| Name: | Register Number: | Class: |
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4E
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**BEDOK GREEN SECONDARY SCHOOL**

**Preliminary Examination 2020**

4E
5N

# MATHEMATICS

**4048/01**

Paper 1

**28 August 2020**

**2 hours**

Candidates answer on the Question Paper.

**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.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.
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 $\pi$, use either your calculator value or 3.142, unless the question requires the answer in terms of $\pi$.

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 80.

| For Examiner's Use |
|---|
| 80 |

This document consists of **21** printed pages including the cover page.



[Turn over

## ***Mathematical Formulae***

*Compound interest*

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

*Mensuration*

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

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

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

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

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

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

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

*Trigonometry*

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

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

*Statistics*

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

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

Answer **all** the questions.

**1** $x$ is a number which has 4 significant figures.
$x = 7$ (nearest integer),
$x = 7.5$ (1 decimal place)
$x = 7.49$ (2 decimal places)

Find

**(a)** the least possible value of the number $x$,

*Answer* .................................................. [1]

**(b)** the greatest possible value of the number $x$.

*Answer* .................................................. [1]

---

**2** Given that $\sin\theta = 0.875$, find the values of $\theta$ where $0° \le \theta \le 180°$.

*Answer* $\theta =$ ..................° or ..................° [2]

---

**3** **(a)** $p^x = \dfrac{p^3}{p \times \sqrt{p}}$

Find the value of $x$.

*Answer* $x =$ .................................................. [1]

**(b)** Simplify $\left(\dfrac{m}{25}\right)^{-\frac{1}{2}}$.

*Answer* .................................................. [1]

---

**4** Write as a single fraction in its simplest form $\dfrac{3}{x-5}-\dfrac{2}{7x-1}$.



*Answer* .................................................. [2]

---

**5** **(a)** The cube root of $n$ is $2^6 \times 5^3$.

Find $n$ as a product of its prime factors.

*Answer* $n =$ .................................................. [1]

**(b)** A roll of wire $A$ is 156 cm long.
A roll of wire $B$ is 390 cm long.
Both rolls of wire $A$ and $B$ are cut into pieces of equal length.

Find the maximum possible length of each piece of wire.

*Answer* ..................................................cm [1]

6 A two-digit number, $x$, where $10 \le x \le 99$, is written down at random.

Find the probability that the number is

**(a)** a multiple of 10,

*Answer* .................................... [1]

**(b)** a perfect square.



*Answer* .................................... [1]

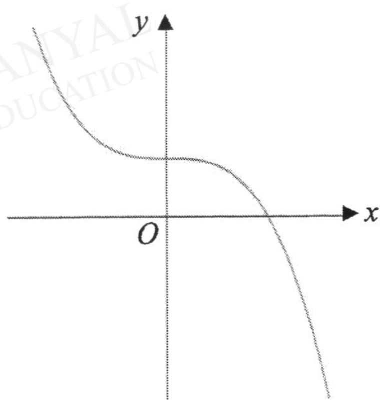
7

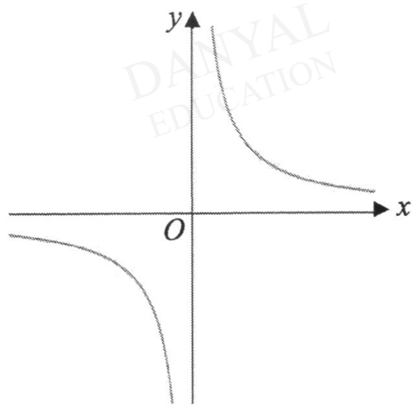
| | | |
|---|---|---|
| $y = x^3 + 2$ | $y = x^3 - 2x^2 - x + 2$ | $y = 2 - x^3$ |
| $y = \dfrac{2}{x}$ | $y = -\dfrac{2}{x}$ | $y = 2^x$ |

Write down a possible equation for each of the given sketch graphs.

In each case, select one of the equations from the given table.

*Answer*




.................................... ....................................

[2]

**8** $y$ is inversely proportional to $x^3$.
When $x$ has a certain value, $y = 5$.

Find the value of $y$ when $x$ is doubled.

*Answer* $y =$ ......................................... [2]

---

**9** On a particular day, the lowest temperature recorded was –5 °C.
The difference between the highest and lowest temperature recorded that day was 6 °C.

**(a)** Find the highest temperature on that day.

*Answer* ......................................... °C [1]

**(b)** The lowest temperature was recorded at 0400.
The highest temperature was recorded at 1200.
The temperature is assumed to increase at a constant rate between 0400 and 1200 that day.

Find the time when the temperature was –1.5 °C.

*Answer* ......................................... [2]

**10** Solve the simultaneous equations

$3x - 4y = -16,$

$5x + 6y = 5.$



*Answer* $x =$ ......................................

$y =$ ...................................... [3]

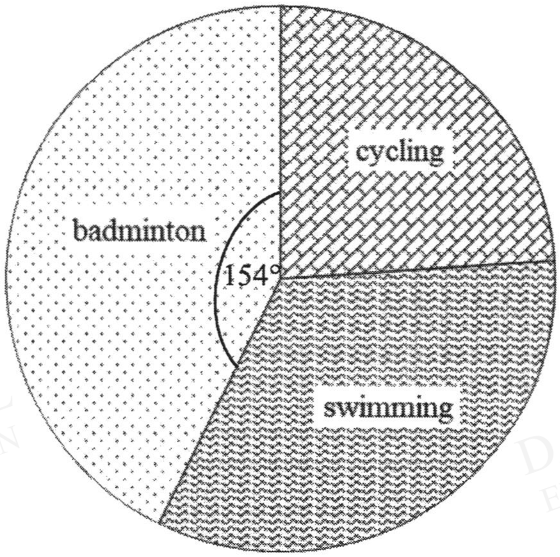
**11** **(a)** Solve the inequalities $-8 \leq 7 - 3x < 10$.

*Answer* .......................................... [2]

**(b)** Write down the smallest integer which satisfy $-8 \leq 7 - 3x < 10$.

*Answer* .......................................... [1]

**12** The pie chart represents the amount of time that Alicia spent on cycling, swimming and playing badminton in a particular week.




The total amount of time that she spent on the three sports that week was 15 hours. The angle representing the amount of time that she spent on playing badminton was 154°.

**(a)** That week, Alicia spent 5 hours swimming.

Calculate the angle of the sector representing the amount of time spent on swimming.

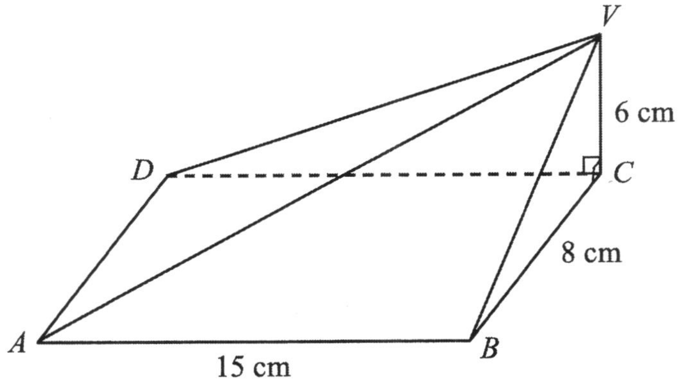
*Answer* ......................................° [1]

**(b)** On each of the seven days that week, Alicia spent the same amount of time playing badminton.

Calculate the amount of time, in minutes, she spent on playing badminton each day.

*Answer* ................................min [2]

**13**




*VABCD* is a rectangular pyramid with vertex *V* directly above *C* of the base *ABCD*.
$AB = 15$ cm, $BC = 8$ cm and $VC = 6$ cm.



Find

**(a)** the volume of the pyramid,



*Answer* ........................................cm³ [1]

**(b)** the length of *AC*,



*Answer* ........................................cm [1]

**(c)** angle *VAC*.

*Answer* ........................................° [1]

**14** Use the factorisation method to solve the equation $(3x - 1)(x + 1) = 4$.



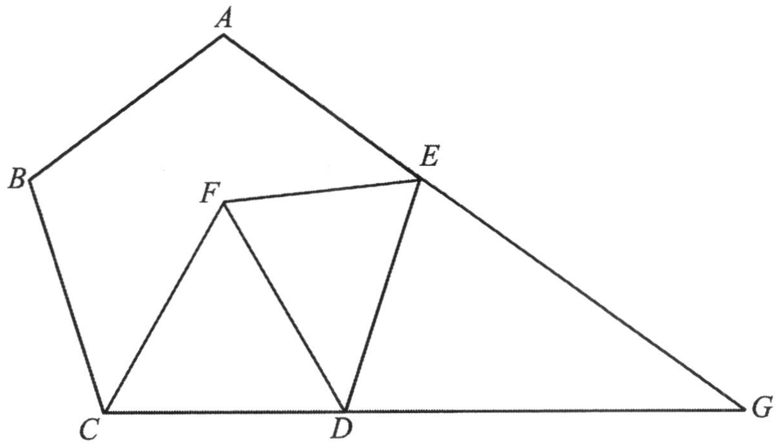
*Answer* $x =$ ................ or ................ [3]

**15** The price of an apartment at the end of 2010 was 7% higher than that at the end of 2009. The price of the same apartment at the end of 2011 was 5% higher than that at the end of 2010.

Calculate the price of the apartment at the end of 2011 as a percentage of the price at the end of 2009.

*Answer* ....................................% [3]

16




*ABCDE* is a regular pentagon.
Triangle *CDF* is an equilateral triangle.
*AEG* and *CDG* are straight lines.



Find

**(a)** angle *EDG*,

*Answer* ....................................° [1]

**(b)** angle *DGE*,

*Answer* ....................................° [1]

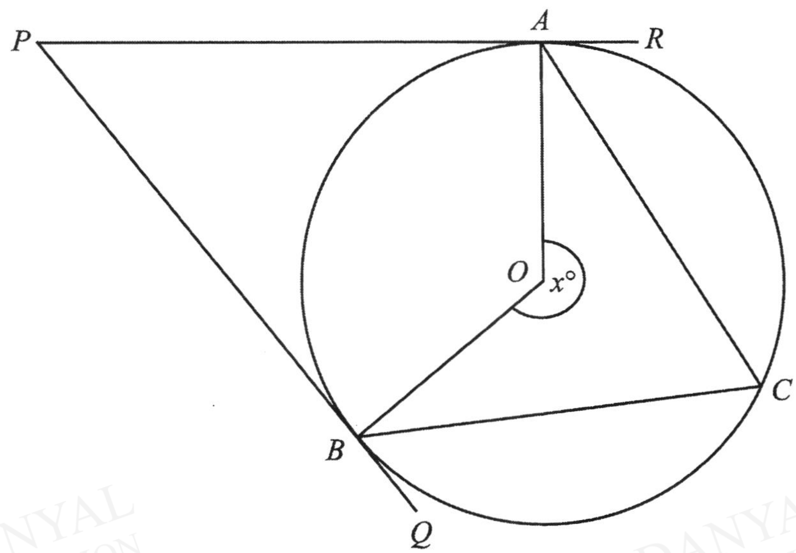
**(c)** angle *BCF*,

*Answer* ....................................° [1]

**(d)** angle *DFE*.

*Answer* ....................................° [1]

17




$A$, $B$ and $C$ are points on a circle with centre $O$.
$PAR$ and $PBQ$ are tangents to the circle at $A$ and $B$ respectively.
Reflex angle $AOB = x°$.

**(a)** Find, in terms of $x$, giving reasons for each answer,

**(i)** angle $ACB$,

*Answer* ..................................° [2]

**(ii)** angle $APB$.

*Answer* ..................................° [1]

**(b)** Given that the size of angle $ACB$ is 1.5 times the size of angle $APB$, find the value of $x$.

*Answer* $x =$ .................................. [1]

**18** A survey was carried out to find out the amount of time that each student spent on social media each day. The results are shown in the table.

| Number of hours | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Number of students | 1 | $x$ | 6 | 11 | 4 |

**(a)** Joe said, "The mode is 4 hours if $x$ has a value equal to or bigger than 0 and less than 11."

State whether you agree with Joe. Explain your answer.

____________________________________________

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____________________________________________ [1]

**(b)** Adeline said, "If the median is 3 hours, the largest possible value of $x$ is 20."

State whether you agree with Adeline. Explain your answer.

____________________________________________

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____________________________________________

____________________________________________ [1]

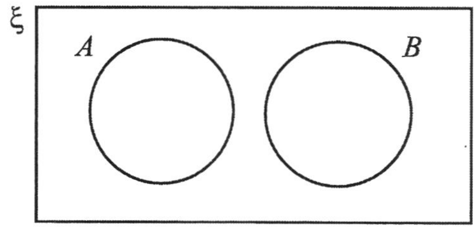
**(c)** The mean number of hours each student spent on social media is 3.3.

Find the value of $x$.

*Answer* $x$ = ........................................ [2]

**19** **(a)** $\xi = \{a, b, c, d, e, f\}$
$A = \{b, d\}$ and $f \notin B$

The Venn diagram represents $\xi$, $A$ and $B$.




**(i)** Find $A \cap B$.



*Answer* $A \cap B$ =........................................ [1]

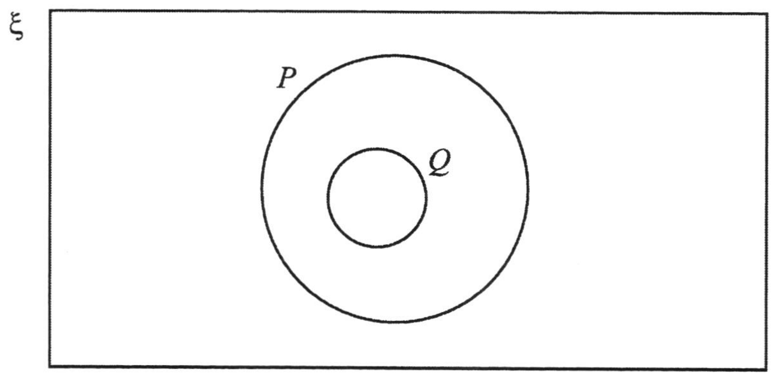
**(ii)** List all the proper subsets of $A$.

*Answer* ........................................................................................ [1]

**(iii)** $B$ contains the largest possible number of elements, list the elements in $B$.

*Answer* ........................................................................... [1]

**(b)** On the Venn diagram, shade the region which represents $P' \cup Q$. [1]



**20** Factorise completely

**(a)** $m^2 - 2m + 1 - n^2$,

*Answer* ………………..…...………………… [2]

**(b)** $3ax + bx - 6ay - 2by$.

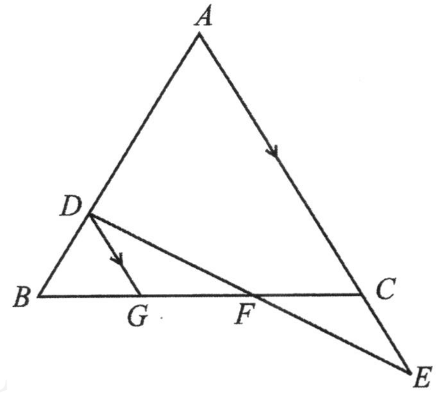
*Answer* ………………..…...………………… [2]

**21** Mrs Huang bought some chicken floss buns and hotdog buns for an outing.
The ratio of the number of chicken floss buns to the number of hotdog buns bought was 11 : 7.
At the end of the outing, the number of each type of buns left was 4.
The ratio of the number of chicken floss buns to the number of hotdog buns consumed was 8 : 5.

Calculate the total number of buns that Mrs Huang bought.

*Answer* .................................................. [4]

**22** The diagram shows an isosceles triangle $ABC$ with $AB = AC$.
Points $G$ and $E$ lie on $BC$ and $AC$ produced such that $DG = CE$.
The lines $DE$ and $BC$ intersect at point $F$. $DG$ is parallel to $AE$.






