Claude Specimen Paper 1: worked solutions

Indicative teaching mark scheme. M = method, A = accuracy, B = independent mark; f = follow-through. Award equivalent valid methods. Non-exact answers to 3 s.f. (angles to 1 d.p.) unless stated.

1 $3.65 \times 10^5 - 4.8 \times 10^4 = 317000$ and $\sqrt{2.7 \times 10^{-3}} = 0.0519615\ldots$ **M1**

Answer: 6.10×10^6 **A1**

The question asks for standard form: a correct value not in standard form (e.g. 6 100 000) scores A0.

2 (a) Tea − milk = 7 − 4 = 3 parts = 360 mL, so 1 part = 120 mL **M1**

Total = 12 parts = 1440 mL

Answer: **1.44 litres** **A1**

(b) 1 cm on the map = 25 000 cm = 250 m, so 1 cm^2 = 250^2 = 62 500 m^2 **M1**

18.4 × 62 500 = 1 150 000 m^2

Answer: **1.15 km^2** **A1**

Accept a method using 1 km^2 = 10^6 m^2 or 25 000^2. Common error: using 25 000 instead of 25 000^2 for area.

3 \$111.18 represents 109% of the sale price **M1**

Sale price = 111.18 ÷ 1.09 = \$102

\$102 represents 85% of the marked price **M1**

Marked price = 102 ÷ 0.85

Answer: **\$120** **A1**

Accept the single step 111.18 ÷ (1.09 × 0.85). Multiplying by 1.15 or 0.91 instead of dividing earns no marks.

4 (a) $10000\left(1+\frac{r}{100}\right)^3 = 10768.91$ **M1**

$\left(1+\frac{r}{100}\right)^3 = \frac{10768.91}{10000} = 1.076891$ or $1+\frac{r}{100} = \left(\frac{10768.91}{10000}\right)^{\frac{1}{3}}$ **M1**

$1+\frac{r}{100} = 1.025$

Answer: $r = 2.5$ **A1**

(b) 600 × 112.40 = ¥67 440; 67 440 − 55 000 = ¥12 440 **M1**

12 440 ÷ 118 = 105.4237...

Answer: **S\$105.42** **A1**

Accept r = 2.50. For (b), dividing by 112.40 on the return conversion scores M1 for the first line only.

5 $(2x-3)^2 = 4x^2 - 12x + 9$ and $(x+4)(x-5) = x^2 - x - 20$ (at least one correct) **M1**

$4x^2 - 12x + 9 - x^2 + x + 20$

Answer: $3x^2 - 11x + 29$ **A1**

Common errors: $(2x-3)^2$ written as $4x^2 + 9$; not changing every sign when subtracting the second product.

6 (a) $3a(x-2y)+b(x-2y)$

Answer: $(3a+b)(x-2y)$ **B1**

(b) $6x^2-9x+10x-15$ or one bracket correct **M1**

Answer: $(3x+5)(2x-3)$ **A1**

In (a) the grouping may be done in either order, e.g. $x(3a+b)-2y(3a+b)$.

7

Numerator: $6x^2-x-2=(3x-2)(2x+1)$ **M1**

Denominator: $4x^2-1=(2x-1)(2x+1)$ **M1**

Answer: $\frac{3x-2}{2x-1}$ **A1**

Cancelling terms rather than factors (e.g. cancelling $6x^2$ with $4x^2$) earns no marks.

8

$p^2=\frac{a+3b}{b}$ **M1**

$p^2b=a+3b$

$p^2b-3b=a$, $b(p^2-3)=a$ **M1**

Answer: $b=\frac{a}{p^2-3}$ **A1**

Accept $b=\frac{-a}{3-p^2}$.

9

$4(x-2)+3(x+1)=2(x+1)(x-2)$ **M1**

$7x-5=2x^2-2x-4$, so $2x^2-9x+1=0$

$x=\frac{9\pm\sqrt{(-9)^2-4(2)(1)}}{2(2)}=\frac{9\pm\sqrt{73}}{4}$ **M1**

Answer: $x=4.39$

Answer: $x=0.11$ **A1**

A1 requires both answers. Accept 4.386 and 0.114 seen before rounding.

10 (a) Answer: $2x+3y=12.70$

Answer: $3x+2y=14.80$ **B1** (both equations needed)

(b) Eliminate one variable, e.g. (1) × 3 and (2) × 2: $6x+9y=38.10$, $6x+4y=29.60$ **M1**

$5y=8.50$

Answer: $y=1.70$ **A1**

$2x+3(1.70)=12.70$

Answer: $x=3.80$ **A1**

Noodles \$3.80; barley drink \$1.70

Accept substitution. Final-answer marks are for correct values with or without the \$ sign.

