NESA NUMBER | | | | | | | | | **CLASS**

TEACHER……..

Year 10
Common Task 2 2020

MATHEMATICS

Instructions

- Time allowed 90 minutes
- All questions may be attempted on the examination paper.
- Calculators may be used.
- All necessary working should be shown where indicated. Full marks may not be awarded for careless or badly arranged work.

Topics Covered	*Syllabus Ref.*	*Outcome Description*	*Section*
Quadratics and Quadratics Equations	MA5.2-6NA MA5.3-5NA MA5.3-7NA	Simplifies algebraic fractions, and expands and factorises quadratic expressions Selects and applies appropriate algebraic techniques to operate with algebraic expressions. Solves complex linear, quadratic, simple cubic and simultaneous equations, and rearranges literal equations.	A
Non-Linear Graphs	MA5.2-8NA MA5.3-9NA	Solves linear and simple quadratic equations, linear inequalities and linear simultaneous equations, using analytical and graphical techniques Sketches and interprets a variety of non-linear relationships	B
Applied Trigonometry	MA5.3-15MG	Applies Pythagoras' Theorem, trigonometric relationships, the sine rule, the cosine rule and the area rule to solve problems.	C
Working Mathematically	MA5.3-1WM MA5.3-2WM MA5.3-3WM	Uses and interprets formal definitions and generalisations when explaining solutions and/or conjectures Generalises mathematical ideas and techniques to analyse and solve problems efficiently Uses deductive reasoning in presenting arguments and formal proofs	D

Part	A	B	C	D	Total	%
Marks	/19	/25	/24	/20	/88	

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Section A: Quadratics and Quadratic equations (19 marks) ***Marks***

1. Factorise fully each of the following expressions

a) $x^2 + 12x + 27$ **1**

b) $x^2 - 6x + 9$ **1**

c) $-64x^2 + 4$ **2**

d) $c^4 - 8c^2 - 9$ **2**

2. Solve $x^2 = 4x$ **2**

Marker's Use only

3. a) Solve $2x^2 + 8x + 5 = 0$ by using the quadratic formula. Give your answer correct to 2 decimal places. **2**

b) Solve $2g^2 - 3g - 4 = 0$ by completing the square. Leave your answer in exact form. **3**

4. Find the equation of a monic quadratic that passes through the points $(-2,18)$ and $(1,0)$. **3**

Marker's Use only

5. Find the exact values of k for which the equation $x^2 - 3kx + (4 - 2k) = 0$ has one real solution. **3**

End of Section A

Marker's Use only

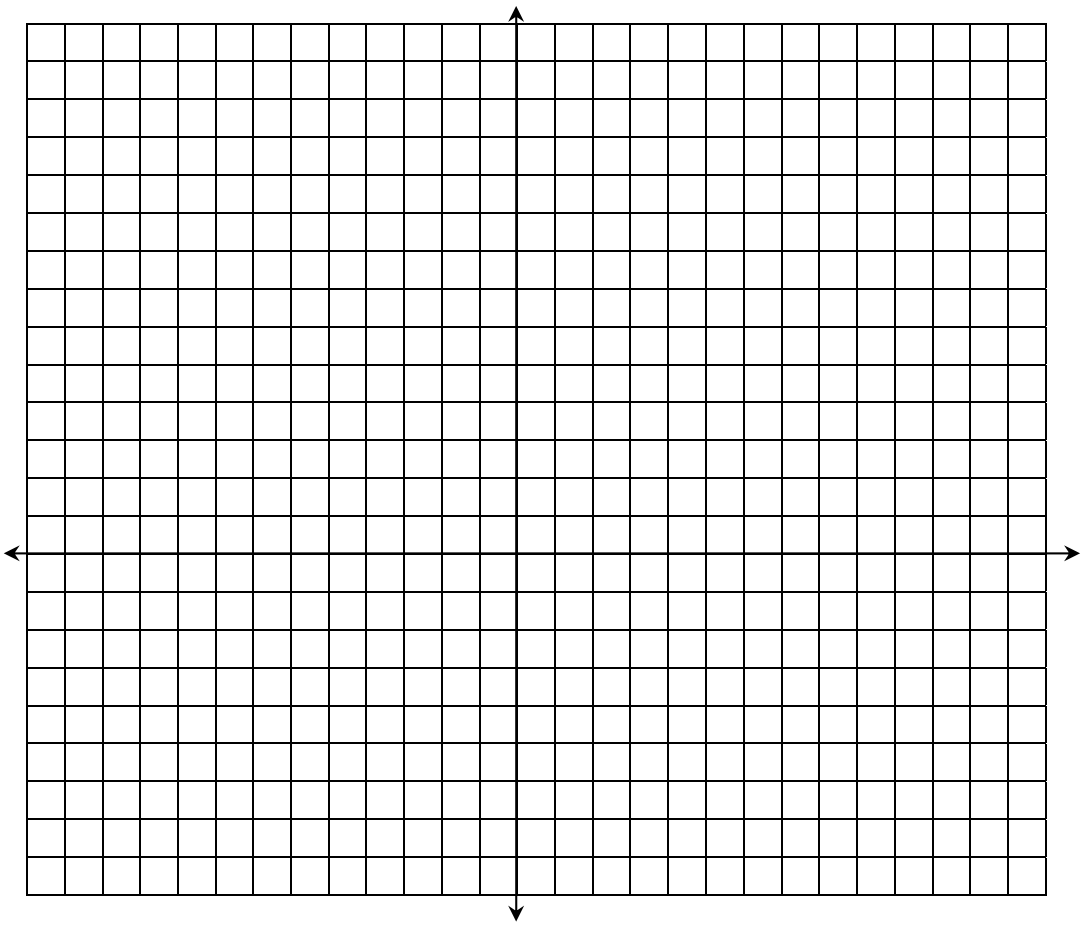
Section B: Non-linear graphs (25 Marks) ***Marks***

1. For the parabola with equation $y = 2x^2 - 4x + 3$ find:

a) The coordinates of the vertex **2**

b) Find the y −intercept. **1**

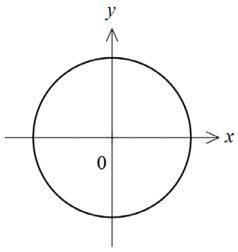
c) Hence, sketch the graph of the parabola, showing the y −intercept and vertex. **2**



