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**MATHEMATICS (US)**

0444/31

Paper 3 (Core)

May/June 2020

2 hours

You must answer on the question paper.

You will need: Geometrical instruments

**INSTRUCTIONS**

- Answer all questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, center number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do not use an erasable pen or correction fluid.
- Do not write on any bar codes.
- You should use a calculator where appropriate.
- You may use tracing paper.
- You must show all necessary work clearly.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.
- For  $\pi$ , use either your calculator value or 3.142.

**INFORMATION**

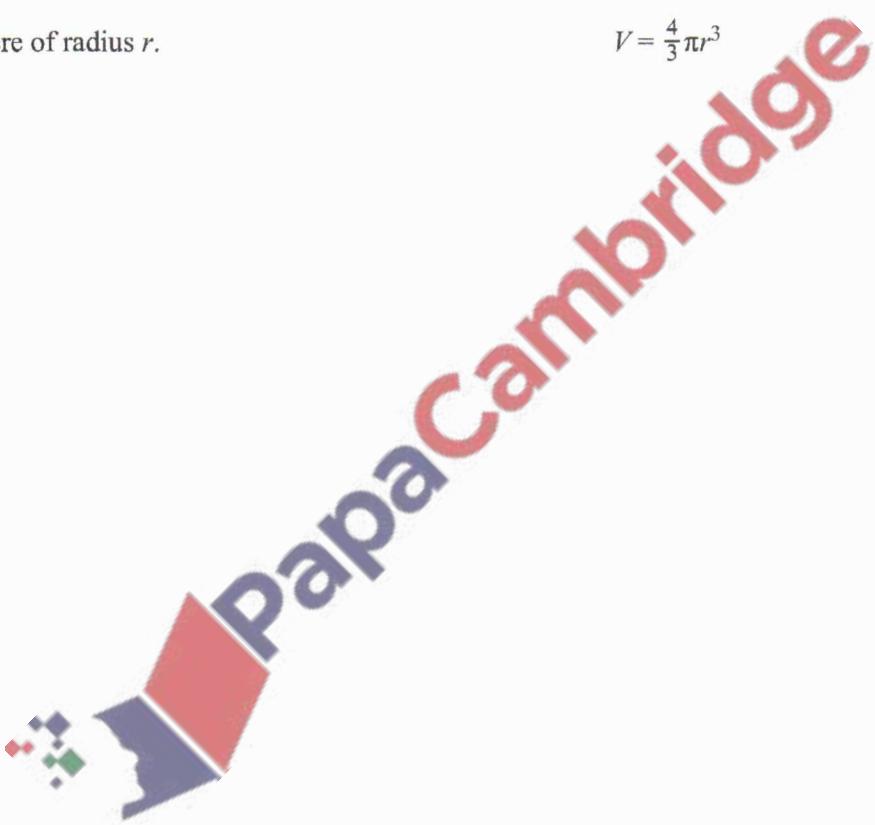
- The total mark for this paper is 104.
- The number of marks for each question or part question is shown in parentheses [ ].

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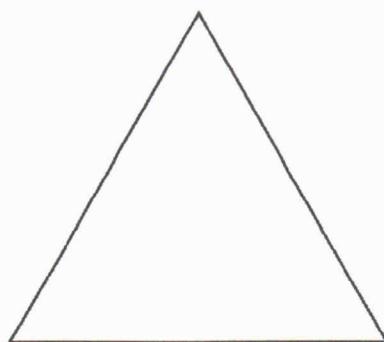
This document has 20 pages. Blank pages are indicated.

### Formula List

Area, $A$ , of triangle, base $b$ , height $h$ .	$A = \frac{1}{2}bh$
Area, $A$ , of circle, radius $r$ .	$A = \pi r^2$
Circumference, $C$ , of circle, radius $r$ .	$C = 2\pi r$
Lateral surface area, $A$ , of cylinder of radius $r$ , height $h$ .	$A = 2\pi rh$
Surface area, $A$ , of sphere of radius $r$ .	$A = 4\pi r^2$
Volume, $V$ , of prism, cross-sectional area $A$ , length $l$ .	$V = Al$
Volume, $V$ , of cylinder of radius $r$ , height $h$ .	$V = \pi r^2 h$
Volume, $V$ , of sphere of radius $r$ .	$V = \frac{4}{3}\pi r^3$



- 1 The diagram shows a triangle with each side of length 5 cm.



- (a) Write down the mathematical name for this type of triangle.

**Equilateral** ..... [1]

- (b) (i) Measure the perpendicular height of the triangle.

..... 4 cm [1]

- (ii) Calculate the area of the triangle.

$$\text{Area} = \frac{1}{2} \times \text{Base} \times \text{height}$$

$$\frac{1}{2} \times 5 \times 4 = 11$$

..... 11 cm<sup>2</sup> [2]

- (iii) The triangle is the cross-section of a prism with length 6 cm.

Calculate the volume of the prism.

$$\text{Volume} = \text{Area of Cross Section} \times \text{length}$$

$$= 11 \times 6 = 66$$

..... 66 cm<sup>3</sup> [2]

- 2 Gabriela designs the seating layout for a new theater.  
There are three sections of seats, A, B, and C.

- (a) Section A has 152 seats.

Section B has 12.5% more seats than Section A.

Section C has  $\frac{3}{8}$  of the number of seats in Section A.

