

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Working time (minutes)	Marks available	Percentage of examination
Section One: Calculator-free	8	8	50	52	35
Section Two: Calculator-assumed	13	13	100	96	65
Total					100

Instructions to candidates

1. The rules for the conduct of CCGS assessments are detailed in the Reporting and Assessment policy. Sitting this examination implies that you agree to abide by these rules.
2. Write your answers in this Question/Answer booklet preferably using a blue/black pen. Do not use erasable or gel pens.
3. You must be careful to confine your answers to the specific question asked and to follow any instructions that are specific to a particular question.
4. Show all your working clearly. Your working should be in sufficient detail to allow your answers to be checked readily and for marks to be awarded for reasoning. Incorrect answers given without supporting reasoning cannot be allocated any marks. For any question or part question worth more than two marks, valid working or justification is required to receive full marks. If you repeat any question, ensure that you cancel the answer you do not wish to have marked.
5. It is recommended that you do not use pencil, except in diagrams.
6. Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.
7. The Formula sheet is not to be handed in with your Question/Answer booklet.

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This Section has eight questions. Answer all questions. Write your answers in the spaces provided.

Supplementary pages for planning/continuing your answers to questions are provided at the end of the Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Working time: 50 minutes.

Question 1
(7 marks)Solve the following equations for x .

(a) $(3x - 1)(x + 2) = 0$. (2 marks)

$$\frac{3}{1} = -2$$

Both solutions correct.
 One solution correct
 One solution

(b) $x^2 - 6x - 7 = 0$. (2 marks)

$$0 = (1+x)(1-x)$$

Both solutions correct.
 One solution correct
 One solution

*(Can also factorise using
DOPS)*

(c) $(x - 11)^2 - 81 = 0$. (3 marks)

$$(x - 11)^2 - 81 = 0$$

$$(x - 11)^2 = 81$$

$$x - 11 = \pm 9$$

$$x = 11 \pm 9$$

$$x = 20 \text{ or } x = 2$$

$$x = 20 \text{ or } x = 2$$

$$\overline{\text{Qd}}$$

(8 marks)

Question 2The straight line L has equation $4x + 2y = 1$.

- (a) Write the equation of
- L
- in the form
- $y = mx + c$
- to show that its gradient is
- -2
- . (2 marks)

$$\begin{aligned} 2y &= 1 - 4x \\ y &= \frac{1 - 4x}{2} \\ y &= \frac{1}{2} - 2x \end{aligned}$$

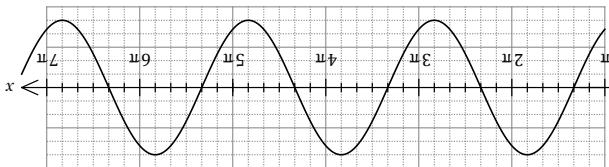
*✓ Rearrange to
 $y = mx + c$
✓ Simplify to show
 $m = -2$*

Line L_1 is perpendicular to L and passes through the point $(2, 6)$.Line L_2 is parallel to L and passes through the point $(1, -7)$.

- (b) Determine the point of intersection of
- L_1
- and
- L_2
- . (6 marks)

$$\begin{aligned} L_1: m &= \frac{1}{2} && \checkmark \text{perpendicular gradient.} \\ y &= \frac{1}{2}x + c && \checkmark \text{equation for } L_1 \\ 6 &= \frac{1}{2}(2) + c && c = 5 \\ y &= \frac{1}{2}x + 5 && \checkmark L_2 \text{ equation.} \\ L_2: y &= -2x + c && \checkmark \text{Uses simultaneous equations to solve for } x \\ -7 &= -2(1) + c && c = -5 \\ y &= -2x - 5 && \checkmark \text{Calculates } y \text{ value.} \\ -2x - 5 &= \frac{1}{2}x + 5 && \checkmark \text{Coordinate of intersection.} \\ -2\frac{1}{2}x &= 10 \\ -\frac{5}{2}x &= 10 \\ x &= -4 \\ y &= -2(-4) - 5 \\ &= 3 \\ \therefore (-4, 3) & \text{ is the intersection point.} \end{aligned}$$

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(a) The graph of $y = a \sin(x + b)$ is shown below, where a and b are positive constants.

(b) Determine the value of a and the least value of b . (2 marks)

Question 3

CALCULATOR-FREE

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METHODS UNIT 1

Question number: _____

CALCULATOR-ASSUMED

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/Determine a
value.
/Determine b
value.