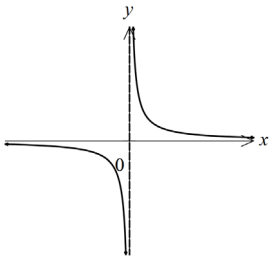
Marker's Use only

2. Classify each of the following as either a relation or a function. **2**

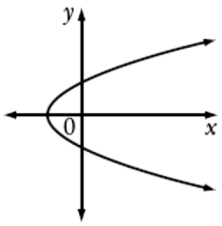
i. _____



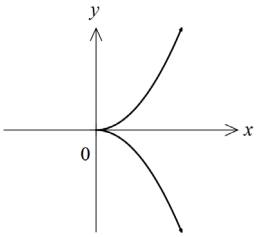
ii. _____



iii. _____



iv. _____



3. i. Show that $(x+y)^2-(x-y)^2=16$ can be simplified to $y=\frac{4}{x}$. **2**

_____

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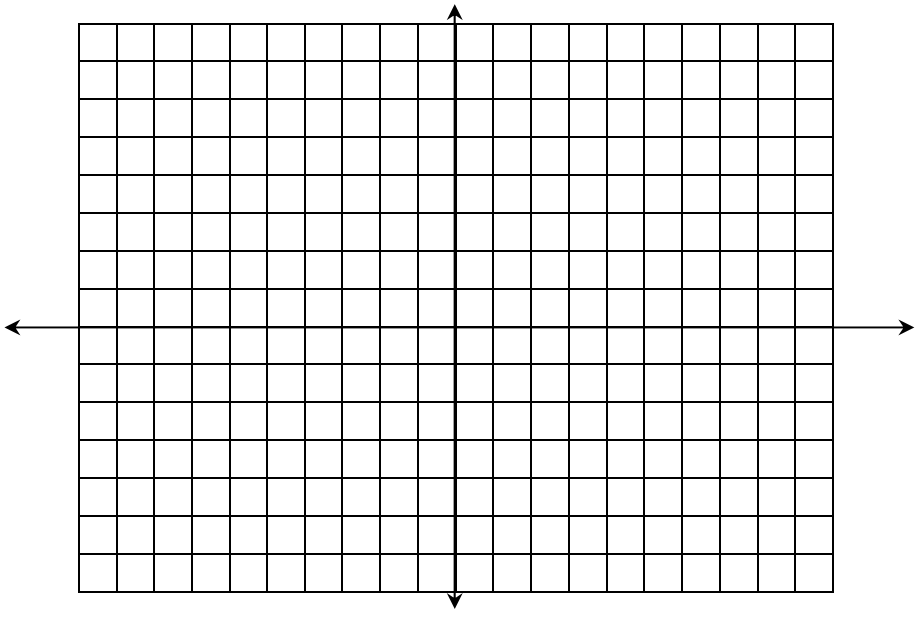
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ii. Hence, Sketch the graph of the $(x+y)^2-(x-y)^2=16$, showing all key features. **2**



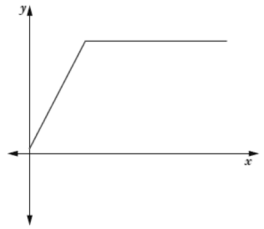
Marker's Use only

4. i. What is the equation of the parabola obtained when the graph of $y = x^2$ is translated 4 units to the left and 2 units down? **2**

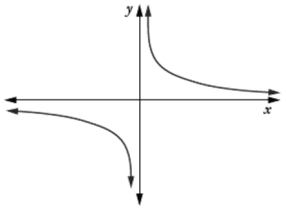
ii. State the transformations that need to be applied to the graph of $y = 2^x$ to obtain the graph of $y = -2^{x-3}$. **2**

5. Which of the following graphs has an inverse that is a function? (*Circle correct answer*) **2**

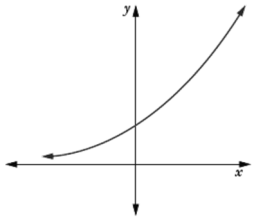
i.



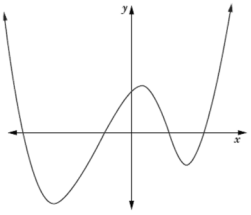
ii.



iii.



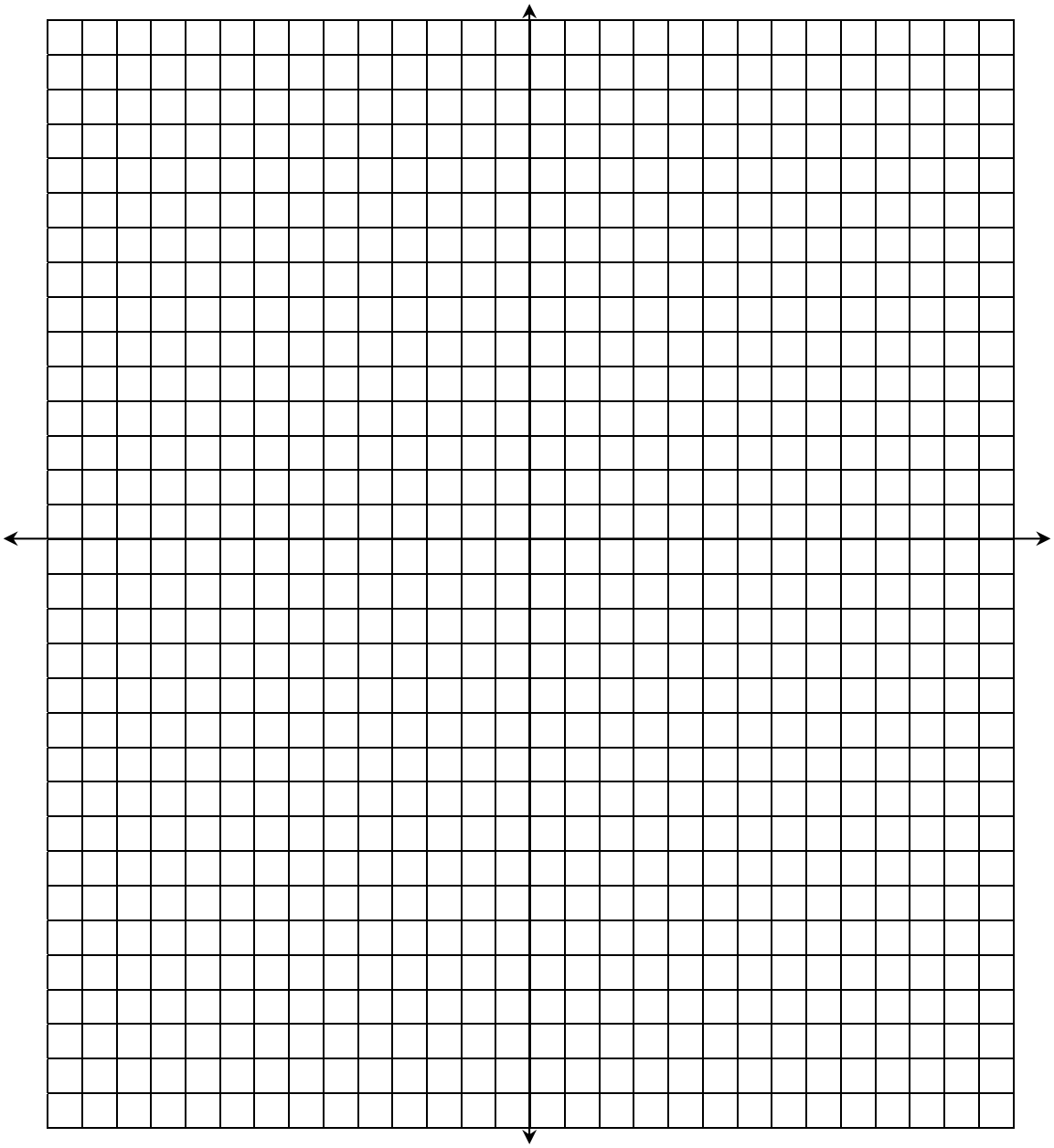
iv.