11 (a) $\left(\frac{27}{64}\right)^{-\frac{2}{3}}=\left(\frac{64}{27}\right)^{\frac{2}{3}}=\left(\frac{4}{3}\right)^2$

Answer: $\frac{16}{9}$ **B1**

(b) $\left(2^3\right)^{x-1}=2^{-5}$ **M1** (writing both sides as powers of 2)

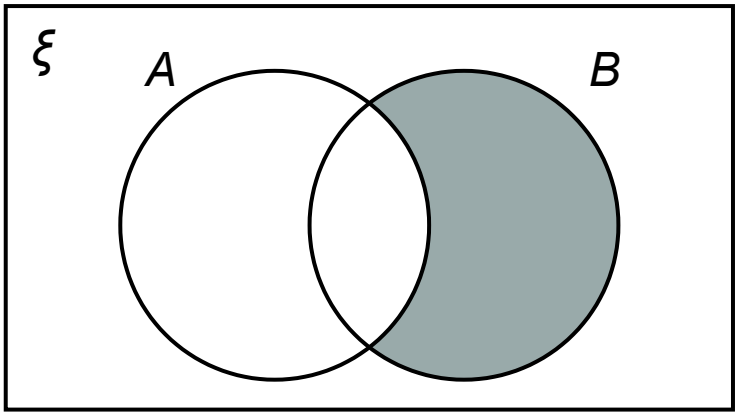
$3(x-1)=-5$

Answer: $x=-\frac{2}{3}$ **A1** (accept −0.667)

Accept −0.667 or −0.6667 for the final answer.

12 (a) Answer: $\{3, 6, 9, 12, 18\}$ **B1**
(A = {3, 6, 9, 12, 15, 18}, B = {1, 2, 3, 4, 6, 9, 12, 18})

(b) The part of circle *B* outside circle *A* is shaded (the elements 1, 2, 4).



B1

(c) $A \cup B$ = {1, 2, 3, 4, 6, 9, 12, 15, 18} has 9 elements
$n\left(\left(A \cup B\right)'\right) = 20 - 9$
Answer: 11 **B1**

Part (b): shading must show exactly the crescent of B; the overlap must not be shaded.

13 (a) $MQ = \begin{pmatrix} 48 \times 3.5 + 32 \times 4.2 \\ 36 \times 3.5 + 45 \times 4.2 \end{pmatrix}$ **M1** (one correct element)
Answer: $\begin{pmatrix} 302.4 \\ 315 \end{pmatrix}$ **A1**

(b) The total sales (in dollars) from both dishes on Tuesday, i.e. \$315. **B1**

(c) $\begin{pmatrix} 1 & 1 \end{pmatrix}\begin{pmatrix} 48 & 32 \\ 36 & 45 \end{pmatrix} = \begin{pmatrix} 48 + 36 & 32 + 45 \end{pmatrix}$
Answer: $\begin{pmatrix} 84 & 77 \end{pmatrix}$ **B1**
(total plates of chicken rice and of nasi lemak sold over the two days)

14 (a) $\frac{360}{5} =$ Answer: $72°$ **B1**

(b) Interior angle of pentagon = 180° − 72° = 108°; interior angle of hexagon = 180° − 60° = 120°
$\angle FAI = 360° - 120° - 108°$ (angles at a point)
Answer: $132°$ **B1**

(c) *AF* = *AB* = *AI* (sides of regular polygons), so triangle *AFI* is isosceles.
$\angle AFI = \frac{180° - 132°}{2}$
Answer: $24°$ **B1**

15 (a) $\angle AOB = 2 \times 64° = 128°$

Reason: angle at the centre is twice the angle at the circumference (standing on the same arc *AB*). **B1**

Answer: $128°$

(b) $\angle OAP = \angle OBP = 90°$ (tangent is perpendicular to the radius at the point of contact) **M1**

$\angle APB = 360° - 90° - 90° - 128°$ (angle sum of quadrilateral *OAPB*)

Answer: $52°$ **A1** (reasons needed)

(c) $\angle ADB = 180° - 64°$

Reason: opposite angles of a cyclic quadrilateral *ACBD* add up to 180°.

Answer: $116°$ **B1**

Part (b): the A1 needs both reasons (tangent perpendicular to radius; angle sum of a quadrilateral). Part (a): the reason must mention the centre and the circumference.