**(a)** Prove that triangle $DGF$ is congruent to triangle $ECF$.

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______________________________________________ [2]

**(b)** Show that $BD = CE$.

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______________________________________________ [2]

**23** Aldrick and Bryan are two salespersons for a fitness programme.
The new subscriptions that they obtained in May and June for packages $F$, $G$ and $H$ are shown in the table.

| | May | | June | |
|---|---|---|---|---|
| | Aldrick | Bryan | Aldrick | Bryan |
| Package $F$ | 18 | 15 | 20 | 21 |
| Package $G$ | 32 | 37 | 30 | 34 |
| Package $H$ | 11 | 14 | 16 | 15 |

The information is represented by the matrices **A** and **B**.

$$\mathbf{A} = \begin{pmatrix} 18 & 15 \\ 32 & 37 \\ 11 & 14 \end{pmatrix} \text{ and } \mathbf{B} = \begin{pmatrix} 20 & 21 \\ 30 & 34 \\ 16 & 15 \end{pmatrix}$$

**(a)** **(i)** Find **B** – **A**.

*Answer* ........................................ [1]

**(ii)** Describe what the elements in **B** – **A** represent.

______________________________________________

______________________________________________

______________________________________________ [1]

**(b)** The sales commissions for packages $F$, $G$ and $H$ are \$30, \$45 and \$60 respectively.

**(i)** Represent the information in a $1 \times 3$ matrix **C**.

*Answer* ........................................ [1]

**(ii)** Find **CA**.

*Answer* ........................................ [1]

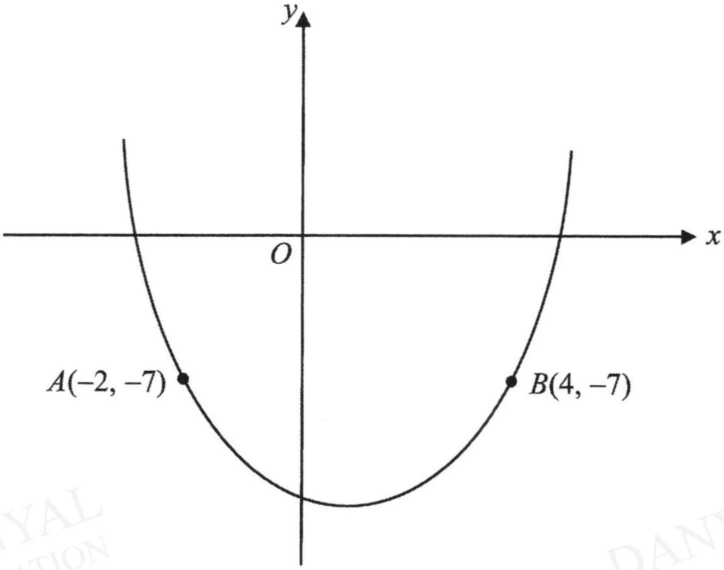
23 **(iii)** Describe what the elements in **CA** represent.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________ [1]

**24**




The figure shows the graph of $y = (x - p)^2 + q$.
Points $A$ (−2, −7) and $B$ (4, −7) lie on the curve.

**(a)** Find the values of $p$ and $q$.

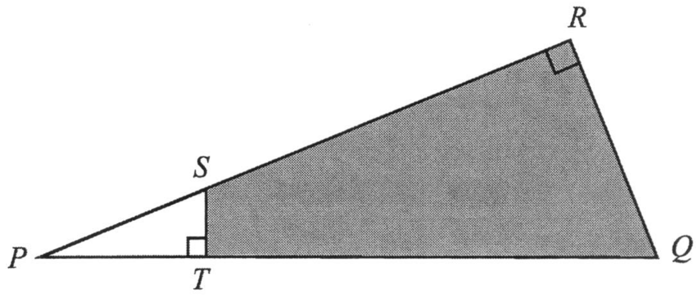
*Answer* $p$ = ....................................

$q$ = .................................... [3]

**(b)** **Hence** find the coordinates of the $x$-intercepts of the curve.

*Answer* (..........., ...........) or (..........., ...........) [2]

**25**




*PQR* is a right-angled triangle.
*ST* is perpendicular to *PQ*.
$PR = 12$ cm, $QR = 5$ cm, $PT = 3$ cm and angle $PRQ = 90°$.

**(a)** Show that triangle *PQR* is similar to triangle *PST*.

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______________________________________________ [2]



**(b)** The area of triangle *PST* is 1.875 cm$^2$.

Find the area of quadrilateral *SRQT*.

*Answer* …………………………………… cm$^2$ [3]

**End of Paper**

| Name: | Register Number: | Class: |
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**BEDOK GREEN SECONDARY SCHOOL**

**Preliminary Examination 2020**

4E
5N

**MATHEMATICS** **4048/02**

Paper 2 **31 August 2020**

**2 hours 30 minutes**

Candidates answer on the Question Paper.

**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.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.
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 $\pi$, use either your calculator value or 3.142, unless the question requires the answer in terms of $\pi$.

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** |
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| 100 |

This document consists of **25** printed pages including the cover page.



[Turn over

## *Mathematical Formulae*

*Compound interest*

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

*Mensuration*

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

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

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

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

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

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

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

*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 **(a)** The cash price of a camera is \$1 880.
Amelia bought the camera on hire purchase. She paid a deposit of one fourth of the cash price and paid the rest by 24 equal monthly instalments of \$65.

**(i)** Find the total amount that Amelia paid for the camera.

*Answer* \$.................................... [1]

**(ii)** Calculate the extra cost of buying the camera on hire purchase as a percentage of the cash price.



*Answer* ....................................% [1]

**(b)** Alyssa bought an identical camera.
In order for her to pay for the camera, she borrowed a sum of \$1 880 for 3 years at a compound interest rate of 4% per year.

Calculate the interest that Alyssa had to pay.

*Answer* \$.................................... [2]

**(c)** On selling a camera at \$1 880, the merchant made a profit of 113% of the cost which he paid for the camera.

Find the cost price of the camera.

*Answer* \$.................................... [2]

**2** **(a)** Microspheres are small spherical particles which transport drugs in the human body. The surface area of one microsphere is $1.54 \times 10^{-10}$ m$^2$.

Find the radius of the microsphere.
Give your answer in standard form.

*Answer* ……………………………m [1]

**(b)** Simplify $\frac{20m^4}{3n} \div \frac{12m}{5n^2}$.

*Answer* ……………………………… [1]

**(c)** $y = \frac{1}{2p}\sqrt{q-r}$

**(i)** Evaluate $y$ when $p = \frac{1}{2}$, $q = 12$ and $r = -4$.

*Answer* $y =$ ……………………………… [1]

**(ii)** Express $r$ in terms of $p$, $q$ and $y$.

*Answer* $r =$ ……………………………… [2]

**2** **(d)** A cylindrical water dispenser, with uniform cross section, has a capacity of 30 litres.

**(i)** Water from Tap $A$ fills the empty dispenser at a constant rate of $x$ litres per second.

Write down, in terms of $x$, the time taken by Tap $A$ to fill up the empty water dispenser.

*Answer* ........................................s [1]

**(ii)** Water from Tap $B$ fills the same dispenser at a constant rate of $(x + 2)$ litres per second.

Write down, in terms of $x$, the time taken by Tap $B$ to fill up the empty water dispenser.

*Answer* ........................................s [1]

**(iii)** Tap $B$ takes 25 seconds less than Tap $A$ to fill up the empty dispenser.

Write down an equation in $x$ and show that it can be simplified to $5x^2 + 10x - 12 = 0$.

*Answer*

[2]

**2** **(d)** **(iv)** Solve the equation $5x^2 + 10x - 12 = 0$.

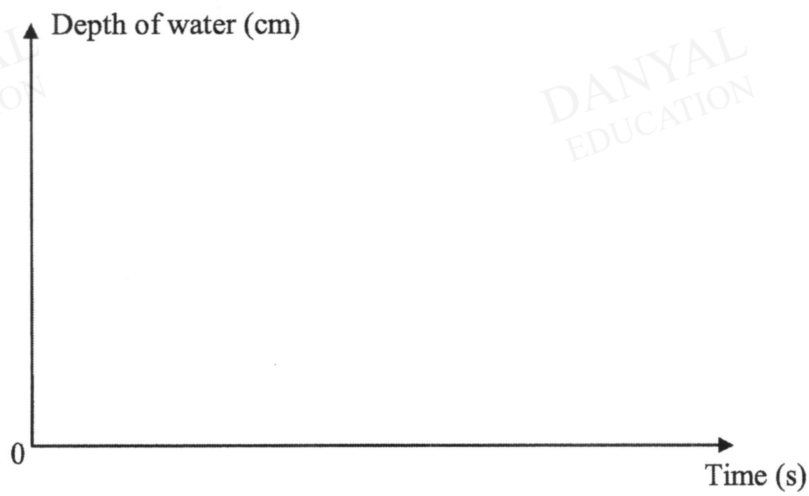
*Answer* $x =$ ………………or ……………… [3]

**(v)** **Hence** find the amount of time taken by Tap $A$ to fill up the water dispenser.

*Answer* ……………………………………s [1]

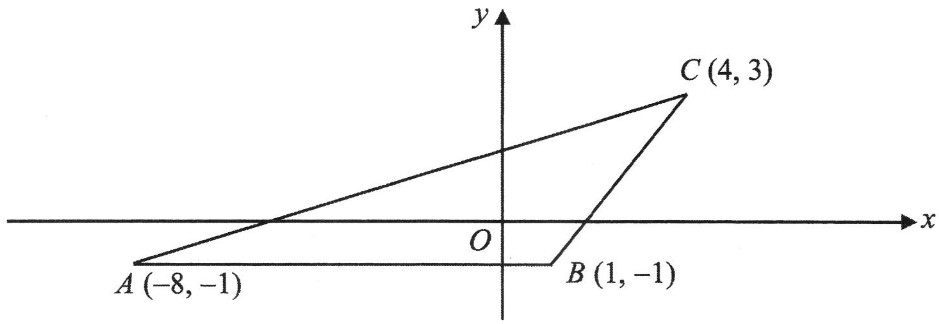
**(vi)** The cylindrical water dispenser has a height of 40 cm.

Sketch a graph showing how the depth of water varies with time as the empty water dispenser is filled up with water from Tap $A$.




[1]

**3** Points $A$ (−8, −1), $B$ (1, −1) and $C$( 4, 3) form a triangle as shown in the diagram.




**(a)** Given that the points $A$, $B$, $C$ and $D$ are vertices of a parallelogram, find the coordinates of all three possible positions of $D$.

*Answer* (………, ………), (………, ………) or (………, ………) [3]

**(b)** Find the length of $BC$.

*Answer* ……………………………units [1]

**(c)** Find, as a fraction in its simplest form, the value of $\cos A\hat{B}C$.

*Answer* …………………………………… [1]

**(d)** Calculate the area of triangle $ABC$.

*Answer* ……………………………$\text{unit}^2$ [1]

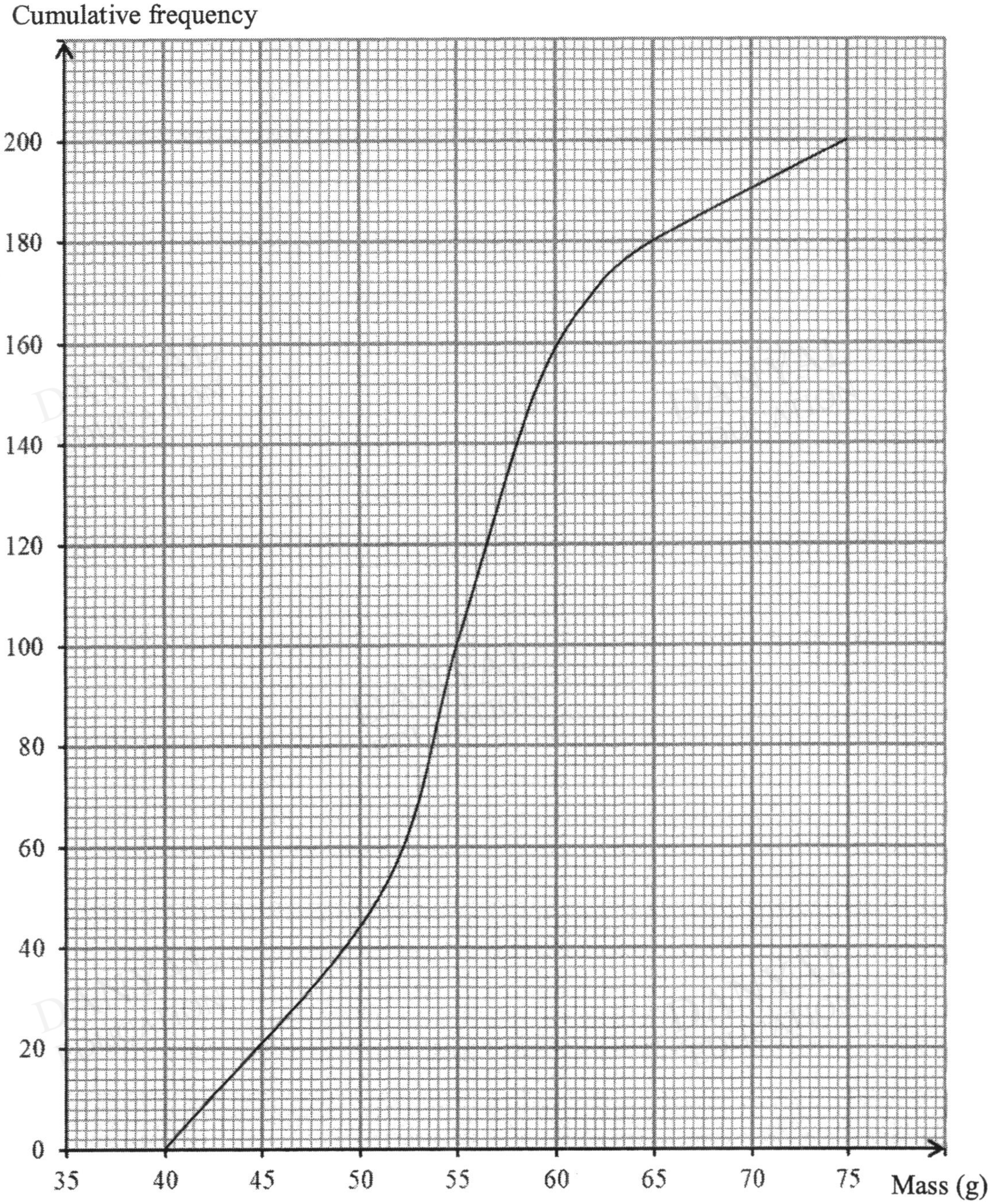
**(e)** Point $E$ $(m, n)$ lies on $AC$ such that $AE : AC = 1 : 4$.

Find the values of $m$ and $n$.

*Answer* $m$ = ………………………………

$n$ = ……………………………… [2]

4 **(a)** The cumulative frequency graph represents the masses of 200 eggs from Sunny Farm.




The eggs are grouped according to their masses.

Grade 1 : $62 \text{ g} < \text{mass} \leq 75 \text{ g}$
Grade 2 : $51 \text{ g} < \text{mass} \leq 62 \text{ g}$
Grade 3 : $40 \text{ g} < \text{mass} \leq 51 \text{ g}$

**4** **(a)** Use the graph to find

**(i)** the median mass,

*Answer* ....................................g [1]

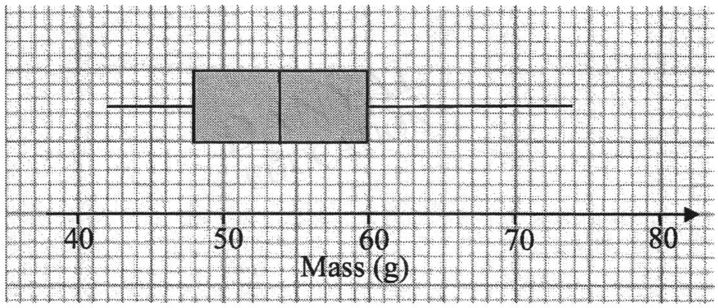
**(ii)** the percentage of eggs which are in Grade 2 category,

*Answer* ....................................% [2]

**(iii)** the interquartile range.

*Answer* ....................................g [1]

**(b)** The box and whisker plot shows the masses of 200 eggs from Happy Farm.




Fiego made two comparisons between the masses of eggs from Happy Farm and Sunny Farm.

