

	Register No.	Class
Name :		



BENDEMEER SECONDARY SCHOOL
2022 PRELIMINARY EXAMINATION
SECONDARY 4 EXPRESS / 5 NORMAL (ACADEMIC)
Elementary Mathematics Paper 2
4048/02

DATE : 24 August 2022
DURATION : 2 hours 30 minutes
TOTAL : 100 marks

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
 Write in dark blue or black pen on both sides of the paper.
 You may use a 2B pencil for any diagrams or graphs.
 Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Answer **all** questions on the question booklet unless otherwise stated by the question.
 All the diagrams in this paper are **not** drawn to scale.
 If working is needed for any question, it must be shown with the answer.
 Omission of essential working will result in loss of marks.
 The use of an approved scientific calculator is expected, where appropriate.
 If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
 For π , use either your calculator value or 3.142, unless the question requires the answer in terms of π .

At the end of the examination, fasten all your work securely together.
 The number of marks is given in brackets [] at the end of each question or part question.
 The total number of marks for this paper is 100.

FOR EXAMINER'S USE
100

MATHEMATICAL FORMULAE

Compound Interest

$$\text{Total amount} = P \left(1 + \frac{r}{100} \right)^n$$

Mensuration

$$\text{Curved surface area of cone} = \pi r l$$

$$\text{Surface area of a sphere} = 4 \pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3} \pi r^2 h$$

$$\text{Volume of sphere} = \frac{4}{3} \pi r^3$$

$$\text{Area of triangle ABC} = \frac{1}{2} ab \sin C$$

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2} r^2 \theta, \text{ where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

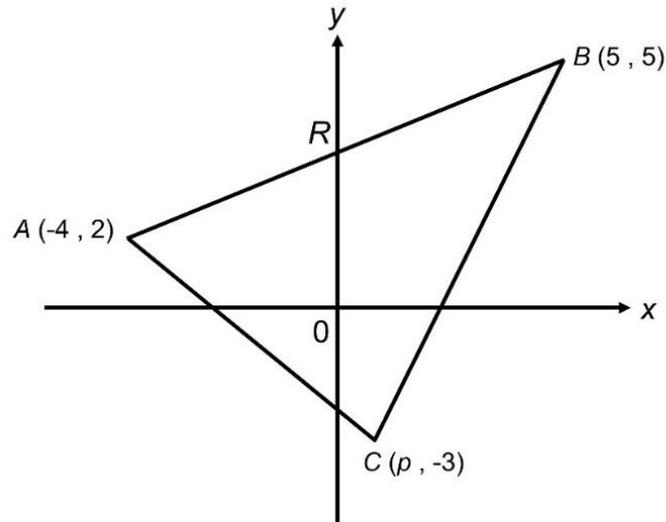
$$a^2 = b^2 + c^2 - 2bc \cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard Deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f} \right)^2}$$

1. The diagram, which is not drawn accurately, shows points A , B and C with coordinates $(-4, 2)$, $(5, 5)$ and $(p, -3)$ respectively. AB intercepts the y -axis at R .



- (a) Find the coordinates of R .

Answer (a) [3]

- (b) Given that the length of AC is $\sqrt{50}$ units, find the value of p .

Answer (b) [3]

2. During a sale, candy is sold at \$ x per 100g.

- (a) Valarie has \$5 to spend on candy. Write down, in terms of x , the mass of sweets that she can buy.

Answer (a) g [1]

- (b) After the sale, the same type of candy is sold at \$ $(x + 0.8)$ per 100g. If Valarie is to spend \$5, write down, in terms of x , the mass of sweets that she can buy.