- (i) Show that the number of seats in Section B is 171.

$$100\% + 12.5\% = 112.5\%$$

$$\frac{112.5}{100} \times 152 = 171 \\ = \underline{\underline{171}}$$

[1]

- (ii) Show that the total number of seats is 380.

$$152 + 171 + \frac{3}{8}(152)$$

$$152 + 171 + 57 = 380$$

$$= \underline{\underline{380}}$$

[2]

- (b) Write down and simplify the ratio of the number of seats in each section A : B : C.

$$A : B : C$$

$$152 : 171 : 57$$

$$\text{Divide by } 19 \\ 8 : 9 : 3$$

$$A : B : C = \underline{\underline{8}} : \underline{\underline{9}} : \underline{\underline{3}} \quad [2]$$

- (c) In Section A:

- There are 12 seats in the front row.
- Each row has 2 more seats than the row in front of it.

Work out the number of rows for the 152 seats in Section A.

$$12, 14, 16$$

$$a + (n-1)d = 152$$

$$12 + 2(n-1) = 152$$

$$12 + 2n - 2 = 152$$

$$2n + 10 = 152$$

$$2n = 152 - 10$$

$$2n = 142$$

$$n = 71$$

$$71$$

rows [2]

- (d) For a concert in the theater, the ticket prices are in the ratio

$$A : B : C = 9 : 7 : 4.$$

A ticket for Section C costs \$6.

- (i) Show that a ticket for Section B costs \$10.50 .

$$\begin{array}{rcl} 4 = \$6 \\ 7 = ? \\ \hline 7 \times \$6 \\ 42 \end{array} = \frac{21}{2} = \underline{\underline{10.50}} = \$\underline{\underline{10.50}} \quad [1]$$

- (ii) Find the cost of a ticket for Section A.

$$\begin{array}{rcl} 4 = \$6 \\ 9 = ? \\ \hline 9 \times \$1.5 \\ 45 \end{array} = 13.5 \quad \$ \dots \dots \underline{13.50} \quad [1]$$

- (iii) The table shows the number of tickets sold in each section.

Section	Number of tickets sold
A	120
B	136
C	30

Calculate the total amount received from the ticket sales.

$$\begin{array}{rcl} 120 \times 13.50 = 1620 \\ 136 \times 10.50 = 1428 \\ \hline 30 \times 6 = \underline{\underline{3228}} \\ \hline \end{array} \quad \$ \dots \dots \underline{3228} \quad [3]$$

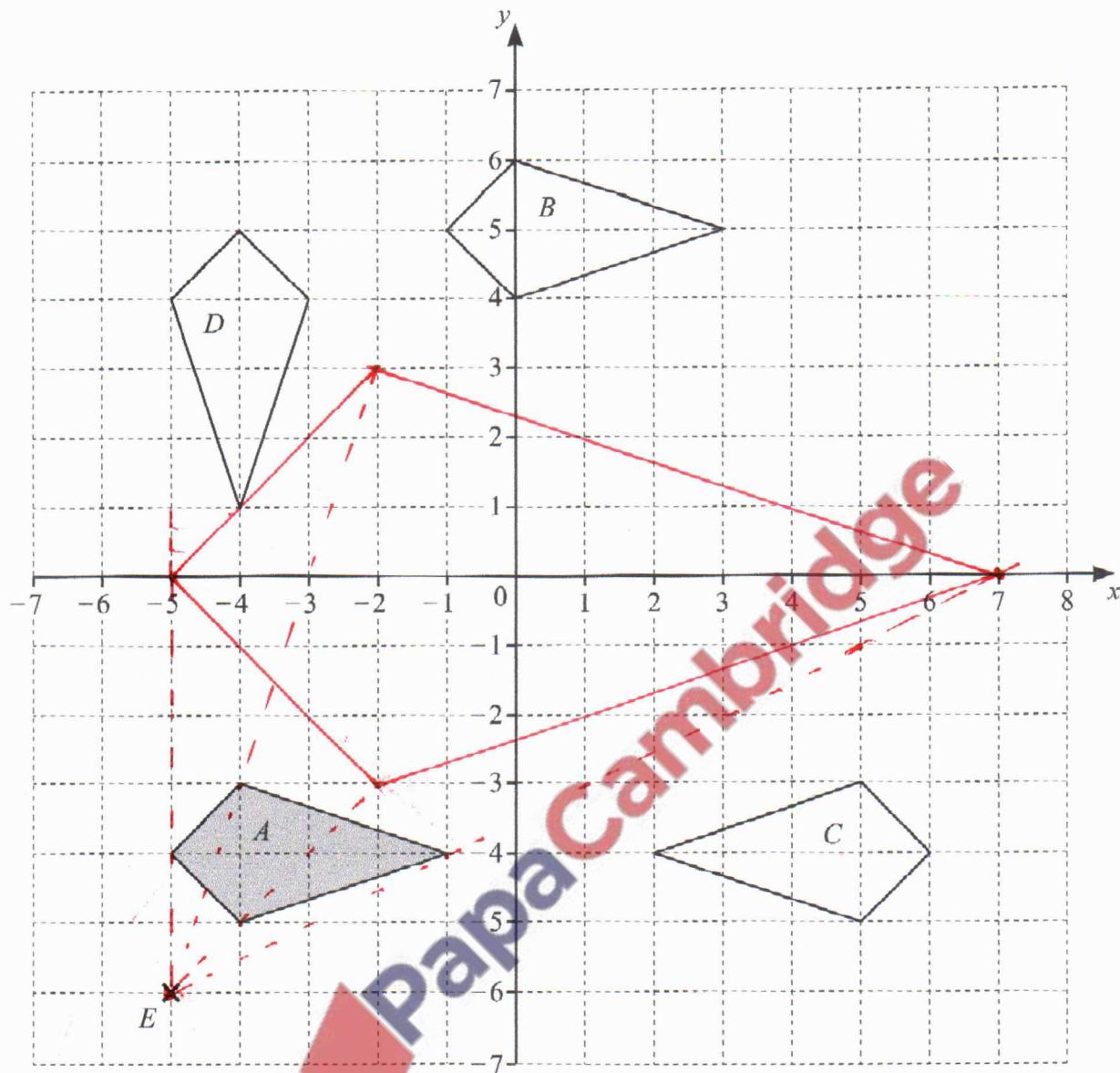
- (iv) The concert costs \$4500 to organize.