(2 marks)

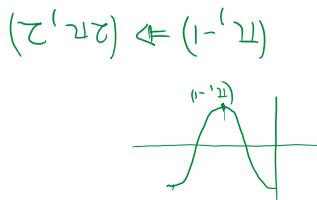
Determine the value of a and the least value of b .

$$a = 5$$

$$b = \frac{3}{\pi}$$

(2 marks)

/x value
correct.
/y value
correct.
/x value
correct.
/y value
correct.



(b) Let $g(x) = 3 + \cos\left(\frac{x}{2}\right)$.

Determine the coordinates of the minimum of the graph of $y = g(x)$ for $0 \leq x \leq 4\pi$. (2 marks)

(7 marks)

Consider the function $f(x) = \frac{p}{x+q}$, where p and q are constants. The graph of $y = f(x)$ has an asymptote with equation $x = 2$ and passes through the point $(6, -1)$.

- (a) Determine the value of p and the value of q . (3 marks)

$$\begin{aligned}f(x) &= \frac{p}{x-2} \\-1 &= \frac{p}{6-2} \\-4 &= p \\\therefore p &= -4 \quad q = -2\end{aligned}$$

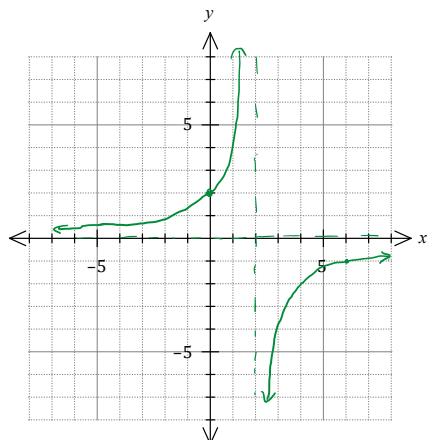
✓ Correct q value
✓ Substitutes to find p
✓ Correct p value.

- (b) State the equation of the other asymptote of the graph of $y = f(x)$. (1 mark)

$$y = 0$$

✓ Correct equation
(Must be $y =$)

- (c) Sketch the graph of $y = f(x)$ on the axes below. (3 marks)



✓ passes through $(6, -1)$ and $(0, 2)$
✓ correct vertical asymptote
✓ smooth hyperbolic shape

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Supplementary page

Question number: _____

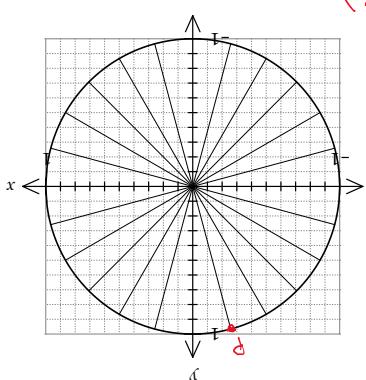
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(5 marks)

Question 5

Mark on the circumference of the circle the point P so that a ray drawn from the origin to point P will make an anticlockwise angle of $\frac{7\pi}{12}$ from the positive x -axis.

Hence estimate the value of $\cos\left(\frac{7\pi}{12}\right)$.



Parallel
 Correctly
 Estimated
 Justified

(2 marks)

(b) Solve the equation $2 \tan(3x - 75^\circ) + 2 = 0$ for $0^\circ \leq x \leq 90^\circ$. (3 marks)

$$\begin{aligned} 2 \tan(3x - 75^\circ) + 2 &= 0 \\ -2 &\equiv 3x - 75^\circ \leq 195^\circ \quad (\text{Because angles to } 195^\circ \text{ are negative}) \\ 135^\circ &\equiv 3x - 75^\circ \\ 210^\circ &= 3x \\ 70^\circ &= x \end{aligned}$$

Book solutions
 Correct
 OA solutions

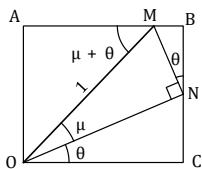
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SN018-172-2

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(7 marks)



(2 marks)

Consider rectangle $OABC$ that contains the right triangle OMN as shown.

Let the length of $OM = 1$,
 $\angle NOC = \angle MNB = \theta$,
 $\angle MON = \mu$ and
 $\angle AMO = \mu + \theta$.

- (a) Explain why $OC = \cos \mu \cos \theta$.

$$\begin{aligned} \text{As } ON &= \cos \mu \\ OC &= \cos \theta \times ON \\ \therefore OC &= \cos \theta \cos \mu \end{aligned}$$

✓ Used $\triangle OMN$
to find ON

✓ Used $\triangle ONC$
to state OC .