Answer (b) g [1]

- (c) Given that she can buy 25g less candy after the sale, form an equation in x and show that it reduces to $5x^2 + 4x - 80 = 0$. [3]

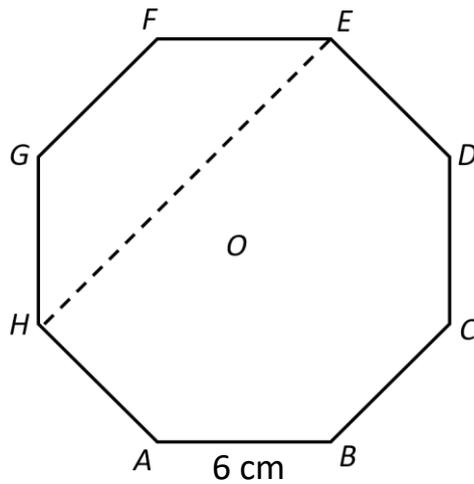
(d) Solve the equation $5x^2 + 4x - 80 = 0$.

Answer (d) $x = \dots\dots\dots$ [2]

(e) How much does 100g of candy cost after the sale?

Answer (e) \$..... [1]

3. $ABCDEFGH$ is a regular octagon with centre O and each side is 6 cm.



Find

(a) $\angle GHE$,

Answer (a)⁰ [2]

(b) $\angle ODC$,

Answer (b)⁰ [2]

(c) Area of $ABCDEFGH$.

Answer (c) cm^2 [3]

(d) If $ABCDEFGH$ is the base area of a prism of height 18 cm, find the volume of the prism.

Answer (d) cm^3 [2]

4. (a) Without using a calculator, show which number is smaller, 3^{19} or 9^6 ? [2]

(b) Show that the quadratic formula $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ can be written in the form $ax^2 + bx + c = 0$ where $a \neq 0$. [3]

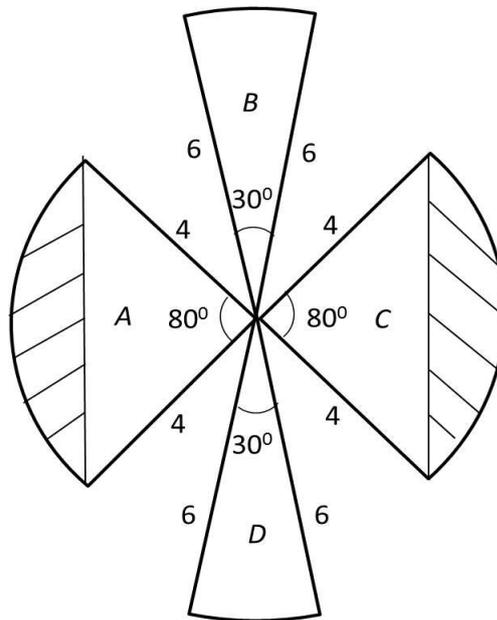
(c) Simplify $\frac{1-9x^2}{27x^2y} \times \frac{(3xy)^2}{3x-1}$.

Answer (c) [3]

(d) Simplify $\sqrt[4]{\left(\frac{a^{-\frac{1}{3}}}{b^8}\right)^3}$, giving you answer in positive indices.

Answer (d) [3]

- (b) The diagram shows a logo made up of four sectors. Sectors A and C are identical while sectors B and D are identical. The radius of sector A is 4 cm and the radius of sector B is 6 cm.



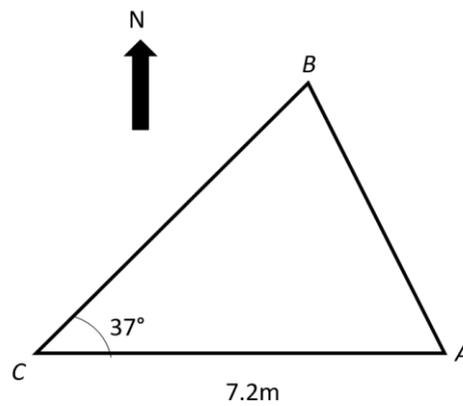
- (i) Find the perimeter of sectors B and D .

Answer (b)(i)cm [2]

- (ii) Find the area of the shaded regions.

Answer (b)(ii)cm² [3]

6. (a) In the diagram, A , B and C are on level ground. The bearing of A from B is 153° . C is 7.2 m due west of A and $\angle BCA = 37^\circ$



- (i) Find the bearing of B from A .

