Secondary 3 Mathematics
WA3 Revision Time Trial — Beatty (2023)

Duration: 48 minutes **Score: _____ / 32**

Topics tested: Graphs of Functions; Graphs in Practical Situations; Further Trigonometry; Applications of Trigonometry.

Section A: Graphs of Functions [8 marks]

1. The variables x and y are connected by the equation $y = \frac{3}{2}x^2 + \frac{1}{2}x^3$. Some corresponding values of x and y are given in the following table.

x	-4	-3.5	-3	-2.5	-1	0	1	1.5	2
y	-8	a	0	1.55	1	0	2	5.06	10

(a) Find the value of a. *[1]*

Answer $a =$ .....

(b) On the graph paper provided on the next page, draw the graph of $y = \frac{3}{2}x^2 + \frac{1}{2}x^3$ using a scale of 2 cm to represent 1 unit on the x-axis and 1 cm to represent 1 unit on the y-axis. *[3]*

(c) Use your graph to write down the range of values of x for which $y > 1$. *[2]*

Answer .....

(d) (i) On the same axes, draw the line with gradient -2 that passes through the point $(2, 1)$. *[1]*

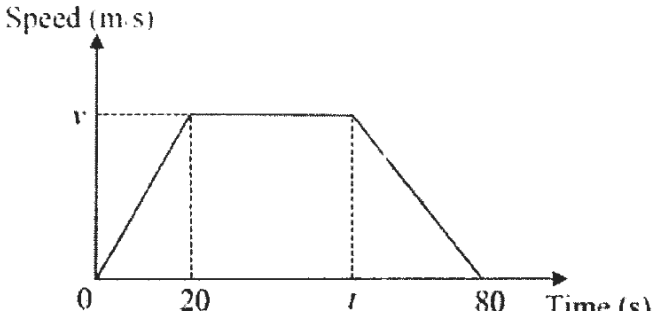
(ii) Write down the x-coordinate of the point of intersection of the line from **d(i)** and the graph of $y = \frac{3}{2}x^2 + \frac{1}{2}x^3$. *[1]*

Answer $x =$ .....

Section B: Graphs in Practical Situations [5 marks]

2. The following diagram shows the speed-time graph of a car during a journey. The car accelerated from rest at 1.25 m/s^2 to a speed of v m/s in 20 seconds. It travelled at this speed until t seconds before it came to a stop at $t = 80$ seconds. The total distance travelled for the whole journey was 1.45 km.

The distance travelled by the car during a certain time interval is equal to the area bounded by the graph and the time-axis in that time interval.



(a) Find the maximum speed of the journey. *[1]*

Answer ..... m/s

(b) Calculate the average speed, in km/h, of the car for the whole journey. *[2]*

Answer ..... km/h

(c) Find the value of t. *[2]*

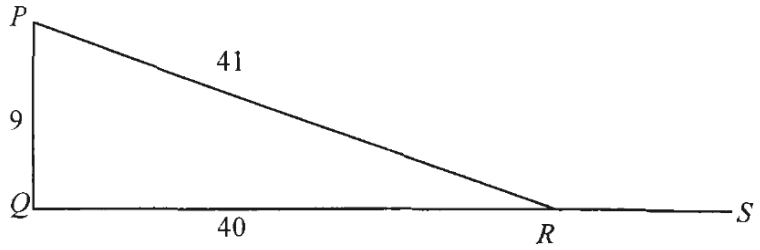
Answer $t =$ .....

Section C: Further Trigonometry [6 marks]

3. (a) The sine of an angle is 0.8711.
Give two possible values for the angle. *[2]*

Answer ..... *or* .....

(b) In triangle PQR, $PQ = 9$ cm, $QR = 40$ cm and $PR = 41$ cm.



(i) Show that angle PQR is right-angled. *[2]*

Answer .....
.....
.....

(ii) Write down the values of

(a) sin $\angle PRQ$, *[1]*

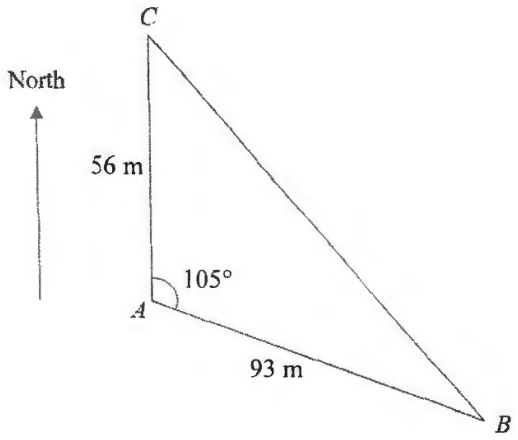
Answer .....

