening class ***A1***

Note: If an incorrect comparison is also made, award at most ***A1A0***.

Award ***A0*** for a comparison that references "the mean score" unless working is shown for the estimated means of the data sets, calculated from the mid-points of the 4 intervals. The estimated mean for the morning class is 71.375 and the estimated mean for the evening class is 70.5.

[2 marks]

Total [5 marks]

Q7.

(a) $x+y+z=600$ ***A1***

$15x+10y+12z=7816$ ***A1***

$x=2y$ ***A1***

Note: Condone other labelling if clear, e.g. a (adult), c (child) and s (student). Accept equivalent, distinct equations e.g. $2y+y+z=600$.

[3 marks]

(b) $x=308,\ y=154,\ z=138$ ***A1A1***

Note: Award ***A1*** for all three correct values seen, ***A1*** for correctly labelled as x, y or z. Accept answers written in words: e.g. 308 adult tickets.

[2 marks]
[Total 5 marks]

Q8.

(a) 50% ***A1***

Note: Do not accept 0.5 or $\frac{1}{2}$.

[1 mark]

(b) 0.0478 (0.0477903…, 4.78%) ***A2***

[2 marks]

(c) $\mathrm{P}(X<k)=0.98$ **OR** $\mathrm{P}(X>k)=0.02$ ***(M1)***

Note: Award ***(M1)*** for a sketch with correct region identified.

506 g (506.161…) ***A2***

[3 marks]
[Total 6 marks]

Q9.

(a) every point in the shaded region is closer to tower T4 ***R1***

Note: Specific reference must be made to the closeness of tower T4.

[1 mark]

(b) (–9, 1) ***A1A1***

Note: Award ***A1*** for each correct coordinate. Award at most ***A0A1*** if parentheses are missing.

[2 marks]

(c) correct use of gradient formula ***(M1)***

e.g. $(m=)\ \frac{5-3}{-9--13}\ \left(=\frac{1}{2}\right)$

taking negative reciprocal of **their** m (at any point) ***(M1)***

edge gradient $=-2$ ***A1***

[3 marks]

Total [6 marks]

Q10.

(a) (i) attempt to find u_{20} using an arithmetic sequence ***(M1)***

e.g. $u_1 = 500$ and $d = 100$ **OR** $u_{20} = 500 + 1900$ **OR** $500, 600, 700, \ldots$

(Charlie ran) 2400 m ***A1***

(ii) $(r =)\ 1.02$ ***(A1)***

attempt to find u_{20} using a geometric sequence ***(M1)***

e.g. identifying $u_1 = 500$ and a value for r **OR** $500 \times r^{19}$ **OR** $500, 510, 520.2, \ldots$

(Daniella ran) 728 m $(728.405...)$ ***A1***

[5 marks]

(b) $500 \times 1.02^{n-1} > 500 + (n-1) \times 100$ ***(M1)***

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

$n > 184.215...$

$n = 185$ ***A1***

[3 marks]

Total [8 marks]

Q11.

(a) $N = 24$

$I = 4$

$PV = \pm 1000$

$PMT = \pm 100$

$P/Y = 12$

$C/Y = 12$ ***(M1)(A1)***

Note: Award ***M1*** for an attempt to use a financial app in their technology (i.e. at least three entries seen, but not necessarily correct).
Approaches that use the compound interest formula receive no marks.
Award ***A1*** for correct values of PV and PMT (signs must be the same) **and** a correct value of N.

$FV = (\$)3577.43$ ***A1***

Note: Award at most ***(M1)(A1)A0*** if the final answer is negative or not rounded to 2 dp.

[3 marks]

(b) $N = 36.5\ (36.4689\ldots)$ ***(A1)***

$N = 37$ (months) ***A1***

Note: Allow ***FT*** from incorrect GDC inputs seen in part (a) for the first ***A1*** providing that PV and FV have opposite signs and the resulting value of N is positive.

[2 marks]

[Total: 5 marks]

Q12.

