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Class	Register Number
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4016/01

15/S4PR2/EM/1

MATHEMATICS

PAPER 1

Friday

31 July 2015

2 hours

[illegible]

VICTORIA SCHOOL

PRELIMINARY EXAMINATION TWO
SECONDARY FOUR

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 a pencil for any diagrams or graphs.

Do not use paper clips, highlighters, glue or correction fluid.

Answer all the 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.

You are expected to use a scientific calculator to evaluate explicit numerical expressions.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.

For π , use either your calculator value or 3.142, unless the question requires the answer in terms of π .

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.

This paper consists of 17 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 school with an area of 0.4 km^2 is represented by an area of 2.5 cm^2 on a map. Find the scale of the map, in the form of $1:n$.

Answer 1 : [2]

- 2 Three light bulbs flicker at intervals of 4 seconds, 12 seconds and 15 seconds respectively. If all three bulbs flicker together at 0915, at what time will they next flicker together again?

Answer [2]

- 3 21 tins of biscuits can last 3 days for a camp of 70 students. What is the number of additional tins of biscuits required if 10 extra students join in the last 2 days of the camp?

Answer additional tins [2]

- 4 Write the following numbers in order of size, starting with the smallest.

$$\frac{1}{3}, \quad \sqrt{0.01}, \quad 0.33, \quad 0.5^{\frac{8}{5}}$$

Answer [2]

- 5 A bookshop sells two types of drawing papers, each with thickness 1.6×10^{-3} cm and 2 mm. If Victor bought 2 sheets of drawing papers of the thicker type and 25 sheets of drawing paper of the other type, what is the total thickness of the papers, in cm, when bound together? Express your answer in standard form.

Answercm [2]

- 6 It is given that y varies inversely as the square root of x . It is known that $x = 32$ for a particular value of y .

(a) Describe the change in y when x increases by 300%.

Answer (a)[2]

(b) Find the value of x when the value of y is doubled.

Answer (b) $x =$ [2]

- 7 (a) Find the integer values of x which satisfy the inequalities $\frac{3}{2}x + 4 < 2x - 9 \leq \frac{3x + 64}{3}$.

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

- (b) If p and q are two of the values of x found in (a), find the least value of $\frac{1}{p^2 - q^2}$.

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

- 8 Simplify $\frac{(3\sqrt{x})^3 \div (xy^3)^{-\frac{4}{3}}}{(2x^3y^2)^2}$, leaving your answer in positive indices.

Answer $\dots\dots\dots$ [3]

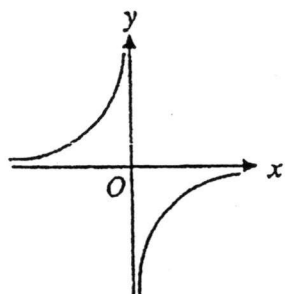


Figure 1

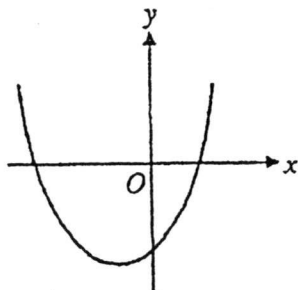


Figure 2

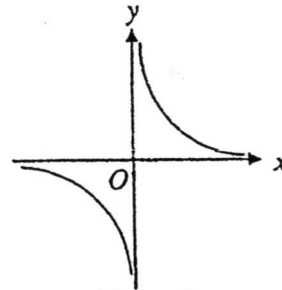


Figure 3

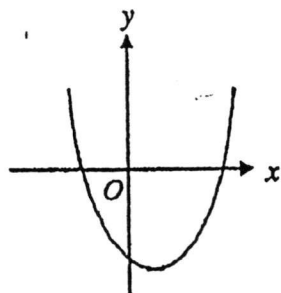


Figure 4

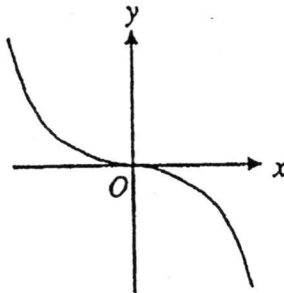


Figure 5

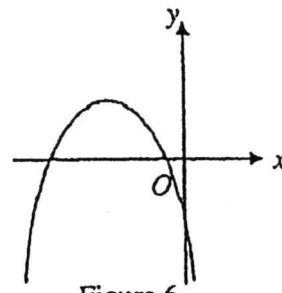


Figure 6

Which of the graphs shown above could be the graph of

(a) $y = 2x^2 + 4x - 3$,

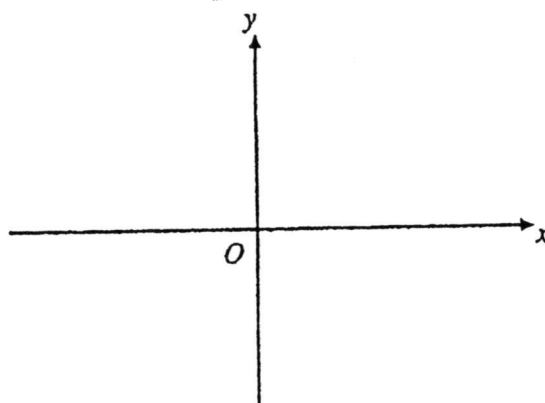
Answer (a) Figure [1]

(b) $y = x^{-1}$?

Answer (b) Figure [1]

(c) Sketch the graph of $y = 3^{-x}$.