Answer (a)(i)⁰ [2]

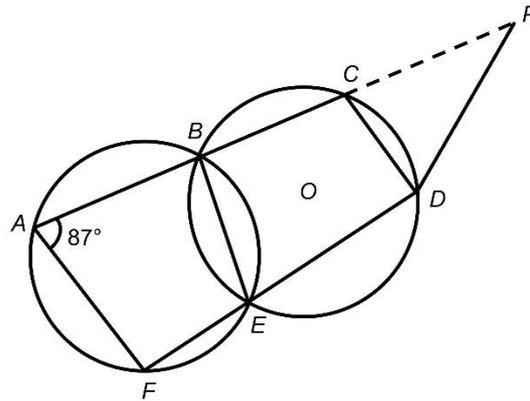
- (ii) Find the distance AB .

Answer (a)(ii) m [2]

- (iii) A pole, 3.8 m, is standing vertically above C . Find the angle of elevation of the highest point of the pole from A .

Answer (a)(iii)⁰ [2]

- (b) The diagram below shows two identical circles that intersect at B and E .
 $\angle FAB = 87^\circ$ and $CD = 10$ cm. P is a point on BC produced such that $CP = 12.3$ cm.



- (i) Find the $\angle BCD$. State the angle properties of circles used.

Answer (b)(i)⁰ [2]

- (ii) Is AF parallel to CD ? Justify your answer.

[2]

- (iii) Find the length of DP .

Answer (b)(iii) cm [2]

7. The table below shows the price of admission tickets to the Zoo, inclusive of 7% GST.

	Adult	Child	Senior Citizen
Standard ticket	\$48	\$33	\$20
Online ticket	Non-peak days – 10% discount		
	Peak days – 5% discount		

The matrix, **S**, shows the price of a standard ticket for adult, child and senior citizen.

$$\mathbf{S} = \begin{pmatrix} 48 \\ 33 \\ 20 \end{pmatrix}$$

- (a) Evaluate the matrix $\mathbf{P} = \mathbf{S}(0.9 \quad 0.95)$
 State what the elements in the second column represent.

Answer (a) $\mathbf{P} = \dots\dots\dots$ [2]

Elements in the second column represent:

.....
[1]

- (b) The Tan family has 2 adults, 3 children and 2 senior citizens.
The Lim family has 4 adults, 2 children and 1 senior citizen.

Represent the family members of the Tan and Lim families in a 2×3 matrix \mathbf{F} .

Evaluate $\mathbf{M} = \mathbf{FP}$.

State what the elements of \mathbf{M} represent.

