revise.wales - Mark Scheme

Mock Paper A - Unit 3: Calculator-Allowed (Higher Tier)

90 marks. R.WM-MNH-U3-001 (MS).

Notation. Mn = method mark; An = accuracy / answer mark; Bn = independent unsupported correct value; Cn = communication (OCW); ft = follow through from a prior error; oe = or equivalent; cao = correct answer only.

Question 1 (6 marks)

(a) **M1** Convert 36 min to hours: $36/60 = 0{\cdot}6$ h (or use speed $= 14{\cdot}4 \div 36 \times 60$).

A1 Speed $= 14{\cdot}4/0{\cdot}6 =$ **24** km/h (cao).

(b) **M1** Apply $\rho = m/V = 486/60$.

A1 **8·1** g/cm^3 (cao).

(c) **M1** Apply rate $= 2{\cdot}5/20$ litres/s and convert: $\times 60$ (or convert 20 s to $\frac{1}{3}$ min first).

A1 Flow rate $= 2{\cdot}5/20 \times 60 =$ **7·5** litres/min (cao).

Question 2 (8 marks)

(a) **M1** Area of rectangle $= 20 \times 12 = 240$ cm^2.

M1 Area of quarter-circle $= \frac{1}{4}\pi(8)^2 = 16\pi \approx 50{\cdot}265$ cm^2.

A1 Area $= 240 - 16\pi =$ **189·7** cm^2 (to 1 d.p.; cao; accept $189{\cdot}73$). Award M1A0 for $240 - 16\pi$ left unevaluated, or for using πr (perimeter formula) by mistake.

(b) **M1** Identify the four straight edges contributing to the perimeter: $AB = 20$, $BE = 12 - 8 = 4$, $FD = 20 - 8 = 12$, $DA = 12$. Sum $= 20 + 4 + 12 + 12 = 48$ cm.

M1 Add the quarter-arc length: $\frac{1}{4} \times 2\pi(8) = 4\pi \approx 12{\cdot}566$ cm.

A1 Perimeter $= 48 + 4\pi =$ **60·6** cm (to 1 d.p.; cao; accept $60{\cdot}57$).

(c) **M1** From $\pi r^2 = 64\pi$, $r^2 = 64$, so $r = 8$ cm.

A1 Circumference $= 2\pi r =$ **16**π cm (cao; must be in the form $k\pi$ — decimal answers score M1A0).

Question 3 (11 marks)

(a) **M1** Pythagoras in base $ABCD$: $AC^2 = 18^2 + 9^2 = 324 + 81 = 405$.

M1 $AC = \sqrt{405} = 9\sqrt{5}$ (oe; exact form acceptable).

A1 $AC =$ **20·1** cm (to 1 d.p.; cao; accept $20{\cdot}12$).

(b) **M1** Apply 3-D Pythagoras: $AG^2 = AC^2 + CG^2 = 405 + 36 = 441$.

M1 $AG = \sqrt{441}$.

A1 $AG =$ **21·0** cm (exact; cao).

(c) **M1** Right-angled triangle ACG, right-angle at C: $\tan\theta = CG/AC = 6/\sqrt{405}$ (or $\sin\theta = 6/21$, $\cos\theta = \sqrt{405}/21$).

M1 $\theta = \tan^{-1}(6/\sqrt{405})$ (or $\sin^{-1}(6/21)$).

A1 $\theta =$ **16·6**° (to 1 d.p.; cao; accept $16{\cdot}60°$).

(d) **M1** Scale factor on lengths: $63/21 = 3$. Apply to the corresponding length $AB = 18$: $AB' = 18 \times 3$.

A1 $AB =$ **54** cm (cao).

Question 4 (9 marks)

(a) **M1** Cylinder volume: $V_{\text{cyl}} = \pi r^2 h = \pi(5)^2(12) = 300\pi \approx 942{\cdot}48\,\text{cm}^3$.

M1 Cone volume: $V_{\text{cone}} = \frac{1}{3}\pi r^2 h = \frac{1}{3}\pi(5)^2(12) = 100\pi \approx 314{\cdot}16\,\text{cm}^3$.

A1 Total $= 400\pi \approx$ **1257** cm^3 (to nearest whole; cao). Award M1M0A0 if cone volume uses $\pi r^2 h$ (no factor of $\frac{1}{3}$).

(b) **M1** Slant height $l = \sqrt{r^2 + h^2} = \sqrt{25 + 144} = \sqrt{169} = 13$ cm.

M1 Curved surface area $= \pi r l = \pi(5)(13) = 65\pi$.

A1 **204·2** cm^2 (to 1 d.p.; cao; accept $204{\cdot}20$). Award 0 for using πr^2 (base area) or $\pi r^2 + \pi r l$ (total cone surface).

(c) **M1** Linear scale factor $k = 15/5 = 3$; volume scale factor $= k^3 = 27$.