Calculate the amount received from the ticket sales as a percentage of the \$4500.

$$\frac{3228}{4500} \times 100 = 71.73$$

71.73 % [1]

- 3 The grid shows a point  $E$  and four quadrilaterals,  $A$ ,  $B$ ,  $C$ , and  $D$ .



- (a) Write down the mathematical name of shape  $A$ .

Kite

[1]

(b) Describe fully the single transformation that maps

- (i) shape A onto shape B,

..... Translation by vector  $\begin{pmatrix} 4 \\ 9 \end{pmatrix}$  .....

[2]

- (ii) shape A onto shape C,

..... Reflection on line  $x = 0.5$  .....

[2]

- (iii) shape A onto shape D.

..... Rotation of  $90^\circ$  clockwise .....

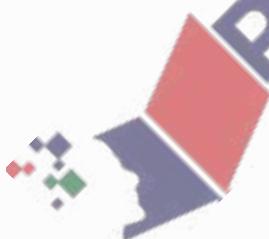
..... about Centre  $(0,0)$  .....

[3]

(c) (i) Write down the coordinates of the point E.

(....., ..... ) [1]

- (ii) On the grid, draw the image of shape A after an enlargement by scale factor 3, center E. [2]



- 4 (a) Complete the table of values for  $y = 7 + 2x - x^2$ .

$x$	-2	-1	0	1	2	3	4
$y$	-1	4	7	8	7	4	-1

[2]

- (b) On the grid, draw the graph of  $y = 7 + 2x - x^2$  for  $-2 \leq x \leq 4$ .

$$y = 7 + 2(-1) - (-1)^2$$

$$y = 7 - 2 - 1$$

$$y = 7 - 3$$

$$y = 4$$

$$y = 7 + 2(0) - (0)^2$$

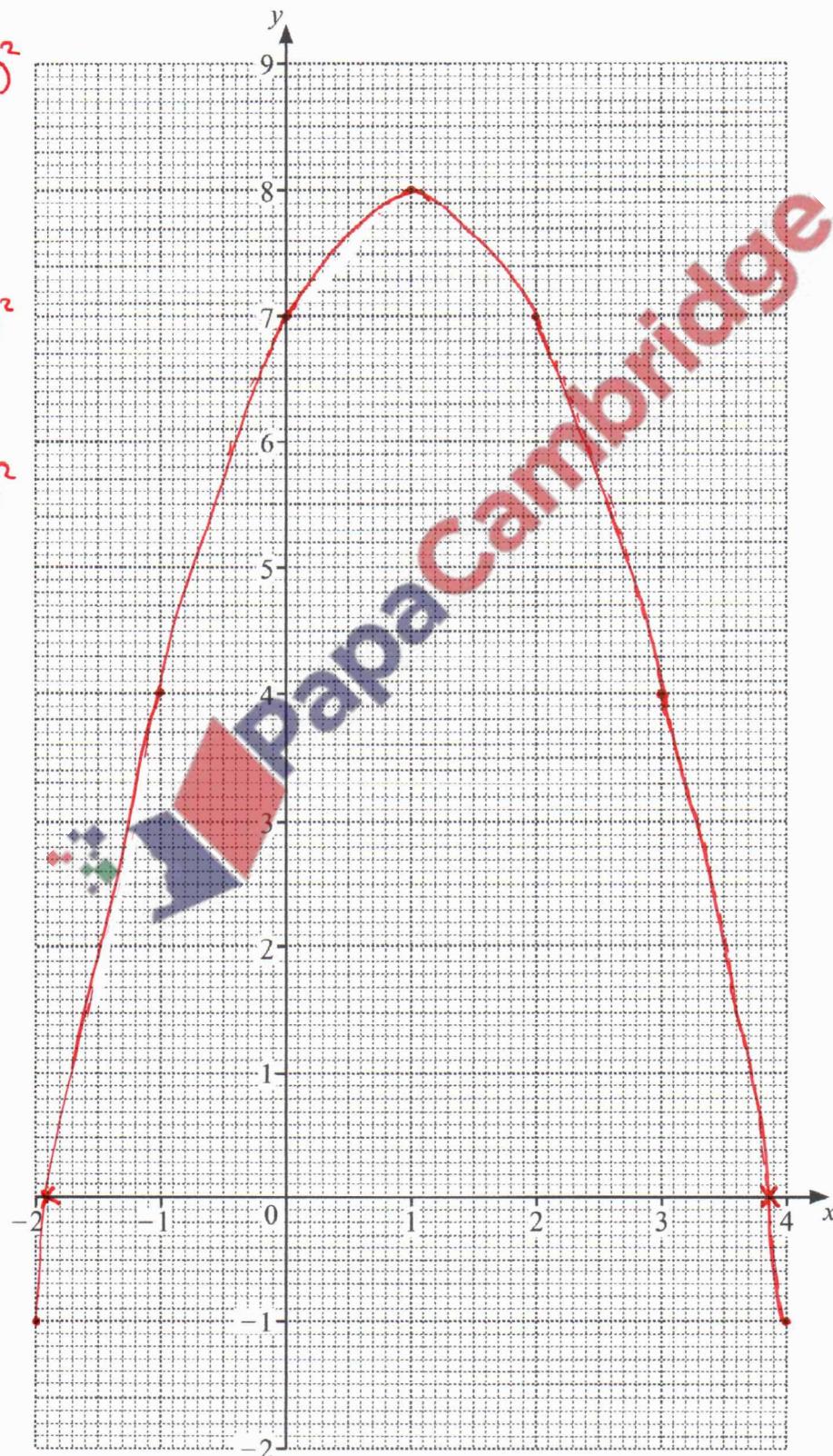
$$y = 7$$

$$y = 7 + 2(3) - (3)^2$$

$$y = 7 + 6 - 9$$

$$y = 13 - 9$$

$$y = 4$$



[4]

- (c) Write down the equation of the line of symmetry of the graph.