6. i. Find the inverse function of $f(x) = x^3$ **1**

Marker's Use only

ii. Hence, on the same set of axes, sketch the graph of $y = x$, $y = x^3$ and its inverse. **3**



7. If $f(x) = x^2 - 2x + 3$ what is $f(3)$? **1**

Marker's Use only

8. A single bacterium divides into three every second, so that one cell becomes 3 in the first second and in the next second three cells become 9 and so on.

a) Write the rule for the number of bacteria, N, after t seconds. **1**

b) How many bacteria will there be after 10 seconds? **1**

c) By trial and error, or otherwise, find how long it takes for the population to exceed 6000, give your answer correct to the nearest second. **1**

End of Section B

Marker's Use only

Section C: Trigonometry (24 Marks) ***Marks***

1. What is the exact value of:

   a) $\tan 240^0$ **1**

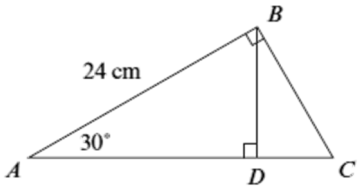
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   b) $\sin 300^0$ **1**

_____

2. Find the exact value of:

   a) AD **2**



_____

_____

_____

_____

   b) DC **3**

_____

_____

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_____

3. Solve $\tan\alpha = -\sqrt{3}$ for $0 \le \alpha \le 360^0$ **3**

_____

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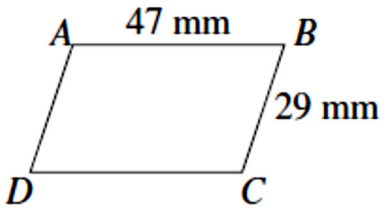
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Marker's Use only

4. A parallelogram $ABCD$ has sides $AB = DC = 47mm$ and $AD = BC = 29mm$. The longer diagonal BD is 60mm. Use the cosine rule to find the size of $\angle BCD$ to the nearest degree.



2

5. Jessica leaves home and walks for 5 km on a bearing of 075^0. She then turns and walks for 3 km on a bearing of 115^0 until she reaches her destination.

a) Draw a diagram to represent this situation. **1**

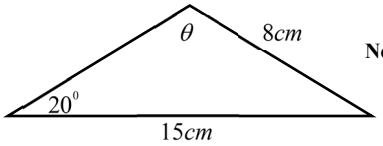
b) How far is she from home, correct to two decimal places? **2**

Marker's Use only

6. The vertical angle of an isosceles triangle is 35^0, and its area is $35\,cm^2$. Find the length of the equal sides, correct to the nearest cm. **2**



7. Calculate the obtuse angle, θ, to the nearest degree. Give mathematical reasoning to explain your answer. **3**

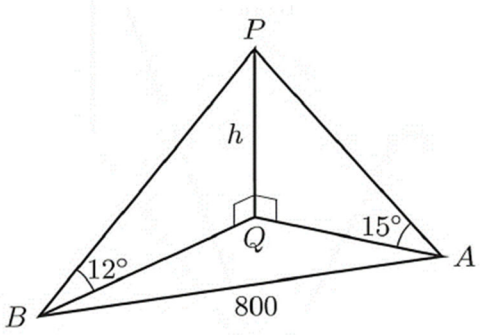


Not to Scale

Section C continued next page

Marker's Use only

8. The angle of elevation of a tower PQ of height h metres at point A due east of it is 15^0. Point B is due south of the tower and the angle of elevation is 12^0. The points A and B are 800 metres apart and on the same level as the base Q of the tower.



a) Show that $AQ = h\tan 75^0$ **1**

b) Find a similar expression for BQ **1**

c) Show that the height of the tower is $h = \dfrac{800}{\sqrt{(\tan 75)^2 + (\tan 78)^2}}$ **2**

End of Section C

Marker's Use only

Section D: Working Mathematically (20 Marks) ***Marks***

1. A new internet software company is launched on the stock exchange and various analysts record its share price over time. The share price ($\$y$) is modelled quite accurately by the rule $y = -t^2 + 20t + 2$, where, t, is the time in months after the company is launched onto the stock exchange.

a) What was the company's share price when it was first launched onto the stock exchange? **1**

b) Find the share price after 1 year on the stock exchange. **1**

c) Calculate the highest share price reached by the company. Give reasons for your answer. **2**

2. a) Show that $x^2 - 6x + y^2 + 4y$ can be written in the form $(x-3)^2 + (y+2)^2 - 13$. **3**

b) A circle has an equation $x^2 - 6x + y^2 + 4y = b$, where b is a real constant. What is the value of b if the radius is 5? **2**

Marker's Use only

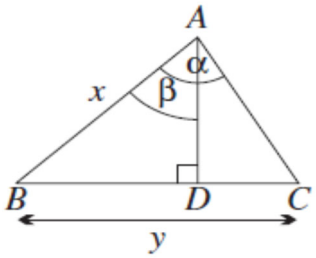
3. The stopping distance, d, of a car on a certain road, once the brakes are applied, is directly proportional to the square of the speed, S, of the car when the brakes are first applied. That is, the stopping distance of a car is $d = kS^2$.

a) What does k represent? **1**

b) Find the value of k if a car travelling at 70 km/h takes 58.8m to stop. **2**

c) What would be the stopping distance for a car travelling at 105 km/h, to one decimal place? **1**