State whether you agree with Fiego's statements.
Provide statistical evidence to support your answer.

**(i)** Statement 1: Generally, eggs from Sunny Farm have more consistent masses than eggs from Happy Farm.

___

___

___

___ [1]

**4** **(b)** **(ii)** Statement 2: Happy Farm has a higher percentage of eggs in Grade 1 category than Sunny Farm.

______________________________________________

______________________________________________

______________________________________________

______________________________________________ [1]

**(c)** Thirty employees in Happy Farm work in either Administrative Department or Farming and Outdoors Department.

The table shows the breakdown of males and females employees in the departments.

| | Administrative | Farming and Outdoors |
|---|---|---|
| Males | 1 | 20 |
| Females | 3 | 6 |

**(i)** Two employees are selected randomly from the 30 employees to be the Chairperson and Deputy Chairperson of the Staff Well-being Committee.

Find, as a fraction in its simplest form, the probability that

**(a)** both of them are from the Administrative Department,

*Answer* .................................... [1]

**(b)** at least one of them is from the Administrative Department,

*Answer* .................................... [2]

**(c)** one of them is a male employee from Farming and Outdoors Department and the other person is a female employee from Farming and Outdoors Department.

*Answer* .................................... [2]

**5** **(a)** Complete Row 5 of the number pattern.

| Row | Number series | Number of terms | Sum of terms | Pattern |
|---|---|---|---|---|
| 1 | 1 | 1 | 1 | $2^1 - 1$ |
| 2 | $1 + 2$ | 2 | 3 | $2^2 - 1$ |
| 3 | $1 + 2 + 4$ | 3 | 7 | $2^3 - 1$ |
| 4 | $1 + 2 + 4 + 8$ | 4 | 15 | $2^4 - 1$ |
| 5 | | | | |

[1]

**(b)** Find the sum of $2^0 + 2^1 + 2^2 + 2^3 + \ldots + 2^{10}$.

*Answer* ........................................ [1]

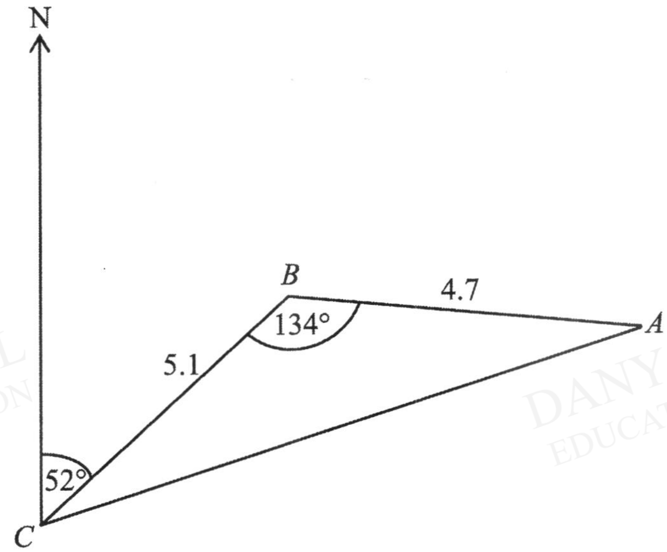
**(c)** **(i)** Find, in terms of $n$, the value of $2^0 + 2^1 + 2^2 + 2^3 + \ldots + 2^n$.

*Answer* ........................................ [1]

**(ii)** **Hence** find the sum of $1 + 3 + 7 + \ldots + (2^{200} - 1)$.
Leave your answer in the form $2^k + h$ where $k$ and $h$ are integers, $1 \leq k \leq 500$ and $-500 \leq h \leq 500$.

*Answer* ........................................ [2]

**6** $A$, $B$, and $C$ are three points on level ground.
The bearing of $B$ from $C$ is 052°.
Angle $ABC = 134°$, $BC = 5.1$ km and $AB = 4.7$ km.






**(a)** Calculate the distance between $A$ and $C$.

*Answer* ………………………………km [3]

**(b)** Find the bearing of $A$ from $B$.

*Answer* ………………………………° [2]

**6** **(c)** A building of height 70 m stands vertically at $B$.
Damien walks along $AC$ and stops at a point $D$ where the angle of elevation of the top of the building from $D$ is the greatest.

Find the angle of elevation of the top of the building from $D$.

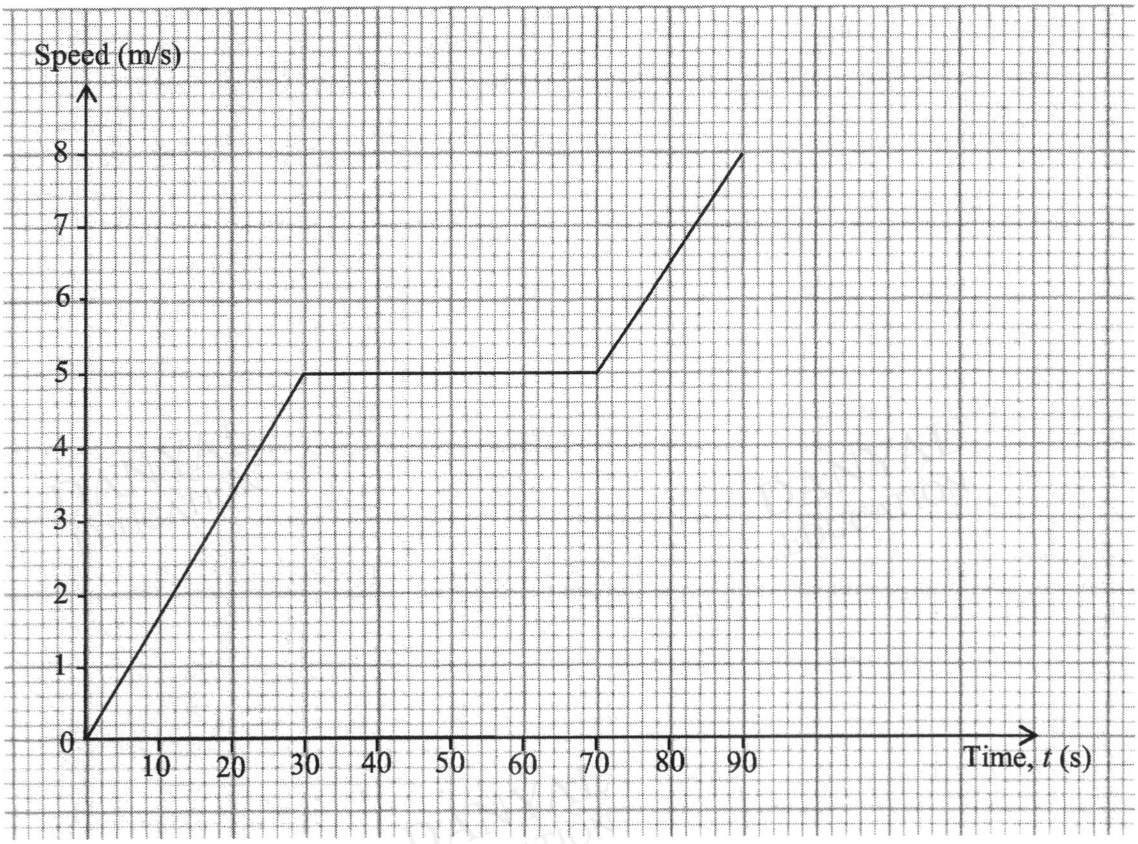
*Answer* ……………………………………° [4]

**(d)** Sufi stands at a point due North of $C$ such that he is equidistant from both points $B$ and $C$.

Find the distance from point $C$ to Sufi.

*Answer* ……………………………………km [3]

7 The graph shows part of the speed-time graph of Selina's cycling journey.




**(a)** Describe the cycling journey between $t = 30$ and $t = 70$.

______________________________________________________________

______________________________________________________________ [1]

**(b)** Find the acceleration for the first 30 seconds of Selina's journey.

*Answer* ....................................m/$s^2$ [1]

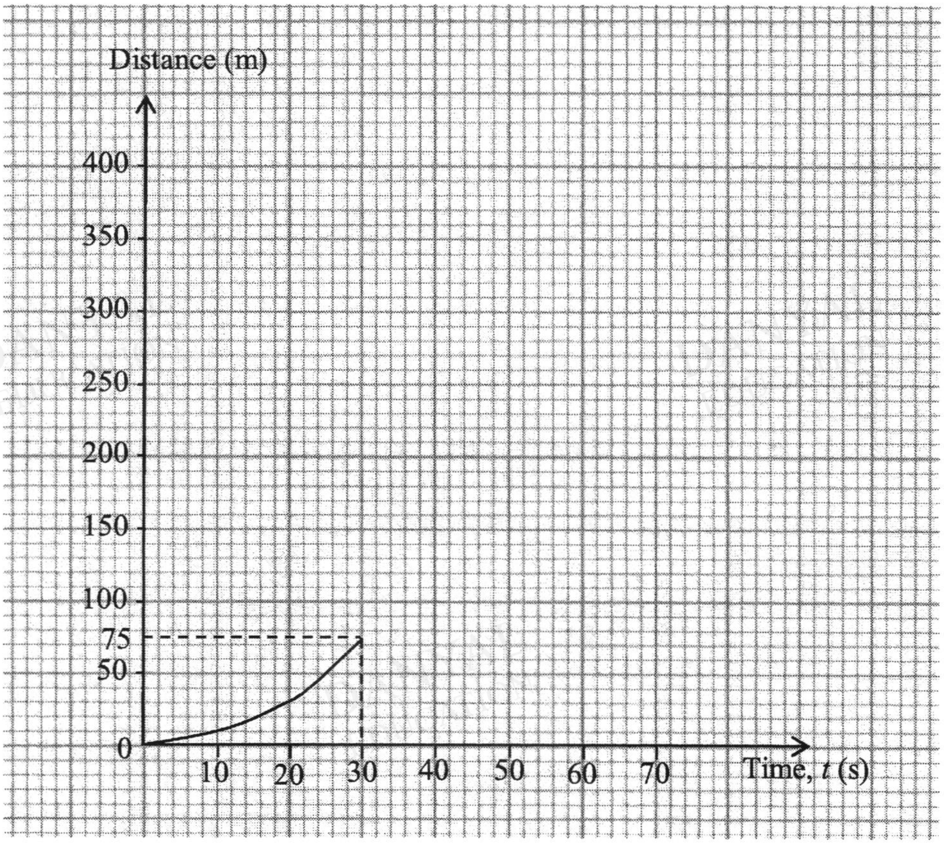
**(c)** After 90 seconds, Selina slowed to a stop with constant deceleration.
She travelled a further 192 m before stopping at $t = p$.

Find the value of $p$.

*Answer* $p =$ .................................... [3]

7 **(d)** The distance-time graph shows the graph for the first 30 seconds of Selina's cycling journey.

Draw the graph from $t = 30$ to $t = 70$ of the journey.
Indicate clearly on the graph the distance travelled in the first 70 seconds.




[2]

**8** A closed cylindrical can of base radius $r$ cm and height $h$ cm has a capacity of $250\pi$ cm$^3$.

**(a)** Express $h$ in terms of $r$.

*Answer* $h =$ .................................. [1]

**(b)** Show that the total external surface area, $A$ cm$^2$, of the cylindrical can is given by $A = 2\pi r^2 + \dfrac{500\pi}{r}$.

*Answer*

[1]

**(c)** The table shows some of the values of $r$ and the corresponding values of $A$, correct to the nearest integer, where $A = 2\pi r^2 + \dfrac{500\pi}{r}$.

| $r$ | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| $A$ | $p$ | 580 | 493 | 471 | 488 | 532 |

**(i)** Find the value of $p$.

*Answer* $p =$ .................................. [1]

**(ii)** On the axes given on the next page, draw the graph of $A = 2\pi r^2 + \dfrac{500\pi}{r}$ for $2 \le r \le 7$. [3]

**(d)** By drawing a tangent, find the gradient of the curve at $r = 6$.

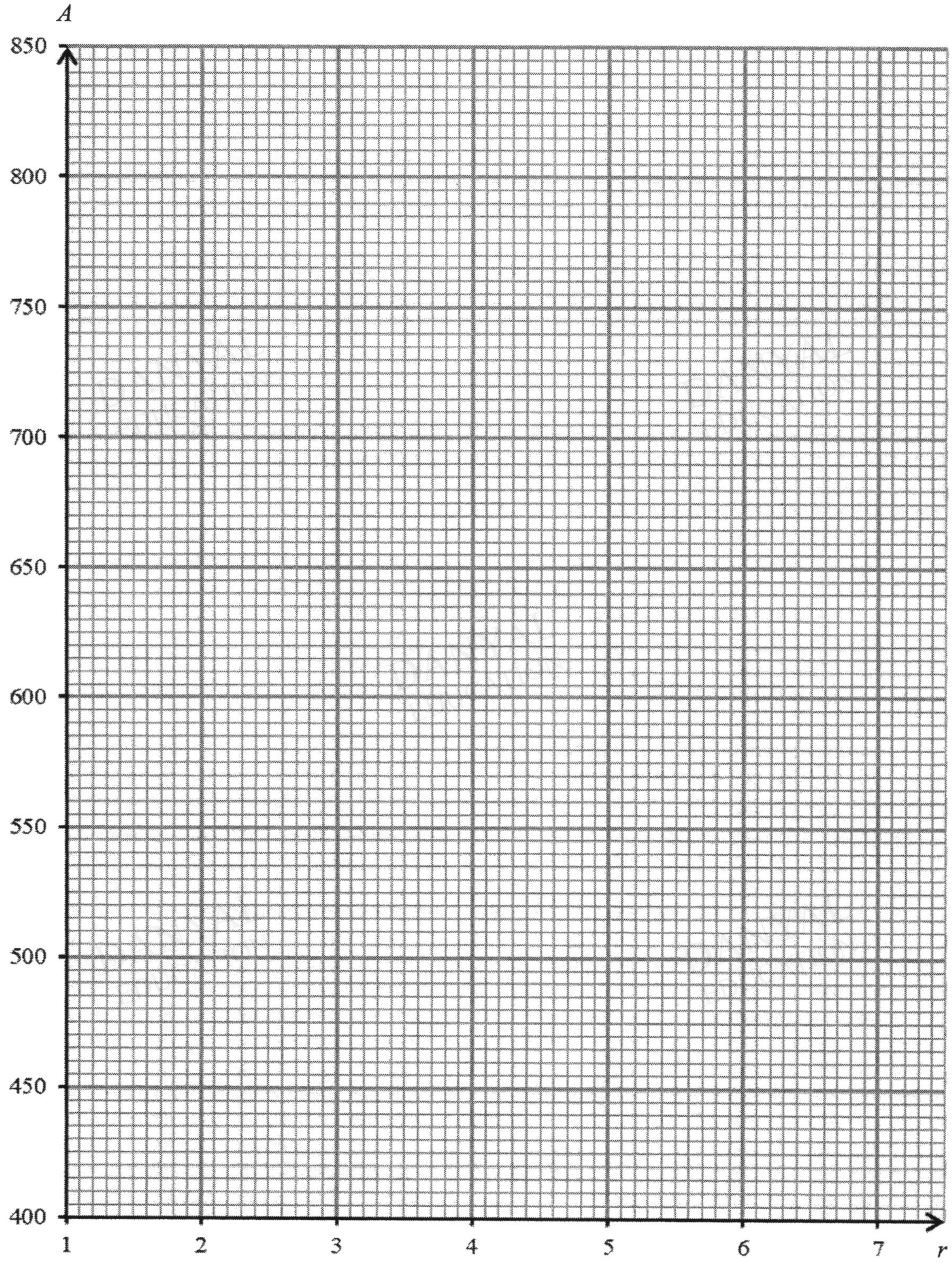
*Answer* .................................. [2]

**(e)** Given that the can has the least surface area, find the value of $r$ and the value of $h$.

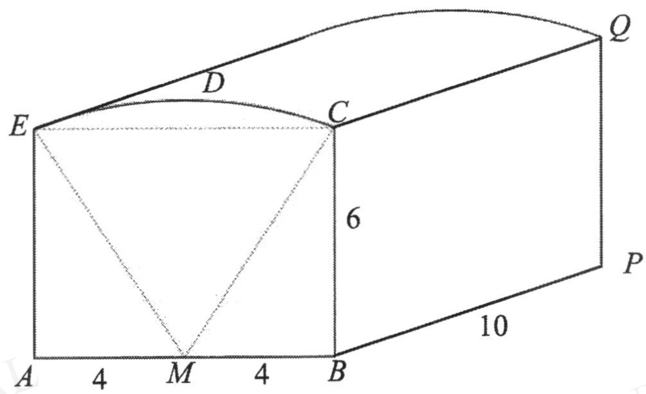
*Answer* $r =$ ..................................

