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

Duration: 47 minutes **Score: _____ / 31**

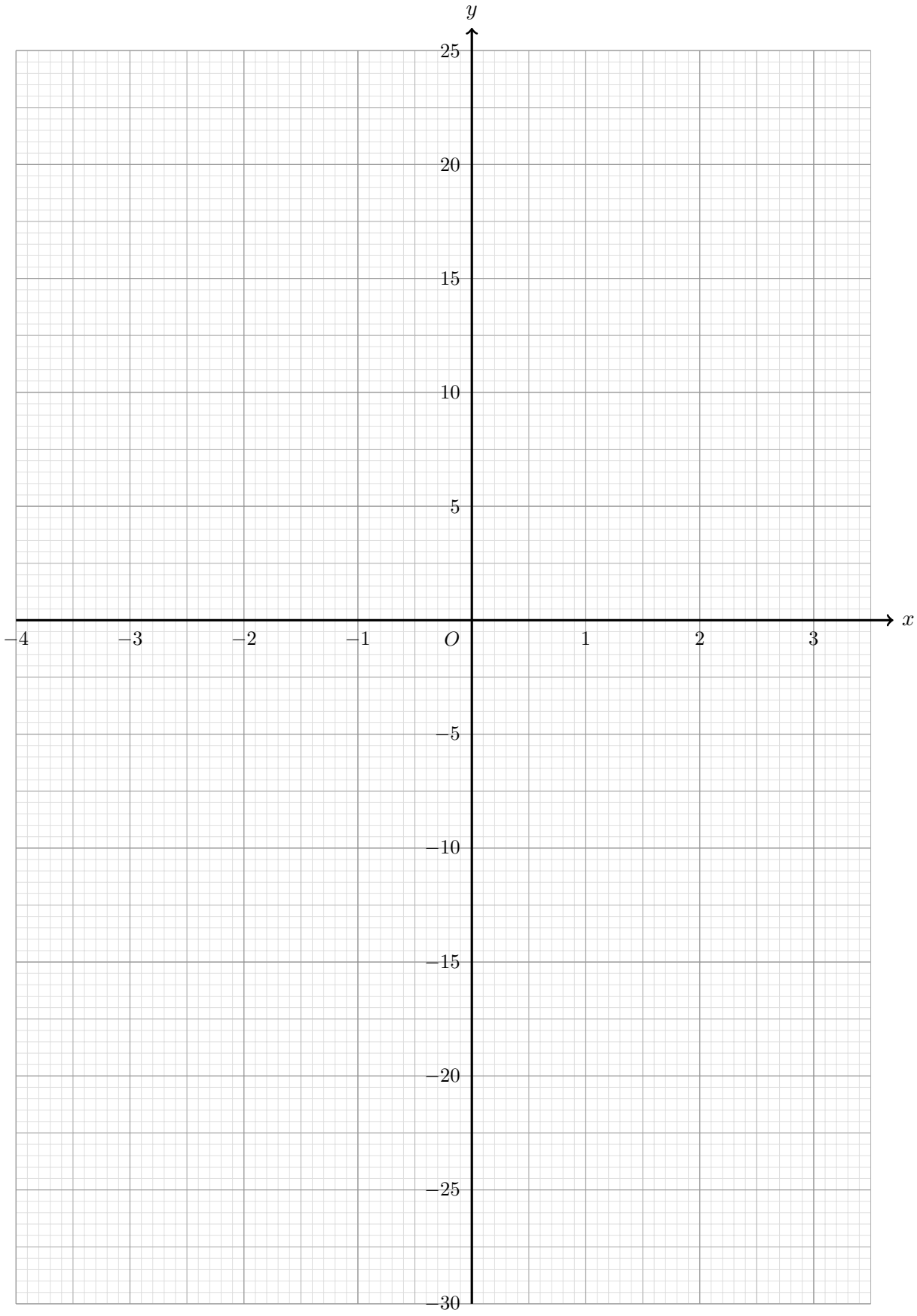
Topics tested: Graphs of Functions; Graphs in Practical Situations; Further Trigonometry; Applications of Trigonometry.

