

MATHEMATICS METHODS UNIT 1

Semester One Examination, 2021 Question/Answer booklet

Grammar School
Christ Church



Important note to Candidates
Other items may be taken into the examination room. It is your responsibility to ensure that you do not have any unauthorised material with you, apart from the supervisor before reading any further.

Important note to candidates

special items: nil

o De provided By the vendor
standard items: pens (black preferred), pencils (including coloured), sharpener, corrugated fluted tape, eraser, ruler, highlighters

Materials required/recommended for this section

Number of additional answer booklets used (if applicable):

Time allowed for this section
Reading time before commencing work:
Working time:

Your name

In words

WA student number: In figures

Please place your student identification label in this box.

Section One: Calculator-free

UNIT 1

METHOD

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.

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

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)

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

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

$$x - 11 = \pm 9$$

$$x = 11 \pm 9$$

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

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

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

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(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)

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

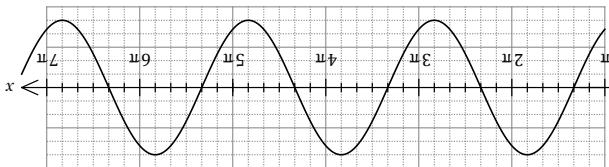
*✓ Rearrange to
 $y = mx + c$
✓ Simplify to show
 $m = -2$*

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)

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

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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

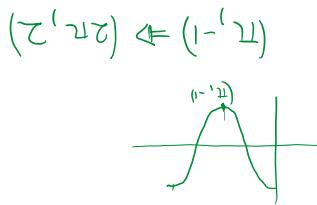
\checkmark Determines a value.
 \checkmark Determines b value.

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

$$a = 5$$

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

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



\checkmark DC value
 \checkmark correct
 \checkmark y value
 \checkmark correct.

\checkmark DC value
 \checkmark correct
 \checkmark y value
 \checkmark correct.

(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)

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

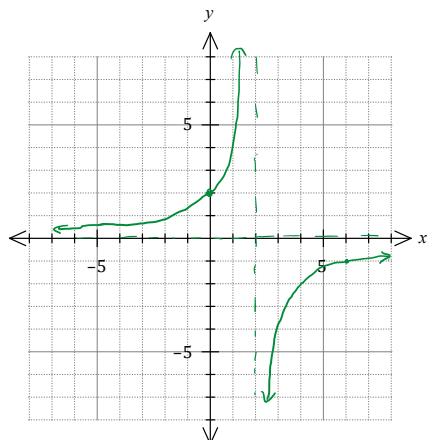
✓ Correct q value
✓ Substitutes to find p
✓ Correct p value.

- (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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(7 marks)

- (a) Determine the number of possible combinations when four students must be chosen from a small class of six.

$$\begin{aligned} {}^6C_4 &= \frac{6!}{4!(6-4)!} \\ &= \frac{6 \times 5 \times 4 \times 3}{4 \times 3 \times 2 \times 1} \\ &= \frac{360}{24} = 15 \end{aligned}$$

 $\therefore 15$ combinations

✓ Uses formula
or Pasals
✓ Correct
value.

- (b) Determine the coefficient of the x^2 term in the expansion of

(i) $(x+4)^3$.

$$3(x)^2(4)^1 = 12x^2$$

 $\therefore 12$

(2 marks)

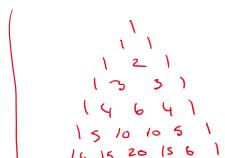
✓ Shows method
✓ States coefficient.

(ii) $(5x-2)^6$.

$${}^6C_2 (5x)^2 (-2)^4$$

$$15(25x^2)(16)$$

$$= 6000x^2$$

 $\therefore 6000$ 

(3 marks)

✓ Shows use of Pascal's
or combinations.
✓ Shows other
components of term
✓ States coefficient.

$$15(5x)^2(-4)^4$$

$$= 6000x^2$$

 $\therefore 6000$

See next page

SN018-172-1

Supplementary page

Question number: _____

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SN018-172-2

Question 7
Determine the coordinates of the point(s) of intersection of $f(x)$ and $g(x)$.
(7 marks)

$$(3x-2)(x+4) = x^3 - x^2 + 3x + 2$$

$$3x^2 + 12x - 2x - 8 = x^3 - x^2 + 3x + 2$$

$$0 = x^3 - 4x^2 - 7x + 10$$

$$\text{When } x=1 \quad 0 = (1)^3 - 4(1)^2 - 7(1) + 10$$

$$0 = 0$$

$$\therefore (x-1) \text{ is a factor}$$

(method must be clear)
Finds $x=1$ and no other factors

$f(x) = g(x)$
Expands & rearranges
to 0.
Solves $f(x) = g(x)$

$\int 2c \text{ jolts}$
 $\int c \text{ odd jets}$

$$(3(-2)-2)(-2+4) = -8(-2) = -16$$

$$(3(5)-2)(5+4) = 13(9) = 117$$

$$(3(1)-2)(1+4) = 5$$

$\therefore \text{Integrals of } (3x^2 - 2x) \text{ is } (-2x^3 + 6x^2)$

$$(x-1)(x-5)(x+2)$$

$$(x^2 - 3x - 10)$$

$$\begin{array}{r} 0 \\ -(x^2 - 3x - 10) \\ \hline -3x^2 + 7x \\ -(3x^2 - 7x) \\ \hline 0 \end{array}$$