4. In the diagram $\angle BAC = \alpha$, $\angle BAD = \beta$, $BC = y$ and $AB = x$.

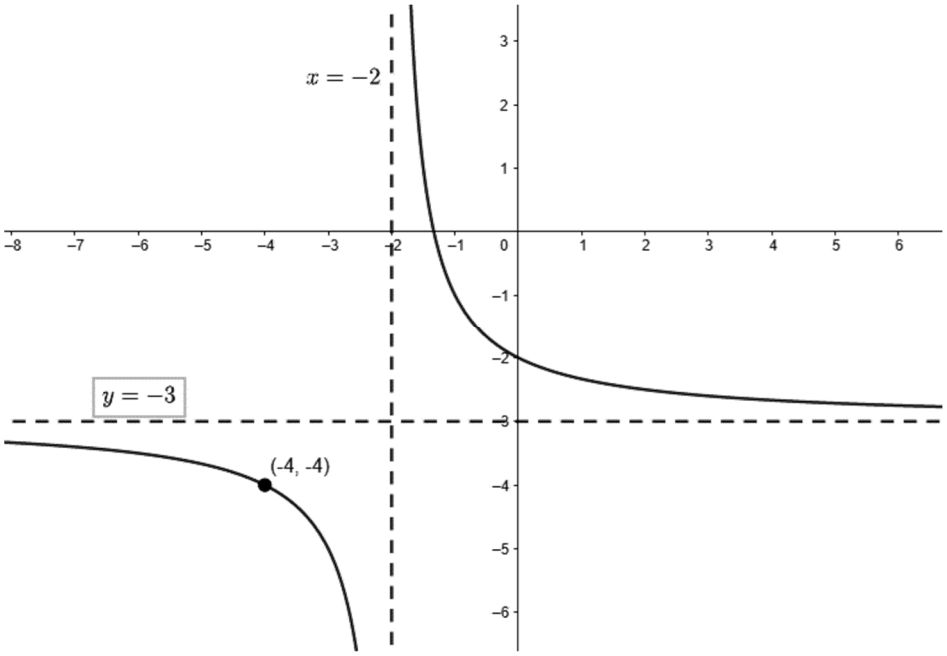


a) Show that $\angle ACB = 90 - (\alpha - \beta)$, giving a reason for your answer. **2**

b) Hence, show that $y = \dfrac{x \sin \alpha}{\cos(\alpha - \beta)}$ **2**

Marker's Use only

5. This graph is of a hyperbola of the form $y = \frac{a}{x-h} + k$. State the rule for the graph. **3**



End of examination.

Marker's Use only

NESA NUMBER | | | | | | | | |

CLASS TEACHER Mark King

Year 10
Common Task 2 2020

MATHEMATICS

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Applied Trigonometry	MA5.3-15MG	Applies Pythagoras' Theorem, trigonometric relationships, the sine rule, the cosine rule and the area rule to solve problems.	C
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Part	A	B	C	D	Total	%
Marks	/19	/25	/24	/20	/88	

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Section A: ***Quadratics and Quadratic equations (19 marks)*** **Marks**

1. Factorise fully each of the following expressions

a) $x^2+12x+27$ **1**

$(x+3)(x+9)$ ✓

b) x^2-6x+9 **1**

$(x-3)^2$ ✓

c) $-64x^2+4$ **2**

$-4(16x^2-1) = -4(4x-1)(4x+1)$ ✓ ✓

d) c^4-8c^2-9 **2**

$(c^2-9)(c^2+1) = (c-3)(c+3)(c^2+1)$ ✓ ✓

2. Solve $x^2=4x$ **2**

$x^2-4x=0$

$x(x-4)=0$

$x=0$ ✓, $x=4$ ✓

Marker's Use only

3. a) Solve $2x^2+8x+5=0$ by using the quadratic formula. Give your answer correct to 2 decimal places. **2**

$x = \frac{-8 \pm \sqrt{64-4(2)5}}{4}$

$= \frac{-8 \pm \sqrt{24}}{4}$

$= \frac{-8 \pm 2\sqrt{6}}{4}$

$\therefore x = \frac{-4 \pm \sqrt{6}}{2}$

$\therefore x = -0.78$ or $x = -3.22$

b) Solve $2g^2-3g-4=0$ by completing the square. Leave your answer in exact form. **3**

$2(g^2 - \frac{3}{2}g) = 4$ ✓

$g^2 - \frac{3}{2}g = 2$ ✓

$(g-\frac{3}{4})^2 = 2 + (\frac{3}{4})^2$

$(g-\frac{3}{4})^2 = 2 + \frac{9}{16}$

$(g-\frac{3}{4})^2 = \frac{41}{16}$ ✓

$g - \frac{3}{4} = \pm\frac{\sqrt{41}}{4}$

$\therefore g = \frac{3}{4} \pm \frac{\sqrt{41}}{4}$ ✓

4. Find the equation of a monic quadratic that passes through the points $(-2,18)$ and $(1,0)$. **3**

$y = (x-1)(x-\beta)$ ✓ sub $(-2,18)$.