Section A: Graphs of Functions [10 marks]

1. (a) Complete the table of values for $y = -x^3 + 3x - 3$. *[2]*

x	-3	-2	-1	0	1	2	3
y		-1	-5	-3		-5	-21

(b) On the grid on the next page, draw the graph of $y = -x^3 + 3x - 3$ for $-3 \leq x \leq 3$. *[3]*


y
25
20
15
10
5
x
−4
−3
−2
−1
O
1
2
3
−5
−10
−15
−20
−25
−30

(c) By drawing a tangent, find the gradient of the curve at $x = -1.5$. *[2]*

Answer .....

(d) By drawing suitable lines on your graph, find the value(s) of

(i) x when $x^3 = 3x - 3$, *[1]*

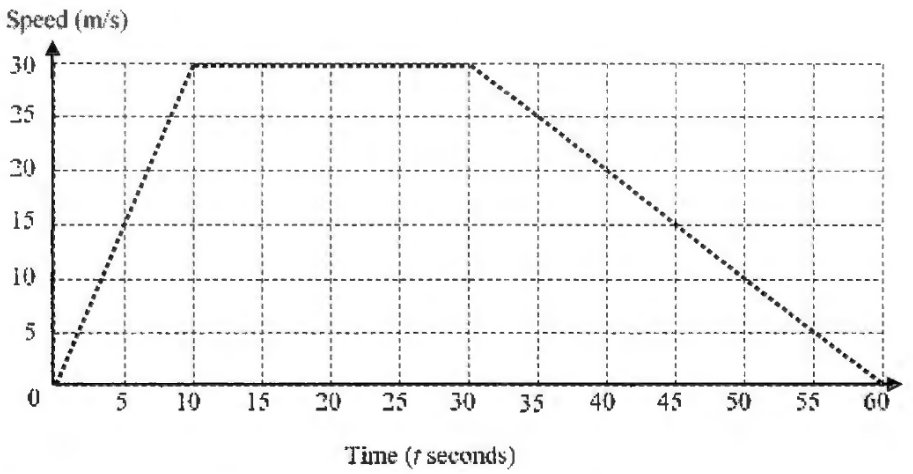
Answer $x =$ .....

(ii) k for which $-x^3 + 3x - 3 = k$ has exactly two solutions. *[2]*

Answer $k =$ .....*or* .....

Section B: Graphs in Practical Situations [4 marks]

2. The diagram below shows a speed-time graph of a cyclist's journey.



(a) Find the speed of the cyclist at $t = 8$ seconds. *[1]*

Answer ..... m/s

(b) Find the deceleration for the last 30 seconds of his journey. *[1]*

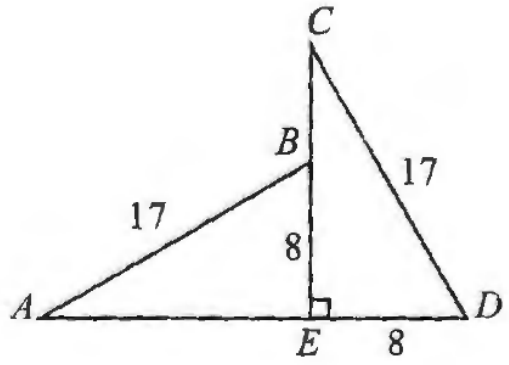
Answer ..... m/s^2

(c) Area under the speed-time graph represents the distance travelled.
Find the average speed of the cyclist's whole journey. *[2]*

Answer ..... m/s

Section C: Further Trigonometry [12 marks]

3. In the diagram, AD is a straight line, $AB = CD = 17$ cm, and $BE = DE = 8$ cm.



Leaving your answers in fractions, find

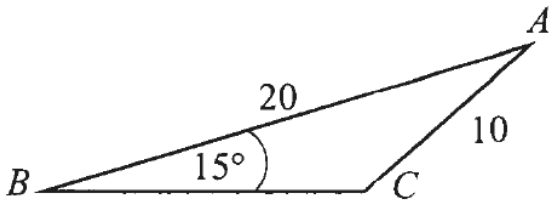
(a) cos $\angle ABC$, *[1]*

Answer .....

(b) sin $\angle ABC$. *[2]*

Answer .....