$h =$ .................................. [2]

**8 (c) (ii)**



**9** **(a)** $ABCDE$ is a uniform cross section of a warehouse model.
$ABCE$ is a rectangle. $EDC$ is an arc of a circle with centre $M$. $M$ lies on $AB$.
$AM = MB = 4$ cm, $BC = 6$ cm and $BP = 10$ cm.




**(i)** Find angle $CME$.

*Answer* ....................................° [2]

**(ii)** Calculate the area of the cross section $ABCDE$.

*Answer* ....................................$cm^2$ [4]

**(iii)** A second geometrically similar warehouse model has a height which is half the height of the original warehouse model.

Find the volume of the second warehouse model.

*Answer* ....................................$cm^3$ [2]

**9** **(b)** The diagram shows a broken piece of a round plate.

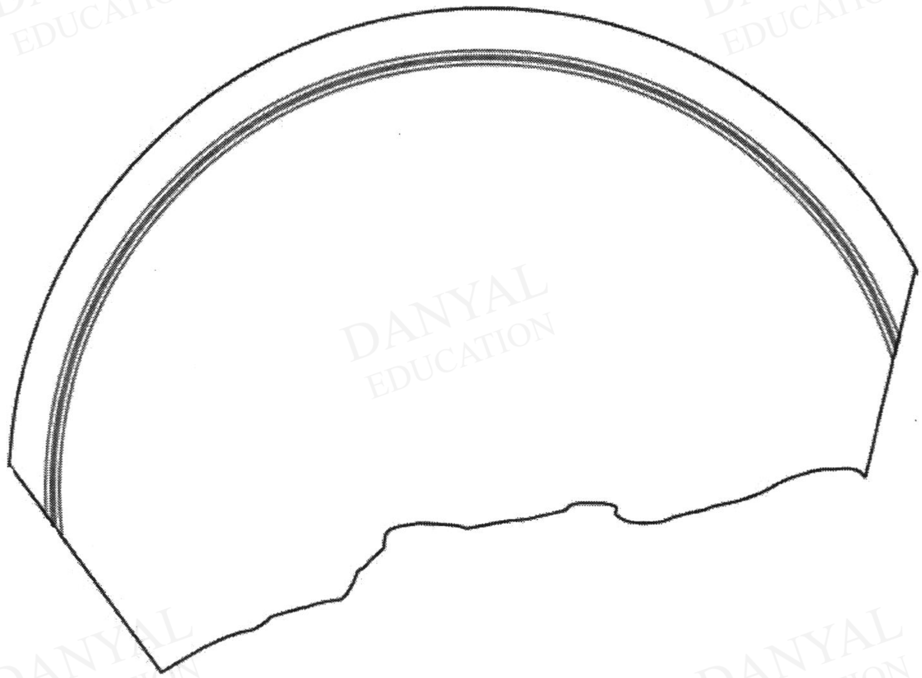
**(i)** State the property of circles you use in finding the centre of the plate.

*Answer* (i) ______________________________________________

______________________________________________ [1]

**(ii)** Find, by constructing perpendicular bisectors, the centre of the plate.
Label the centre of the plate $C$.

*Answer* (ii)



[2]

**10** $A$ is the point $(5, -8)$ and $B$ is the point $(-10, 4)$.

**(a)** Find the equation of the line $AB$.

*Answer* .......................................... [2]

**(b)** The equation of the line $l$ is $4x + 5y = 10$.

**(i)** Explain whether the line $l$ intersects the line $AB$.

*Answer*

[2]

**(ii)** Explain whether the point $C$ $(10, -10)$ lies on the line $l$.

*Answer*

[2]

**10** **(b)** **(iii)** Line $l$ intersects the curve $y = \frac{x^3}{5} - x^2 - 2$ at point $D$.

The $x$-ccordinate of point $D$ is a real solution of the equation $x^3 + px^2 + qx - 20 = 0$ where $p$ and $q$ are constants.

Find the values of $p$ and $q$.





*Answer* $p$ = ....................................

$q$ = .................................... [2]

**11** **(a)** Mr Tan has a medical condition which requires him to be on long-term prescribed medication.

On a particular day, he took a 200 mg dose of the prescribed drug at 8 o'clock in the morning. His body gradually broke down the drug so that one hour after taking the drug, only 80% of the drug would remain active.

This pattern continues: at the end of each hour, only 80% of the drug that was present at the end of the previous hour remains active.

To combat Mr Tan's illness effectively, the amount of the drug in the body should not fall below 30 mg.

There should not be more than 300 mg of the drug in the body, beyond which the drug becomes toxic.

The table shows the amount, $x$ mg, of the drug present in Mr Tan's body $t$ hours after taking the drug.

| $t$ (hours) | 0 | 2 | 4 | 6 | 10 |
|---|---|---|---|---|---|
| $x$ (mg) | 200 | 128 | 82 | 53 | 22 |

**(i)** Estimate the amount of the drug in Mr Tan's body 8 hours after he has taken it.

*Answer* ………………………………… mg [1]

**(ii)** Explain why the recommended dosage for the drug is 3 times a day. Show your calculations clearly.

[2]

**11** **(b)** In Singapore, Ministry of Health provides subsidies for drugs at public specialist outpatient clinics (SOCs) and polyclinics to support Singapore citizens with healthcare costs.

The table below shows the per-capita household income (PCHI) criteria for subsidies at public SOCs and polyclinics.
(Source: https://www.moh.gov.sg/docs/librariesprovider5/default-document-library/annex-a---revision-to-pchi-criteria99abfc1511b54b6f87ddadb91140922f2.pdf)

<table>
<tr><th rowspan="2">Monthly PCHI* to qualify for subsidy (Singapore Citizens)</th><th colspan="3">Subsidy tier** (Singapore Citizens)</th></tr>
<tr><th>Subsidised SOC services</th><th>Subsidised SOC drugs</th><th>Subsidised polyclinic drugs for adults</th></tr>
<tr><td>PCHI ≤ $1 200</td><td>70%</td><td rowspan="2">75%</td><td rowspan="2">75%</td></tr>
<tr><td>$1 200 < PCHI ≤ $2 000</td><td>60%</td></tr>
<tr><td>PCHI > $2 000</td><td>50%</td><td>50%</td><td>50%</td></tr>
</table>

*Monthly PCHI is computed as the total gross household monthly income divided by the total number of family members living in the household.
** Subsidy tier shows the subsidy rate the Singapore Citizen is entitled to

Mr Tan, his wife and two children are Singapore Citizens. They live together in a 4-room HDB flat.

| Member | Age | Gross Monthly Salary |
|---|---|---|
| Mr Tan | 34 | $3 500 |
| Mrs Tan | 32 | $2 000 |
| First Child | 5 | Nil |
| Second Child | 3 | Nil |

Mr Tan's medication costs $1.90 per dose. Every 6 months, he receives outpatient services at a public SOC. Each visit at the public SOC costs $245.

Mr Tan decides to apply for both polyclinic drug subsidies and public SOCs service and drug subsidies.

Find, after Mr Tan is granted the subsidies, the amount he will save on the cost of drugs and outpatient treatment each year as a percentage of his annual gross salary.

**11** **(b)** *Answer space*

[5]

**End of Paper**

Answer **all** the questions.

1 $x$ is a number which has 4 significant figures.
$x = 7$ (nearest integer),
$x = 7.5$ (1 decimal place)
$x = 7.49$ (2 decimal places)

Find

**(a)** the smallest possible value of the number,

*Answer* ……………………………………7.485 [1]

**(b)** the greatest possible value of the number.

*Answer* ……………………………………7.494 [1]

2 Given that $\sin\theta = 0.875$, find the values of $\theta$ where $0° \leq \theta \leq 180°$.

*Answer* $\theta =$ ……61.0° or ……119.0° [2]

3 **(a)** $p^x = \dfrac{p^3}{p \times \sqrt{p}}$

Find the value of $x$.

*Answer* $x =$ ……………1.5 or $1\frac{1}{2}$ or $\frac{3}{2}$ [1]

**(b)** Simplify $\left(\dfrac{m}{25}\right)^{-\frac{1}{2}}$.

*Answer* ………$5m^{-\frac{1}{2}}$ (or $\dfrac{5}{m^{\frac{1}{2}}}$ or $\dfrac{5}{\sqrt{m}}$) [1]

**4** Write as a single fraction in its simplest form $\dfrac{3}{x-5}-\dfrac{2}{7x-1}$.

$$\frac{3(7x-1)-2(x-5)}{(x-5)(7x-1)}$$

$$=\frac{19x+7}{(x-5)(7x-1)}$$



*Answer* .................................... $\dfrac{19x+7}{(x-5)(7x-1)}$ [2]

---

**5** **(a)** The cube root of $n$ is $2^6 \times 5^3$.

Find $n$ as a product of its prime factors.

*Answer* $n =$ .......$2^{18} \times 5^9$. [1]

**(b)** A roll of wire $A$ is 156 cm long.
A roll of wire $B$ is 390 cm long.
Both rolls of wire $A$ and $B$ are cut into pieces of equal length.

Find the maximum possible length of each piece of wire.

<u>Method (1)</u>
$156 = 39 \times 2 \times 2$
$390 = 39 \times 2 \times 5$

<u>Method (2)</u>
$$\frac{156}{390}=\frac{2}{5}$$

$156 \div 2 = 78$
$390 \div 5 = 78$

*Answer* ....................................78 cm [1]

**6** A two-digit number, $x$, where $10 \leq x \leq 99$, is written down at random.

Find the probability that the number is

**(a)** a multiple of 10,

$$\frac{9}{90}$$

*Answer* .................................... $\frac{1}{10}$ [1]

**(b)** a perfect square.

$$\frac{6}{90}$$

*Answer* .................................... $\frac{1}{15}$ [1]

---

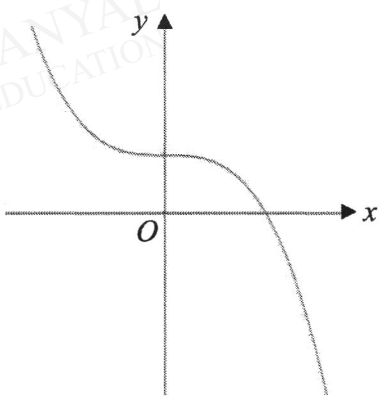
**7**

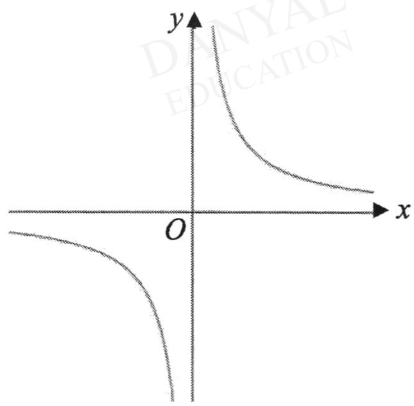
| | | |
|---|---|---|
| $y = x^3 + 2$ | $y = x^3 - 2x^2 - x + 2$ | $y = 2 - x^3$ |
| $y = \frac{2}{x}$ | $y = -\frac{2}{x}$ | $y = 2^x$ |

Write down a possible equation for each of the given sketch graphs.

In each case, select one of the equations from the given table.

*Answer*




$y = 2 - x^3$

$y = \frac{2}{x}$

[2]

**8** $y$ is inversely proportional to $x^3$.
When $x$ has a certain value, $y = 5$.

Find the value of $y$ when $x$ is doubled.

Method (1)

$$\frac{y}{5} = \frac{kx^3}{k(2x)^3}$$

Method (2)

$5 = \frac{k}{x_1^3}$ where $k$ is a constant

$k = 5x_1^3$

$$\text{new } y = \frac{5x_1^3}{(2x_1)^3}$$

*Answer* $y =$ .................................... $\frac{5}{8}$ [2]

---

**9** On a particular day, the lowest temperature recorded was –5 °C.
The difference between the highest and lowest temperature recorded that day was 6 °C.

**(a)** Find the highest temperature on that day.

*Answer* ....................................1 °C [1]

**(b)** The lowest temperature was recorded at 0400.
The highest temperature was recorded at 1200.
The temperature is assumed to increase at a constant rate between 0400 and 1200 that day.

Find the time when the temperature was –1.5 °C.

Method (1)

Change of 6 °C in 8 h

Change of 3.5 °C in

$$\frac{3.5}{6} \times 8$$

$$= 4\frac{2}{3}\text{ h}$$

Method (2)

gradient (or rate of change of temperature)

$$= \frac{1-(-1.5)}{12-4} = \frac{3}{4}$$

$$\frac{1-(-1.5)}{12-t} = \frac{3}{4} \Rightarrow t = 8\frac{2}{3}$$

*Answer* ....................................0840 [2]

**10** Solve the simultaneous equations

$3x - 4y = -16,$
$5x + 6y = 5.$



*Answer* $x =$ ..............................–2

$y =$ ..............................2.5 [3]

---

**11** **(a)** Solve the inequalities $-8 \leq 7 - 3x < 10$.

$-8 \leq 7 - 3x$ and $7 - 3x < 10$

$x \leq 5$ and $x > -1$

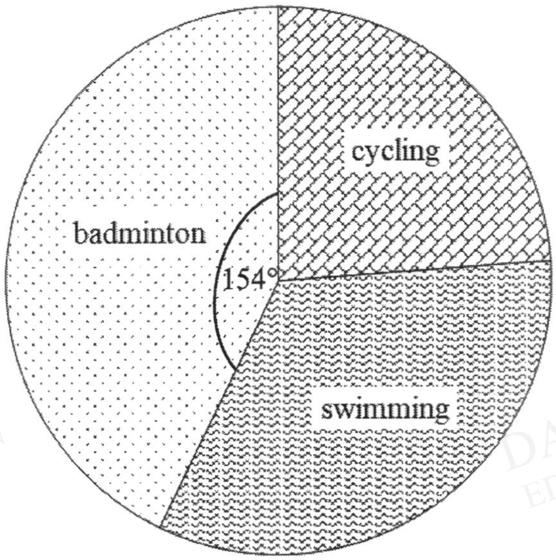
$-1 < x \leq 5$

*Answer* .............................................. [2]

**(b)** Write down the smallest integer which satisfy $-8 \leq 7 - 3x < 10$.

*Answer* ..............................0 [1]

**12** The pie chart represents the amount of time that Alicia spent on cycling, swimming and playing badminton in a particular week.




The total amount of time that she spent on the three sports that week was 15 hours. The angle representing the amount of time that she spent on playing badminton was 154°.

**(a)** That week, Alicia spent 5 h swimming.

Calculate the angle of the sector representing the amount of time spent on swimming.

*Answer* ....................................120° [1]

**(b)** On each of the seven days that week, Alicia spent the same amount of time playing badminton.

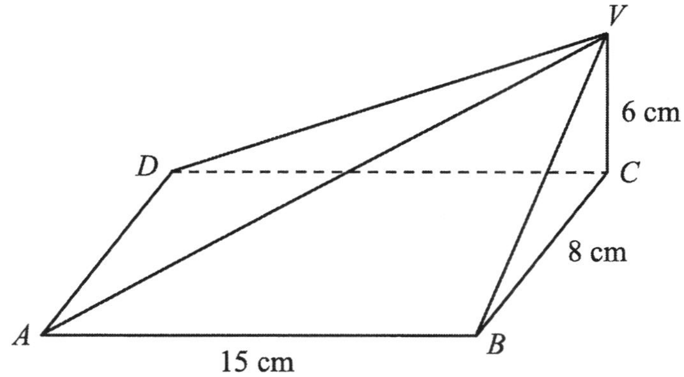
Calculate the amount of time, in minutes, she spent on playing badminton each day.

$$\frac{154}{360} \times 15 \div 7 \times 60$$

$$= 55$$

*Answer* ....................................min [2]

**13**




*VABCD* is a rectangular pyramid with vertex *V* directly above *C* of the base *ABCD*.
$AB = 15$ cm, $BC = 8$ cm and $VC = 6$ cm.