$18 = (-2-1)(-2-\beta)$

$-6 = -2-\beta$

$\therefore \beta = 4$ ✓

$\therefore y = (x-1)(x-4)$ ✓

Marker's Use only

5. Find the exact values of k for which the equation $x^2 - 3kx + (4 - 2k) = 0$ has one real solution. **3**

For one real solution $\Delta = 0$

$\Delta = (-3k)^2 - 4(1)(4-2k) = 0$ ✓

$9k^2 - 16 + 8k = 0$

$9k^2 + 8k - 16 = 0$

$k = \dfrac{-8 \pm \sqrt{64 - 4(9)(-16)}}{2 \times 9}$ ✓

$= \dfrac{-8 \pm \sqrt{640}}{18}$

$= \dfrac{-8 \pm 8\sqrt{10}}{18}$

$\therefore k = \dfrac{-4 \pm 4\sqrt{10}}{9}$ ✓

End of Section A

Marker's Use only

Section B: ***Non-linear graphs (25 Marks)*** ***Marks***

1. For the parabola with equation $y = 2x^2 - 4x + 3$ find:

a) The coordinates of the vertex **2**

$x = -b/2a \Rightarrow x = \frac{-(-4)}{2(2)}$

$\therefore x = 1$ ✓

When $x = 1$ $y = 2(1)^2 - 4(1) + 3$

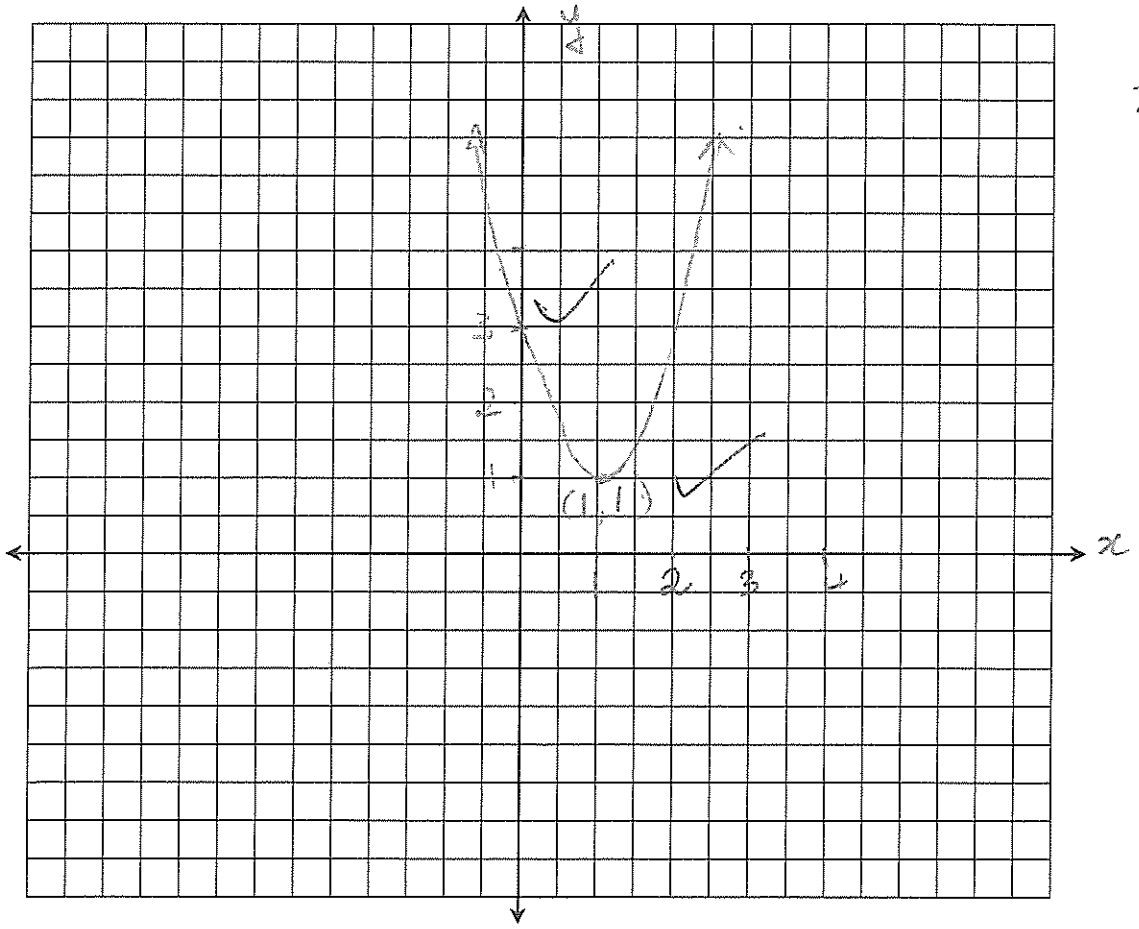
$= 2 - 4 + 3$ $\therefore$ Vertex is $(1, 1)$

$\therefore y = 1$ ✓

b) Find the y –intercept. **1**

y intercept where $x = 0$ $\therefore y = 3$

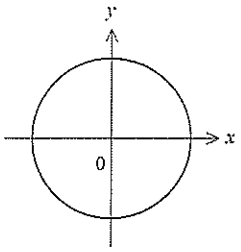
c) Hence, sketch the graph of the parabola, showing the y –intercept and vertex. **2**



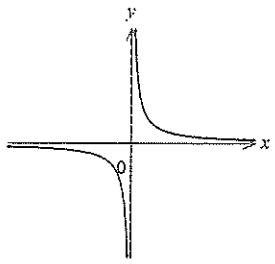
Marker's Use only

2. Classify each of the following as either a relation or a function. **2**

i. Relation

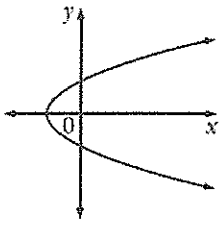


ii. Function

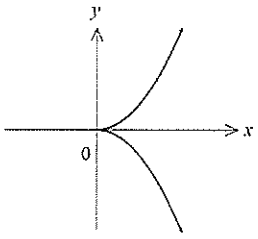


- 2 marks for all correct
- 1 mark for 2 correct

iii. Relation



iv. Relation



3. i. Show that $(x+y)^2-(x-y)^2=16$ can be simplified to $y=\frac{4}{x}$. **2**

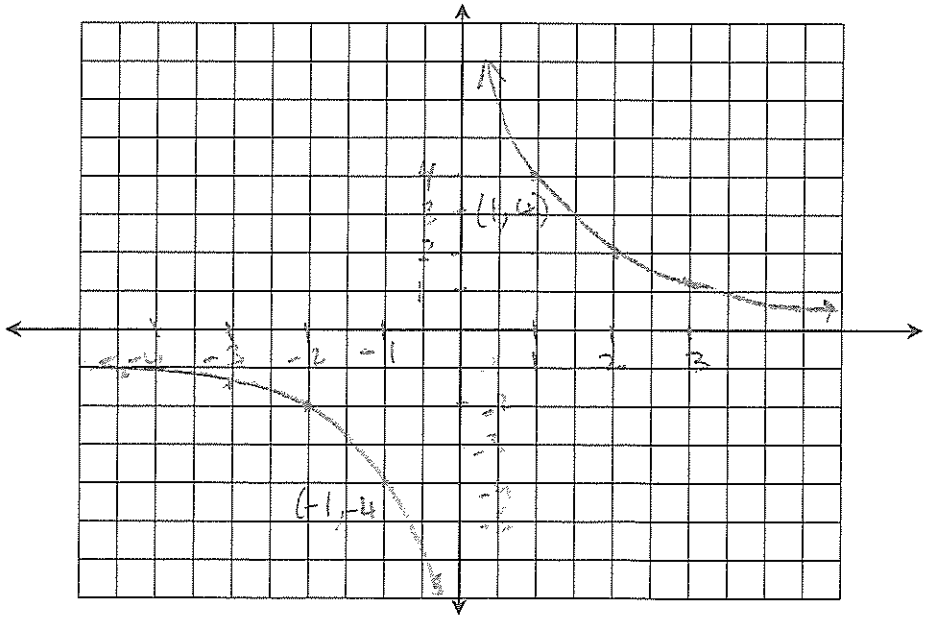
$x^2+2xy+y^2-(x^2-2xy+y^2)=16$

$x^2+2xy+y^2-x^2+2xy-y^2=16$ ✓

$4xy=16 \Rightarrow xy=4$ ✓

$\therefore y=\frac{4}{x}$

ii. Hence, Sketch the graph of the $(x+y)^2-(x-y)^2=16$, showing all key features. **2**