16 (a) Ratio of heights = 12 : 8 = 3 : 2, so the ratio of volumes = $3^3 : 2^3 = 27 : 8$ **M1**

$175 \times \frac{27}{8} = 590.625$

Answer: **591 mℓ** **A1**

(b) $315 \times \left(\frac{8}{12}\right)^2$

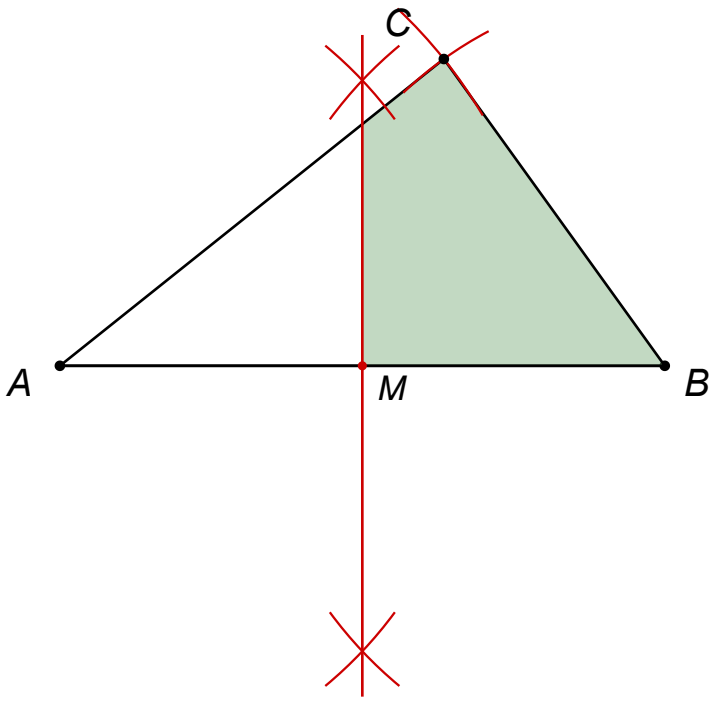
Answer: **140 cm^2** **B1**

(a): 175 × (12/8)³ = 590.625, giving 591 mℓ to 3 significant figures. (b): 315 × 4/9 = 140 cm² exactly.

17 (a) With compasses set to 6.5 cm (65 mm), draw an arc centred at *A*. With compasses set to 5.0 cm (50 mm), draw an arc centred at *B*. The arcs cross at *C*. Join *AC* and *BC*. **M1** (one arc correct, ±1 mm) **A1** (triangle correct, *AC* = 6.5 ± 0.1 cm, *BC* = 5.0 ± 0.1 cm, arcs shown)

(b) With compasses set to the same radius greater than 4.0 cm (here 5.5 cm), draw arcs centred at *A* and at *B* that cross above and below *AB*; join the two crossing points. This line passes through the midpoint *M* of *AB* (*AM* = 4.0 cm) at right angles. Shade the part of the triangle on the *B* side of this line (quadrilateral with vertices *M*, *B*, *C* and the point where the bisector meets *AC*). **B1** (arcs shown, line within ±1 mm, correct region shaded)

Construction check: C is 5.08 cm from A along the base line and 4.06 cm above it. The perpendicular bisector meets AC at 3.20 cm above AB (about 5.1 cm from A). Answer figure (not necessarily to scale on screen):



18 (a) $\overrightarrow{AB} = \overrightarrow{AO} + \overrightarrow{OB} = -\boldsymbol{a} + \boldsymbol{b}$

Answer: $\boldsymbol{b} - \boldsymbol{a}$ **B1**

(b) $\overrightarrow{AC} = \frac{1}{3}\overrightarrow{AB} = \frac{1}{3}\left(\boldsymbol{b} - \boldsymbol{a}\right)$

$\overrightarrow{OC} = \overrightarrow{OA} + \overrightarrow{AC} = \boldsymbol{a} + \frac{1}{3}\boldsymbol{b} - \frac{1}{3}\boldsymbol{a} = \frac{1}{3}\left(2\boldsymbol{a} + \boldsymbol{b}\right)$ **B1** (all steps shown)

(c) $\overrightarrow{OM} = \frac{1}{2}\boldsymbol{b}, \overrightarrow{OE} = 2\boldsymbol{a}$

$\overrightarrow{ME} = \overrightarrow{MO} + \overrightarrow{OE} = 2\boldsymbol{a} - \frac{1}{2}\boldsymbol{b}$ **M1**

$\overrightarrow{MC} = \overrightarrow{MO} + \overrightarrow{OC} = -\frac{1}{2}\boldsymbol{b} + \frac{2}{3}\boldsymbol{a} + \frac{1}{3}\boldsymbol{b} = \frac{2}{3}\boldsymbol{a} - \frac{1}{6}\boldsymbol{b}$

$\overrightarrow{ME} = 3\overrightarrow{MC}$, so $\overrightarrow{ME}$ is parallel to $\overrightarrow{MC}$ and they share the point *M*; hence *M*, *C* and *E* are collinear. **A1**

(d) Area of *OBC* : area of *OAB* = *CB* : *AB* = 2 : 3 (same height from *O*); *OMC* has half the base *OM* = ½*OB* with the same height from *C*, so area *OMC* = ½ × (2/3) of *OAB* = 1/3.