Answer (b) $\mathbf{F} = \dots\dots\dots [1]$

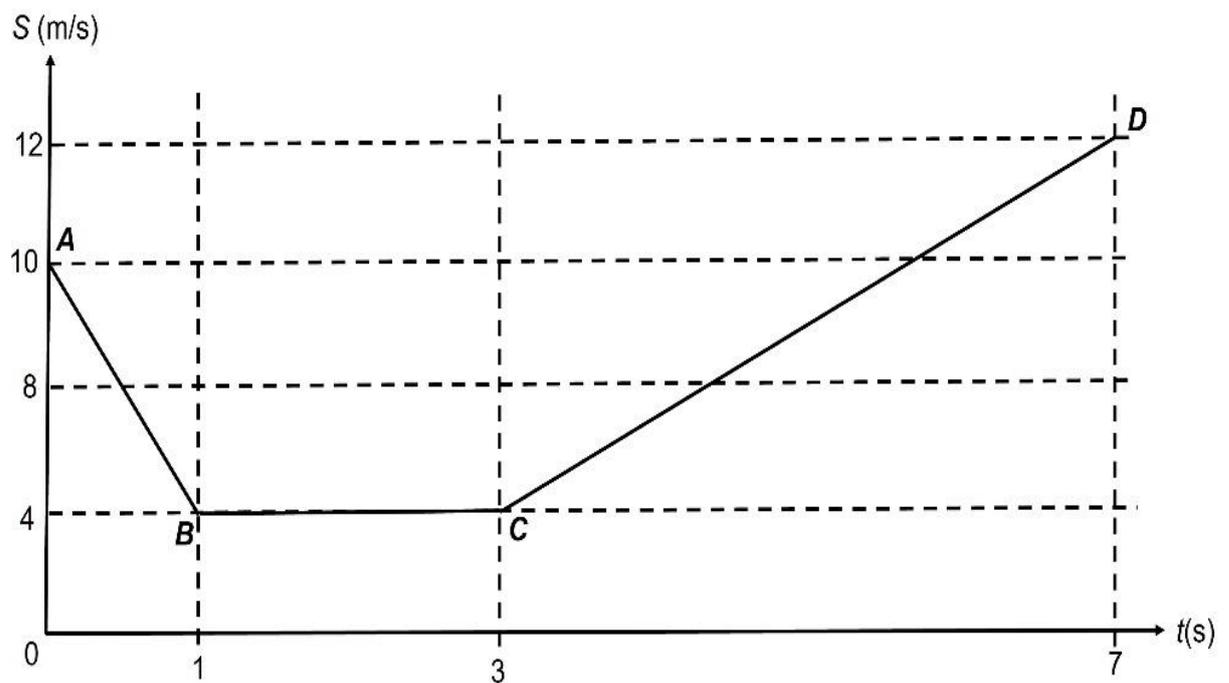
$\mathbf{M} = \dots\dots\dots [1]$

$\dots\dots\dots [1]$

- (c) The Tan and Lim families decide to visit the Zoo together.
Using matrix multiplication, show how much they have to pay together if they visit on non-peak and peak days respectively.

Answer (c) \$..... [2]