(b) cos $\angle PRS$. *[1]*

Answer .....

Section D: Applications of Trigonometry [13 marks]

4. ABC is a triangular plot of land. It is given that $AB = 93$ m, $AC = 56$ m and $\angle BAC = 105°$. A is due south of C.



(a) Find BC. *[2]*

Answer ..... m

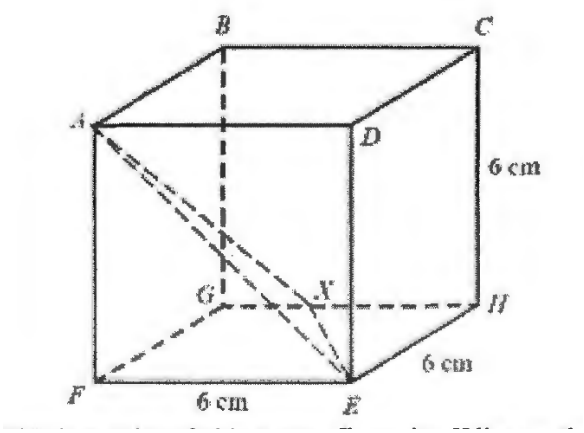
(b) Find the bearing of C from B. *[2]*

Answer ..... °

(c) A tree of height 25 m is planted at A. A man walks from B to C. Calculate the largest angle of elevation of the top of the tree from the man. *[3]*

Answer ..... °

5. $ABCDEFGH$ is a cube of side 6 cm. The point X lies on the side GH such that $GX : XH = 1 : 3$.



(a) Find the length of EX. *[2]*

Answer ..... cm

(b) Find $\angle AXE$. *[4]*

Answer .... $^\circ$

— END OF PAPER —

Answer Key
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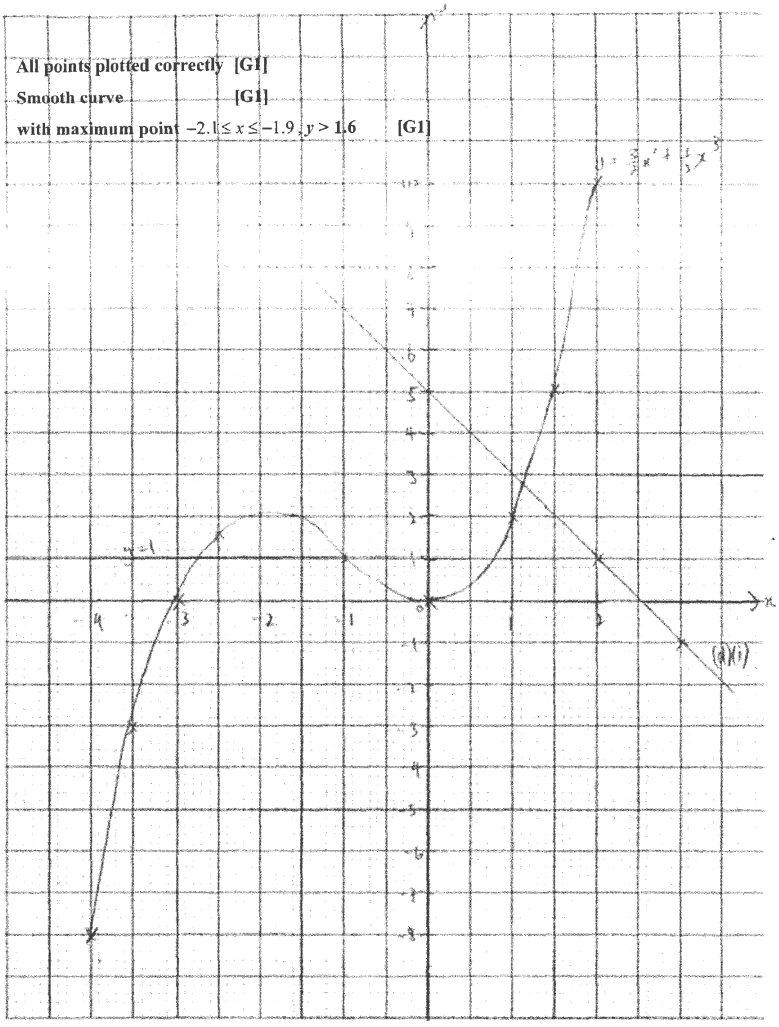
Section A: Graphs of Functions [8 marks]

1(a) At $x = -3.5$: $y = \frac{3}{2}(-3.5)^2 + \frac{1}{2}(-3.5)^3 = 18.375 - 21.4375 = -3.0625$.
$\therefore a = -$**3.06** (3 s.f.). *[1]*

1(b) Axes ruled with the given scale (x: 2 cm per unit from -4 to 2; y: 1 cm per unit from -8 to 10), all nine points plotted and joined with a smooth curve: local maximum $\approx (-2,\ 2)$, local minimum at $(0,\ 0)$. *[3]*



(Marking scheme graph shown, including the line for (d)(i).)