Marker's Use only

4. i. What is the equation of the parabola obtained when the graph of $y = x^2$ is translated 4 units to the left and 2 units down? **2**

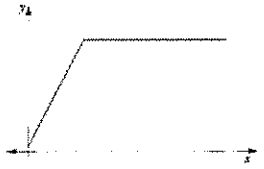
$y = (x+4)^2 - 2$ ✓ ✓

ii. State the transformations that need to be applied to the graph of $y = 2^x$ to obtain the graph of $y = -2^{x-3}$. **2**

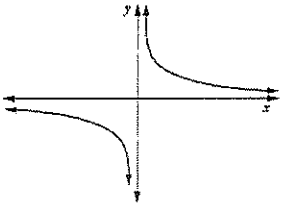
Reflected ✓ over the x-axis and translated 3 ✓ units to the right

5. Which of the following graphs has an inverse that is a function? (*Circle correct answer*) **2**

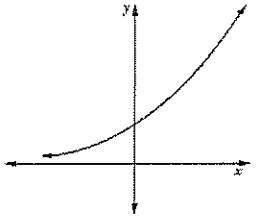
i.



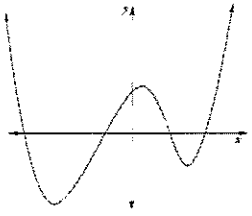
ii. ✓



iii. ✓



iv.



6. i. Find the inverse function of $f(x) = x^3$ **1**

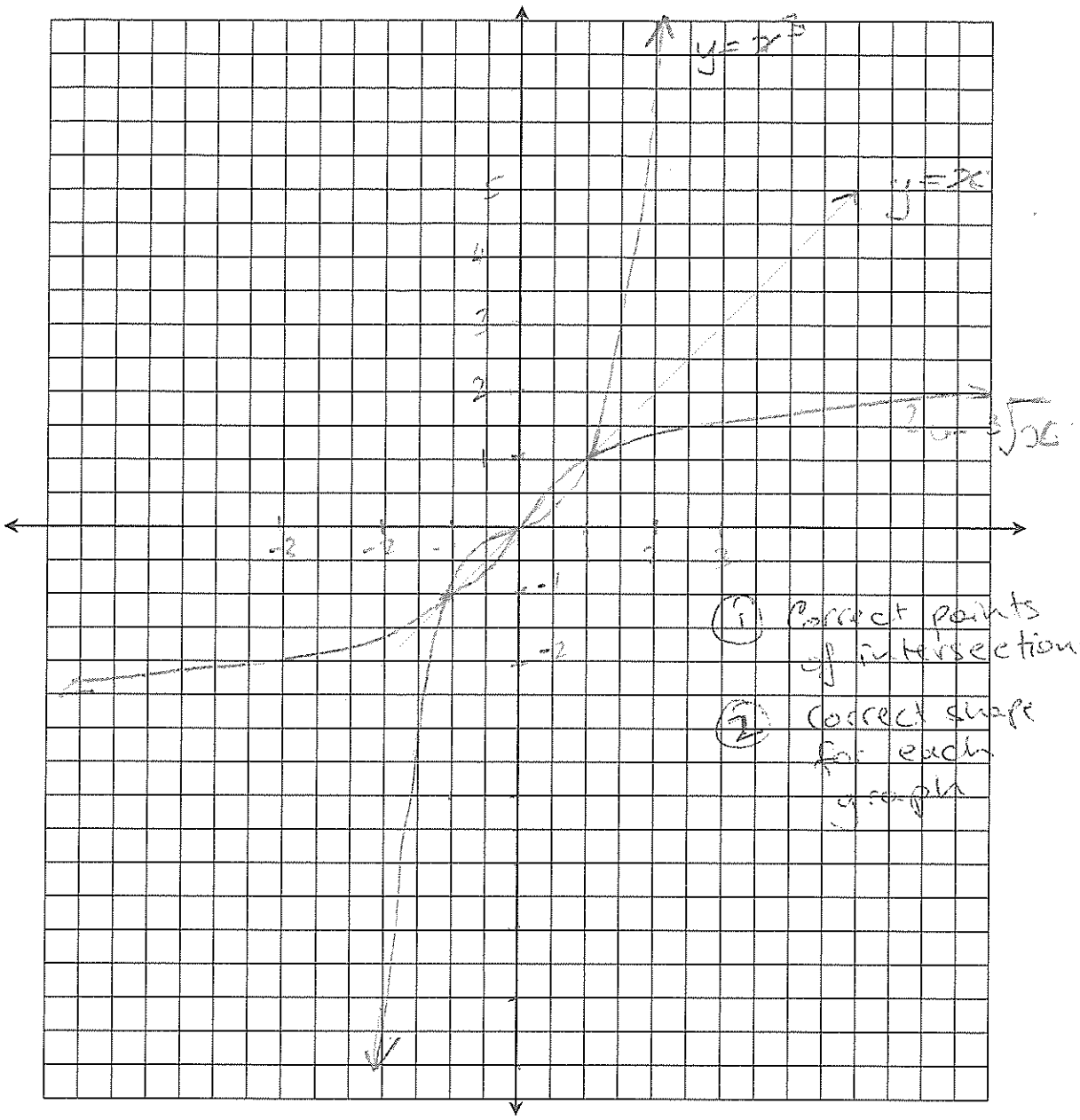
$y = x^3$

$y^3 = x$

$\therefore y = \sqrt[3]{x}$ ✓

Marker's Use only

ii. Hence, on the same set of axes, sketch the graph of $y = x$, $y = x^3$ and its inverse. **3**



7. If $f(x) = x^2 - 2x + 3$ what is $f(3)$? **1**

$f(3) = 3^2 - 2(3) + 3$

$= 6$ ✓

Marker's Use only

8. A single bacterium divides into three every second, so that one cell becomes 3 in the first second and in the next second three cells become 9 and so on.

a) Write the rule for the number of bacteria, N, after t seconds. **1**

$N = 3^t$

b) How many bacteria will there be after 10 seconds? **1**

when $t = 10$

$N = 3^{10}$

$= 59049$

c) By trial and error, or otherwise, find how long it takes for the population to exceed 6000, give your answer correct to the nearest second. **1**