Answer: **1 : 3** **B1**

19 (a) 065° + 180° = Answer: **245°** B1

(b) $\angle QPR = 90 - 65 = 25°$ (or use $PR = 18\sin 65°$) M1
$PR = 18\cos 25° =$ Answer: **16.3 km** A1

(c) $QR = 18\sin 25° =$ Answer: **7.61 km** B1

Accept 16.31 km for (b). In (c), Pythagoras using the unrounded value of PR is also acceptable.

(c): a student who uses the rounded PR = 16.3 km gets 7.64 km; accept 7.61 km to 7.64 km.

20 (a) $AC^2 = AB^2 + BC^2 - 2 \times AB \times BC \times \cos ABC$ with values substituted:
$13.1^2 = 6.5^2 + 9.2^2 - 2 \times 6.5 \times 9.2 \times \cos ABC$ M1
$\cos ABC = \frac{6.5^2 + 9.2^2 - 13.1^2}{2 \times 6.5 \times 9.2} = -0.3739$ M1
$\angle ABC =$ Answer: **112.0°** A1

(b) $\frac{1}{2} \times 6.5 \times 9.2 \times \sin 112.0°$ M1
Answer: **27.7 m²** A1

Using the unrounded angle gives 27.7 m²; using 112.0° gives 27.7 m², which is also accepted. Accept any correct alternative, e.g. finding another angle and using the sine rule.

21 (a) $140 \times \frac{\pi}{180} =$ Answer: $\frac{7\pi}{9}$ **radians** B1

(b) $\frac{1}{2} \times 6.5^2 \times \frac{7\pi}{9} =$ Answer: **51.6 cm²** B1

(c) $r \times \frac{7\pi}{9} = 22 \Longrightarrow r = \frac{22 \times 9}{7\pi}$
Answer: **9.00 cm** B1

(a) Accept 2.44 only if the form with π is also seen. (b) Accept 51.5 to 51.7 from rounded values. (c) Accept 9.0 or 9.00.

22 Volume of cone = $\frac{1}{3}\pi \times 3.5^2 \times 9 = 115.5$ M1
Volume of hemisphere = $\frac{2}{3}\pi \times 3.5^3 = 89.8$ M1
Total volume = Answer: **205 cm³** (205.250720…) A1

The final answer is 205 cm³ to 3 significant figures; retain 205.250720… during working. Using 7 cm as the radius scores no marks for the volumes.

23 (a) Reading at cumulative frequency 50: Answer: **32 minutes** (accept 31.5 to 32.5) B1

(b) Lower quartile (cumulative frequency 25) = 23 minutes (accept 22.5 to 23.5)
Upper quartile (cumulative frequency 75) = 40 minutes (accept 39.5 to 40.5) M1
Interquartile range = 40 − 23 = Answer: **17 minutes** (accept 16 to 18, or follow through from the readings seen) A1

(c) At 35 minutes the cumulative frequency is 60 (accept 58 to 62).
Number more than 35 minutes = 100 − 60 = Answer: **40** (accept 38 to 42) B1

(d) 10% of 100 = 10 students, so read at cumulative frequency 100 − 10 = 90: *t* = Answer: **47** (accept 46.5 to 47.5) B1

The printed curve gives approximately Q_1 = 22.95, median = 31.91, Q_3 = 40.00 and P_{90} = 47.02 minutes, and cumulative frequency 59.96 at 35 minutes. The rounded readings above agree with this curve. Use the stated tolerances consistently; follow through a correctly calculated IQR from acceptable quartile readings.

24 (a) $\frac{6+9+4+11+7+8+5+10}{8} =$ Answer: **7.5 minutes** B1

(b) Sum of squared deviations from the mean = 42, so $\sqrt{\frac{42}{8}} = \sqrt{5.25}$ (or use the calculator):

Answer: **2.29 minutes** B1

(c) The mean waiting time at Tampines (6.8 minutes) is shorter than at Orchard (7.5 minutes), so customers wait for a shorter time on average at Tampines. B1
The standard deviation at Orchard (2.29) is smaller than at Tampines (3.6), so waiting times at Orchard are more consistent (less spread out), while waiting times at Tampines vary more. B1

Each comment must refer to waiting times or customers, not just to "the mean" or "the standard deviation". The standard deviation uses divisor 8, as on the formula page.