8. The speed-time graph $ABCD$ below shows the movement of a particle in 7 seconds.

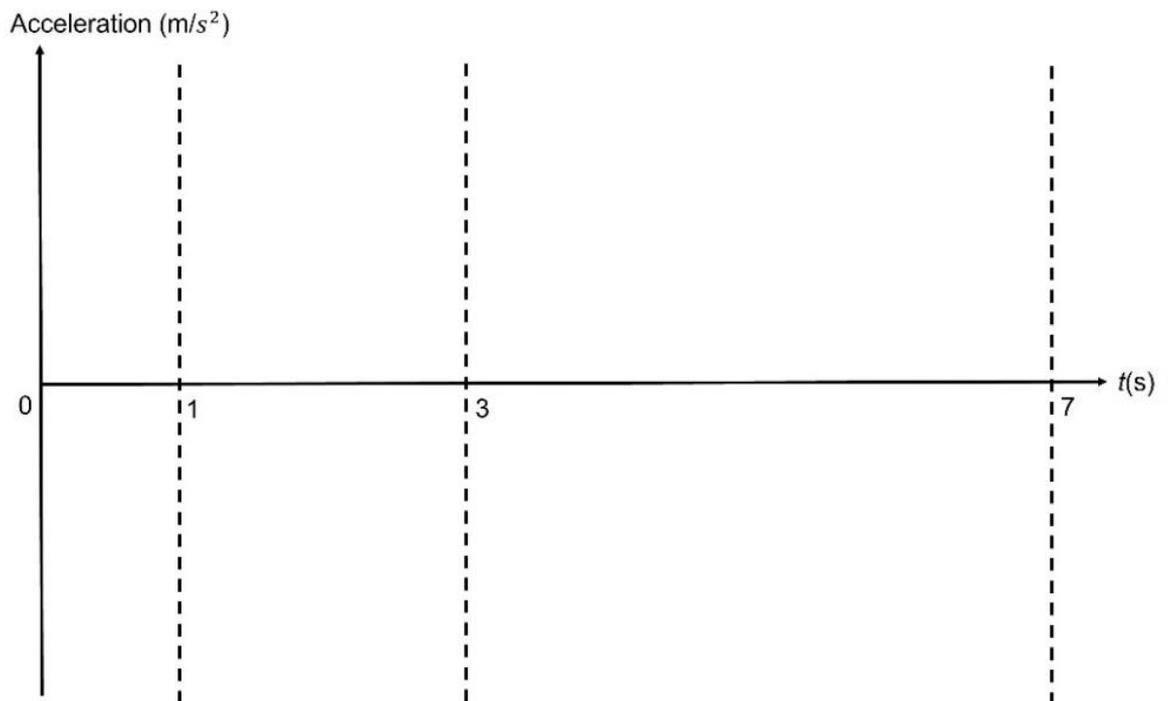


(a) Sketch the corresponding distance-time graph of the particle. Indicate the value on the vertical axis clearly. [3]



- (b) Sketch the corresponding acceleration-time graph of the particle.
Indicate the value on the vertical axis clearly.

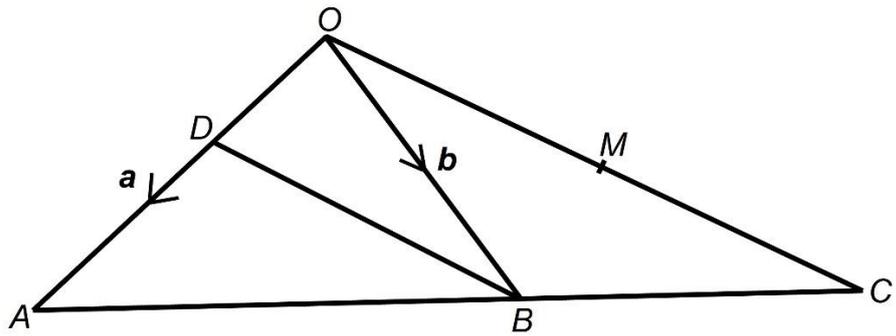
[3]



- (c) Find the average speed of the particle.

Answer m/s [2]

9. The position vectors of A and B relative to O are \mathbf{a} and \mathbf{b} respectively.
 M is the midpoint of OC and $AB : BC = 3 : 2$.



- (a) Express in terms of \mathbf{a} and/or \mathbf{b} , as simply as possible,
 (i) \overrightarrow{AC}
 (ii) \overrightarrow{OC}
 (iii) \overrightarrow{BM}

Answer (a)(i) $\overrightarrow{AC} = \dots\dots\dots$ [1]

(a)(ii) $\overrightarrow{OC} = \dots\dots\dots$ [2]

(a)(iii) $\overrightarrow{BM} = \dots\dots\dots$ [2]

(b) D is a point on OA such that $5OD = 2OA$.

Express \overrightarrow{DB} in terms of \mathbf{a} and \mathbf{b} .

Hence, write down 2 statements about DB and OC . Show your working clearly.

Answer (b) $\overrightarrow{DB} = \dots\dots\dots [1]$

.....
.....
.....
.....[2]

10. The variables of x and y are connected by the equation $y = x^3 + \frac{1}{x}$.

Some corresponding values of x and y are given in the table below.

x	-2	-1.5	-1	-0.5	-0.3	-0.1	0.1	0.3	0.5	1	1.5	2
y	-8.5	-4.0	-2	-2.1	-3.4	-10.0	10.0	3.4	2.1	2	4.0	8.5

(a) On the grid given next page, draw the graph of $y = x^3 + \frac{1}{x}$ for $-2 \leq x \leq 2$. [2]

(b) Use your graph to estimate the coordinates of the turning points.