(a) attempt to set up a direct variation equation that includes a constant, k, or the calculation of a constant using 12.3 and 50 ***(M1)***

e.g., $d = kv^2$ **OR** $12.3 = k \times 50^2$

$(k =)\ 0.00492 \quad \left(\frac{1}{203.252...}\right)$

$d = 0.00492v^2$ **OR** $d = \frac{v^2}{203}$ ***A1***

[2 marks]

(b) substituting 33 for d in their part (a) ***(A1)***

$33 = 0.00492 \times v^2$ **OR** $33 = \frac{v^2}{203.252...}$

$(v =)\ 81.9\ (\text{km h}^{-1})\quad (81.8982\ldots\ (\text{km h}^{-1}))$ ***A1***

[2 marks]

(c) *Award **R1** for a reasonable variable that exists after the brakes are applied such as:*

- road material
- weather conditions
- condition/type of brakes
- weight/type of vehicle
- gradient/incline of road
- traction
- wind resistance
- friction

R1

Note: Do not accept a variable that refers to the timing of the brakes being applied such as:

- slow reaction time
- inexperienced driver

[1 mark]

[Total: 5 marks]

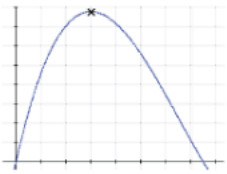
Q13.

(a) $(k =)\ 15$ ***A1***

[1 mark]

(b) **EITHER**

attempt to sketch the function $V(x)$ with indication of maximum ***(M1)***



OR

recognition of setting the derivative to 0 ***(M1)***

e.g. $V'(x) = 0$

THEN

$(x =)\ 6\ (\text{cm})$ ***A1***

Note: Award ***(M1)A0*** for the maximum given as a coordinate pair.

[2 marks]

(c) 44 or 26 seen ***(A1)***

attempting to adjust the constant(s) in the given volume formula ***(M1)***

volume of second box $= (44-2x)(26-2x)(x)$

(New maximum volume $=$) $2730\ \text{cm}^3$ $(2726.13...\ \text{cm}^3)$ ***A1***

Note: Units must be seen to award the final ***A1***. Award ***(A1)(M1)A0*** for the maximum given as a coordinate pair.

[3 marks]

[Total: 6 marks]

Q14.

(a) $34 + p$ ***A1***

[1 mark]

(b) attempt to substitute into the mean formula, equating to 4.5 ***(M1)***

$$\frac{1\times1+2\times4...5\times p+6\times9+7\times4}{34+p} = 4.5$$ ***A1***

$(p =)\ 10$ ***A1***

Note: Do not award the final ***A1*** if final answer is not an integer.
Award ***(M1)A0A1*** for an unsupported answer of $(p =)\ 10$.

[3 marks]
Total [4 marks]

Q15.

(a) $x = 0$ ***A1***

Note: Answer must be an equation; an answer of "0" or "the y-axis" is awarded ***A0***.

[1 mark]

(b) $(g'(x) =) -8x^{-2} + x$ ***A1A1A1***

Note: Award ***A1*** for -8 seen, ***A1*** for x^{-2} $\left(\text{or } \frac{1}{x^2}\right)$ and ***A1*** for second term being x.
Award at most ***A1A1A0*** if additional terms are seen.

(c) $x > 2$ **OR** $(2, \infty)$ **OR** $2 < x < \infty$ ***A1A1***

Note: Award ***A1*** for 2 seen and award ***A1*** for **correct** inequality.

[2 marks]
[Total 6 marks]

Q16.