$$\begin{array}{r} 0 \\ -(x^2 - 3x - 10) \\ \hline -x^2 + 10 \\ -(x^2 - x^2) \\ \hline 0 \end{array}$$

$\therefore (x-1)$ is a factor

$$\text{When } x=1 \quad 0 = (1)^3 - 4(1)^2 - 7(1) + 10$$

$$0 = 0$$

$\therefore (x-1)$ is a factor

(method must be clear)

Finds $x=1$ and no other factors

to 0.

Expands & rearranges

$f(x) = g(x)$

Solves $f(x) = g(x)$

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$\int c \text{ odd jets}$

$\int c \text{ even by inspection}$

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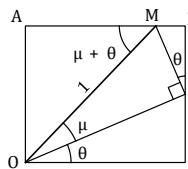
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(7 marks)



(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.

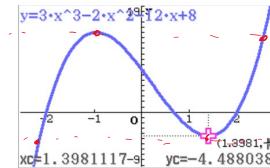
Determine the value(s) of the constant k , rounded to 2 decimal places. Explain your reasoning.

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

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

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

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



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).

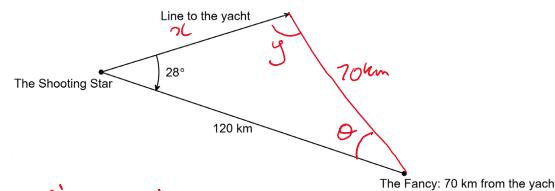
Supplementary page

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.

(a) A ferry and a trawler receive a request for help from a stranded yacht. The ferry is 7.2 km from the yacht. The trawler is 5.6 km from the yacht. The trawler is 10.3 km from the trawler and is on a bearing of 240° from the trawler. Draw a diagram and hence calculate the bearing of the yacht from the trawler.

(4 marks)

$$\begin{aligned} \theta &= \cos^{-1}\left(\frac{-2(5.6)(10.3)}{7.2^2 - 5.6^2 - 10.3^2}\right) \\ &= 42.09^\circ \end{aligned}$$

$$\begin{aligned} B &= 240 + 42.09^\circ \\ &= 282.09^\circ \end{aligned}$$

With sides
diagram
Use cosine
bearing.

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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

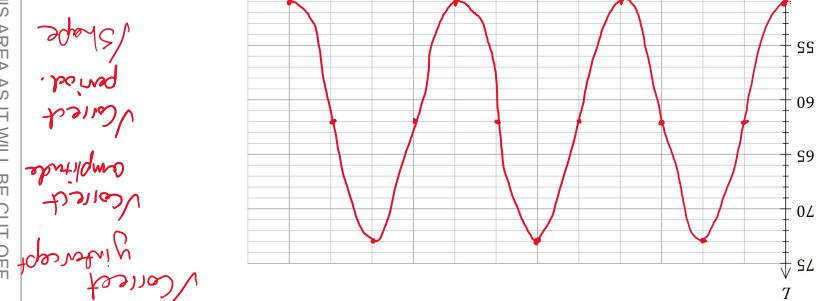
-1 if not a coordinate.

$$L = 62 - 11 \cos\left(\frac{\pi t}{10}\right)$$

(1 mark)

(a) Determine the initial loudness emitted by the machine.

(4 marks)

(b) Draw the graph of L against t on the axes below for the first 60 minutes.

(c) State the maximum loudness emitted by the machine and the time this maximum was first reached. (2 marks)

(d) A health and safety inspector can deem a machine unsafe if the loudness it emits exceeds 70 dB for more than 15 minutes in any hour that it is running. Determine, with justification, whether this machine could be deemed unsafe. (3 marks)

$$\begin{aligned} & 12.41 - 7.59 = 4.82 \text{ min} \\ & 3(4.82) = 14.46 \text{ min} \\ & / 10 \leq 14.46 \text{ min} \\ & \therefore \text{No, unsafe as less than } 14.46 \text{ or } 15 \text{ min.} \end{aligned}$$

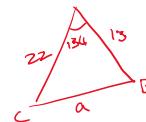
See next page

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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 .