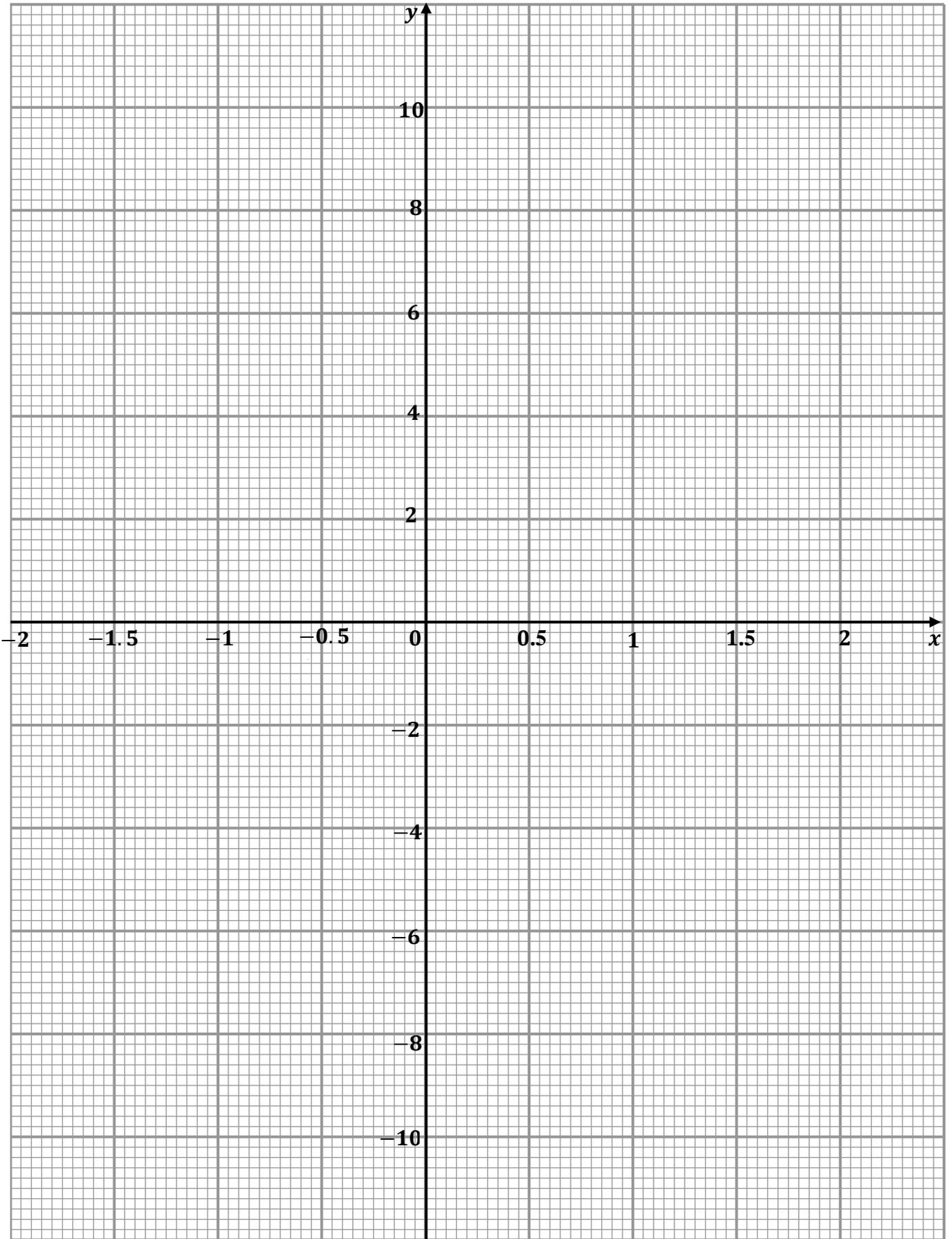
Answer (b) and [2]

(c) By drawing a tangent, estimate the coordinates of two points on the graph where the gradient of the tangent is 2.

Answer (c) and [3]

(d) By drawing a suitable straight line, use your graph to solve $x^4 - 3x^2 - 6x + 1 = 0$.