(b): the population standard deviation (σ on the calculator) is intended: 2.29. The sample standard deviation (2.45) is not accepted. (c): one mark for a comment on the averages and one for a comment on the spread, each in the context of waiting times; a bare 'Orchard has a higher SD' earns no mark.

25 (a) Square numbers: 1, 4, 9, 16, 25, so P(square number) = $\frac{5}{25} =$ Answer: $\frac{1}{5}$ B1

(b) $\frac{1}{5} \times \frac{12}{25} =$ Answer: $\frac{12}{125}$ (0.096) B1

Accept 0.2 for (a) and 0.096 for (b). The ticket is replaced, so the two draws are independent and the probabilities are multiplied.

26 (a) $y = (x+3)^2 - 9 + 1$ M1
Answer: $y = (x+3)^2 - 8$ A1

(b) Answer: **(−3, −8)** B1

(c) Answer: $x = -3$ B1

In (a) award M1 for a correct squared bracket with the 9 subtracted (or the correct completion of the square with the constant term wrong). In (b) and (c) follow through from an incorrect form $(x + p)^2 + q$ in (a): accept (−p, q) and x = −p.

Claude Specimen Paper 2: worked solutions

Indicative teaching mark scheme. M = method, A = accuracy, B = independent mark; f = follow-through. Award equivalent valid methods. Non-exact answers to 3 s.f. (angles to 1 d.p.) unless stated.

1 (a) $\frac{9}{9+11} \times 1.6 \times 10^6$ **M1**

Answer: 7.2×10^5 **m³** **A1**

(b)(i) $7.2 \times 10^5 \times 1000$

Answer: 7.2×10^8 **litres** **B1**

(b)(ii) $\frac{7.2 \times 10^8}{5.6 \times 10^6}$ **M1**

Answer: **129 litres** (128.57…) **A1**

(b)(iii) $\frac{2.4 \times 10^7}{7.2 \times 10^5} \approx 33.3$

Answer: **33.3 days** **B1**

(c) $108\,\% \rightarrow 3.78$ or $\frac{3.78}{1.08}$ **M1**

Answer: **$3.50** **A1**

(b)(ii): 128.5714… litres rounds to 129 litres (3 s.f.). (b)(iii): 33⅓ days rounds to 33.3 days. Do not truncate intermediate values. Using (a) in m³: (2.4 × 10⁷) ÷ (7.2 × 10⁵) is equally valid.

2 (a)

Mid-value, *x*	5	15	25	35	45
Frequency, *f*	6	14	17	9	4
fx	30	210	425	315	180
***fx*²**	150	3150	10625	11025	8100

$\frac{1160}{50}$ **M1** (mid-values and $\sum fx = 1160$)

Answer: **23.2 minutes** **A1**

(b) $\sqrt{\frac{33050}{50} - (23.2)^2}$ **M1**

$\sqrt{661 - 538.24} = \sqrt{122.76}$

Answer: **11.1 minutes** (11.08…) **A1**

(c) Mean: students at *B* take less time on average (19.8 < 23.2). **B1**

or Standard deviation: the times at *B* are more consistent / less spread out (6.4 < 11.1). **B1**

Answer: **One valid comparison with a reason**

(d) $\frac{6+14}{50}$

Answer: $\frac{2}{5}$ **(0.4)** **B1**

(e) $\frac{9+4}{50} \times \frac{12}{49}$ **M1**

$\frac{156}{2450} = \frac{78}{1225}$

Answer: **0.0637** **A1**

(a) and (b): the marks are for a correct use of the formulae on the formula page with mid-values 5, 15, 25, 35, 45. (c) award only one mark; the comparison must refer to the context and give the numbers or the meaning of mean/standard deviation. (e) accept 78/1225 or 0.06367…

(c): accept either a comparison of the means (A's journeys are longer on average, 23.2 min against 19.8 min) or of the spreads (A's times vary more, SD 11.1 against 6.4), with the reason stated in context. (d): journeys of 20 minutes or less are the first two classes: (6 + 14)/50 = 2/5.

3 (a) $\frac{1}{3} \times \pi \times 6^2 \times 15$ **M1**

Answer: **565 cm³** (565.48…) **A1**

(b)(i) $l = \sqrt{6^2 + 15^2}$ **M1**

$= \sqrt{261} = 16.155... = 16.2$ (3 s.f.) **A1**

(b)(ii) $\pi r l = \pi \times 6 \times 16.155...$ **M1**

Answer: **305 cm²** (304.52…) **A1**

(c)(i) The juice forms a cone similar to the cup, with height 9 cm: length ratio = 9 : 15 = 3 : 5.