4. In triangle ABC, angle ABC is $15°$, AB is 20 cm, and AC is 10 cm.



(a) Find angle ACB. *[2]*

Answer *Angle* $ACB =$ ..... °

(b) Find angle BAC. *[1]*

Answer *Angle* $BAC =$ ..... °

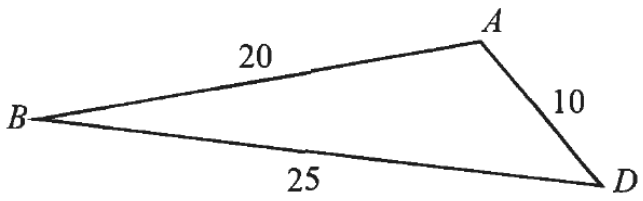
(c) Find the area of triangle ABC. *[2]*

Answer ..... cm^2

(d) Find the shortest distance from C to AB. *[2]*

Answer ..... cm

(e) The point C is now moved to point D, such that BD is 25 cm.

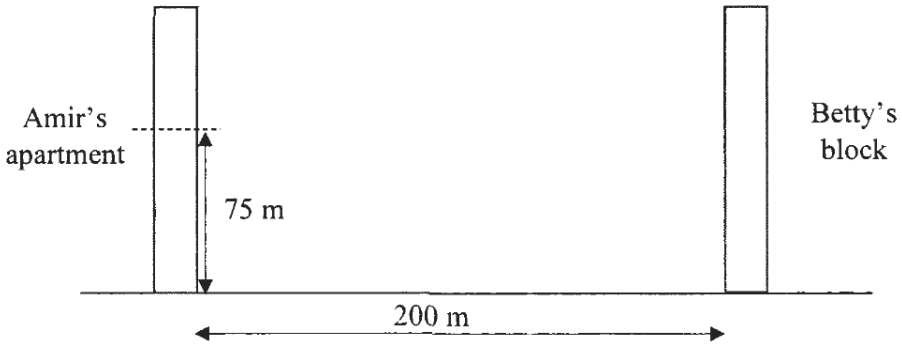


Show that angle BAD is approximately $108.2°$. *[2]*

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

Section D: Applications of Trigonometry [5 marks]

5. Amir's apartment is 75 m above ground. Betty's apartment is in a neighbouring block that is 200 m away from Amir's block.
[Assumption: the thickness of the wall is negligible.]



(a) Calculate the angle of depression from Amir's apartment to the base of Betty's block. *[2]*

Answer ..... °

(b) The angle of elevation from Amir to Betty's apartment is $10°$.
Calculate the height of Betty's apartment above the ground. *[3]*

Answer ..... m

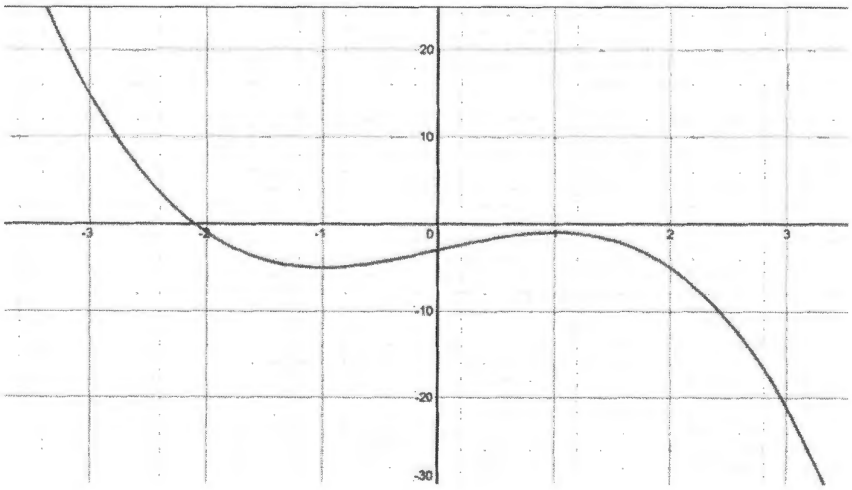
— END OF PAPER —

Answer Key
Sec 3 WA3 Revision Time Trial — Bartley (2023)

Section A: Graphs of Functions [10 marks]

