revise.wales - Mark Scheme

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

90 marks. R.WM-MNH-U3-002 (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** Apply rate $= 54/45$ litres/s and convert ($\times 60$); or convert 45 s $= 0{\cdot}75$ min first.

A1 Flow rate $= 54/45 \times 60 =$ **72** litres/min (cao).

(b) **M1** Apply $\rho = m/V = 672/80$.

A1 **8·4** g/cm^3 (cao).

(c) **M1** Convert 3 h 6 min to hours: $3 + 6/60 = 3{\cdot}1$ h.

A1 Speed $= 248/3{\cdot}1 =$ **80·0** km/h (cao; accept 80).

Question 2 (8 marks)

(a) **M1** Outer disc area $= \pi(9)^2 = 81\pi$ cm^2; inner hole area $= \pi(4)^2 = 16\pi$ cm^2.

M1 Shaded $= 81\pi - 16\pi = 65\pi$.

A1 Area $= 65\pi \approx$ **204·2** cm^2 (to 1 d.p.; cao; accept $204{\cdot}20$). Award 0 for using πr (circumference) in place of πr^2.

(b) **M1** Outer circumference $= 2\pi(9) = 18\pi$ cm; inner circumference $= 2\pi(4) = 8\pi$ cm.

M1 Total perimeter $= 18\pi + 8\pi = 26\pi$.

A1 Perimeter $= 26\pi \approx$ **81·7** cm (to 1 d.p.; cao; accept $81{\cdot}68$).

(c) **M1** From $2\pi r = 18\pi$, $r = 9$ cm.

A1 Area $= \pi(9)^2 =$ **81**π cm^2 (cao; must be in the form $k\pi$ - decimal answers score M1A0).

Question 3 (11 marks)

(a) **M1** Pythagoras in front face ABE, right-angled at B: $AE^2 = AB^2 + BE^2 = 12^2 + 5^2 = 144 + 25 = 169$.

M1 $AE = \sqrt{169}$.

A1 $AE =$ **13·0** cm (exact; cao).

(b) **M1** Identify the horizontal diagonal AC of the base ($AC^2 = AB^2 + BC^2 = 144 + 64 = 208$); then $AF^2 = AC^2 + CF^2$ with $CF = 5$.

M1 $AF^2 = 208 + 25 = 233$; $AF = \sqrt{233}$. *Or single step:* $AF^2 = 12^2 + 8^2 + 5^2 = 233$.

A1 $AF =$ **15·3** cm (to 1 d.p.; cao; accept $15{\cdot}26$).

(c) **M1** Right-angled triangle ACF, right-angle at C: $\tan\theta = CF/AC = 5/\sqrt{208}$ (or $\sin\theta = 5/\sqrt{233}$, $\cos\theta = \sqrt{208}/\sqrt{233}$).

M1 $\theta = \tan^{-1}\left(5/\sqrt{208}\right)$ (oe).

A1 $\theta =$ **19·1**$^\circ$ (to 1 d.p.; cao; accept $19{\cdot}12^\circ$).

(d) **M1** Scale factor on lengths: $32{\cdot}5/13 = 2{\cdot}5$. Apply to corresponding depth: depth $= 8 \times 2{\cdot}5$.

A1 Depth $=$ **20** cm (cao).

Question 4 (9 marks)

(a) **M1** Cylinder volume: $V_{\text{cyl}} = \pi r^2 h = \pi(4)^2(10) = 160\pi \approx 502{\cdot}655\,\text{cm}^3$.

M1 Hemisphere volume: $V_{\text{hem}} = \frac{2}{3}\pi r^3 = \frac{2}{3}\pi(4)^3 = \frac{128}{3}\pi \approx 134{\cdot}041\,\text{cm}^3$.

A1 Total $= 160\pi + \frac{128}{3}\pi \approx$ **637 cm³** (to nearest whole; cao; accept 636). Award M1M0A0 if hemisphere uses $\frac{4}{3}\pi r^3$ (full-sphere formula).

(b) **M1** Curved cylinder surface $= 2\pi rh = 2\pi(4)(10) = 80\pi$; flat circular base $= \pi r^2 = 16\pi$.

M1 Curved hemisphere surface $= 2\pi r^2 = 2\pi(4)^2 = 32\pi$. Total $= 80\pi + 32\pi + 16\pi = 128\pi$.