- (b) Determine expressions for the lengths of BM and AM and hence prove the angle sum identity $\cos(\mu + \theta) = \cos \mu \cos \theta - \sin \mu \sin \theta$. (3 marks)

$$\begin{aligned} \frac{\sin \theta}{MN} &= \frac{BM}{MN} & AM &= \cos(\mu + \theta) & \text{✓ Expression for } BM \\ MN &= \sin \mu & & & \text{✓ Expression for } AM \\ BM &= \sin \theta \sin \mu & & & \text{✓ Uses equal sides of } OABC \\ AM + BM &= OC & & & \text{✓ Uses equal sides of } OABC \\ \cos(\mu + \theta) + \sin \theta \sin \mu &= \cos \theta \cos \mu & & & \text{to complete proof} \\ \therefore \cos(\mu + \theta) &= \cos \theta \cos \mu - \sin \theta \sin \mu \end{aligned}$$

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(7 marks)

The equation $f(x) = ax^3 + bx^2 - 12x + 8$ has two solutions, where $f(x) = k$ and a, b and k are constants.

The graph of $y = f(x)$ cuts the x -axis at $x = 2$, $x = -2$, and at one other point.

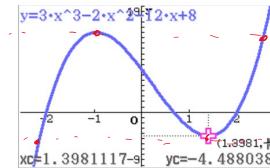
Determine the value(s) of the constant k , rounded to 2 decimal places. Explain your reasoning.

$$\begin{aligned} f(2) &= 0 & a(2)^3 + b(2)^2 - 12(2) + 8 &= 0 \\ & & 8a + 4b - 24 + 8 &= 0 \end{aligned}$$

$$\begin{aligned} f(-2) &= 0 & a(-2)^3 + b(-2)^2 - 12(-2) + 8 &= 0 \\ & & -8a + 4b + 24 + 8 &= 0 \end{aligned}$$

$$\begin{aligned} \text{Solve } & \left\{ \begin{array}{l} 8a + 4b = 16 \\ -8a + 4b = 32 \end{array} \right|_{a,b} \text{ in classpad} \\ a &= 3 & b &= -2 \end{aligned}$$

$$\therefore f(x) = 3x^3 - 2x^2 - 12x + 8$$



For two solutions to exist,
 k must be at local maximum
or local minimum.

Minimum $y = -4.488$
maximum $y = 15.023$

$$\therefore k = -4.49 \quad \text{or} \quad k = 15.02$$

✓ Shows substitution of $x = -2$ or $x = 2$ into $f(x)$ by inspection clearly.

✓ Shows method to solve for a

✓ Shows method to solve for b .

✓ Describes case for solution

✓ States value of local max or min

✓ States k value.

(-1 if not to 2 dp).

*(a) Substitutes
into identity
and expands
using brackets
and simplifies.*

$$\cos(x)\cos\left(\frac{\pi}{2}\right) - \sin(x)\sin\left(\frac{\pi}{2}\right) = -\sin(x)$$

- (c) Use the identity from part (b) to show that $\cos\left(x + \frac{\pi}{2}\right) = -\sin x$. (2 marks)

METHODS UNIT 1

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METHODS UNIT 1

CALCULATOR-FREE

- Question 18 A row of Pascal's Triangle is shown below in combination notation. (8 marks)

${}_5C_0$	${}_5C_1$	${}_5C_2$	${}_5C_3$	${}_5C_4$	${}_5C_5$
1	4	6	4	1	1
1	3	3	1	1	1
1	2	1	1	1	1
1	1	1	1	1	1

(i) State the natural numbers in the row above this row. (1 mark)

(ii) Expand and simplify $(p+q)^4$. (2 marks)

(iii) Without expanding, show clearly that the coefficient of x^3 in the binomial expansion of $(3-2x)^5$ is -720 . (3 marks)

(c) From a squad of 9 basketball players, a coach needs to select a team of 5 to play during a match. How many different teams are possible? (1 mark)

(b) (i) Calculate the number of ways to choose 3 Simplified factors from 5 factors. (1 mark)

(ii) Calculate the value of 5C_3 . (1 mark)

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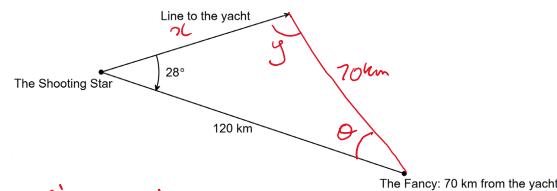
Supplementary page