Find

**(a)** the volume of the pyramid,

$\frac{1}{3}\times 15\times 8\times 6$



*Answer* ....................................240 cm$^3$ [1]

**(b)** the length of *AC*,

$15^2 + 8^2$



*Answer* .................................... 17 cm [1]

**(c)** angle *VAC*.

tan angle $VAC = \frac{6}{17}$

*Answer* ....................................19.4° [1]

**14** Use the factorisation method to solve the equation $(3x-1)(x+1)=4$.

$3x^2+2x-5=0$

$(3x+5)(x-1)=0$

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

*Answer* $x=$ ................ or ................ [3]

---

**15** The price of an apartment at the end of 2010 was 7% higher than that at the end of 2009. The price of the same apartment at the end of 2011 was 5% higher than that at the end of 2010.

Calculate the price of the apartment at the end of 2011 as a percentage of the price at the end of 2009.

Let $x$ be price of apartment at the end of 2009.

Price at the end of 2010 $=\frac{107}{100}x$

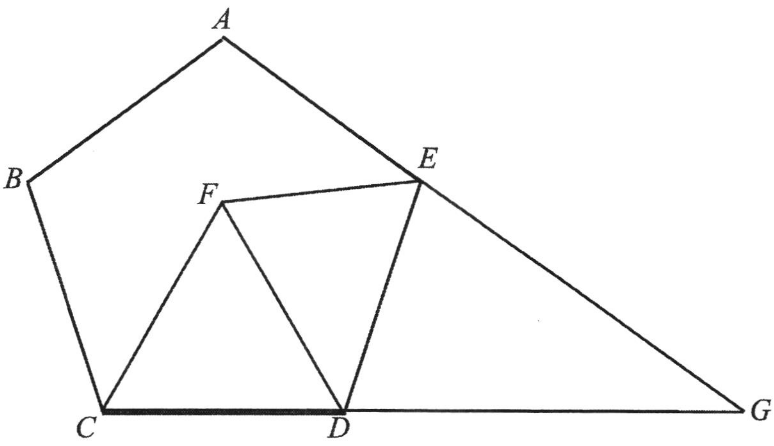
Price at the end of 2011 $=\frac{105}{100}\times\frac{107}{100}x$

$$\frac{\frac{105}{100}\times\frac{107}{100}x}{x}\times 100\,\%$$

$=112\frac{7}{20}$ or 112.35

*Answer* .................................... % [3]

**16**




*ABCDE* is a regular pentagon.
Triangle *CDF* is an equilateral triangle.
*AEG* and *CDG* are straight lines.

Find

**(a)** angle *EDG*,

$$\frac{360}{5}$$

*Answer* ....................................72° [1]

**(b)** angle *DGE*,

180 – 72 – 72

*Answer* ....................................36° [1]

**(c)** angle *BCF*,

180 – 72 – 60

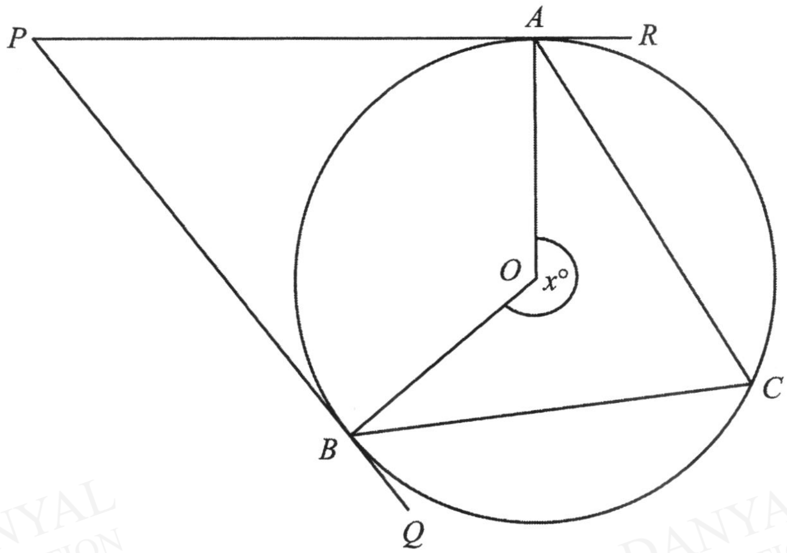
*Answer* ....................................48° [1]

**(d)** angle *DFE*.

(180 – 48) ÷ 2

*Answer* ....................................66° [1]

**17**




$A$, $B$ and $C$ are points on circle with centre $O$.
$PAR$ and $PBQ$ are tangents to the circle at $A$ and $B$ respectively.
Reflex angle $AOB = x°$.

**(a)** Find, in terms of $x$, giving reasons for each answer,

**(i)** angle $ACB$,

Angle $AOB$ $= 360° - x°$ (angles at a point)

Angle $ACB$ $= \dfrac{360° - x°}{2}$ (angle at centre = twice angle at circumference)
(or $180° - 0.5x°$)

*Answer* ........................................° [2]

**(ii)** angle $APB$.

Angle $PAO$ = angle $PBO = 90°$ (tangent $\perp$ radius)

Angle $APB$ $= 360° - 90° - 90° - (360° - x°)$ (angle sum of quadrilateral)
$= (x - 180)°$

*Answer* ........................................° [1]

**(b)** Given that the size of angle $ACB$ is 1.5 times the size of angle $APB$, find the value of $x$.

$180° - 0.5x° = 1.5(x° - 180°)$

$2x° = 450°$

$x = 225$

*Answer* $x =$ ........................................ [1]

**18** A survey was carried out to find out the amount of time that each student spent on social media each day. The results are shown in the table.

| Number of hours | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Number of students | 1 | $x$ | 6 | 11 | 4 |

**(a)** Joe said, "The mode is 4 hours if $x$ has a value equal to or bigger than 0 and less than 11."

State whether you agree with Joe. Explain your answer.

Agree with Joe.
**Mode has the highest frequency** or **mode is the most common** number of hours spent on social media so the value of $x$ should not exceed the number of students with 4 hours. [1]

**(b)** Adeline said, "If the median is 3 hours, the largest possible value of $x$ is 20."

State whether you agree with Adeline. Explain your answer.

Disagree with Adeline
<u>Possible reasons</u>

- When $x$ is 20, the median should be **2.5 h**.
- If the median is 3, the largest possible value of $x$ should be **19**.
- When $x$ is 20, the **middle value is not 3 hour. The middle value is** between 2 hour and 3 hour.
- If the median is 3, $x$ is largest when the **middle value** is the **number of hours** spent by the **$(x + 2)^{th}$ student**. This means that the largest possible value of $x$ should be less than 20.

[1]

**(c)** The mean number of hours each student spent on social media is 3.3.

Find the value of $x$.

$$\frac{1+2x+18+44+20}{1+x+6+11+4}=3.3$$

$$\frac{2x+83}{x+22}=3.3$$

$$2x + 83 = 3.3x + 72.6$$

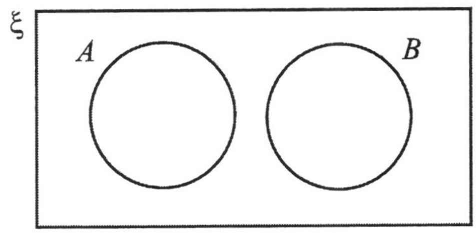
$$1.3x = 10.4$$

$$x = 8$$

*Answer* $x =$ ………………………………… [2]

**19** **(a)** $\xi = \{a, b, c, d, e, f\}$
$A = \{b, d\}$ and $f \notin B$

The Venn diagram represents $\xi$, $A$ and $B$.




**(i)** Find $A \cap B$.



*Answer* ........................................$\varnothing$ [1]

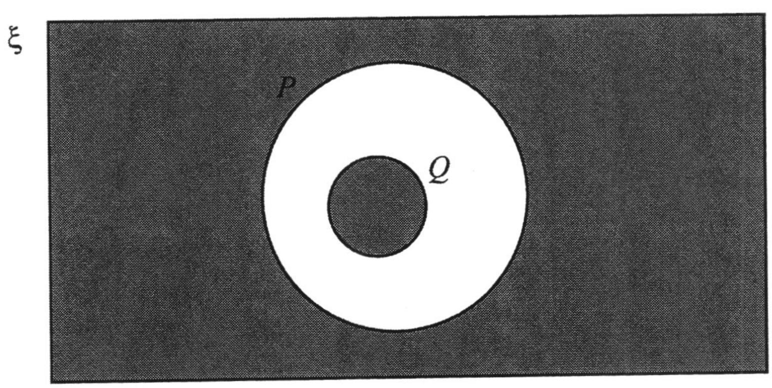
**(ii)** List all the proper subsets of $A$.

*Answer* ...........................$\{b\}$, $\{d\}$, $\varnothing$ [1]

**(iii)** $B$ contains the largest possible number of elements, list the elements in $B$.

*Answer* ...................................$\{a, c, e\}$ [1]

**(b)** On the Venn diagram, shade the region which represents $P' \cup Q$. [1]



**20** Factorise completely

**(a)** $m^2 - 2m + 1 - n^2$,

$(m - 1)^2 - n^2$

$= (m - 1 + n)(m - 1 - n)$

*Answer* ........................................ [2]

**(b)** $3ax + bx - 6ay - 2by$.

$x(3a + b) - 2y(3a + b)$

$= (3a + b)(x - 2y)$

*Answer* ........................................ [2]

**21** Mrs Huang bought some chicken floss buns and hotdog buns for an outing.
The ratio of the number of chicken floss buns to the number of hotdog buns bought was 11 : 7.
At the end of the outing, the number of each type of buns left was 4.
The ratio of the number of chicken floss buns to the number of hotdog buns consumed was 8 : 5.

Calculate the total number of buns that Mrs Huang bought.

Let $x$ be the total number of buns Mrs Huang bought

| | chicken floss buns | hotdog buns |
|---|---|---|
| Initial number of buns | $\frac{11}{18}x$ | $\frac{7}{18}x$ |
| Number of buns consumed () | $\frac{11}{18}x-4$ | $\frac{7}{18}x-4$ |
| Number of buns consumed (2) | $\frac{8}{13}(x-8)$ | $\frac{5}{13}(x-8)$ |

<u>Method (1)</u>

$$\frac{\frac{11}{18}x-4}{\frac{7}{18}x-4}=\frac{8}{5}$$

$$5(\frac{11}{18}x-4)=8(\frac{7}{18}x-4)$$

$$x=216$$

<u>Method (2)</u>

$$\frac{8}{13}(x-8)=\frac{11}{18}x\ -4$$

$$x=216$$

or $\frac{5}{13}(x-8)=\frac{7}{18}x-4$

$$x=216$$

**21** Method (3)

Let $x$ be the number of chicken floss buns bought
Let $y$ be the number of hotdog buns bought

$$\frac{x}{y}=\frac{11}{7} \text{ and } \frac{x-4}{y-4}=\frac{8}{5}$$

$$\frac{x}{y}=\frac{11}{7} \Rightarrow x=\frac{11}{7}y$$

$$\frac{x-4}{y-4}=\frac{8}{5} \Rightarrow 5x-8y=-12$$

$x = 132$ and $y = 84$

Total number of buns bought = 132 + 84 = 216

Method (4)

Let $11u$ be the number of chicken floss buns bought
Let $7u$ be the number of hotdog buns bought

Let $8w$ be the number of chicken floss buns consumed
Let $5w$ be the number of hotdog buns consumed

$11u - 8w = 4$
$7u - 5w = 4$

$u = 12$ (and $w = 16$)

Total number of buns bought
$= 11 \times 12 + 7 \times 12$
$= 216$

Method (5)

Let $8w$ be the number of chicken floss buns consumed
Let $5w$ be the number of hotdog buns consumed

Number of chicken floss buns bought = $8w + 4$
Number of hotdog buns bought = $5w + 4$

$$\frac{8w+4}{5w+4}=\frac{11}{7}$$

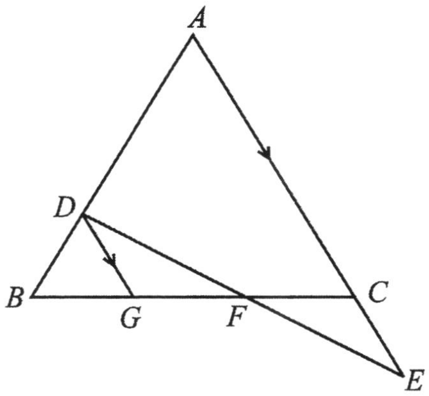
$56w + 28 = 55w + 44$

$w = 16$

Total number of buns bought = $8 \times 16 + 4 + 5 \times 16 + 4 = 216$

*Answer* ........................................ [4]

**22** The diagram shows an isosceles triangle $ABC$ with $AB = AC$.
Points $G$ and $E$ lie on $BC$ and $AC$ produced such that $DG = CE$.
The lines $DE$ and $BC$ intersect at point $F$. $DG$ is parallel to $AE$.




**(a)** Prove that triangle $DGF$ is congruent to triangle $ECF$.

**$DG = EC$ (given)**
**Angle $DFG$ = angle $EFC$ (vertically opposite angles)**
**Angle $GDF$ = angle $CEF$ (alternate angles)**

$\therefore$ Triangle $DGF$ is congruent to triangle $ECF$ (AAS)

[2]

**(b)** Show that $BD = CE$.

<u>Method (1)</u>
Angle $ABC$ = Angle $ACB$ ($AB = AC$ given)
Angle $DGB$ = Angle $ACB$ (corresponding angles)
$\therefore$ Angle $DGB$ = Angle $ABC$

$\Rightarrow DB = DG$
Since $DG = EC$ (given),
$\therefore BD = CE$

<u>Method (2)</u>
Angle $ABC$ = Angle $DBG$ (common)
Angle $BAC$ = Angle $BDG$ (corresponding angles)
$\therefore$ Triangle ABC is similar to Triangle $DGB$ (AA)
$\Rightarrow$ Triangle $DGB$ is also isosceles

$\Rightarrow DB = DG$
Since $DG = EC$ (given),
$\therefore BD = CE$

[2]

**23** Aldrick and Bryan are two salespersons for a fitness programme.
The new subscriptions that they obtained in May and June for packages $F$, $G$ and $H$ are shown in the table.

| | May | | June | |
|---|---|---|---|---|
| | Aldrick | Bryan | Aldrick | Bryan |
| Package $F$ | 18 | 15 | 20 | 21 |
| Package $G$ | 32 | 37 | 30 | 34 |
| Package $H$ | 11 | 14 | 16 | 15 |

The information is represented by the matrices **A** and **B**.

$$\mathbf{A} = \begin{pmatrix} 18 & 15 \\ 32 & 37 \\ 11 & 14 \end{pmatrix} \text{ and } \mathbf{B} = \begin{pmatrix} 20 & 21 \\ 30 & 34 \\ 16 & 15 \end{pmatrix}$$



**(a)** **(i)** Find **B** – **A**.

*Answer* ........................................ $\begin{pmatrix} 2 & 6 \\ -2 & -3 \\ 5 & 1 \end{pmatrix}$ [1]

**(ii)** Describe what the elements in **B** – **A** represent.

The **change** (or students could use "**increase or decrease**") in new subscriptions **between May and June** which **Aldrick and Bryan** obtained for **packages F, G and H respectively**.