A1 **402·1 cm²** (to 1 d.p.; cao; accept $402{\cdot}12$). Penalise A0 for omitting the flat base, or for including the top of the cylinder twice.

(c) **M1** Volume scale factor $k^3 = 4860/637 = 7{\cdot}629\ldots$ (or use exact value $4860/\frac{608\pi}{3} = 7{\cdot}629\ldots$).

M1 Linear scale factor $k = \sqrt[3]{7{\cdot}629\ldots} = 1{\cdot}969\ldots$; new radius $= 4k$.

A1 Radius $=$ **7·9** cm (to 1 d.p.; cao; accept $7{\cdot}87$–$7{\cdot}88$). Award M1M1A0 for using k^2 (area scale factor) in error.

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

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

A1 Bearing of Y from $X \approx$ **135**$^\circ$ (accept 132°–138°; 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 YZ on the map: $\approx 6{\cdot}0$ cm (accept $5{\cdot}7$–$6{\cdot}3$ cm).

M1 Apply scale 1 cm : 500 m: real distance $= 6{\cdot}0 \times 500 = 3000$ m, i.e. convert to km.

A1 $YZ \approx$ **3·0** km (accept $2{\cdot}8$–$3{\cdot}2$ km; ft from their measurement).

(c) *OCW - working must be in connected sentences.* **M1** Measure XY on the map: $\approx 7{\cdot}9$ cm, giving $XY \approx 7{\cdot}9 \times 500 = 3950$ m $\approx 3{\cdot}95$ km (accept $3{\cdot}8$–$4{\cdot}1$ km). Total distance $= XY + YZ \approx 3{\cdot}95 + 3{\cdot}0 = 6{\cdot}95$ km.

M1 Apply time $=$ distance/speed $= 6{\cdot}95/4 = 1{\cdot}74$ hours (ft from candidate's distances).

A1 Time $= 1{\cdot}74 \times 60 =$ **104** minutes (accept 100–108 minutes; ft).

C1 (OCW) Working reads as connected English sentences: distances measured from the map, scale applied, conversion to hours, final conversion to minutes, all justified in words.

C1 (OCW) Correct mathematical notation throughout: units stated (km, hours, minutes), explicit speed–time–distance relationship, and a clear final answer rounded sensibly.

Question 6 (12 marks)

(a) **M1** Identify $a = 3$, $b = 4$, $c = -8$ and substitute into $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \dfrac{-4 \pm \sqrt{16 + 96}}{6} = \dfrac{-4 \pm \sqrt{112}}{6}$.

A1 $\sqrt{112} = 10{\cdot}583\ldots$; so $x = \dfrac{-4 + 10{\cdot}583}{6} = 1{\cdot}097\ldots$ or $x = \dfrac{-4 - 10{\cdot}583}{6} = -2{\cdot}430\ldots$.

B1 $x =$ **1·10** or $x =$ **−2·43** (to 2 d.p.; cao; both required).

(b) **M1** Multiply throughout by $(x+1)(x-3)$: $4(x-3) + (x+1) = 2(x+1)(x-3)$.

M1 Expand and simplify LHS: $4x-12+x+1 = 5x-11$; expand RHS: $2(x^2-2x-3) = 2x^2-4x-6$. So $5x - 11 = 2x^2 - 4x - 6$, i.e. $2x^2 - 9x + 5 = 0$.

M1 Apply quadratic formula: $x = \dfrac{9 \pm \sqrt{81 - 40}}{4} = \dfrac{9 \pm \sqrt{41}}{4}$.

A1 $x =$ **3·85** or $x =$ **0·65** (to 2 d.p.; cao; both required).

(c) **B1** Table completed: $x = -1 \Rightarrow y = 1$; $x = 2 \Rightarrow y = -2$; $x = 4 \Rightarrow y = 6$ (all three required; one error costs the B1).

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

A1 Smooth parabolic curve through all seven points (no straight-line segments; symmetric about $x = 1$).

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

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

Question 7 (11 marks)

(a) **M1** Apply the cosine rule: $MN^2 = LM^2 + LN^2 - 2 \cdot LM \cdot LN \cdot \cos L = 24^2 + 31^2 - 2(24)(31)\cos 47°$.

M1 Evaluate: $576 + 961 - 1488\cos 47° = 1537 - 1014{\cdot}73\ldots = 522{\cdot}27\ldots$.

A1 $MN = \sqrt{522{\cdot}27} =$ **22·9** m (to 1 d.p.; cao; accept $22{\cdot}85$).