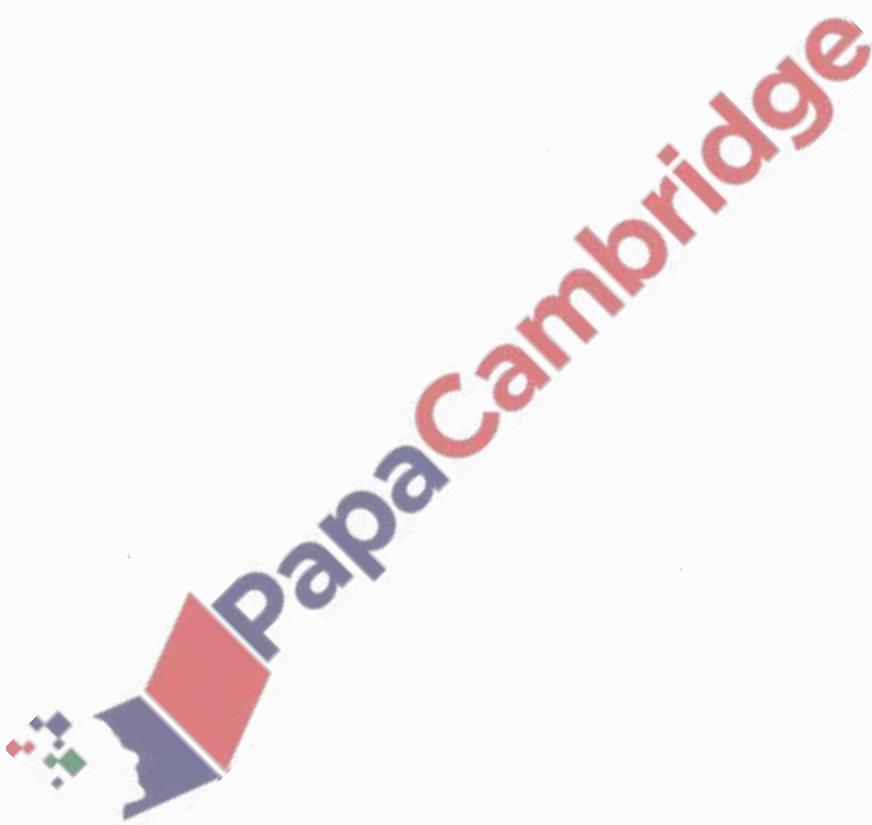
$x = 1$

[1]

- (d) Use your graph to solve the equation  $7 + 2x - x^2 = 0$ .

Values of  $f(x)$  where the  
curve crosses the  $x$ -axis

$x = -1.9$  or  $x = 3.8$  [2]



- 5 (a) Using the integers from 60 to 75 only, find

(i) a multiple of 17,

$$\begin{aligned} 17 \times 3 &= 51 \\ 17 \times 4 &= 68 \end{aligned}$$

..... 68 .....

[1]

(ii) the prime numbers.

..... 61, 67, 71, 73 .....

[2]

(b) Find

(i) the square root of 4489,

$$\sqrt{4489} = 67$$

..... 67 .....

[1]

(ii)  $4^3$ ,

$$4 \times 4 \times 4 = 64$$

..... 64 .....

[1]

(iii)  $\sqrt[3]{274\,625}$ ,

..... 65 .....

[1]

(iv)  $2^{-3} \times 24^2$ .

$$\begin{aligned} \frac{1}{2^3} \times 24 \times 24 \\ \cdot \frac{1}{8} \times 2^3 \times 24 = 72 \end{aligned}$$

..... 72 .....

[1]

(c) Write 0.0379 correct to 2 significant figures.

0.0379 , 0.038

..... 0.038 .....

[1]

(d) Find the least common multiple (LCM) of 8 and 14.

2	8	14
2	4	7
2	2	7
7	1	7
	1	1

$$2 \times 2 \times 2 \times 7 = 56$$

..... 56 .....

[2]

- (e) Write 479 000 000 in scientific notation.

$$4.79 \times 10^8$$

$$4.79 \times 10^8$$

[1]

- (f) George invests \$8000 at a rate of 3.6% per year compound interest.