Question number: _____

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Question 17 continued

- (b) Two cargo ships, The Shooting Star and The Fancy, are 120 km apart when they pick up the distress call from the stranded yacht from (a). The captain of The Fancy estimates that the yacht is 70 km away and that the angle between the line from The Fancy to The Shooting Star and the line from The Shooting Star to the yacht is 28° . What are two possible distances, to the nearest tenth of a km, from The Shooting Star to the yacht? (4 marks)



$$\frac{\sin y}{120} = \frac{\sin 28}{70}$$

$$y = 53.59^\circ \quad \theta = 98.41^\circ$$

$$\begin{aligned} y &= 180 - 53.59 \\ &\approx 126.41^\circ \quad \theta = 25.59^\circ \end{aligned}$$

$$\frac{x}{\sin 98.41} = \frac{70}{\sin(28)} \quad \frac{x}{\sin(25.59)} = \frac{70}{\sin(28)}$$

$$x = 147.5 \text{ km}$$

$$x = 64.4 \text{ km}$$

OR $\text{solve } 70^2 = x^2 + 120^2 - 2x(120)\cos(28)$

✓ Uses sine rule to find y or cosine
✓ Ambiguous case for θ.

✓ Shows method for one distance

✓ both distances given.

-1 if not to nearest tenth of km.

From the port, the distance to the nearest land is 5.6 km from the eye of the yacht. The eye is 10.3 m from therewer and is on a bearing of 240° . From therewer, draw a diagram and hence calculate the bearing of the yacht from therewer. (4 marks)

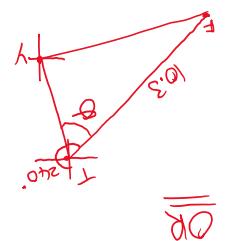
(8 marks)

$$\theta = \cos^{-1} \left(\frac{-2(5.6)(10.3)}{7.2^2 - 5.6^2 - 10.3^2} \right) \quad (\text{Correct})$$

With slides
behaving
useless cases
rule
calculating
calculators
behaving.

$$Q = 240 + 42 \cdot 0.9$$

$$\begin{aligned} & \text{Left side: } 1.816 \\ & \text{Right side: } 1.716 \\ & \text{Difference: } 1.816 - 1.716 = 0.100 \end{aligned}$$



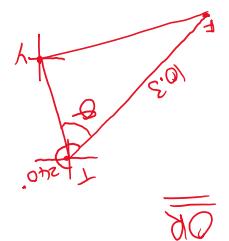
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(8 marks)

$$\text{bearing} = 282.09^\circ \quad \text{or } 282.0^\circ$$

$$\begin{aligned} & \text{Left side: } 1.816 \\ & \text{Right side: } 1.716 \\ & \text{Difference: } 1.816 - 1.716 = 0.100 \end{aligned}$$



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Supplementary page

Question number: _____

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(9 marks)

- (a) Let $f(x) = x^2 + bx + c$, where b and c are constants. The graph of $y = f(x)$ has an axis of symmetry with equation $x = 4$ and an axis intercept at $(0, 6)$.

- (i) State the value of the constant c . (1 mark)

$$c = 6$$

✓ States y-intercept
for c .

- (ii) Determine the value of the constant b . (2 marks)

$$\begin{aligned} x_c &= -\frac{b}{2a} \\ 4 &= -\frac{b}{2(1)} \\ b &= -8 \end{aligned}$$

✓ Shows method
clearly

✓ States b value.

- (b) Let $g(x) = -(x + 3)^2 + 5$. Determine

- (i) the coordinates of the turning point of the graph of $y = g(x)$. (1 mark)

$$(-3, 5)$$

✓ Correct turning
point.

- (ii) the domain and range of $g(x)$. (3 marks)

Domain: $\{x \in \mathbb{R}\}$ ✓ Value of domain

Range: $\{g(x) \in \mathbb{R} : g(x) \leq 5\}$ ✓ Value of range

✓ notation.

- (iii) the coordinates of the turning point of the graph of $y = g(x + 2) - 3$. (2 marks)

$$\begin{pmatrix} -3 \\ 5 \end{pmatrix}$$

$$= (-5, 2)$$

✓ Correct x

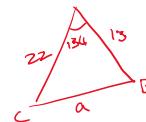
✓ Correct y

-1 if not a coordinate.

Question 14

(9 marks)

- (a) Triangle ABC is such that $b = 22$ cm, $c = 13$ cm and $\angle A = 134^\circ$. Determine, with justification, the length of side a .