Area ratio = $3^2 : 5^2$

Answer: **9 : 25** **B1**

(c)(ii) Volume ratio (juice : cup) = $3^3 : 5^3 = 27 : 125$ **M1**

Volume of juice = $\frac{27}{125} \times 565.48...$

Answer: **122 cm³** (122.1…) **A1**

(c)(ii): accept a method using the height of the juice cone: V = (1/3)π(3.6)²(9) = 122 cm³, but the question asks for similar figures so the ratio method is expected. Accept 0.216 × 565 = 122.

(a): with π = 3.142 the volume is 565.56, so accept 565 or 566. (b)(i): the working must show √261 = 16.155… (at least 4 s.f.) before rounding to 16.2. (b)(ii) and (c)(ii) give the same 3 s.f. answer with either π.

4 (a) $\angle ABC = \frac{148}{2}$

Answer: **74°** B1 (angle at the centre is twice the angle at the circumference, both standing on arc *AC*)

(b) $AC^2 = 6.74^2 + 6.74^2 - 2 \times 6.74 \times 6.74 \times \cos 148°$ M1

$AC = \sqrt{167.9...}$

Answer: **13.0 m** (12.957807… before rounding) A1

(c) $180 - 74 =$

Answer: **106°** B1 (opposite angles of a cyclic quadrilateral *ABCD* add up to 180°)

(d) $\frac{\sin \angle CAD}{7.6} = \frac{\sin 106°}{12.957...}$ M1

$\sin \angle CAD = 0.5638...$

Answer: **34.3°** (34.32…) A1

(e) Angle *ACD* = 180° − 106° − 34.32…° = 39.68…° M1 (angle sum of a triangle)

$\frac{1}{2} \times 12.957... \times 7.6 \times \sin 39.68...°$

Answer: **31.4 m²** (31.44…) A1

(f) $\frac{148}{360} \times 2 \times \pi \times 6.74$ *or* $6.74 \times 148 \times \frac{\pi}{180}$ M1

Answer: **17.4 m** (17.41…) A1

(b) accept the sine rule or AC = 2 × 6.74 × sin 74° = 12.957807… (isosceles triangle OAC split in half). (e) if the rounded values 12.96, 34.3° and 39.7° are used the area is 31.5 m²: accept 31.4 or 31.5. (f) the arc ADC is the minor arc (148° at the centre), not the major arc. Reasons must be stated: do not award the B marks for the angle alone.

Rounding: students who carry the rounded AC = 13.0 m get CAD = 34.2° and an area of about 31.6 m². Accept 34.2° to 34.3° in (d) and 31.4 to 31.6 m² in (e). In (f) the answer uses only the 148° central angle (the 7.6 m chord is not needed); adding the chords AD + DC (16.2 m) earns no marks.

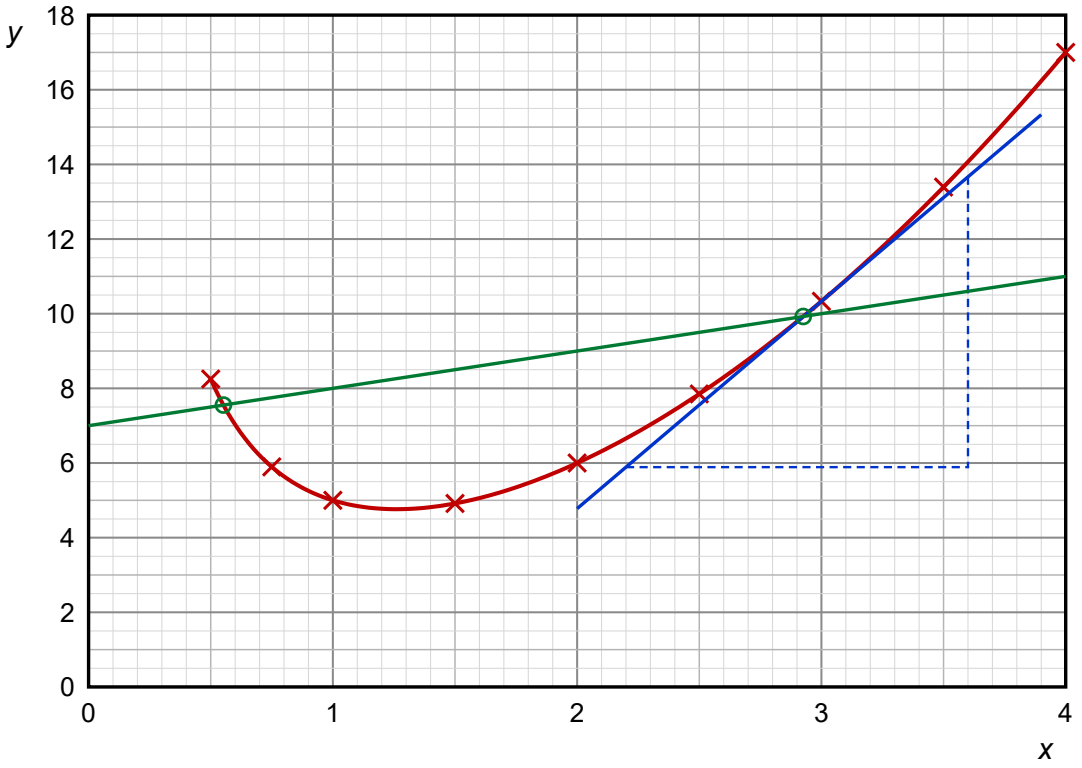
5 (a) $y = 1.5^2 + \frac{4}{1.5} = \mathbf{4.92}$ **B1** ; $y = 3.5^2 + \frac{4}{3.5} = \mathbf{13.39}$ **B1**