M1 Volume of second cone $= 100\pi \times 27 = 2700\pi$ (ft from their (a) cone volume).

A1 **8482** cm^3 (to nearest whole; cao; accept $8482{\cdot}30$).

Question 5 (11 (incl. 2 OCW) marks)

(a) **M1** Place a protractor at P, aligning 0° with the north line, and measure the clockwise angle to the line PQ.

A1 Bearing of Q from $P \approx$ **050**$^\circ$ (accept 048°–052°; cao; must be three-figure bearing).

B1 Three-figure form used (i.e. leading zero present for any bearing less than 100°).

(b) **M1** Measure QR on the map: $\approx 3{\cdot}5$ cm (accept $3{\cdot}3$–$3{\cdot}7$ cm).

M1 Apply scale 1 cm : 2 km: real distance $= 3{\cdot}5 \times 2$.

A1 $QR \approx$ **7** km (accept $6{\cdot}6$–$7{\cdot}4$ km; ft from their measurement).

(c) *OCW - working must be in connected sentences.* **M1** Identify that the bearing of P from R is the *back bearing* of the bearing of R from P, and that back bearings differ by 180°.

M1 Measure (or compute) the bearing of R from P: $\approx 110^\circ$ (accept 105°–115°).

A1 Return bearing $= 110 + 180 =$ **290**$^\circ$ (accept 285°–295°; ft).

C1 (OCW) Working reads as connected English sentences: explicitly states the back-bearing rule ($\pm 180^\circ$), the measured forward bearing and the final value.

C1 (OCW) Correct mathematical notation throughout, including three-figure bearings consistently and a clear statement of why 180° is added rather than subtracted (forward bearing $< 180^\circ$ so we add).

Question 6 (12 marks)

(a) **M1** Identify $a = 2$, $b = -7$, $c = 3$ and substitute into $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \dfrac{7 \pm \sqrt{49 - 24}}{4} = \dfrac{7 \pm \sqrt{25}}{4} = \dfrac{7 \pm 5}{4}$.

A1 $x = \dfrac{12}{4} =$ **3** or $x = \dfrac{2}{4} =$ **0·5** (cao; both required for A1; exact answers acceptable since

discriminant is a perfect square).

B1 Both solutions stated explicitly (lose B1 if only one solution is given).

(b) **M1** Multiply throughout by $(x-2)(x+1)$: $3(x+1)-2(x-2)=(x-2)(x+1)$.

M1 Expand and simplify LHS: $3x+3-2x+4=x+7$; expand RHS: x^2-x-2. So $x+7=x^2-x-2$, i.e. $x^2-2x-9=0$.

M1 Apply quadratic formula: $x=\dfrac{2\pm\sqrt{4+36}}{2}=\dfrac{2\pm\sqrt{40}}{2}=1\pm\sqrt{10}$.

A1 $x=$ **4·16** or $x=$ **−2·16** (to 2 d.p.; cao; both required).

(c) **B1** Table completed: $x=1\Rightarrow y=-1$; $x=2\Rightarrow y=-1$; $x=4\Rightarrow y=5$ (all three required; one error costs the B1).

M1 Plot all six points correctly to within half a small square (at least four of six correct for the M1).

A1 Smooth parabolic curve through all six points (no straight-line segments; symmetric about $x=1{\cdot}5$).

B1 Recognise $x^2-4x-1=0\Leftrightarrow x^2-3x+1=x+2$, so draw the straight line $\mathbf{y=x+2}$ on the same grid.

B1 Read off intersections of parabola with $y=x+2$: $x\approx$ **−0·2** and $x\approx$ **4·2** (ft from their curve, accept $\pm0{\cdot}1$). Both roots required.

Question 7 (11 marks)

(a) **M1** Apply the cosine rule: $BC^2=AB^2+AC^2-2\cdot AB\cdot AC\cdot\cos A=8{\cdot}5^2+11{\cdot}2^2-2(8{\cdot}5)(11{\cdot}2)\cos 58^\circ$.

M1 Evaluate: $72{\cdot}25+125{\cdot}44-190{\cdot}4\cos 58^\circ=197{\cdot}69-100{\cdot}900\ldots=96{\cdot}789\ldots$.

A1 $BC=\sqrt{96{\cdot}79}=$ **9·8** cm (to 1 d.p.; cao; accept $9{\cdot}84$).

(b) **M1** Apply area $=\frac{1}{2}ab\sin C=\frac{1}{2}(8{\cdot}5)(11{\cdot}2)\sin 58^\circ$.

A1 Area $=40{\cdot}356\ldots=$ **40·4** cm^2 (to 1 d.p.; cao).

(c) **M1** Apply the sine rule: $\dfrac{\sin R}{14}=\dfrac{\sin 32^\circ}{9}$, so $\sin R=\dfrac{14\sin 32^\circ}{9}=0{\cdot}8243\ldots$.