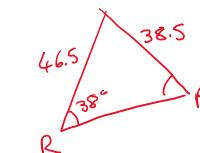
$$\begin{aligned} a^2 &= 22^2 + 13^2 - 2(22)(13)\cos 134^\circ \\ &= \sqrt{1050.345} \\ a &= 32.41 \text{ cm} \end{aligned}$$

✓ Uses cosine rule.

✓ Calculates a value.

✓ Units

- (b) Triangle PQR is such that $p = 46.5$ cm, $r = 38.5$ cm and $\angle R = 38^\circ$. Determine all possible areas of this triangle.



$$\frac{\sin P}{46.5} = \frac{\sin 38^\circ}{38.5}$$

$$P = \sin^{-1}\left(\frac{46.5 \times \sin 38^\circ}{38.5}\right)$$

$$= 48.04 \quad \text{OR} \quad P = 180 - 48.04$$

$$= 131.96$$

$$\begin{aligned} R &= 180 - 48.04 - 38 \\ &= 93.96^\circ \end{aligned}$$

$$R = 10.04^\circ$$

✓ Uses sine Rule

✓ Calculates LP

✓ Calculates LR

✓ Calculates one area correctly

✓ Calculates 2nd angles for P & R

✓ Calculates 2nd area correctly.

$$\text{Area} = \frac{1}{2}(46.5)(38.5)\sin(93.96)$$

$$= 892.99 \text{ cm}^2$$

$$\text{Area} = \frac{1}{2}(46.5)(38.5)\sin(10.04)$$

$$= 156.02 \text{ cm}^2$$

allow any dp
must be rounded correctly.

Semester One Examination, 2021

Christ Church
Grammar School



MATHEMATICS METHODS UNIT 1 SECTION TWO: CALCULATOR-ASSUMED

If required by your examination administrator, please place your student identification label in this box.

Question/Answer booklet

Semester One Examination, 2021

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Time allocated for this section
Materials required/recommended for this section
To be provided by the supervisor

Working time: Reading time before commencing work: ten minutes
Formula sheet (relained from Section One)
This Question/Answer booklet

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: drawing instruments, templates, notes on two unruled sheets of A4 paper, course examination

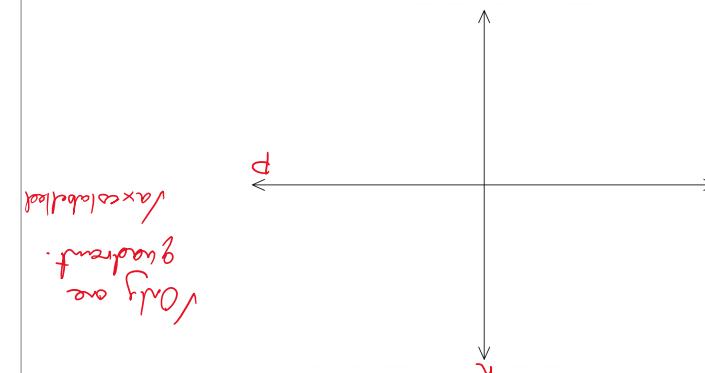
Computer Algebra System (CAS) calculators, graphic and and up to three calculators, which can include scientific, graphic and

No other items may be taken into the examination room. It is **your responsibility** to ensure that you do not have any unauthorised material if you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Important note to candidates

SN18-172-2

See next page



(c) Draw a sketch of the graph of this model labelling the axes appropriately. (2 marks)

$\approx 54 \text{ or } 53 \text{ cans.}$

$= 53.8 \text{ cans}$

$n = \frac{296}{5.5} = 54$

The price of a can was \$5.50. State the number of cans which would be sold if

the value of a can was \$5.50. (2 marks)

According to the given model, state the number of cans which would be sold if

the value of a can was \$5.50. (2 marks)

$n = \frac{296}{5.5} = 54$

$\therefore \text{No. of cans sold as the value of a can is } 54.$

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Structure of this paper

Section	Number of questions available	Number of questions to be answered	Working time (minutes)	Marks available	Percentage of examination
Section One: Calculator-free	8	8	50	52	35
Section Two: Calculator-assumed	13	13	100	93	65
Total					100

Instructions to candidates

- The rules for the conduct of examinations are detailed in the school handbook. Sitting this examination implies that you agree to abide by these rules.
- Write your answers in this Question/Answer booklet preferably using a blue/black pen. Do not use erasable or gel pens.
- You must be careful to confine your answers to the specific question asked and to follow any instructions that are specific to a particular question.
- Show all your working clearly. Your working should be in sufficient detail to allow your answers to be checked readily and for marks to be awarded for reasoning. Incorrect answers given without supporting reasoning cannot be allocated any marks. For any question or part question worth more than two marks, valid working or justification is required to receive full marks. If you repeat any question, ensure that you cancel the answer you do not wish to have marked.
- It is recommended that you do not use pencil, except in diagrams.
- Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.
- The Formula sheet is not to be handed in with your Question/Answer booklet.

DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

Question 12 continued

- (c) Show that
- QS
- is Perpendicular to
- PR
- .

$$m_{QS} = \frac{-11-9}{8+2} \\ = -2$$

$$m_{PR} = \frac{1}{2} \quad \frac{1}{2} \times -2 = -1$$

∴ perpendicular

(2 marks)

✓ Calculates gradients
✓ Uses $m_1 \times m_2 = -1$ to compare.

- (d) Calculate
- θ
- , the angle of inclination of
- QS
- , as shown in the diagram.

$$\tan \theta = -2 \\ \theta = 116.57^\circ$$

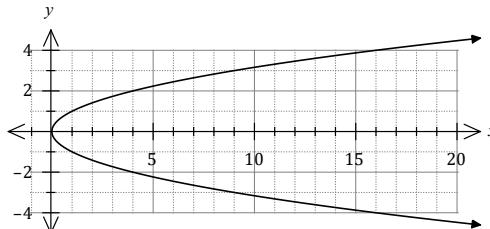
$$\text{OR} \quad 180 + \tan^{-1}(-2) = \theta \\ \theta = 116.57^\circ$$

(2 marks)

✓ Uses $\tan \theta = m$ to find angle
✓ Correct angle.

Question 10

- (a) The parabolic graph of a relation is shown below.



- (i) State the equation of its axis of symmetry.

$$y = 0$$

✓ Correct equation.

- (ii) State the equation of the relationship between x and y .

$$y^2 = x$$

✓ Correct equation.

- (b) Points A and B have coordinates $(-7, 8)$ and $(5, 4)$ respectively. Determine the equation of the circle that has diameter AB .

$$M = \left(\frac{-7+5}{2}, \frac{8+4}{2} \right) \\ = (-1, 6)$$

$$\text{radius} = \sqrt{(8-4)^2 + (-7-5)^2} \div 2 \quad \text{OR} \quad \text{radius}^2 = (6-4)^2 + (-1-5)^2 \\ = 12.649 \div 2 \quad = 40$$

$$\text{radius}^2 = 40$$

✓ Calculates midpoint

✓ Calculates radius

✓ Correct center in equation

✓ Correct radius.

$$(x+1)^2 + (y-6)^2 = 40$$

See next page

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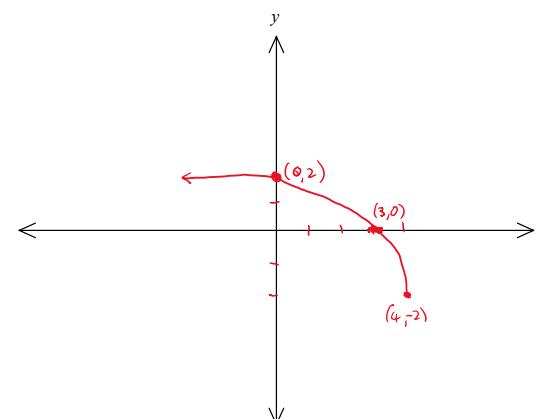
Question 11

Let $f(x) = 2\sqrt{4-x} - 2$.

- (a) Sketch the graph of $y = f(x)$ on the axes below.

(3 marks)

*✓ x-intercept
✓ y-intercept
✓ shape.*



- (b) Describe the transformation(s) required to obtain the graphs of the following functions from the graph of $y = f(x)$:

(2 marks)

Translation parallel to x axis left 3 units

*✓ States translation with direction
✓ Correct distance*

$$(i) \quad y = 2\sqrt{1-x} - 2.$$

(2 marks)

Translation parallel to x axis left 3 units

$$(ii) \quad y = \sqrt{4-x} - 1.$$

(3 marks)

*Dilation parallel to y axis, scale factor = ½
Translation parallel to y axis up 1 unit.*

*✓ States dilation parallel to y axis
✓ Scale factor ½*

✓ Vertical translation with distance .

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See next page