Calculate the value of his investment at the end of 9 years.

$$A = 8000 \left(1 + \frac{3.6}{100}\right)^9$$

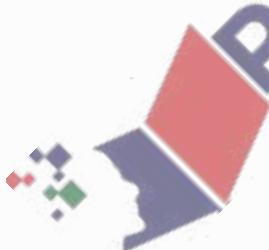
$$A = 8000 (1 + 0.036)^9$$

$$A = 8000 (1.036)^9 = 10998.358$$

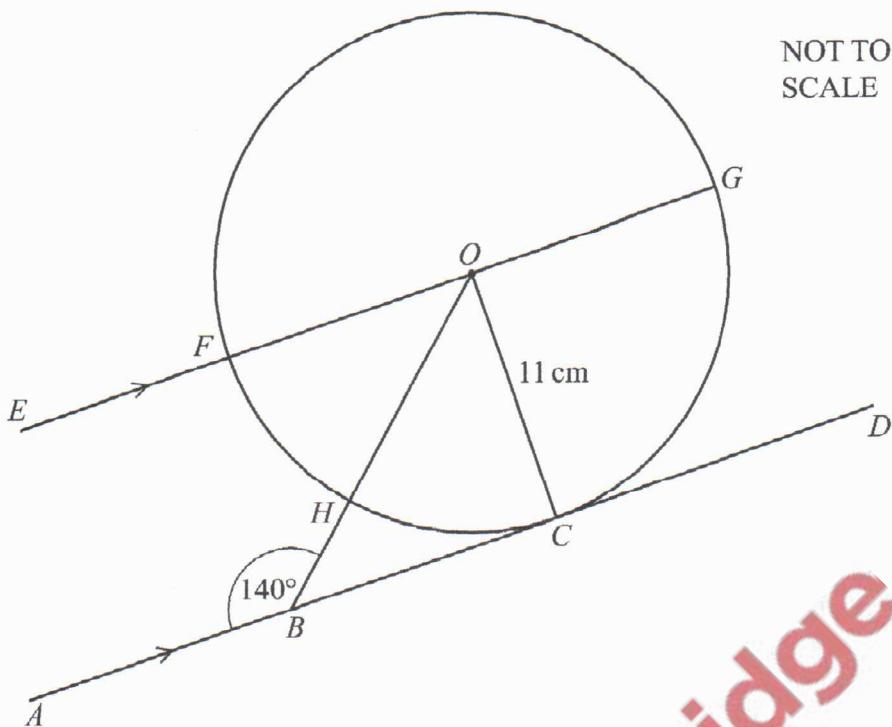
=

$$10998.36$$

[2]



6

NOT TO  
SCALE

The diagram shows a circle, center  $O$ , radius 11 cm.  
 $C, F, G$ , and  $H$  are points on the circumference of the circle.  
The line  $AD$  touches the circle at  $C$  and is parallel to the line  $EG$ .  
 $B$  is a point on  $AD$  and angle  $ABO = 140^\circ$ .

- (a) Write down the mathematical name of the straight line  $AD$ .

Tangent ..... [1]

- (b) (i) Calculate the circumference of the circle.

$$\begin{aligned}C &= 2\pi r \\C &= 2 \times 3.142 \times 11 \\C &= 69.124\end{aligned}$$

69.12 ..... cm [2]

- (ii) Work out angle  $FOH$ .

$$\begin{aligned}180 - 140 &= 40 \\&\text{Co-interior angle}\end{aligned}$$

Angle  $FOH$  = .....  $40^\circ$  [2]

- (iii) Calculate the length of the minor arc  $FH$ .

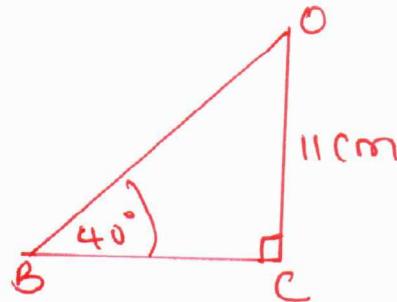
$$\begin{aligned}\text{Arc length} &= \frac{\theta}{360} \times 2\pi r \\&= \frac{40}{360} \times 2 \times 3.142 \times 11 = 7.68\end{aligned}$$

7.68 ..... cm [2]

- (c) (i) Give a reason why angle  $BCO$  is  $90^\circ$ .

Angle between a tangent and radius [1]

- (ii) Show that  $BC = 13.11$  cm, correct to 2 decimal places.



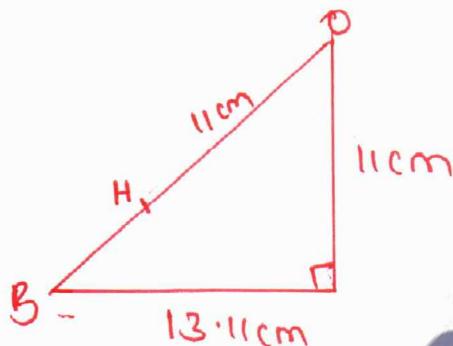
$$\tan 40^\circ = \frac{11}{BC}$$

$$BC \tan 40^\circ = 11$$

$$BC = \frac{11}{\tan 40^\circ} = \underline{\underline{13.11 \text{ cm}}}$$

[3]

- (iii) Calculate  $BH$ .



$$BO^2 = 17.11^2 + 11^2$$

$$BO = \sqrt{17.11^2 + 11^2}$$

$$BO = 17.11$$

$$BH = 17.11 - 11 = 6.11$$

$$BH = \underline{\underline{6.11}} \text{ cm} [3]$$

- 7 (a) 20 students from College A each run 5 km.  
The times, correct to the nearest minute, are recorded.

~~32~~    ~~51~~    ~~25~~    ~~40~~    ~~47~~    ~~21~~    ~~37~~    ~~32~~    ~~48~~    ~~36~~  
~~46~~    ~~39~~    ~~30~~    ~~29~~    ~~44~~    ~~39~~    ~~53~~    ~~35~~    ~~40~~    ~~31~~

21, 25, 29, 30, 31, 32, 32, 35, 36, 37, 39, 39, 40, 40  
 44, 46, 47, 51

- (i) Find the median of the times.

$$\frac{37+39}{2} = 38 \quad \dots \dots \dots \text{min} [1]$$

- (ii) Explain why mode is not a suitable measure of average in this case.