Answer (d) $x =$ [2]



- 11. (a)** Mr and Mrs Raju bought their 5-room flat in 1981. There were 7 people in the household at that time.
 In 2005, they downsized to a 3-room flat as there were only 3 people living together. Since the floor area of a 3-room flat is smaller than a 5-room flat, the living space per person has decreased for the Raju family. Is this true?
 Show your working clearly to justify your answer. [3]

HOUSEHOLD SIZE VERSUS FLAT SIZE AND LIVING SPACE PER PERSON				
Period	Flat type	(a) Floor area	(b) Average household size	Living space per person = (a)/(b)
1980s	3-room	69 sq m	4.6	15 sq m
	4-room	105 sq m		23 sq m
	5-room	123 sq m		27 sq m
	Executive	145 sq m		32 sq m
1990s	3-room	NA	3.9	NA
	4-room	100 sq m		26 sq m
	5-room	120 sq m		31 sq m
	Executive	140 sq m		36 sq m
2000s	3-room	65 sq m	3.4	19 sq m
	4-room	90 sq m		26 sq m
	5-room	110 sq m		32 sq m
	Executive	NA		NA

- (b) Mr Raju's son, Arun, is getting married soon and will be applying for a HDB flat with his fiancée.
Arun and his fiancée earn a monthly income of \$4500 and \$3900 respectively.
They are deciding between a Build-To-Order (BTO) flat in Yishun or a resale flat in Bishan.

Build-To-Order (BTO) flats are HDB flats where construction will begin only if 65-70% of the apartments in the flat have been booked. BTOs have a wait time of three to four years from the date the construction begins. It starts with a brand new lease of 99 years.

Resale flats are HDB flats that are currently owned by someone else. They have already been lived in for at least the Minimum Occupation Period (MOP), which is typically five years. Resale flats do not come with a fresh 99-year lease. The older a flat is, the fewer years will be left on the lease.

The couple are deciding between these two flats:

Type of flat	4-room HDB Resale Flat	4-room HDB BTO Flat
Location	Bishan (within 4 km from Mr Raju's flat)	Yishun
Lease	Remaining 63 years lease	99 years
Purchase Price	\$608 000	\$370 000
Estimated floor area	904 square feet	93 square metres

Different types of grant are applicable for resale and BTO flats.

	Resale Flat	BTO Flat												
Enhanced CPF Housing Grant (EHG)	Applicable <table border="1" data-bbox="507 1279 1131 1547"> <thead> <tr> <th>Average monthly household income</th> <th>Grant amount</th> </tr> </thead> <tbody> <tr> <td>S\$3,001 – S\$3,500</td> <td>S\$60,000</td> </tr> <tr> <td>S\$3,501 – S\$4,000</td> <td>S\$55,000</td> </tr> <tr> <td>S\$4,001 – S\$4,500</td> <td>S\$50,000</td> </tr> <tr> <td>S\$4,501 – S\$5,000</td> <td>S\$45,000</td> </tr> <tr> <td>S\$5,001 – S\$5,500</td> <td>S\$40,000</td> </tr> </tbody> </table>	Average monthly household income	Grant amount	S\$3,001 – S\$3,500	S\$60,000	S\$3,501 – S\$4,000	S\$55,000	S\$4,001 – S\$4,500	S\$50,000	S\$4,501 – S\$5,000	S\$45,000	S\$5,001 – S\$5,500	S\$40,000	Applicable
Average monthly household income	Grant amount													
S\$3,001 – S\$3,500	S\$60,000													
S\$3,501 – S\$4,000	S\$55,000													
S\$4,001 – S\$4,500	S\$50,000													
S\$4,501 – S\$5,000	S\$45,000													
S\$5,001 – S\$5,500	S\$40,000													
Family Grant	S\$50,000 for four-room flats or smaller and S\$40,000 for five-room flats or larger. To qualify, monthly household income must not be more than S\$14,000 (or S\$21,000 for extended family applicants).	Not Applicable												
Proximity Housing grant (PHG)	\$30,000 (if living with parents/children), or \$20,000 (if living within 4km of parents/children). There is no income ceiling for the PHG.	Not Applicable												

- (i) How much do Arun and his fiancée have to pay if they buy the 4-room HDB **Resale** Flat in Bishan?

Answer (b)(i) \$ [1]

- (ii) How much do Arun and his fiancée have to pay if they buy the 4-room HDB **BTO** Flat in Yishun?

Answer (b)(ii) \$ [1]

- (iii) Besides cost, what is another factor that the couple has to consider when deciding between the two flats?