(a) 25° ***A1***

[1 mark]

(b) $\text{AC} = \frac{380}{\tan 25^\circ}$ **OR** $\text{AC} = \sqrt{\left(\frac{380}{\sin 25^\circ}\right)^2 - 380^2}$ **OR** $\frac{380}{\sin 25^\circ} = \frac{\text{AC}}{\sin 65^\circ}$ ***(M1)***

$\text{AC} = 815 \text{ m } (814.912\ldots)$ ***A1***

[2 marks]

(c) **METHOD 1**
attempt to find AB ***(M1)***

$\text{AB} = \frac{380}{\tan 40^\circ}$
$= 453 \text{ m } (452.866\ldots)$ ***(A1)***

$\text{BC} = 814.912\ldots - 452.866\ldots$
$= 362 \text{ m } (362.046\ldots)$ ***A1***

METHOD 2
attempt to find HB ***(M1)***

$\text{HB} = \frac{380}{\sin 40^\circ}$
$591 \text{ m } (= 591.175\ldots)$ ***(A1)***

$\text{BC} = \frac{591.175\ldots \times \sin 15^\circ}{\sin 25^\circ}$
$= 362 \text{ m } (362.046\ldots)$ ***A1***

[3 marks]

(d) $362.046\ldots \times 4$
$= 1450 \text{ m h}^{-1}$ $(1448.18\ldots)$ ***A1***

[1 mark]

Total [7 marks]

Q17.

(a) recognizing supplementary angles or acute angles in right-triangles ***(M1)***

$(A\hat{B}C =)\ 41^\circ + (180^\circ - 112^\circ)$, $41^\circ + (90^\circ - 22^\circ)$

$A\hat{B}C = 109^\circ$ ***A1***

[2 marks]

(b) $A\hat{C}B = 49^\circ$ (may be seen in part (a)) ***(A1)***

attempt to substitute into the sine rule (or equivalent) ***(M1)***

$\frac{AC}{\sin 109^\circ} = \frac{100}{\sin 49^\circ}$ ***(A1)***

$AC = 125$ (km) $(= 125.282...)$ ***A1***

[4 marks]

[Total 6 marks]

Q18. (a)

Markscheme
$a = 3$ ***A1***
[1 mark]

(b)

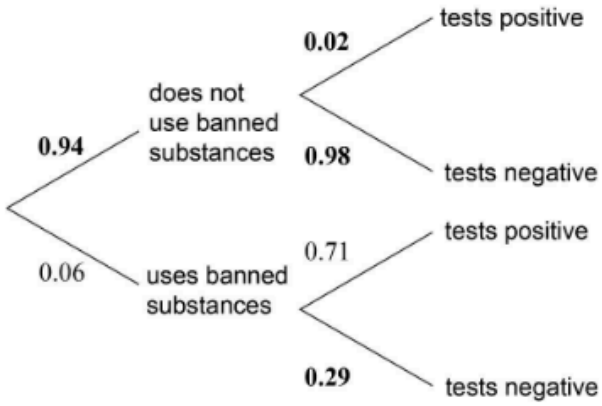
Markscheme
period$= 12$ ***(A1)*** $\left(\frac{360}{b} = 12\right.$ **OR** $\left.\frac{2\pi}{b} = 12\right)$ $b = 30$ $b = \frac{\pi}{6}$ ***A1***
[2 marks]

(c)

Markscheme
equating their expression to 3 ***(M1)*** $3 = 3\sin(30t) + 4$ **OR** $3 = 3\sin\left(\frac{\pi}{6}t\right) + 4$ $t = 6.64904$ ... ***(A1)*** $6.39\ (pm)\ (18{:}39)$ ***A1*** **Note:** Follow through within the part for the final ***A1***; this mark is awarded for expressing **their** intermediate answer (seen) as a time correct to the nearest minute.
[3 marks]

Q19.

(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***

te: 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***

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

[4 marks]

(c) (i) $0.94\times0.02+0.06\times0.29$ ***(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)***

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

0.668 $(0.667607\ldots)$ ***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) $\mathrm{P}(X\geq3)$ **OR** $\mathrm{P}(X\leq17)$ ***(M1)***

0.00707 $(0.00706869\ldots)$ ***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]

Q20.