There is more than one mode. [1]

- (iii) Find the probability that a student, chosen at random, took less than 33 minutes.

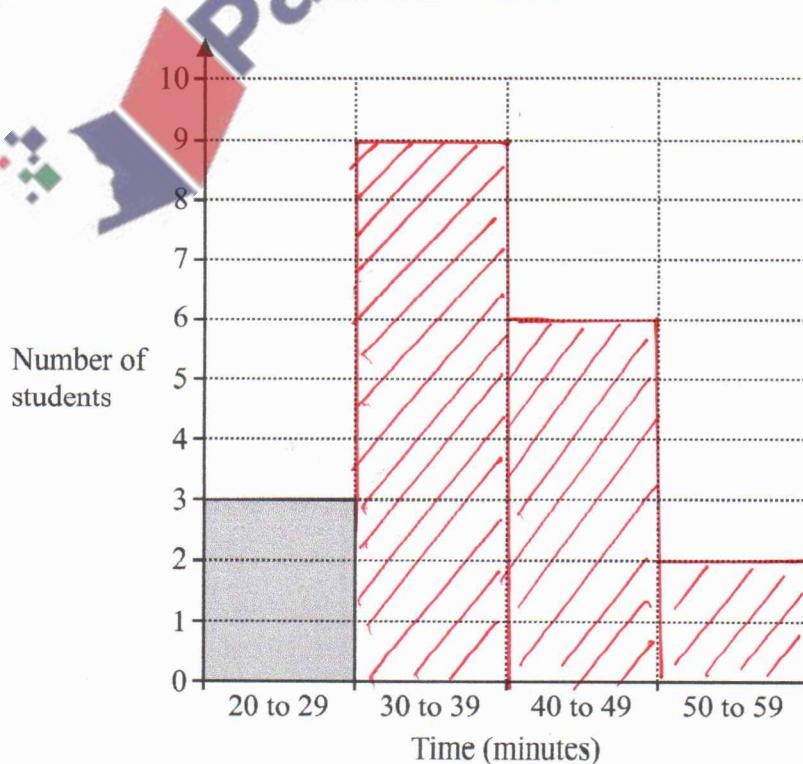
$$\frac{7}{20} \quad \dots \dots \dots [1]$$

- (iv) Complete the frequency table.

Time (minutes)	Frequency
20 to 29	3
30 to 39	9
40 to 49	6
50 to 59	2

[1]

- (v) Complete the bar chart for the times of the students.



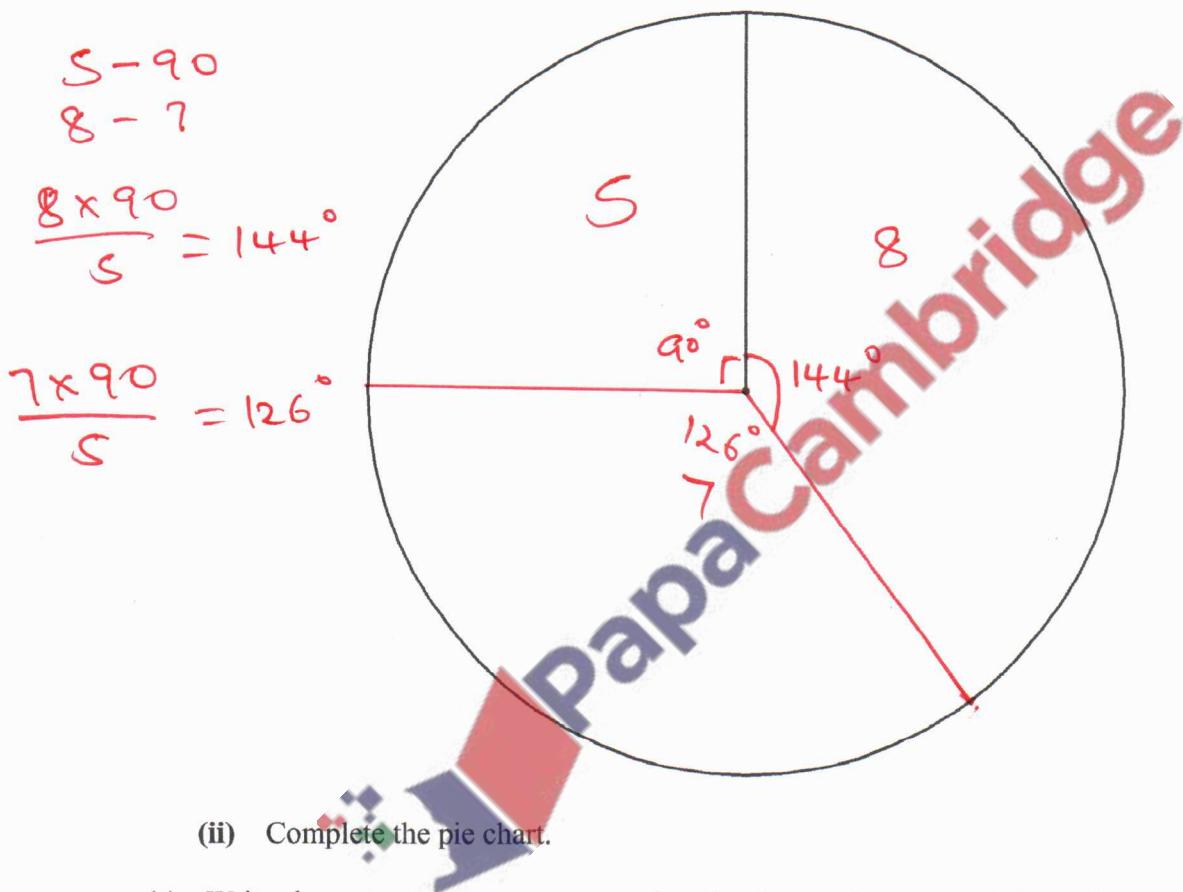
[2]

- (b) 20 students from College B each run 5km.  
Their times, correct to the nearest minute, are recorded and the results are shown in the table.