(b) **M1** Apply area $= \frac{1}{2}\,ab\sin C = \frac{1}{2}(24)(31)\sin 47°$.

A1 Area $= 272{\cdot}06\ldots =$ **272·1** m² (to 1 d.p.; cao).

(c) **M1** Apply the sine rule: $\dfrac{\sin S}{TU} = \dfrac{\sin U}{ST}$, i.e. $\dfrac{\sin S}{13} = \dfrac{\sin 78°}{18}$, so $\sin S = \dfrac{13\sin 78°}{18} = 0{\cdot}7064\ldots$.

M1 $S = \sin^{-1}(0{\cdot}7064)$; take the acute solution as required by the question.

A1 Angle $TSU =$ **44·9°** (to 1 d.p.; cao; accept $44{\cdot}95°$). Award M1M1A0 for taking the obtuse branch $135{\cdot}1°$.

(d) *"Show that" - algebra must be visible.* **M1** Find angle STU: $180 - 78 - 44{\cdot}9 = 57{\cdot}1°$ (ft from their (c); accept $57{\cdot}05°$).

M1 Apply sine rule for SU: $\dfrac{SU}{\sin 57{\cdot}1°} = \dfrac{18}{\sin 78°}$, so $SU = \dfrac{18\sin 57{\cdot}1°}{\sin 78°}$.

A1 $SU = 15{\cdot}44$ m (to 2 d.p.). Conclude: $15{\cdot}44 > 15$, so $SU > 15$ m (cao - explicit comparison required; bare value scores M1M1A0).

Question 8 (11 marks)

(a) **B1** Cumulative frequencies: $4, 18, 44, 74, 92, 100$ (all six required; one error costs the B1).

M1 Plot at the upper class boundaries the points $(5, 4)$, $(10, 18)$, $(15, 44)$, $(20, 74)$, $(25, 92)$, $(30, 100)$, and include $(0, 0)$. At least five of the seven plotted correctly.

A1 Smooth curve drawn through the points (S-shape; no straight-line segments between points).

Penalise a polygon-style (straight-line) graph by dropping the A1.

(b) **M1** Identify median position at cf $= 50$, lower quartile at cf $= 25$, upper quartile at cf $= 75$ (or $\frac{n}{2}, \frac{n}{4}, \frac{3n}{4}$ with $n = 100$).

A1 Median $\approx$ **16** cm (accept 14–18; ft from their curve).

A1 LQ ≈ 11, UQ ≈ 20, IQR $\approx$ **9** cm (accept 7–11; 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 1 (minimum) to LQ, and from UQ to 29 (maximum). All three components present and to scale.

(d) **B1** Comparison of central tendency: the second batch has a smaller median (13 cm) than the first (≈ 16 cm), so on average the second batch of seedlings is shorter. Comparison must be in context (mention seedlings / height).

B1 Comparison of spread: the second batch has a larger IQR (11 cm) than the first (≈ 9 cm), so the second batch's heights are more varied / less consistent. 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: $12/2 = 6$. For the $2 < \ell \leq 5$ row: frequency $= 14 \times 3 = 42$. For $5 < \ell \leq 10$: density $= 60/5 = 12$. For $10 < \ell \leq 20$: density $= 70/10 = 7$.

B1 Missing total: $200 - (12 + 42 + 60 + 70) = 16$ batteries in $20 < \ell \leq 30$; density $= 16/10 = 1{\cdot}6$.

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

A1 Bar heights match frequency densities of $6, 14, 12, 7, 1{\cdot}6$ to within half a small square (cao; ft from their densities).

(b) **M1** Identify batteries with $\ell > 15$: half of the $10 < \ell \leq 20$ bar plus all bars beyond. Half-bar count $= 5 \times 7 = 35$; plus the final bar $= 16$.

A1 Estimate $= 35 + 16 =$ **51** batteries (accept 49–53; cao).

(c) **B1** Point W plotted at $(7, 72)$ (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 $(5{\cdot}4, 59{\cdot}3)$).

A1 Line spans the full data range 1–11 hours and shows clear positive gradient (judged by eye).

(d) **B1** Read test score at revision time 10 hours from the line of best fit: $\approx$ **85** (accept 80–90; ft from their line).

B1 Correlation: **strong positive**. Both descriptors required (sign *and* strength) - "positive" 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 measured distances, scale conversion, application of the speed–distance–time relationship and a clear final time.