Answer: **4.92 and 13.39**

(b) All 9 points plotted correctly (to within 1 mm, i.e. ½ small square) **B2** : B2 for all points correct, B1 for 6 to 8 points correct.

Smooth curve through all the points, with the minimum between $x = 1$ and $x = 1.5$ (at about (1.26, 4.76)), no straight segments, not extended beyond the first and last points C1.

Answer: **Curve as shown in the figure below**



(c) Tangent drawn touching the curve at (3, 10.33) **B1** (ruled line, not cutting the curve)

Gradient = $\frac{\text{change in y}}{\text{change in x}}$ from a triangle on the tangent, e.g. from (2.2, 5.89) to (3.6, 13.67): $\frac{7.78}{1.4} = 5.6$

Answer: **5.6 (accept 5.0 to 6.1)** **B1**

(d)(i) Straight line through (0, 7) and (4, 11) ruled across the grid **B1**

(d)(ii) The line meets the curve at the points where $x \approx 0.55$ and $x \approx 2.9$.

Answer: ***x* = 0.55 or 2.9 (accept 0.50 to 0.60 and 2.85 to 3.00)** **B1**

(e) $x^2 + \frac{4}{x} = x + 7$

Multiply by x: $x^3 + 4 = x^2 + 7x$

$x^3 - x^2 - 7x + 4 = 0$ (shown) **B1**

(f) Divide by x: $x^2 - x - 9 + \frac{4}{x} = 0$, so $x^2 + \frac{4}{x} = x + 9$

Answer: ***y* = *x* + 9** **B1**

Computed values: x = 0.5, 0.75, 1, 1.5, 2, 2.5, 3, 3.5, 4 give y = 8.25, 5.90, 5.00, 4.92, 6.00, 7.85, 10.33, 13.39, 17.00. The exact gradient at x = 3 is 2(3) − 4/9 = 50/9 ≈ 5.56 (calculus is not required; this is the value a good tangent should approach). Numerically computed intersections of the line with the curve: roots of $x^3 - x^2 - 7x + 4 = 0$ are x = 0.552, 2.925 (and −2.477, outside the plotted range). Marks: (a) 2, (b) 3, (c) 2, (d) 2, (e) 1, (f) 1 (GRF 9 in (a) to (d), EQ 2 in (e) and (f)). Follow-through is allowed for (c) and (d)(ii) from the candidate's own graph.

6 (a) $\frac{4-1}{7-1}$

Answer: $\frac{1}{2}$ **B1**

(b) $AD = \sqrt{(2-1)^2 + (6-1)^2}$ **M1**

$= \sqrt{26}$

Answer: **5.10 (3 s.f.)** **A1**

(c) Gradient of $BC = \frac{8-4}{6-7} = -4$ **M1**

$y - 4 = -4(x - 7)$

Answer: $y = -4x + 32$ **A1**

(d) At $y = 0$: $0 = -4x + 32$, so F is (8, 0) **M1**

$GF = 8 - (-1) = 9$; height of triangle = 4 (the y-coordinate of B)

Area $= \frac{1}{2} \times 9 \times 4$

Answer: **18 units²** **A1**

(e) (i) Answer: $\overrightarrow{AB} = \begin{pmatrix} 6 \\ 3 \end{pmatrix}$ **B1**

(ii) $\overrightarrow{DC} = \begin{pmatrix} 4 \\ 2 \end{pmatrix}$

Answer: $k = \frac{2}{3}$ **B1**

(a) accept 0.5. (b) accept 5.1 if √26 is seen. (c) accept 4x + y = 32. (d) any correct method is acceptable. (e)(ii) accept 0.667.