Time (minutes)	Number of students	Pie chart sector angle
30 to 39	5	90°
40 to 49	8	144°
50 to 59	7	126°

- (i) Complete the table.

[2]



- (ii) Complete the pie chart.

[2]

- (c) Write down two comments comparing the times of students from College A with the times of students from College B.

- 1 Students in College A take less time to run 5km.  
 2 Three students in College A are the fastest in the two Colleges.

[2]

- 8 (a) Simplify  $3c - 5d - c + 2d$ .

$$\begin{aligned} & 3c - c - 5d + 2d \\ & 2c - 3d \end{aligned}$$

$$2c - 3d$$

[2]

- (b) Solve the equation  $12x - 7 = 23$ .

$$\begin{aligned} 12x &= 23 + 7 \\ 12x &= 30 \\ x &= \frac{30}{12} \quad 5 \\ &\quad 2 \end{aligned}$$

$$x = 2.5$$

$$x = \underline{\hspace{2cm}} \quad 2.5 \quad [2]$$

- (c) Expand.

$$9(3 - x)$$

$$27 - 9x$$

$$\underline{\hspace{2cm}} \quad 27 - 9x \quad [1]$$

(d)  $A = \frac{(a+b)h}{2}$

Work out the value of  $h$  when  $A = 38.64$ ,  $a = 5.5$ , and  $b = 3.7$ .

$$2 \times 38.64 = \frac{(5.5 + 3.7)h}{2} \quad \cancel{\times 2}$$

$$2(38.64) = 9.2h$$

$$h = \frac{2(38.64)}{9.2}$$

$$h = \underline{\hspace{2cm}} \quad 8.4$$

$$h = \underline{\hspace{2cm}} \quad 8.4 \quad [3]$$

- (e) Alphonse is  $x$  years old and Beatrice is  $y$  years old.  
 Three times Alphonse's age is equal to 5 times Beatrice's age.  
 Twice Beatrice's age is 4 years more than Alphonse's age.

- (i) Use this information to write down two equations in  $x$  and  $y$ .

$$\begin{aligned} A &= x \\ B &= y \end{aligned}$$

$$3x = 5y,$$

$$2y = x + 4$$

$$x = 2y - 4$$

$$3x = 5y$$

$$2y = x + 4$$

[2]

- (ii) Find the age of Alphonse and the age of Beatrice.

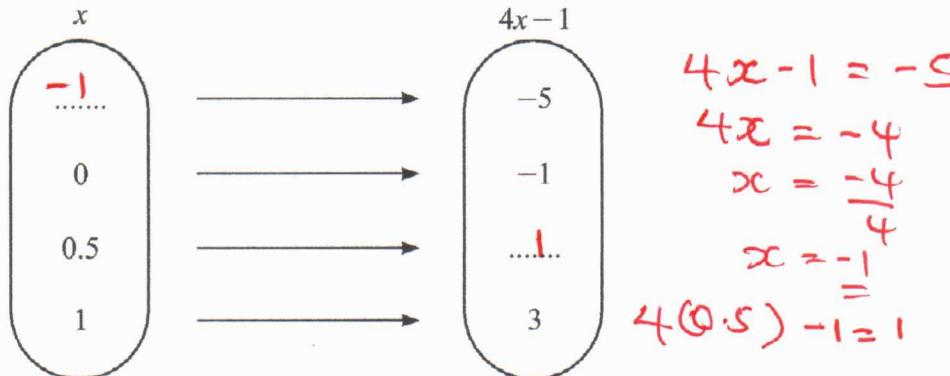
$$\begin{aligned} x &= 2y - 4 \\ 3(2y - 4) &= 5y \\ 6y - 12 &= 5y \\ 6y - 5y &= 12 \\ y &= 12 \end{aligned}$$

$$\begin{aligned} 3x &= 5 \times 12 \\ 3x &= 60 \\ x &= \frac{60}{3} \\ x &= 20 \end{aligned}$$

Alphonse ..... 20 years old

Beatrice ..... 12 years old [3]

- 9 (a) (i) Complete the mapping diagram for the function  $f: x \rightarrow 4x - 1$ .

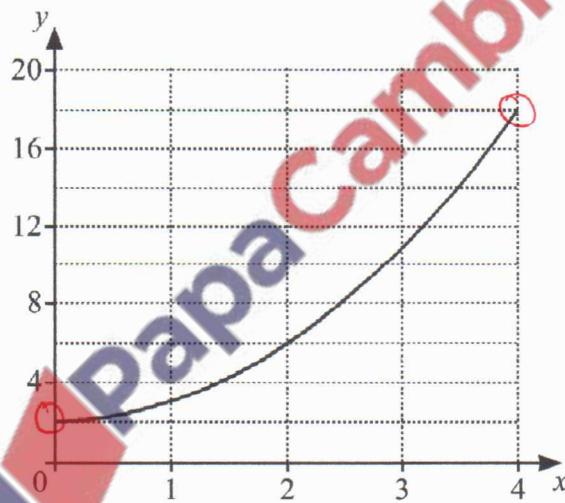


[2]

- (ii) Write down the domain of the function  $f$ .