1(a) At $x = -3$: $y = -(-27) + (-9) - 3 =$ **15**.
At $x = 1$: $y = -1 + 3 - 3 =$ **−1**. *[2]*

1(b) All seven points plotted and joined with a smooth cubic curve: falling from $(-3,\ 15)$ through a local minimum at $(-1,\ -5)$, rising to a local maximum at $(1,\ -1)$, then falling to $(3,\ -21)$. *[3]*



1(c) Tangent drawn at $x = -1.5$.
Exact gradient: $\dfrac{dy}{dx} = -3x^2 + 3 = -3(2.25) + 3 =$ **−3.75** (accept -4.5 to -2.5). *[2]*

1(d)(i) $x^3 = 3x - 3 \Leftrightarrow -x^3 + 3x - 3 = 0$, i.e. where the curve cuts the x-axis ($y = 0$).
From the graph: **x** $\approx$ **−2.1** (accept -2.3 to -2.05). *[1]*

1(d)(ii) $y = k$ (a horizontal line) meets the curve exactly twice when it passes through a turning point:
local maximum $(1,\ -1)$ or local minimum $(-1,\ -5)$.
$\therefore$ **k** $=$ **−1** or **k** $=$ **−5**. *[2]*

Section B: Graphs in Practical Situations [4 marks]

2(a) The cyclist accelerates uniformly from 0 to 30 m/s over the first 10 s:
$\dfrac{v}{8} = \dfrac{30}{10} \Rightarrow v =$ **24** m/s. *[1]*

2(b) Deceleration $= \dfrac{30 - 0}{30} =$ **1** m/s^2. *[1]*

2(c) Distance $=$ area under graph $= \dfrac{1}{2}(60 + 20)(30) = 1200$ m.

Average speed $= \dfrac{1200}{60} =$ **20** m/s. *[2]*

Section C: Further Trigonometry [12 marks]

3(a) In right-angled triangle ABE: $\cos\angle ABE = \dfrac{BE}{AB} = \dfrac{8}{17}$.
$\angle ABC = 180° - \angle ABE$ (adjacent $\angle$s on straight line EBC)
$\therefore \cos\angle ABC = -\cos\angle ABE = -\mathbf{\dfrac{8}{17}}$. *[1]*

3(b) $AE = \sqrt{17^2 - 8^2} = 15$ cm (Pythagoras).
$\sin\angle ABC = \sin\angle ABE = \dfrac{AE}{AB} = \mathbf{\dfrac{15}{17}}$. *[2]*

4(a) By the Sine Rule: $\dfrac{\sin\angle ACB}{20} = \dfrac{\sin 15°}{10}$
$\sin\angle ACB = 2\sin 15° = 0.5176\ldots \Rightarrow \angle ACB = 31.2°$ (rejected) or **148**.**8**°
(from the diagram, $\angle ACB$ is obtuse). *[2]*

4(b) $\angle BAC = 180° - 15° - 148.8° =$ **16**.**2**°. *[1]*

4(c) Area $= \dfrac{1}{2}(20)(10)\sin 16.2° = 27.86\ldots =$ **27**.**9** cm^2 (3 s.f.). *[2]*

4(d) Taking AB as base: $\dfrac{1}{2}(20)h = 27.86\ldots$
$h =$ **2**.**79** cm (3 s.f.). *[2]*

4(e) By the Cosine Rule in triangle ABD:
$\cos\angle BAD = \dfrac{20^2 + 10^2 - 25^2}{2(20)(10)} = \dfrac{-125}{400} = -0.3125$
$\angle BAD = 108.21\ldots° \approx$ **108**.**2**° (shown). *[2]*

Section D: Applications of Trigonometry [5 marks]

5(a) Angle of depression $=$ angle of elevation of Amir from the base (alternate $\angle$s):
$\tan\theta = \dfrac{75}{200} \Rightarrow \theta = 20.556\ldots =$ **20**.**6**° (1 d.p.). *[2]*

5(b) Height of Betty's apartment above Amir's level: $h = 200\tan 10° = 35.265\ldots$ m.
Height above ground $= 75 + 35.265\ldots = 110.26\ldots =$ **110** m (3 s.f.). *[3]*