7 (a) Outward time $\frac{20}{x}$ h; return time $\frac{20}{x+3}$ h; 10 minutes = $\frac{1}{6}$ h **M1**

$\frac{20}{x} - \frac{20}{x+3} = \frac{1}{6}$ **M1**

$120(x + 3) - 120x = x(x + 3)$

$360 = x^2 + 3x$

$x^2 + 3x - 360 = 0$ (shown) **A1**

(b) $x = \frac{-3 \pm \sqrt{3^2 - 4(1)(-360)}}{2(1)}$ **M1**

Answer: $x = 17.53$ **or** $x = -20.53$ **A1**

(c) A speed cannot be negative, so $x = -20.53$ is rejected. **B1**

(d) Outward time $= \frac{20}{17.53} = 1.141$ h; return time $= \frac{20}{20.53} = 0.974$ h **M1**

Total time $= 2.115$ h **M1**

Average speed = total distance ÷ total time $= \frac{40}{2.115}$

Answer: **18.9 km/h** **A1**

(b) The formula or completing the square is needed; the equation does not factorise. (d) The mean of the two speeds, 19.0 km/h, is incorrect: the distances are equal but the times are not.

8 (a) Pattern 4: 4 rows of 6 dots = 24; Pattern 5: 5 rows of 7 dots = 35
Answer: **24 and 35** B1

(b) Pattern n has n rows of $(n+2)$ dots M1
Answer: $n(n+2)$ **or** n^2+2n A1
Alternatively: differences 5, 7, 9 with constant second difference 2 give n² + 2n.

(c) $N(N+2)=575$ M1
$N^2+2N-575=0,\ (N-23)(N+25)=0$
Answer: $N=23$ A1 *(N = −25 rejected; 23 × 25 = 575 found by trial is also accepted)*

(d) Pattern $(n+1)$ has $(n+1)(n+3)$ dots M1
$(n+1)(n+3)-n(n+2)$
$n^2+4n+3-n^2-2n$
$=2n+3$ (shown) A1

(e) $n(n+2)+(n+2)(n+4)$ M1
$=(n+2)(n+n+4)$
$=(n+2)(2n+4)$
$=2(n+2)^2$ (shown) A1

(d), (e): expanding both sides to the same expression is also acceptable.

9 (a) Answer: $\frac{7}{n+7}$ B1

(b) After a red ball is removed there are 6 red balls among $(n+6)$ balls M1
P(both red) $=\frac{7}{n+7}\times\frac{6}{n+6}=\frac{42}{(n+7)(n+6)}$ (shown) A1

(c) $\frac{42}{(n+7)(n+6)}=\frac{7}{22}$ M1
$42\times22=7(n+7)(n+6)$, so $(n+7)(n+6)=132$
$n^2+13n+42=132$
$n^2+13n-90=0$ (shown) A1

(d) $(n+18)(n-5)=0$ M1
Answer: $n=5$ A1 *(n = −18 rejected as n is a number of balls)*

(d) The quadratic formula is also accepted. Award A1 only if the negative root is rejected or only n = 5 is given.

In (d), n = −18 is rejected because the number of balls cannot be negative; accept the answer n = 5 only.

10 (a) Energy used = $2.4 \times \frac{40}{60} = 1.6$ kWh **M1**
Cost = 1.6 × \$0.30 = \$0.48 (shown) **A1**

(b) Cost of a batch = \$9.60 + \$0.48 = \$10.08; $\frac{10.08}{24} = 0.42$ (shown) **B1**

(c) Batches for 110 cupcakes: $\frac{110}{24} = 4.58\ldots$, so 5 batches **M1**
Income = 110 × \$2.00 = \$220; cost of batches = 5 × \$10.08 = \$50.40 **M1**
Profit = 220 − 50.40 − 60
Answer: **\$109.60** **A1**

(d) Demand is 160 but she can bake at most 5 × 24 = 120 cupcakes, so she sells 120 **M1**
Profit = 120 × \$1.50 − 5 × \$10.08 − 60 = 180 − 50.40 − 60
Answer: **\$69.60** **A1**

(e) Profits: \$1.00 gives \$9.60; \$1.50 gives \$69.60; \$2.00 gives \$109.60; \$2.50 gives \$84.76.
Answer: **\$2.00** **B1**
Reason: it gives the greatest profit (\$109.60), which is \$24.84 more than the next best price (\$2.50). **B1**

(e) The reason must refer to the profits. For reference, at \$2.50 only 3 batches are needed (72 cupcakes, \$30.24): \$175 − 30.24 − 60 = \$84.76.

In (e), full marks need \$2.00 together with a reason that compares the actual profit figures (for example \$109.60 against \$84.76, \$69.60 and \$9.60). 'Highest profit' alone earns one mark.