______________________________ [1]

**(b)** The sales commissions for packages $F$, $G$ and $H$ are \$30, \$45 and \$60 respectively.

**(i)** Represent the information in a $1 \times 3$ matrix **C**.

*Answer* ........................................ $\begin{pmatrix} 30 & 45 & 60 \end{pmatrix}$ [1]

**(ii)** Find **CA**.

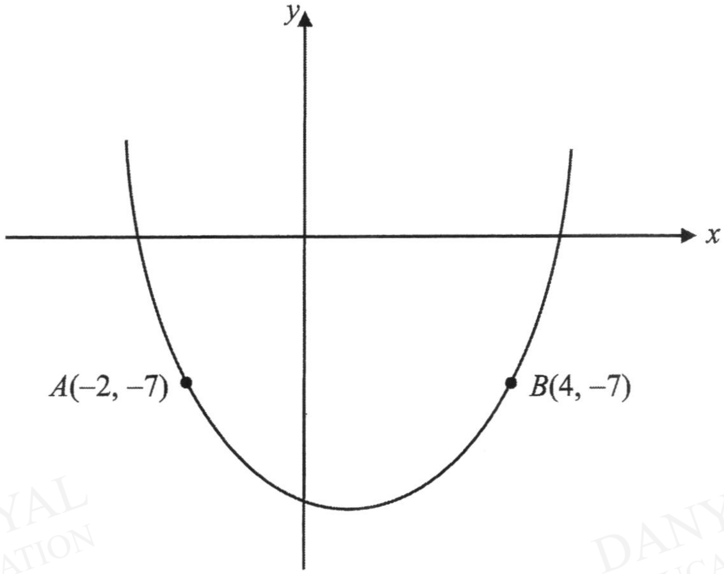
*Answer* ........................................ $\begin{pmatrix} 2640 & 2955 \end{pmatrix}$ [1]

**(iii)** Describe what the elements in **CA** represent.

The **total sales commissions Aldrick and Bryan received respectively** in **May**.

______________________________ [1]

**24**




The figure shows the graph of $y = (x - p)^2 + q$.
Points $A(-2, -7)$ and $B(4, -7)$ lie on the curve.

**(a)** Find the values of $p$ and $q$.

Method (1)
$p = (4 - 2) \div 2 = 1$
Substitute $(4, -7)$ into $y = (x - 1)^2 + q \Rightarrow q = -16$

Method (2)
$-7 = (4 - p)^2 + q$
$-7 = (-2 - p)^2 + q$

*Answer* $p =$ ....................................

$q =$ .................................... [3]

**(b)** **Hence** find the $x$-intercepts of the curve.

$(x - 1)^2 - 16 = 0$

Method (1)
$x - 1 = \pm 4$

Method (2)
$x^2 - 2x - 15 = 0$

$(x - 5)(x + 3) = 0$

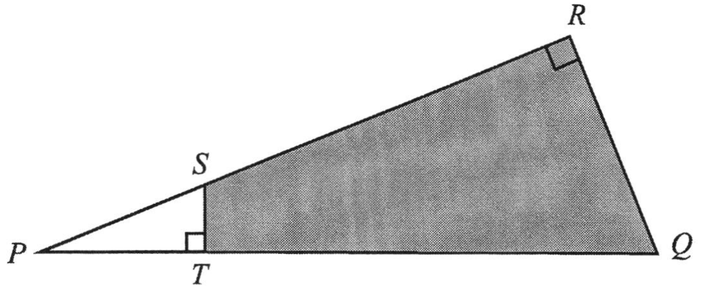
$x = 5$ or $-3$

Method (3)
$x^2 - 2x - 15 = 0$

$$x = \frac{-(-2) \pm \sqrt{(-2)^2 - 4 \times 1 \times (-15)}}{2}$$

*Answer* (5, 0) or (–3, 0) [2]

25




$PQR$ is a right-angled triangle.
$ST$ is perpendicular to $PQ$.
$PR = 12$ cm, $QR = 5$ cm, $PT = 3$ cm and angle $PRQ = 90°$.

**(a)** Show that triangle $PQR$ is similar to triangle $PST$.

**Angle *QPR* = angle *SPT* (common angle)**

Angle $PRQ = 90°$ (given)
Angle $PTS = 90°$ ($ST$ is perpendicular to $PQ$)
$\therefore$ **Angle *PRQ* = Angle *PTS***

Triangle $PQR$ is similar to Triangle $PST$ (AA)

[2]

**(b)** The area of triangle $PST$ is $1.875\ \text{cm}^2$.
Find the area of quadrilateral $SRQT$.

Method (1)

$$\frac{area of\ \Delta PQR}{area of\ \Delta PST} = \left(\frac{12}{3}\right)^2 = 16$$

Area of $SRQT = 15 \times 1.875$

$$= 28\frac{1}{8}\ \text{cm}^2 \text{ or } 28.125\ \text{cm}^2$$

Method (2)

$$\frac{ST}{5} = \frac{3}{12} \Rightarrow ST = 1\frac{1}{4}$$

Area of $SRQT = \frac{1}{2}\times 12\times 5 - \frac{1}{2}\times 3\times 1\frac{1}{4} = 28\frac{1}{8}\ \text{cm}^2$ or $28.125\ \text{cm}^2$

**25** **(b)** Method (3)

$$\frac{area of \Delta PQR}{area of \Delta PST} = (\frac{12}{3})^2 = 16$$

Area of $\Delta PQR = 16 \times 1.875 = 30$

Area of $SRQT = 30 - 1.875 = 28\frac{1}{8}$ cm$^2$ or 28.125 cm$^2$

Method (4)

Area of $\Delta PQR = 0.5 \times 12 \times 5 = 30$

Area of $SRQT = 30 - 1.875$

$= 28\frac{1}{8}$ cm$^2$ or 28.125 cm$^2$

*Answer* ……………..…...………………cm$^2$ [3]

1 **(a)** The cash price of a camera is \$1 880.
Amelia bought the camera on hire purchase.
She paid a deposit of one fourth of the cash price and paid the rest by 24 equal monthly instalments of \$65.

**(i)** Find the total amount that Amelia paid for the camera.

$1880 \div 4 + 24 \times 65$

*Answer* \$2030.................................... [1]

**(ii)** Calculate the extra cost of buying the camera on hire purchase as a percentage of the cash price.

$$\frac{2030-1880}{1880}\times 100$$

*Answer* .................................... $7\frac{46}{47}$ % [1]

**(b)** Alyssa bought an identical camera.
In order for her to pay for the camera, she borrowed a sum of \$1 880 for 3 years at a compound interest rate of 4% per year.

Calculate the interest that Alyssa had to pay.

$$1880(1+\frac{4}{100})^3 - 1880$$

*Answer* \$234.74.................................... [2]

**(c)** On selling a camera at \$1 880, the merchant made a profit of 113% of the cost which he paid for the camera.

Find the cost price of the camera.

$$\frac{1880}{213}\times 100$$

*Answer* \$882.63.................................... [2]

**2** **(a)** Microspheres are small spherical particles which transport drugs in the human body. The surface area of one microsphere is $1.54 \times 10^{-10}$ m$^2$.

Find the radius of the microsphere.
Give your answer in standard form.

$4\pi r^2 = 1.54 \times 10^{-10}$

*Answer* ....................................$3.50 \times 10^{-6}$ m [1]

**(b)** Simplify $\frac{20m^4}{3n} \div \frac{12m}{5n^2}$.



*Answer* .......................................... $\frac{25m^3n}{9}$ [1]

**(c)** $y = \frac{1}{2p}\sqrt{q-r}$

**(i)** Evaluate $y$ when $p = \frac{1}{2}$, $q = 12$ and $r = -4$.

*Answer* $y = 4$.................................... [1]

**(ii)** Express $r$ in terms of $p$, $q$ and $y$.

$2py = \sqrt{q-r}$

$(2py)^2 = q - r$

*Answer* $r = q - 4p^2y^2$.................................... [2]

**2** **(d)** A cylindrical water dispenser, with uniform cross section, has a capacity of 30 litres.

**(i)** Water from Tap *A* fills the empty dispenser at a constant rate of $x$ litres per second.

Write down, in terms of $x$, the time taken by Tap *A* to fill up the empty water dispenser.

*Answer* .......................................... $\frac{30}{x}$ s [1]

**(ii)** Water from Tap *B* fills the same dispenser at a constant rate of $(x + 2)$ litres per second.

Write down, in terms of $x$, the time taken by Tap *B* to fill up the empty water dispenser.

*Answer* .......................................... $\frac{30}{x+2}$ s [1]

**(iii)** Tap *B* takes 25 seconds less than Tap *A* to fill up the empty dispenser.

Write down an equation in $x$ and show that it can be simplified to $5x^2 + 10x - 12 = 0$.

*Answer*

$$\frac{30}{x} - \frac{30}{x+2} = 25$$

$$60 = 25x(x + 2)$$

$$5x^2 + 10x - 12 = 0$$

[2]

**2** **(d)** **(iv)** Solve the equation $5x^2 + 10x - 12 = 0$.

$$x = \frac{-10 \pm \sqrt{10^2 - 4 \times 5 \times (-12)}}{2 \times 5}$$

$x = 0.84391$ (5sf) or $-2.8439$ (5sf)

*Answer* $x = 0.844$ ……….…....or $-2.84$ ……….…..... [3]

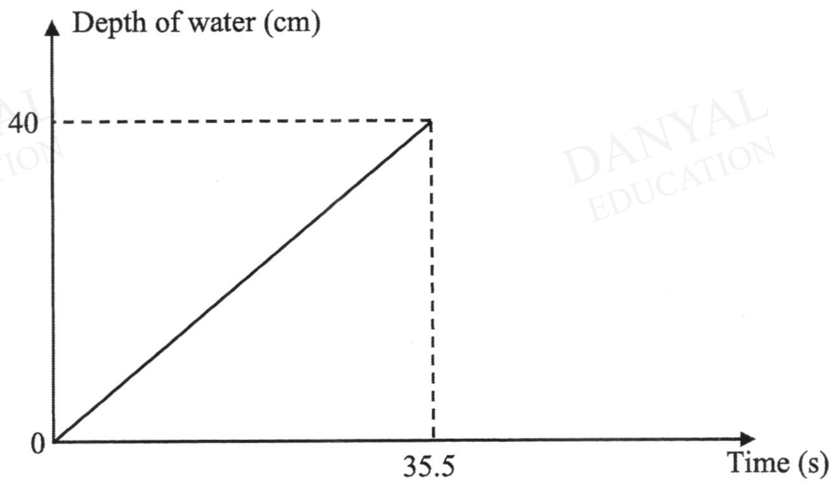
**(v)** **Hence** find the amount of time taken by Tap *A* to fill up the water dispenser.

$$\frac{30}{0.84391}$$

*Answer* ………………...……………35.5 s [1]

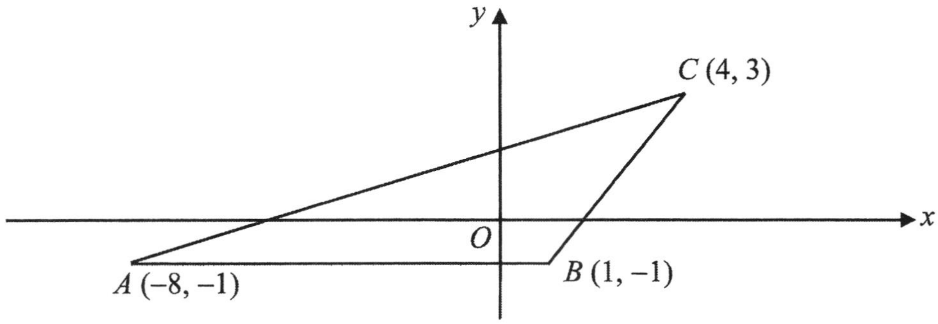
**(vi)** The cylindrical water dispenser has a height of 40 cm.

Sketch a graph showing how the depth of water varies with time as the empty water dispenser is filled up with water from Tap *A*.




[1]

**3** Points $A\,(-8, -1)$, $B\,(1, -1)$ and $C(4, 3)$ form a triangle as shown in the diagram.




**(a)** Given that the points $A$, $B$, $C$ and $D$ are vertices of a parallelogram, find the coordinates of all three possible positions of $D$.

*Answer* $(-5, 3)$, $(13, 3)$ or $(-11, -5)$ [3]

**(b)** Find the length of $BC$.

*Answer* ..............................5 units [1]

**(c)** Find, as a fraction in its simplest form, the value of $\cos A\hat{B}C$.

*Answer* ..................................... $-\frac{3}{5}$ [1]

**(d)** Calculate the area of triangle $ABC$.

*Answer* ..................................18 unit$^2$ [1]

**(e)** Point $E(m, n)$ lies on $AC$ such that $AE : AC = 1 : 4$.

Find the values of $m$ and $n$.

<u>Method (1)</u>

$F$, midpoint of $AC = (-2, 1)$

$\therefore$ midpoint of $AF$ is

$$\left(\frac{-2+(-8)}{2}, \frac{1+(-1)}{2}\right)$$

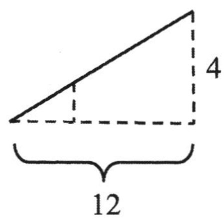
<u>Method (2)</u>

$x$-coordinate

$$= -8 + \frac{12}{4} = -5$$

$y$-coordinate

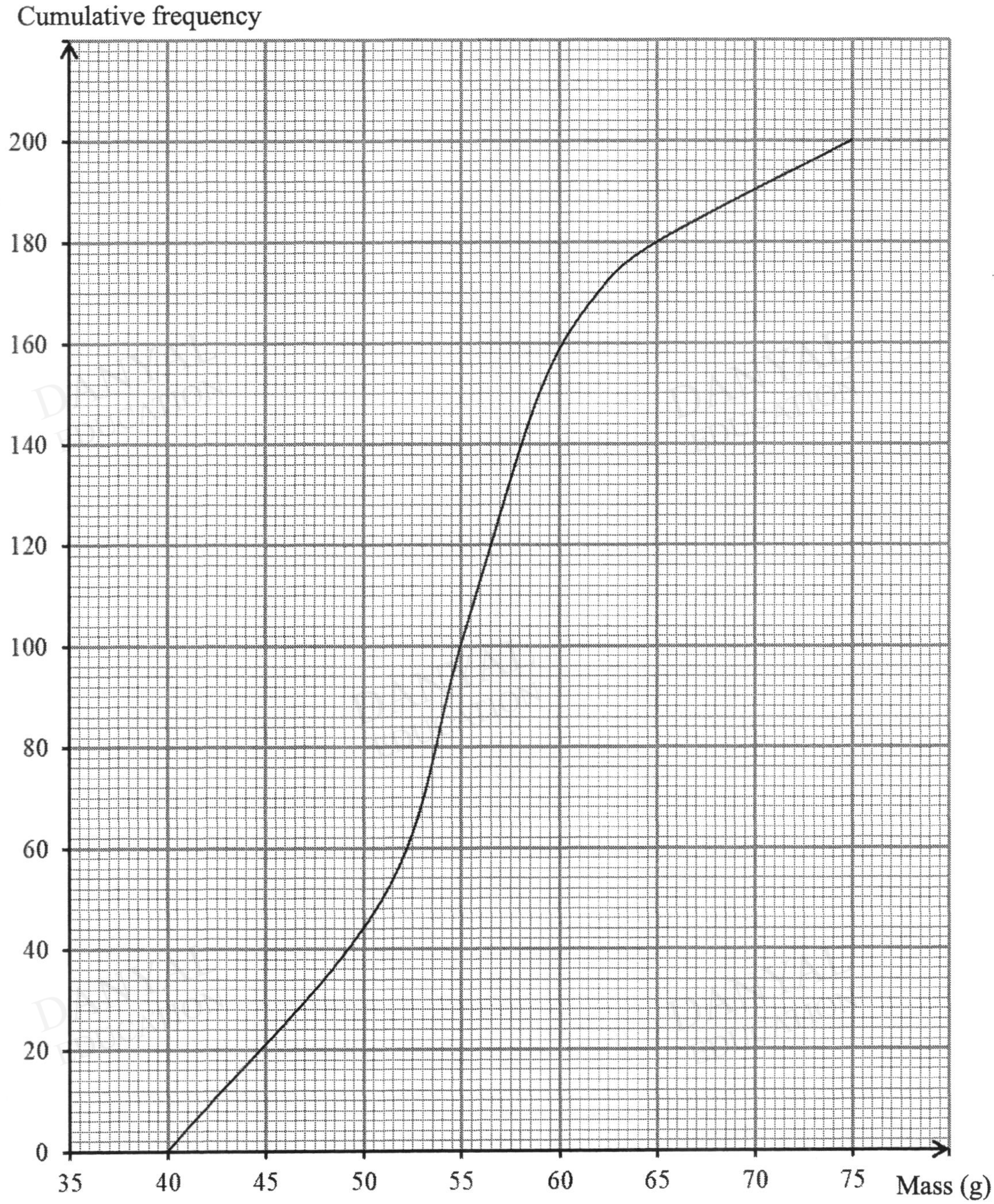
$$= -1 + \frac{4}{4} = 0$$




*Answer* $m = -5$ ..............................