-1, 0, 0.5, 1 ..... [1]

(b)

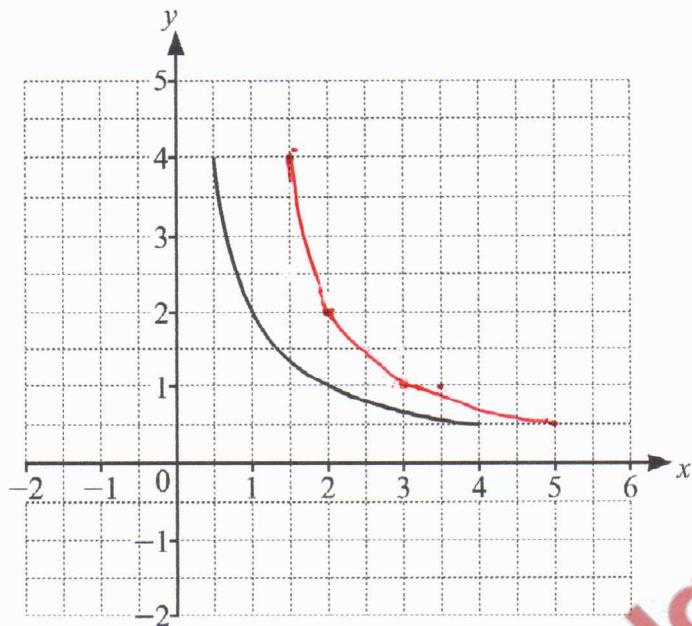


The diagram shows the graph of the function  $y = g(x)$  where  $g(x) = x^2 + 2$  for  $0 \leq x \leq 4$ .

Complete the range of  $g(x)$ .

..... 2 .....  $\leq g \leq$  ..... 18 ..... [2]

(c)

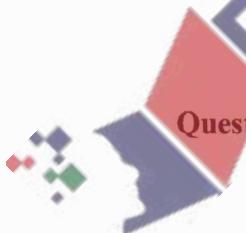


The graph of  $y = h(x)$  is shown on the grid.

On this grid, draw the graph of  $y = h(x - 1)$ .

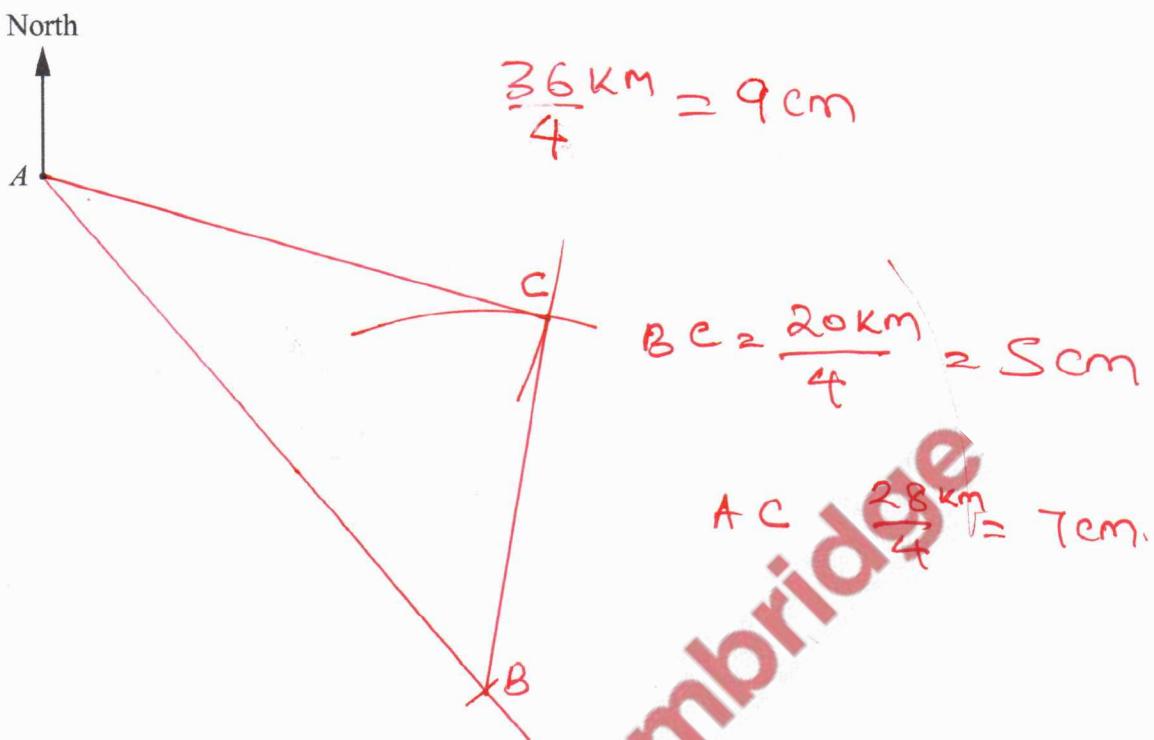
[2]

Question 10 is printed on the next page.



- 10 Point  $B$  is 36 km from point  $A$  on a bearing of  $140^\circ$ .

- (a) Using a scale of 1 centimeter to represent 4 kilometers, mark the position of  $B$ .



Scale: 1 cm to 4 km

[2]

- (b) (i) Point  $C$  is 28 km from  $A$  and 20 km from  $B$ .  
The bearing of  $C$  from  $A$  is less than  $140^\circ$ .

**Using a ruler and compasses only**, construct triangle  $ABC$ .  
Show all your construction arcs.

[3]

- (ii) Measure angle  $ACB$ .

Angle  $ACB$  = .....  $96^\circ$  [1]

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