$6000 > 3^t$

$t = 8$ seconds

End of Section B

Marker's Use only

Section C: Trigonometry (24 Marks) **Marks**

1. What is the exact value of:

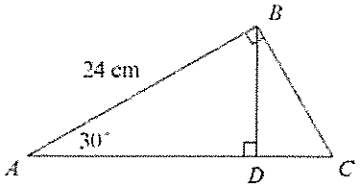
a) $\tan 240^0$ **1**

$\sqrt{3}$

b) $\sin 300^0$ **1**

$-\frac{\sqrt{3}}{2}$

2. Find the exact value of:



a) AD **2**

$\cos 30^\circ = \frac{AD}{24}$ ✓

$AD = \frac{\sqrt{3}}{2} \times 24$

$\therefore AD = 12\sqrt{3}$ ✓

b) DC **3**

$DC = AC - AD$

$\cos 30^\circ = \frac{24}{AC}$ ✓

$AC = \frac{24}{\cos 30^\circ}$ ✓

$= \frac{48}{\sqrt{3}}$

$= \frac{48}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$ ✓

$= 16\sqrt{3}$

$DC = 16\sqrt{3} - 12\sqrt{3}$

$\therefore DC = 4\sqrt{3}$ cm ✓

3. Solve $\tan\alpha = -\sqrt{3}$ for $0 \le \alpha \le 360^0$ **3**

✓ ✓

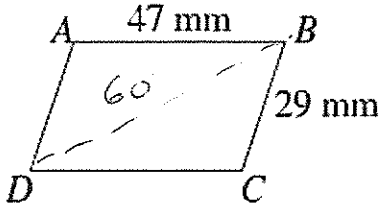
Base angle $= 60^\circ$ ✓

$\alpha = 180^\circ - 60^\circ$ or $360^\circ - 60^\circ$

$\therefore \alpha = 120^\circ$ or 300° ✓ ✓

Marker's Use only

4. A parallelogram $ABCD$ has sides $AB = DC = 47mm$ and $AD = BC = 29mm$. The longer diagonal BD is 60mm. Use the cosine rule to find the size of $\angle BCD$ to the nearest degree. **2**



$\cos C = \frac{a^2 + b^2 - c^2}{2ab}$

$= \frac{47^2 + 29^2 - 60^2}{2(47)(29)}$ ✓

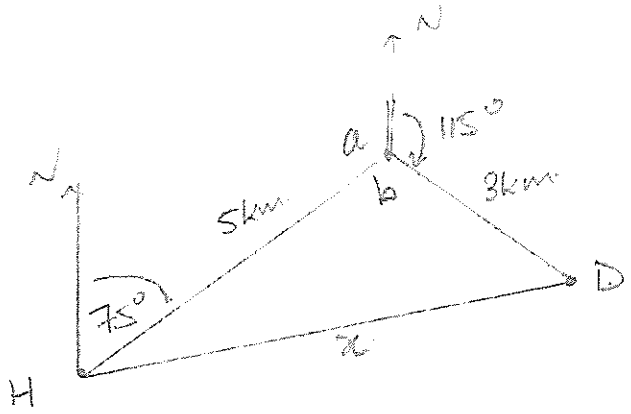
$\therefore \cos C = \frac{-275}{1363}$ ✓

$\angle BDC = 180 - \cos^{-1}\left(\frac{275}{1363}\right)$

$= 102^\circ$ ✓

5. Jessica leaves home and walks for 5 km on a bearing of 075^0. She then turns and walks for 3 km on a bearing of 115^0 until she reaches her destination.

a) Draw a diagram to represent this situation. **1**



b) How far is she from home, correct to two decimal places? **2**

$\measuredangle a = 105^\circ$ (co-interior angles)

$b^\circ = 360 - 105 - 115$

$= 140^\circ$ ✓

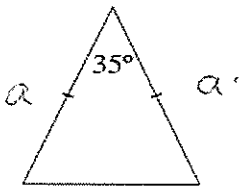
$x^2 = 5^2 + 3^2 - 2(3)(5)\cos 140^\circ$

$= 56.98$

$\therefore x = 7.55$ km ✓

Marker's Use only

6. The vertical angle of an isosceles triangle is 35^0, and its area is $35\,cm^2$. Find the length of the equal sides, correct to the nearest cm. **2**



$A = \frac{1}{2}ab\sin C$

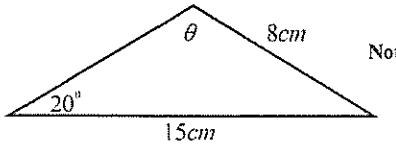
$35 = \frac{1}{2}a^2 \sin 35$ ✓

$a^2 = \frac{70}{\sin 35}$

$= 122.041\ldots$

$\therefore a = 11\ cm$ ✓

7. Calculate the obtuse angle, θ, to the nearest degree. Give mathematical reasoning to explain your answer. **3**



Not to Scale

$\frac{\sin\theta}{15} = \frac{\sin 20}{8}$ ✓

$\sin\theta = 0.6412\ldots$

$\theta = 39.88\ldots$ or $140.11\ldots$ ✓

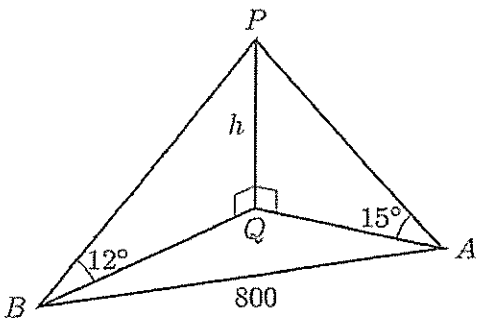
But since θ is obtuse

then $\theta = 140°$ (to the nearest degree) ✓

Section C continued next page

Marker's Use only

8. The angle of elevation of a tower PQ of height h metres at point A due east of it is 15^0. Point B is due south of the tower and the angle of elevation is 12^0. The points A and B are 800 metres apart and on the same level as the base Q of the tower.



a) Show that $AQ = h\tan 75^0$ **1**

$\angle APQ = 75^\circ$ $\quad \tan 75^\circ = \frac{AQ}{h}$

$\therefore AQ = h\tan 75^\circ$

b) Find a similar expression for BQ **1**

$\angle BPQ = 78^\circ$

$\tan 78^\circ = \frac{BQ}{h}$

$\therefore BQ = h\tan 78^\circ$

c) Show that the height of the tower is $h = \dfrac{800}{\sqrt{(\tan 75)^2 + (\tan 78)^2}}$ **2**