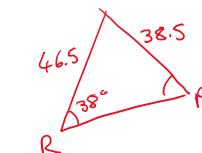
$$\begin{aligned} a^2 &= 22^2 + 13^2 - 2(22)(13)\cos 134^\circ \\ &= \sqrt{1050.345} \\ a &= 32.41 \text{ cm} \end{aligned}$$

✓ 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.



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

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

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

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

$$\begin{aligned} &= 131.96 \\ R &= 10.04^\circ \end{aligned}$$

✓ Uses sine Rule

✓ Calculates LP

✓ Calculates LR

✓ Calculates one area correctly

✓ Calculates 2nd angles for P & R

✓ Calculates 2nd area correctly.

$$\begin{aligned} \text{Area} &= \frac{1}{2}(46.5)(38.5)\sin(93.96) \\ &= 892.99 \text{ cm}^2 \end{aligned}$$

$$\begin{aligned} \text{Area} &= \frac{1}{2}(46.5)(38.5)\sin(10.04) \\ &= 156.02 \text{ cm}^2 \end{aligned}$$

allow any dp
must be rounded correctly.

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.

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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.

(5 marks)

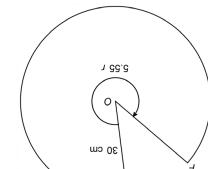
(2 marks)

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: 100 minutes.

(5 marks)

(a) The diagram below shows a sector of a circle with centre O. The radius of the circle is 30 cm and $\angle DOP = 5.55$ radians. Calculate the length of the major arc DF.

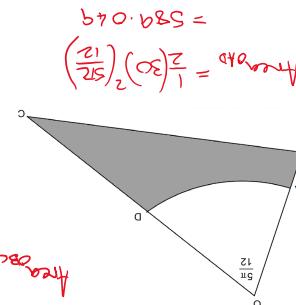


$$a = (30)(5.55)$$

(b) The diagram below shows a sector of a circle with centre O. The radius of the circle is 30 cm and $\angle AOD = 3.0$ radians. Calculate the length of the minor arc AD.

In the diagram below, OAD is a sector of the circle with centre O. BOC is a triangle. In sector AOD, the radius is 30 cm and angle AOD is $\frac{3\pi}{2}$ radians. In triangle OBC, OB = 38 cm and OC = 55 cm.

(3 marks)



Calculate the shaded area of the shape with vertices of ABCD rounded to 3 dp.

$$\text{Shaded} = 100\pi \cdot 3.0 - 584.04\pi$$

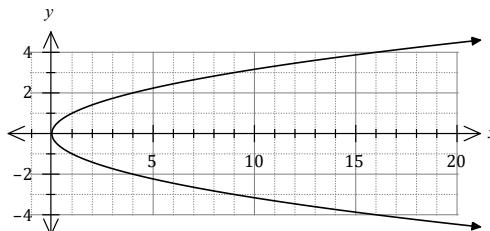
*(-1) ! + 3 dp**shaded region**area of sector OAB**area of triangle ABC**area of triangle OBC**area of triangle OAD**area of sector OAD**area of triangle ODC**area of sector ODC**area of triangle OBC**area of sector OAD**area of triangle ODC**area of sector OBC**area of triangle OBC**area of sector OAD**area of triangle ODC**area of sector OBC**area of triangle ODC**area of sector OBC**area of triangle ODC**area of sector OBC**area of triangle ODC**area of sector OBC*

(3 marks)

*(-1) ! + 3 dp**shaded region**area of sector OAB**area of triangle ABC**area of triangle OBC**area of triangle OAD**area of sector OAD**area of triangle ODC**area of sector ODC**area of triangle OBC**area of sector OAD**area of triangle ODC**area of sector OBC**area of triangle ODC**area of sector OBC*

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.

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

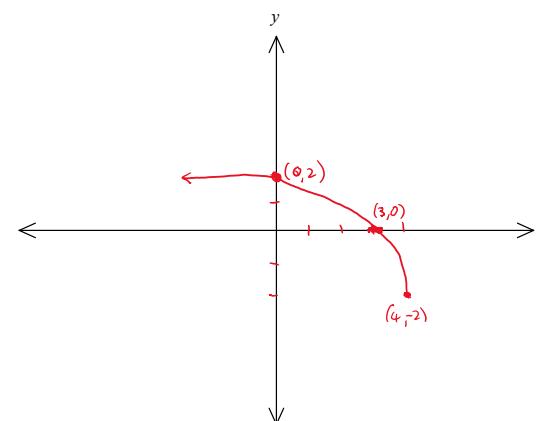
Question 11

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*

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

(3 marks)

Translation parallel to y axis up 1 unit.

*✓ States dilation parallel to y axis
✓ Scale factor $\frac{1}{2}$*

Dilation parallel to y axis, scale factor $\frac{1}{2}$

✓ Vertical translation with distance .

Translation parallel to y axis up 1 unit.