(a) (i) $(m =)\ 54(\%)$ ***A1***

(ii) $(n =)\ 14(\%)$ ***A1***

(iii) $(p =)\ 22(\%)$ ***A1***

(iv) $(q =)\ 10(\%)$ ***A1***

Note: Based on their n, follow through for parts (i) and (iii), but only if it does not contradict the given information. Follow through for part (iv) but only if the total is 100%.

[4 marks]

(b) $90\ (\%)$ ***A1***

Note: Award ***A0*** for a decimal answer.

[1 mark]

(c) (i) $0.54\ \left(\frac{54}{100}, \frac{27}{50}, 54\%\right)$ ***A1***

(ii) $\frac{54}{64}\ \left(0.844, \frac{27}{32}, 84.4\%, 0.84375\right)$ ***A1A1***

Note: Award ***A1*** for a correct denominator (0.64 or 64 seen), ***A1*** for the correct final answer.

[3 marks]

(d) (i) recognizing Binomial distribution with correct parameters ***(M1)***

$X \sim \mathrm{B}(10,\ 0.68)$

$\left(\mathrm{P}(X = 5) =\right)\ 0.123\ \ (0.122940..., 12.3\%)$ ***A1***

(ii) $1 - \mathrm{P}(X \leq 3)$ **OR** $\mathrm{P}(X \geq 4)$ **OR** $\mathrm{P}(4 \leq X \leq 10)$ ***(M1)***

$0.984\ (0.984497..., 98.4\%)$ ***A1***

(iii) $(0.68)^9 \times 0.32$ ***(M1)***

recognition of two possible cases ***(M1)***

$2 \times \left((0.68)^9 \times 0.32\right)$

$0.0199\ \ (0.0198957..., 1.99\%)$ ***A1***

[7 marks]

(e) **EITHER**

the probability is not constant ***A1***

OR

the events are not independent ***A1***

OR

the events should be modelled by the hypergeometric distribution instead ***A1***

[1 mark]

Total [16 marks]

Q21.

(a) (i) 30 ***A1***

(ii) 40 ***A1***

[2 marks]

(b) arithmetic formula chosen ***(M1)***

(i) $w_n = 20 + (n-1)10 \quad (= 10 + 10n)$ ***A1***

(ii) $l_n = 30 + (n-1)10 \quad (= 20 + 10n)$ ***A1***

[3 marks]

(c) (i) $740 = 30 + (n-1)10$ **OR** $740 = 20 + 10n$ ***M1***

$n = 72$ ***A1***

144 tiles ***AG***

Note: The ***AG*** line must be stated for the final ***A1*** to be awarded.

(ii) $w_{72} = 730$ ***A1***

[3 marks]

(d) $(10 \times 20) \times 144$ ***(M1)***

$= 28800$ ***(A1)***

$2.88 \times 10^4 \ \text{cm}^2$ ***A1***

Note: Follow through within the question for correctly converting *their* intermediate value into standard form (but only if the pre-conversion value is seen).

[3 marks]

(e) **EITHER**

1 square metre $= 100\,\text{cm} \times 100\,\text{cm}$ ***(M1)***

(so, 50 tiles) and hence 10 packs of tiles in a square metre ***(A1)***

(so each pack is $\frac{\$24.50}{10 \text{ packs}}$)

OR

area covered by one pack of tiles is $(0.2\,\text{m} \times 0.1\,\text{m} \times 5 =)\ 0.1\ \text{m}^2$ ***(A1)***

24.5×0.1 ***(M1)***

THEN

\$2.45 per pack (of 5 tiles) ***A1***

[3 marks]

(f) $\frac{1.08 \times 144}{5} \ (= 31.104)$ ***(M1)(M1)***

Note: Award ***M1*** for correct numerator, ***M1*** for correct denominator.

32 (packs of tiles) ***A1***

[3 marks]

(g) $35 + (32 \times 2.45)$ ***(M1)***

\$113 (113.4) ***A1***

[2 marks]

[Total 19 marks]