In $\triangle ABQ$: $800^2 = AQ^2 + BQ^2$

$800^2 = h^2\tan^2 75 + h^2\tan^2 78$

$= h^2(\tan^2 75 + \tan^2 78)$

$h^2 = \dfrac{800^2}{\tan^2 75 + \tan^2 78} \Rightarrow \therefore h = \dfrac{800}{\sqrt{\tan^2 75 + \tan^2 78}}$ as req'd

End of Section C

Marker's Use only

Section D: Working Mathematically (20 Marks) **Marks**

1. A new internet software company is launched on the stock exchange and various analysts record its share price over time. The share price ($\$y$) is modelled quite accurately by the rule $y = -t^2 + 20t + 2$, where, t, is the time in months after the company is launched onto the stock exchange.

a) What was the company's share price when it was first launched onto the stock exchange? **1**

When $t = 0$ $y = \$2$

b) Find the share price after 1 year on the stock exchange. **1**

$y = -(1)^2 + 20(1) + 2$

$= \$21$

c) Calculate the highest share price reached by the company. Give reasons for your answer. **2**

highest value is at the vertex

$t = \frac{-20}{2(-1)}$ $y = -(10)^2 + 20(10) + 2$

$t = 10$ ✓ $= \$102$

∴ Highest share price = $\$102$ ✓

2. a) Show that $x^2 - 6x + y^2 + 4y$ can be written in the form $(x-3)^2 + (y+2)^2 - 13$. **3**

(1) $x^2 - 6x + (-3)^2 + y^2 + 4y + (2)^2 - (-3)^2 - (2)^2$ (1)

$(x-3)^2 + (y+2)^2 - 9 - 4$

$(x-3)^2 + (y+2)^2 - 13$ as req'd (1)

b) A circle has an equation $x^2 - 6x + y^2 + 4y = b$, where b is a real constant. What is the value of b if the radius is 5? **2**

from part (a) $x^2 - 6x + y^2 + 4y = (x-3)^2 + (y+2)^2 - 13$

hence, $(x-3)^2 + (y+2)^2 - 13 = b$

$(x-3)^2 + (y+2)^2 = b + 13$ ✓

where $b+13$ is the radius squared hence $b + 13 = 25$

$\therefore b = 12$ ✓

Marker's Use only

3. The stopping distance, d, of a car on a certain road, once the brakes are applied, is directly proportional to the square of the speed, S, of the car when the brakes are first applied. That is, the stopping distance of a car is $d = kS^2$.

a) What does k represent? **1**

Constant of proportionality

b) Find the value of k if a car travelling at 70 km/h takes 58.8m to stop. **2**

$0.0588 = k \times 70^2$ ✓

$k = 1.2 \times 10^{-5}$ ✓

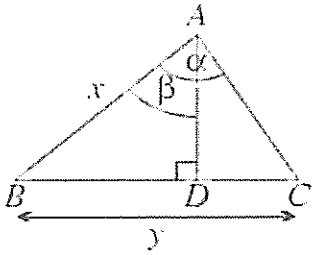
c) What would be the stopping distance for a car travelling at 105 km/h, to one decimal place? **1**

$d = 1.2 \times 10^{-5} \times 105^2$

$= 0.1323$ km

$= 132.3$ m ✓

4. In the diagram $\angle BAC = \alpha$, $\angle BAD = \beta$, $BC = y$ and $AB = x$.



a)

b) Show that $\angle ACB = 90 - (\alpha - \beta)$, giving a reason for your answer. **2**

$\angle BAC = \alpha$ $\angle BAD = \beta$, $\angle DCA = \alpha - \beta$,

$\angle ACD = 90 - (\alpha - \beta)$ complementary angles ✓ ✓

c) Hence, show that $y = \dfrac{x \sin \alpha}{\cos(\alpha - \beta)}$ **2**

$\dfrac{y}{\sin\alpha} = \dfrac{x}{\sin(90 - (\alpha - \beta))}$

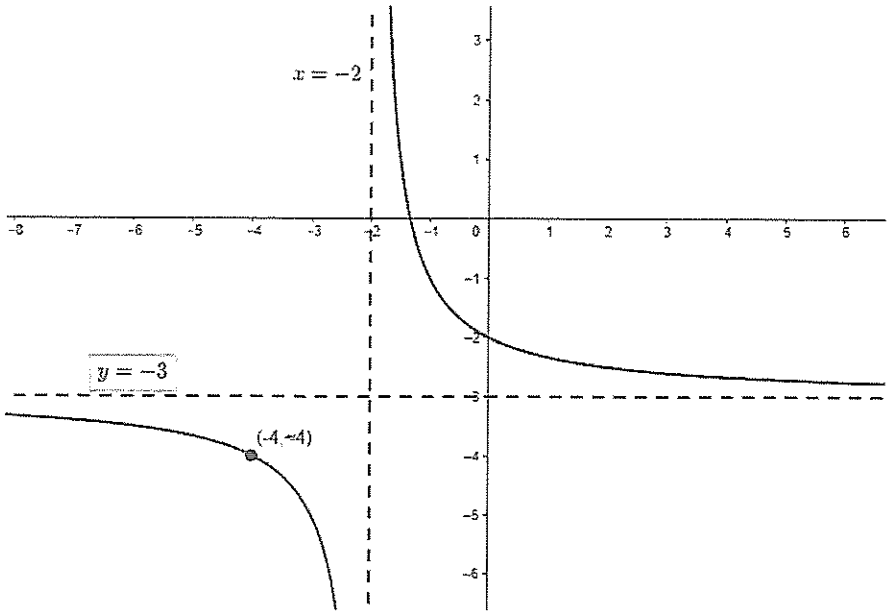
$\sin(90 - (\alpha - \beta)) = \cos(\alpha - \beta)$ (complementary angles)

Hence, $\dfrac{y}{\sin\alpha} = \dfrac{x}{\cos(\alpha - \beta)}$ ✓

$\therefore y = \dfrac{x \sin\alpha}{\cos(\alpha - \beta)}$ as req'd.

Marker's Use only

5. This graph is of a hyperbola of the form $y = \frac{a}{x-h} + k$. State the rule for the graph. 3



k represents horizontal asymptote

h represents vertical asymptote, hence

$y = \frac{a}{x-(-2)} - 3$

$y = \frac{a}{x+2} - 3$ at $(-4, -4)$

$-4 = \frac{a}{-4+2} - 3$

$\frac{a}{-2} = -1$ $\therefore a = 2$.

$\therefore y = \frac{2}{x+2} - 3$

End of examination.

Marker's Use only