M1 $\sin^{-1}(0{\cdot}8243)=55{\cdot}5^\circ$; the *obtuse* solution is $R=180-55{\cdot}5$.

A1 Angle $QRP=$ **124·5**$^\circ$ (to 1 d.p.; cao). Award M1M1A0 for the acute value $55{\cdot}5^\circ$ without identifying the obtuse branch.

(d) *"Show that" - algebra must be visible.* **M1** Find angle PQR: $180-32-124{\cdot}5=23{\cdot}5^\circ$ (ft from their (c)).

M1 Apply sine rule for PR: $\dfrac{PR}{\sin 23{\cdot}5^\circ}=\dfrac{9}{\sin 32^\circ}$, so $PR=\dfrac{9\sin 23{\cdot}5^\circ}{\sin 32^\circ}$.

A1 $PR=6{\cdot}77$ cm (to 2 d.p.). Conclude: $6{\cdot}77<11$, so $PR<11$ cm (cao - explicit comparison required; bare value scores M1M1A0).

Question 8 (11 marks)

(a) **B1** Cumulative frequencies: $6, 20, 42, 62, 74, 80$ (all six required; one error costs the B1).

M1 Plot at the upper class boundaries the points $(10,6)$, $(20,20)$, $(30,42)$, $(40,62)$, $(50,74)$, $(60,80)$, and include $(0,0)$. At least five of the seven plotted correctly.

A1 Smooth curve drawn through the points (S-shape; no straight segments between points). Penalise a polygon-style (straight-line) graph by dropping the A1.

(b) **M1** Identify median position at cf $= 40$, lower quartile at cf $= 20$, upper quartile at cf $= 60$ (or $\frac{n}{2}$, $\frac{n}{4}$, $\frac{3n}{4}$ with $n = 80$).

A1 Median $\approx$ **29** minutes (accept 27–31; ft from their curve).

A1 LQ ≈ 20, UQ ≈ 39, IQR $\approx$ **19** minutes (accept 17–21; ft).

(c) **B1** Box drawn from LQ to UQ at the correct horizontal positions on the axis (ft from (b)).

B1 Median line drawn inside the box at correct horizontal position (ft from (b)).

B1 Whiskers drawn from 2 (minimum) to LQ, and from UQ to 58 (maximum). All three components present and to scale.

(d) **B1** Comparison of central tendency: the second group has a larger median (35) than the first group (≈ 29), so on average their journey is longer. Comparison must be in context (mention the commuters / journey time).

B1 Comparison of spread: the second group has a smaller IQR (8) than the first (≈ 19), so the second group's travel times are more consistent / less varied. Award only for an explicit in-context comparison; raw value comparison without interpretation scores 0.

Question 9 (11 marks)

(a) **B1** Frequency density for first row: $8/4 = 2$. For the $4 < m \leq 6$ row: frequency $= 9 \times 2 = 18$. For $6 < m \leq 10$: density $= 40/4 = 10$. For $10 < m \leq 20$: density $= 36/10 = 3{\cdot}6$.

B1 Missing total: $120 - (8 + 18 + 40 + 36) = 18$ parcels in $20 < m \leq 30$; density $= 18/10 = 1{\cdot}8$.

M1 Histogram bars drawn at the correct widths (matching class intervals) on the grid.

A1 Bar heights match frequency densities of $2, 9, 10, 3{\cdot}6, 1{\cdot}8$ to within half a small square (cao; ft from their densities).

(b) **M1** Identify parcels with $m > 8$: half of the $6 < m \leq 10$ bar plus all bars beyond. Half-bar count $= 2 \times 10 = 20$; plus $36 + 18 = 54$. (Alternatively sum frequency density $\times$ width for each portion.)

A1 Estimate $= 20 + 36 + 18 =$ **74** parcels (accept 72–76; cao).

(c) **B1** Point K plotted at $(2{\cdot}4, 11)$ (to within half a small square).

M1 Line of best fit drawn as a single straight line that follows the trend, with approximately equal numbers of points above and below the line, passing through the visual centre of the data (near the mean point $(2{\cdot}26, 12{\cdot}4)$).

A1 Line spans the full data range $1{\cdot}0$–$4{\cdot}0$ litres and shows clear negative gradient (judged by eye).

(d) **B1** Read fuel consumption at engine size $3{\cdot}0$ from the line of best fit: $\approx$ **10** km/litre (accept 9–11; ft from their line).

B1 Correlation: **strong negative**. Both descriptors required (sign *and* strength) - "negative" alone caps at B0.

Total: $6 + 8 + 11 + 9 + 11 + 12 + 11 + 11 + 11 =$ **90 marks.**

OCW marks (Q5): the 2 OCW marks are included in the question total of 11. To award full OCW the candidate's working must read as connected English sentences with correct mathematical notation throughout, including an explicit statement of the back-bearing rule and a justified conclusion.