Answer (b)(iii)
..... [1]

- (iv) Does the **Resale** Flat in Bishan or the **BTO** Flat in Yishun have a larger estimated floor area?

Show your working clearly to justify your answer.

[2]

[1 metre = 3.28084 feet]

- (c) The couple would like to apply for a loan to pay for their flat. Assuming that they are getting the 4-room HDB **BTO** Flat in Yishun with a purchase price of \$370 000, they can take up a loan of 85% of the purchase price of the flat. The repayment period is 25 years. Currently, the interest rate is 2.60% per annum.

The monthly interest is based on the outstanding loan balance at the beginning of every month.

Monthly interest payable = Outstanding loan balance as at the 1st of the month $\times \frac{R}{12}$

Note: R = interest rate (per annum)

Calculate the monthly interest payable for the **first** month.

Answer (c) \$..... [3]

<https://www.teoalida.com/singapore/hdbflatsizes/>

<https://www.propertyguru.com.sg/property-guides/what-is-a-bto-flat-2-6515>

<https://www.propertyguru.com.sg/property-guides/the-ultimate-guide-to-buying-an-hdb-resale-flat-12568>

<https://www.99.co/singapore/insider/hdb-grants-for-couples/>

<https://www.hdb.gov.sg/cs/infoweb/residential/servicing-your-hdb-housing-loan/loan-matters/interest-rate>

End of Paper

Answers for checking

1(a) $(0, 3\frac{1}{3})$ (b) $p = 1$ 2(a) $\frac{500}{x}$ (b) $\frac{500}{x+0.8}$

2(d) $x = 3.62$ or -4.42 (e) $\$4.42$

3(a) 45° (b) 67.5° (c) 174 cm^2 (d) 3130 cm^3

4(a) 9^6 is smaller (c) $\frac{-y(1+3x)}{3}$ (d) $\frac{1}{a^4b^6}$

5(a)(i) $\frac{3}{11}$; $\frac{5}{12}$; $\frac{5}{11}$ (ii) $\frac{1}{4}$ (iii) $\frac{7}{22}$

(b)(i) 30.3 cm (ii) 6.58 cm^2

6(a)(i) 333° (ii) 4.40m (iii) 27.8°

(b)(i) 93° (ii) Yes (iii) 15.4 cm

7(a) $\begin{pmatrix} 43.2 & 45.6 \\ 29.7 & 31.35 \\ 18 & 19 \end{pmatrix}$; Price of tickets for adult, child and senior citizen respectively for peak days

(b) $\mathbf{F} = \begin{pmatrix} 2 & 3 & 2 \\ 4 & 2 & 1 \end{pmatrix}$; $\mathbf{M} = \begin{pmatrix} 211.5 & 223.25 \\ 250.2 & 264.1 \end{pmatrix}$;

Elements in \mathbf{M} represent the cost of tickets for each family on **peak and non-peak** days respectively

(c) $(461.7 \quad 487.35)$

8(c) 6.71 m/s

9(a)(i) $\frac{5}{3}\mathbf{b} - \frac{5}{3}\mathbf{a}$ (a)(ii) $\frac{1}{3}(-2\mathbf{a} + 5\mathbf{b})$ (a)(iii) $-\frac{1}{3}\mathbf{a} - \frac{1}{6}\mathbf{b}$

(b) $\frac{1}{5}(-2\mathbf{a} + 5\mathbf{b})$ DB and OC are parallel . or $DB = \frac{3}{5}OC$

10(b) $(0.75, 1.8)$ and $(-0.75, -1.8)$ (c) $(1, 2)$ and $(-1, -2)$ (d) $x = 0.15$ (Accept 0.1 to 0.2)

11(a) Not true (b)(i) $\$488 \text{ 000}$ (ii) $\$320 \text{ 000}$

(b)(iii) Proximity to work place / Amenities in the area / Accessibility to public transport / Other reasonable answers

(b)(iv) The BTO flat in Yishun has a larger estimated floor area.

(c) $\$681.42$