$n = 0$ .............................. [2]

**4** **(a)** The cumulative frequency graph represents the masses of 200 eggs from Sunny Farm.




The eggs are grouped according to their masses.

Grade 1 : $62\text{ g} < \text{mass} \le 75\text{ g}$
Grade 2 : $51\text{ g} < \text{mass} \le 62\text{ g}$
Grade 3 : $40\text{ g} < \text{mass} \le 51\text{ g}$

4 (a) Use the graph to find

(i) the median mass,

*Answer* ……………..…....…………..….55 g [1]

(ii) the percentage of eggs which are in Grade 2 category,

170 – 50 = 120 eggs

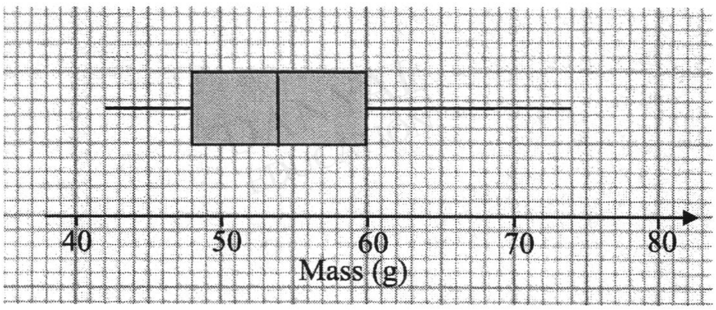
*Answer* ……………..…....…………..….60 % [2]

(iii) the interquartile range.

59 – 51

*Answer* ……………..…....…………..….8 g [B1]

(b) The box and whisker plot shows the masses of 200 eggs from Happy Farm.




Fiego made two comparisons between the masses of eggs from Happy Farm and Sunny Farm.

State whether you agree with Fiego's statements.
Provide statistical evidence to support your answer.

(i) Statement 1: Generally, eggs from Sunny Farm have more consistent masses than eggs from Happy Farm.

Agree. Sunny Farm has a lower **interquartile range** than Happy Farm.

______________________________________________

______________________________________________ [1]

4 (b) (ii) Statement 2: Happy Farm has a higher percentage of Grade 1 eggs than Sunny Farm.

Disagree. The box-and-whiskers plot **does not provide information on number of eggs which have masses equal to or more than 62 g**. From the box-and-whiskers plot, we could only tell that Happy Farm's upper quartile is 60 g which means that 25% of eggs have masses more than 60 g.

[1]

(c) Thirty employees in Happy Farm work in either Administrative Department or Farming and Outdoors Department.

The table shows the breakdown of males and females employees in the departments.

| | Administrative | Farming and Outdoors |
|---|---|---|
| Males | 1 | 20 |
| Females | 3 | 6 |

(i) Two employees are selected randomly from the 30 employees to be the Chairperson and Deputy Chairperson of the Staff Well-being Committee.

Find, as a fraction in its simplest form, the probability that

(a) both of them are from the Administrative Department,

*Answer* .................................... $\frac{2}{145}$ [1]

(b) at least one of them is from the Administrative Department,

Method (1)

$$1-\frac{26}{30}\times\frac{25}{29}$$

Method (2)

$$\frac{4}{30}\times\frac{26}{29}+\frac{26}{30}\times\frac{4}{29}+\frac{4}{30}\times\frac{3}{29}$$

*Answer* .................................... $\frac{22}{87}$ [2]

(c) one of them is a male employee from Farming and Outdoors Department and the other person is a female employee from Farming and Outdoors Department.

$$\frac{20}{30}\times\frac{6}{29}\times2$$

*Answer* .................................... $\frac{8}{29}$ [2]

**5** Complete Row 5 of the number pattern.

| Row | Number series | Number of terms | Sum of terms | Pattern |
|---|---|---|---|---|
| 1 | 1 | 1 | 1 | $2^1 - 1$ |
| 2 | $1 + 2$ | 2 | 3 | $2^2 - 1$ |
| 3 | $1 + 2 + 4$ | 3 | 7 | $2^3 - 1$ |
| 4 | $1 + 2 + 4 + 8$ | 4 | 15 | $2^4 - 1$ |
| 5 | $1 + 2 + 4 + 8 + 16$ | 5 | 31 | $2^5 - 1$ |

[1]

**(a)** Find the sum of $2^0 + 2^1 + 2^2 + 2^3 + \ldots + 2^{10}$.

*Answer* ....................................2047 [1]

**(b)** **(i)** Find, in terms of $n$, the value of $2^0 + 2^1 + 2^2 + 2^3 + \ldots + 2^n$.

*Answer* ....................................$2^{n+1} - 1$ (or $2(2^n) - 1$) [1]

**(ii)** **Hence** find the sum of $1 + 3 + 7 + \ldots + (2^{200} - 1)$.
Leave your answer in the form $2^k + h$ where $k$ and $h$ are integers, $1 \le k \le 500$ and $-500 \le h \le 500$.

$= (2^1 - 1) + (2^2 - 1) + (2^3 - 1) + \ldots + (2^{200} - 1)$

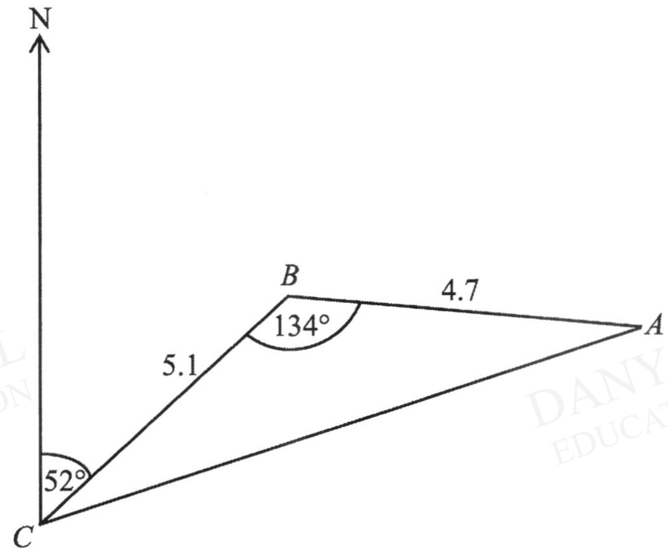
$= 2^1 + 2^2 + 2^3 + \ldots + 2^{200} - 1 \times 200$
or $(2^0 + 2^1 + 2^2 + 2^3 + \ldots + 2^{200} - 1) - 1 \times 200$

$= (2^{201} - 1 - 1) - 200$

$= 2^{201} - 202$

*Answer* .................................... [2]

6 $A$, $B$, and $C$ are three points on level ground.
The bearing of $B$ from $C$ is 052°.
Angle $ABC = 134°$, $BC = 5.1$ km and $AB = 4.7$ km.




**(a)** Calculate the distance between $A$ and $C$.

$AC^2 = 5.1^2 + 4.7^2 - 2 \times 5.1 \times 4.7 \cos 134°$

$AC = 9.0223$ (5 sf)

$AC = 9.02$ km

*Answer* ................................... km [3]

**(b)** Find the bearing of $A$ from $B$.

$180° - 52° = 128°$

$360° - 128° - 134°$
$= 98°$

*Answer* ...................................098° [2]

**6** **(c)** A building of height 70 m stands vertically at $B$.
Damien walks along $AC$ and stops at a point $D$ where the angle of elevation of the top of the building from $D$ is the greatest.

Find the angle of elevation of the top of the building from $D$.

Method (1)
Let shortest distance be $BD$

$$\frac{1}{2}\times 5.1\times 4.7\times \sin 134^\circ = \frac{1}{2}\times 9.0223\times BD$$

$BD = 1.9111$ (5 sf) km

$$\tan x = \frac{70}{1.9111\times 1000}$$

$x = 2.1^\circ$ (1dp)

Method (2)
Let shortest distance be $BD$

$$\frac{4.7}{\sin B\hat{C}A} = \frac{9.0223}{\sin 134^\circ} \Rightarrow \sin B\hat{C}A = 0.37473 \text{ (5 sf)}$$

$$\sin B\hat{C}A = \frac{BD}{5.1}$$

$BD = 1.9111$ (5 sf) km

$$\tan x = \frac{70}{1.9111\times 1000}$$

$x = 2.1^\circ$ (1dp)

*Answer* ....................................2.1° [4]

**(d)** Sufi stands at a point due North of $C$ such that he is equidistant from both points $B$ and $C$.

Find the distance from point $C$ to Sufi.

Let point where Sufi stands be $S$.

<u>Method (1)</u>
Angle $BSC = 180° - 52° - 52° = 76°$

$$\frac{CS}{\sin 52°} = \frac{5.1}{\sin 76°}$$

$CS = 4.14$ (3 sf) km



<u>Method (2)</u>

$5.1 \div 2 = 2.55$

$$\cos 52° = \frac{2.55}{SB}$$

$CS = SB = 4.14$ (3sf) km

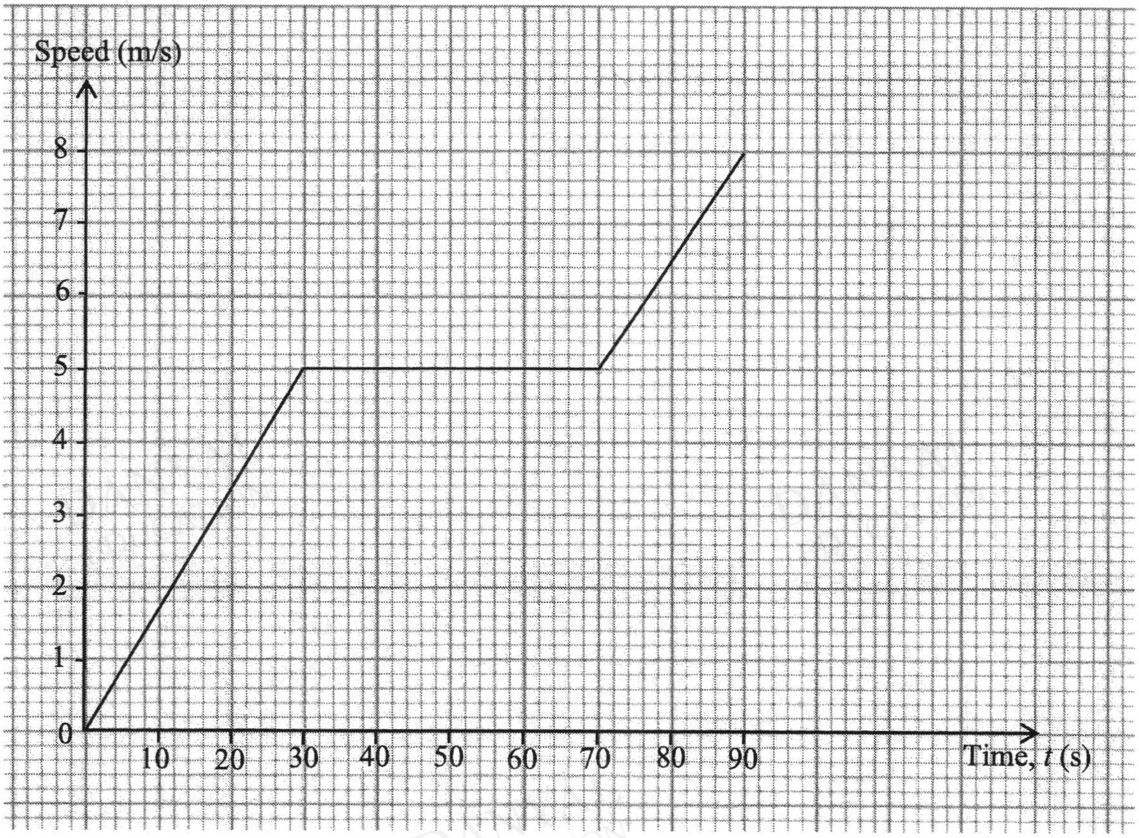
<u>Method (3)</u>
Let distance from $C$ to Sufi be $x$

$x^2 = x^2 + 5.1^2 - 2 \times x \times 5.1 \cos 52°$

$x = 4.14$ (3 sf) km

*Answer* ...................................km [3]

**7** The graph shows part of the speed-time graph of Selina's cycling journey.




**(a)** Describe the cycling journey between $t = 30$ and $t = 70$.

Selina was cycling at a **constant speed** of 5 m/s. [1]

**(b)** Find the acceleration for the first 30 seconds of Selina's journey.

*Answer* ………………………… $\frac{1}{6}$ m/s² [1]

**(c)** After 90 s, Selina slowed to a stop with constant deceleration.
She travelled a further 192 m before stopping at $t = p$.

Find the value of $p$.

$$\frac{1}{2}\times T\times 8=192$$

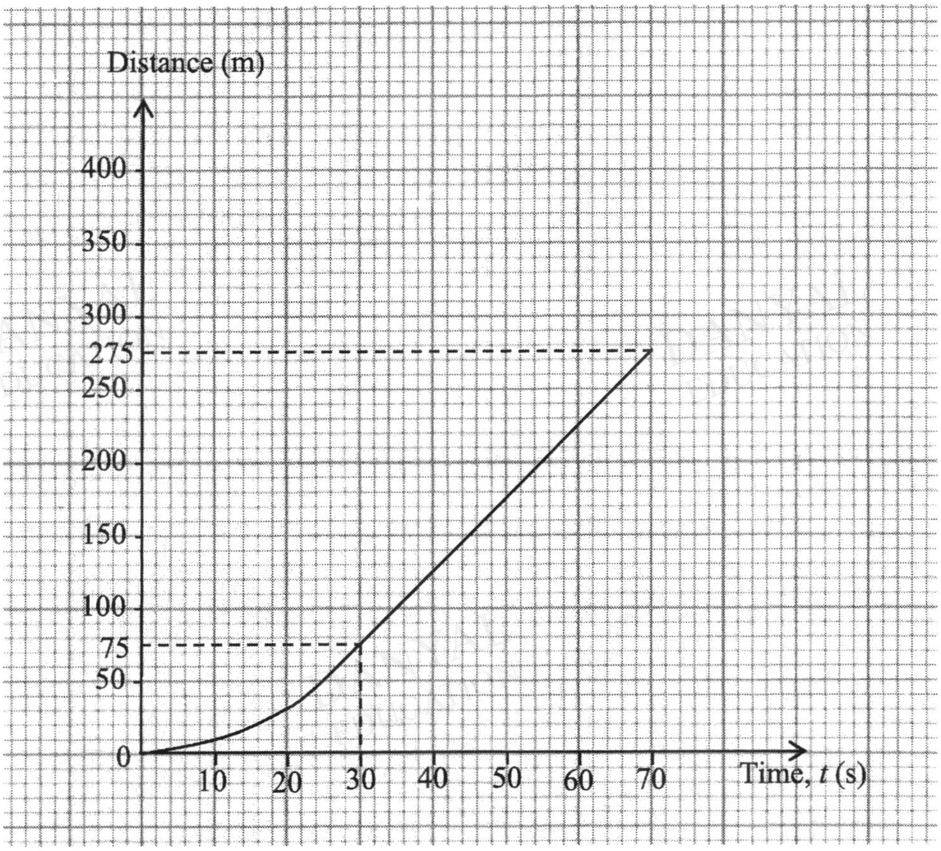
$$T=48$$

$$p=90+48=138$$

*Answer* $p =$ ………………………… [3]

7 (d) The distance-time graph shows the graph for the first 30 seconds of Selina's cycling journey.