1(c) $y = 1$ line drawn; curve above it for: $-$**2.75** $<$ **x** $<$ $-$**1** and **x** $>$ **0.8**
(accept -2.8 to -2.7 for the left end, 0.75 to 0.85 for the right). *[2]*

1(d)(i) Line through $(2,\ 1)$ with gradient -2, i.e. $y = -2x + 5$ (e.g. through $(0,\ 5)$ and $(2,\ 1)$), drawn on the same axes. *[1]*

1(d)(ii) From the graph: **x** $\approx$ **1.1** (accept 1.05 to 1.15). *[1]*

Section B: Graphs in Practical Situations [5 marks]

2(a) $\dfrac{v}{20} = 1.25 \Rightarrow v =$ **25** m/s. *[1]*

2(b) Average speed $= \dfrac{1450}{80} = 18.125$ m/s $= 18.125 \times 3.6 =$ **65.25** km/h. *[2]*

2(c) Area under graph (trapezium) $= \dfrac{1}{2}\big[80 + (t - 20)\big](25) = 1450$
$80 + t - 20 = 116 \Rightarrow$ **t** $=$ **56**. *[2]*

Section C: Further Trigonometry [6 marks]

3(a) $\sin\theta = 0.8711 \Rightarrow \theta = 60.6°$ or $180° - 60.6° = 119.4°$.
$\therefore \theta =$ **60.6**° or **119.4**° (1 d.p.). *[2]*

3(b)(i) $PR^2 = 41^2 = 1681$ and $PQ^2 + QR^2 = 9^2 + 40^2 = 1681$.
Since $PR^2 = PQ^2 + QR^2$, by the **Converse of Pythagoras' Theorem**, triangle PQR is right-angled and $\angle PQR = 90°$. *[2]*

3(b)(ii)(a) $\sin\angle PRQ = \dfrac{PQ}{PR} =$ $\dfrac{\textbf{9}}{\textbf{41}}$. *[1]*

3(b)(ii)(b) $\angle PRS = 180° - \angle PRQ$ (adjacent ∠s on straight line QRS)
$\cos\angle PRS = -\cos\angle PRQ = -\dfrac{QR}{PR} = -$$\dfrac{\textbf{40}}{\textbf{41}}$. *[1]*

Section D: Applications of Trigonometry [13 marks]

4(a) By the Cosine Rule: $BC^2 = 56^2 + 93^2 - 2(56)(93)\cos 105°$
$BC = 120.336\ldots =$ **120** m (3 s.f.). *[2]*

4(b) By the Sine Rule: $\dfrac{\sin \angle ACB}{93} = \dfrac{\sin 105°}{120.336\ldots} \Rightarrow \angle ACB = 48.288\ldots°$
A is due south of C, so bearing of C from $B = 360° - 48.288\ldots° =$ **311.7**° (1 d.p.). *[2]*

4(c) The angle of elevation is largest at the point X on BC nearest to A (foot of the perpendicular from A).
$AX = 56\sin 48.288\ldots° = 41.80\ldots$ m.
$\tan\theta = \dfrac{25}{41.80\ldots} \Rightarrow \theta =$ **30.9**° (1 d.p.). *[3]*

5(a) $GX : XH = 1 : 3$ with $GH = 6$ cm, so $HX = \dfrac{3}{4} \times 6 = 4.5$ cm.
In right-angled triangle EHX: $EX = \sqrt{6^2 + 4.5^2} = \sqrt{56.25} =$ **7.5** cm. *[2]*

5(b) $AE = \sqrt{6^2 + 6^2} = \sqrt{72}$ cm (face diagonal).
$FX = \sqrt{6^2 + 1.5^2} = \sqrt{38.25}$ cm, so $AX = \sqrt{6^2 + 38.25} = \sqrt{74.25} = 8.6168\ldots$ cm.
By the Cosine Rule in triangle AXE:
$(\sqrt{72})^2 = 74.25 + 7.5^2 - 2(8.6168\ldots)(7.5)\cos\angle AXE$
$\cos\angle AXE = \dfrac{74.25 + 56.25 - 72}{129.25\ldots} = 0.4526\ldots \Rightarrow \angle AXE =$ **63.1**° (1 d.p.). *[4]*