Draw the graph from $t = 30$ to $t = 70$ of the journey.
Indicate clearly on the graph the distance travelled in the first 70 seconds.




[2]

**8** A closed cylindrical can of base radius $r$ cm and height $h$ cm has a capacity of $250\pi$ cm$^3$.

**(a)** Express $h$ in terms of $r$.

$\pi r^2 h = 250\pi$

*Answer* $h = \dfrac{250}{r^2}$ .................................. [1]

**(b)** Show that the total external surface area, $A$ cm$^2$, of the cylindrical can is is given by $A = 2\pi r^2 + \dfrac{500\pi}{r}$ .

*Answer*

$A = 2\pi r^2 + 2\pi r\dfrac{250}{r^2}$



[1]

**(c)** The table shows some of the values of $r$ and the corresponding values of $A$, correct to the nearest integer, where $A = 2\pi r^2 + \dfrac{500\pi}{r}$.

| $r$ | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| $A$ | $p$ | 580 | 493 | 471 | 488 | 532 |

**(i)** Find the value of $p$.

*Answer* $p = 811$.................................. [1]

**(ii)** On the axes given on the next page, draw the graph of $A = 2\pi r^2 + \dfrac{500\pi}{r}$ for $2 \le r \le 7$. [3]

**(d)** By drawing a tangent, find the gradient of the curve at $r = 6$.



*Answer* .................................. [2]

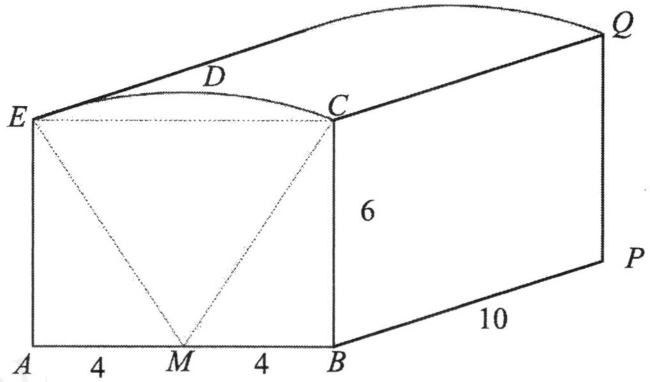
**(e)** Given that the can has the least surface area, find the value of $r$ and the value of $h$.

*Answer* $r = 5$..................................

$h = 10$.................................. [2]

**8 (c) (ii)**

**9** **(a)** *ABCDE* is a uniform cross section of a warehouse model.
*ABCE* is a rectangle. *EDC* is an arc of a circle with centre *M*. *M* lies on *AB*.
$AM = MB = 4$ cm, $BC = 6$ cm and $BP = 10$ cm.






**(i)** Find angle *CME*.

<u>Method (1)</u>

$\tan C\hat{M}B = \dfrac{6}{4}$

Angle $CMB = 56.31°$ (2dp)

Angle $CME$ $= 180° - 56.31° \times 2$
$= 67.38°$
$= 67.4°$ (1dp)

<u>Method (2)</u>

$MC^2 = 4^2 + 6^2 = 52$

Using cosine rule

$8^2 = 52 + 52 - 2 \times 52 \cos \angle CME$

$\cos \angle CME = \dfrac{5}{13}$

Angle $CME$ $= 67.38°$
$= 67.4°$ (1dp)

<u>Method (3)</u>

$MC^2 = 4^2 + 6^2 = 52$

Using area of triangle *CME*

$\dfrac{1}{2} \times 52 \times \sin C\hat{M}E = \dfrac{1}{2} \times 8 \times 6$

Angle $CME$ $= 67.38°$
$= 67.4°$ (1dp)

*Answer* ……………………………………° [2]

**(ii)** Calculate the area of the cross section *ABCDE*.

<u>Method (1)</u>

$MC^2 = 4^2 + 6^2 = 52$

$$\frac{67.38}{360} \times \pi \times 52 + \frac{1}{2} \times 4 \times 6 \times 2 \quad \text{or} \quad \frac{1}{2} \times 52 \times \frac{67.38\pi}{180} + \frac{1}{2} \times 4 \times 6 \times 2$$

$= 54.576$ (5sf)

$= 54.6$ (3sf) $\text{cm}^2$

<u>Method (2)</u>

$MC^2 = 4^2 + 6^2 = 52$

Area of segment $= \dfrac{67.38}{360} \times \pi \times 52 - \dfrac{1}{2} \times 8 \times 6 = 6.5761$

or $\dfrac{1}{2} \times 52 \times \dfrac{67.38\pi}{180} - \dfrac{1}{2} \times 8 \times 6$

Area of cross section

$= 6 \times 8 + 6.5761$

$= 54.576$ (5sf)

$= 54.6$ (3sf) $\text{cm}^2$

*Answer* ................................ $\text{cm}^2$ [4]

**(iii)** A second geometrically similar warehouse model has a height which is half the height of the original warehouse model.

Find the volume of the second warehouse model.

$$\left(\frac{1}{2}\right)^3 \times 54.576 \times 10 = 68.2 \text{ cm}^3$$

*Answer* ................................ $\text{cm}^3$ [2]

**9** **(b)** The diagram shows a broken piece of a round plate.

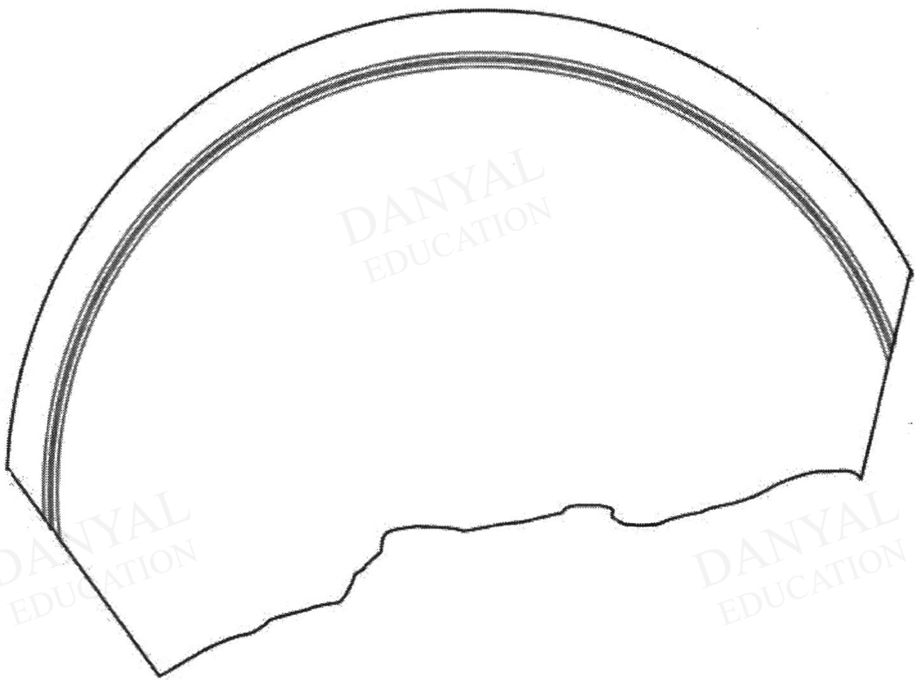
**(i)** State the property of circles you used in finding the centre of the plate.

*Answer* (i) Accept any of the following:

- The perpendicular bisector of a chord passes through the centre
- Tangent perpendicular to radius [1]

**(ii)** Find, by constructing perpendicular bisectors, the centre of the plate.
Label the centre of the plate *C*.

*Answer* (ii)



**10** $A$ is the point $(5, -8)$ and $B$ is the point $(-10, 4)$.

**(a)** Find the equation of the line $AB$.

Gradient of $AB = \dfrac{4-(-8)}{-10-5} = -\dfrac{4}{5}$

$-8 = -\dfrac{4}{5}(5) + c \Rightarrow c = -4$

Equation of $AB$ is $y = -\dfrac{4}{5}x - 4$

*Answer* .................................................. [2]

**(b)** The equation of the line $l$ is $4x + 5y = 10$.

**(i)** Explain whether the line $l$ intersects the line $AB$.

*Answer*

Method (1)

Gradient of line $l$ is $-\dfrac{4}{5}$ and $y$-interecpt of line $l$ is 2.

Both line $AB$ and line $l$ have the **same gradient**
(or the two lines are **parallel**.)

But the two lines **do not have the same *y*-intercept**. Hence the two parallel lines **do not intersect**.

Method (2)

Solving the two simultaneous equations, a solution of $-20 = 10$ is reached.

This means that there are **no solutions to the two simultaneous equations**. Hence, the two lines **do not intersect**.

**10** **(b)** **(ii)** Explain whether the point $C$ (10, –10) lies on the line $l$.

*Answer*

<u>Method (1)</u>
Substitute $x = 10$ and $y = -10$ into $4x + 5y$,
$4x + 5y = 4(10) + 5(-10) = -10$

But equation of the line $l$ is $4x + 5y = 10$ (or coordinates of $C$ do not satisfy the equation of $l$). Hence point $C$ (10, –10) does **not** lie on the line $l$.

<u>Method (2)</u>
Substitute $x = 10$ into $4x + 5y = 10$.
$4(10) + 5y = 10$
$y = -6$

Since $y = -6$ is not the $y$-coordinate of point $C$, $C$(10, –10) does **not** lie on the line $l$.

[2]

**10** **(iii)** Line $l$ intersects the curve $y = \frac{x^3}{5} - x^2 - 2$ at point $D$.

The $x$-ccordinate of point $D$ is a real solution of the equation $x^3 + px^2 + qx - 20 = 0$ where $p$ and $q$ are constants.

Find the values of $p$ and $q$.

$$\frac{x^3}{5} - x^2 - 2 == -\frac{4}{5}x + 2$$

$$x^3 - 5x^2 + 4x - 20 = 0$$

$$p = -5, q = 4$$

*Answer* $p =$ ……………………………

$q =$ …………………………… [2]

**11** **(a)** Mr Tan has a medical condition which requires him to be on long-term prescribed medication.

On a particular day, he took a 200 mg dose of the prescribed drug at 8 o'clock in the morning. His body gradually broke down the drug so that one hour after taking the drug, only 80% of the drug would remain active.

This pattern continues: at the end of each hour, only 80% of the drug that was present at the end of the previous hour remains active.

To combat Mr Tan's illness effectively, the amount of the drug in the body should not fall below 30 mg.

There should not be more than 300 mg of the drug in the body, beyond which the drug becomes toxic.

The table shows the amount, $x$ mg, of the drug present in Mr Tan's body $t$ hours after taking the drug.

| $t$ (hours) | 0 | 2 | 4 | 6 | 10 |
|---|---|---|---|---|---|
| $x$ (mg) | 200 | 128 | 82 | 53 | 22 |

**(i)** Estimate the amount of the drug in Mr Tan's body 8 hours after he has taken it.

<u>Method (1)</u>
$0.8 \times 0.8 \times 53 = 34$ (also accept 33.92)

<u>Method (2)</u>
$0.8^8 \times 200 = 33.6$ (3 sig fig)

*Answer* ……………………………… mg [1]

**(ii)** Explain why the recommended dosage for the drug is 3 times a day. Show your calculations clearly.

After 8 hours, the amount of drug in Mr Tan's body is 34 mg.
After 9 hours, the amount of drug in his body is $0.8 \times 34$ is 27 mg.
To maintain at least 30 mg of drug in the body, Mr Tan needs to take a new dose every 8 (to 8.5) hours each day.

Since there are 24 hours in a day, the number of doses for each day is $24 \div 8 = 3$.

**11 (a) (ii)** Students solutions:

Solution (1)
8 hours after the first dose of the day, 34 mg of drug is left in the body. After consuming the 2nd dose of drug 8 hours after the first dose, the amount of drug in the body is $200 + 34 = 234$ mg.
8 hours after the 2nd dose of drug, $0.8^8 \times 234 = 39.3$ (3 sf) mg of drug is left in the body.
After consuming the 3rd dose of drug 8 hours after the 2nd does, the amount of drug in the body is $200 + 39.3 = 239$ (3 sf) mg.
8 hours after the 3rd dose of drug, $0.8^8 \times 239 = 40.1$ (3sf) mg of drug is left in the body.

Three doses of drug per day allow Mr Tan's illness to be managed effectively (amount of drug is always more than 30 mg) and keep the amount of drug in the body below the toxic level.

Solution (2)
There are 24 hours in a day. However Mr Tan does not stay awake 24 hours. Assuming that he sleeps from 10 pm to 8 am and does not wake up to take his medication during this 10 hour period,

At 8 am, he consumes the 1st dose of drug. At 2pm, 6 hours after the 1st dose, he consumes the 2nd dose of drug.
The amount of drug in the body $= 53 + 200 = 253$ mg.
At 10pm, 8 hours after the 2nd dose of drug, the amount of drug in the body $= 0.8^8 \times 253 = 42.4$ (3 sf) mg. After he consumes the 3rd dose of drug at 10pm, the amount of drug in the body $= 242$ (3sf) mg.
At 8am the following day, the amount of drug left in the body
$= 0.8^8 \times 242 = 40.6$ (3 sf) mg.

Three doses of drug per day allow Mr Tan's illness to be managed effectively (amount of drug is always more than 30 mg) and keep the amount of drug in the body below the toxic level.

[2]

**11** **(b)** In Singapore, Ministry of Health provides subsidies for drugs at public specialist outpatient clinics (SOCs) and polyclinics to support Singapore citizens with healthcare costs.

The table below shows the per-capita household income (PCHI) criteria for subsidies at public SOCs and polyclinics.
(Source: https://www.moh.gov.sg/docs/librariesprovider5/default-document-library/annex-a---revision-to-pchi-criteria99abfc1511b54b6f87ddadb9114092f2.pdf)

<table>
<tr><th rowspan="2">Monthly PCHI* to qualify for subsidy (Singapore Citizens)</th><th colspan="3">Subsidy tier** (Singapore Citizens)</th></tr>
<tr><th>Subsidised SOC services</th><th>Subsidised SOC drugs</th><th>Subsidised polyclinic drugs for adults</th></tr>
<tr><td>PCHI ≤ $1 200</td><td>70%</td><td rowspan="2">75%</td><td rowspan="2">75%</td></tr>
<tr><td>$1 200 < PCHI ≤ $2 000</td><td>60%</td></tr>
<tr><td>PCHI > $2 000</td><td>50%</td><td>50%</td><td>50%</td></tr>
</table>

*Monthly PCHI is computed as the total gross household monthly income divided by the total number of family members living in the household.
** Subsidy tier shows the subsidy rate the Singapore Citizen is entitled to

Mr Tan, his wife and two children are Singapore Citizens. They live together in a 4-room HDB flat.

| Member | Age | Gross Monthly Salary |
|---|---|---|
| Mr Tan | 34 | $3 500 |
| Mrs Tan | 32 | $2 000 |
| First Child | 5 | Nil |
| Second Child | 3 | Nil |

Mr Tan's medication costs $1.90 per dose. Every 6 months, he receives outpatient services at a public SOC. Each visit at the public SOC costs $245.

Mr Tan decides to apply for both polyclinic drug subsidies and public SOCs service and drug subsidies.

Find, after Mr Tan is granted the subsidies, the amount he will save on the cost of drugs and outpatient treatment each year as a percentage of his annual gross salary.

**11** **(b)** *Answer space*

PCHI of Mr Tan's family = (3500 + 2000) ÷ 4 = $1375

Subsidy tier Mr Tan qualifies is 60% subsidised SOC services and 75% subsidised drugs

Savings on cost of drug and treatment in a year

$= 0.75 \times 1.9 \times 3 \times 365 + 0.6 \times 245 \times 2$

= $1 854.375

% saving

$= \frac{1854.375}{3500 \times 12} \times 100$

$= \frac{1854.375}{42000} \times 100$

= 4.42%

[5]