Answer (c)



[1]

- 10 Solve the simultaneous equations

$$\begin{aligned}x + 2y &= 4, \\ -0.1x + 0.9y &= 2.35.\end{aligned}$$

Answer $x = \dots\dots\dots$, $y = \dots\dots\dots$ [3]

- 11 Dylan would like to accumulate an interest of \$800 in his account after $3\frac{1}{2}$ years. Given that a bank pays 2.8% per annum interest compounded half yearly, how much does Dylan need to deposit in his account? Give your answer to the nearest dollar.

Answer \$ $\dots\dots\dots$ [3]

- 12 In 15 years' time from 2015, Valerie's age will be the square of her age 15 years ago from 2015. Find Valerie's age in 2015.

Answer $\dots\dots\dots$ years old [3]

- 13 (a) Given that A is the point $(1,3)$ and B is the point $(-2,9)$, find the equation of the line PQ that is parallel to line AB and passes through the point $(3,2)$.

Answer (a).....[2]

- (b) Determine the type of solution (I, II, III) when the line PQ intersects the line $x + \frac{1}{2}y = 4$.

Type I 1 unique solution
 Type II No solution
 Type III Infinite number of solutions

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

- 14 Shops A and B are having sales on a particular jacket. Shop A offers a 35% discount on the original price, p , while Shop B offers a 20% discount on the same original price, with a further reduction of $x\%$ on the discounted price for members.

- (i) Given that Ali holds the membership of Shop B , the total amount of discount offered to him from Shop B can be written as $\frac{p}{125}(a+x)$. Find the value of a .

Answer (i) $a =$[1]

- (ii) Given that Ali is offered a higher discount from Shop B , form an inequality in x and show that it reduces to $x > k$, where k is a constant to be determined.

Answer (ii).....

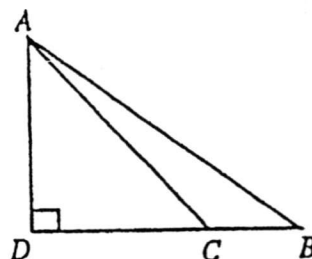
.....

.....

..... [2]

- 15 In triangle ADB , $\angle ADB = 90^\circ$ and $DC = 2CB$. Given that $\cos^2 \angle ACB = \frac{16}{25}$, express as a fraction in its lowest term,

(i) $\tan \angle ACB$,



Answer (i) $\tan \angle ACB = \dots\dots\dots$ [2]

(ii) $\tan \angle ABD$.

Answer (ii) $\tan \angle ABD = \dots\dots\dots$ [2]

- 16 The queuing time, in minutes, of 20 customers queuing at the cashier during peak hours is shown in the table below.

Time (minutes)	1-4	5-8	9-12	13-16
Number of customers	9	7	3	1

Calculate the

(i) mean queuing time,

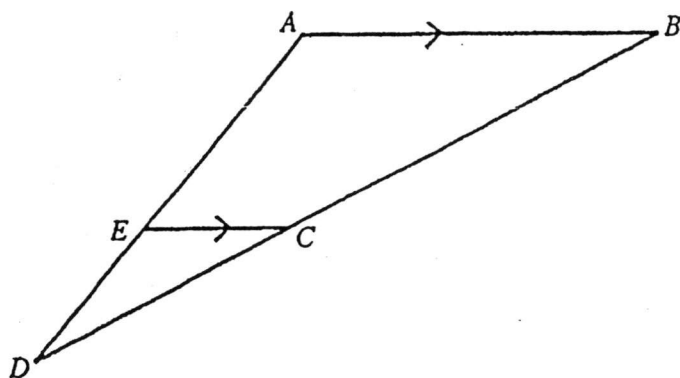
Answer (i) $\dots\dots\dots$ min [1]

(ii) standard deviation.

17

Answer (ii) $\dots\dots\dots$ min [2]

17: In the diagram, lines AB and EC are parallel, and $DE : EA = 2 : 3$.



- (a) Prove that triangles ABD and ECD are similar.

Answer (a)

.....

.....

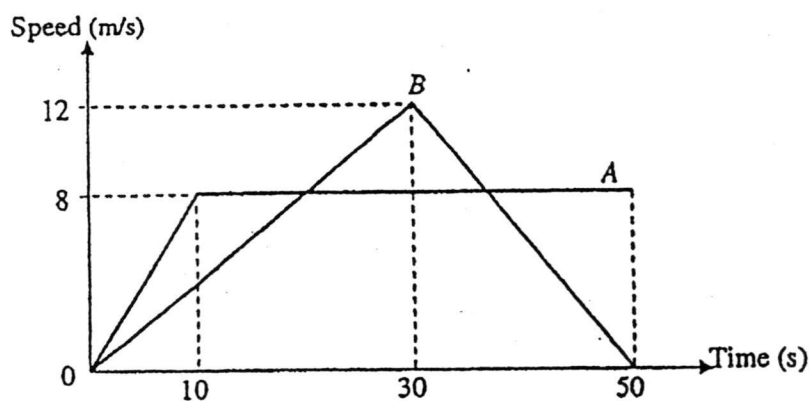
.....

..... [2]

- (b) Find $\frac{\text{area of } \triangle ECD}{\text{area of } ABCE}$.

Answer (b) [2]

- 18 The diagram shows the speed-time graph for the motion of two objects A and B travelling in opposite directions. Both objects are 1 km apart at $t = 0$ s.



Calculate the

- (i) deceleration of object B in the last 5 seconds of the motion,

Answer (i) m/s^2 [1]

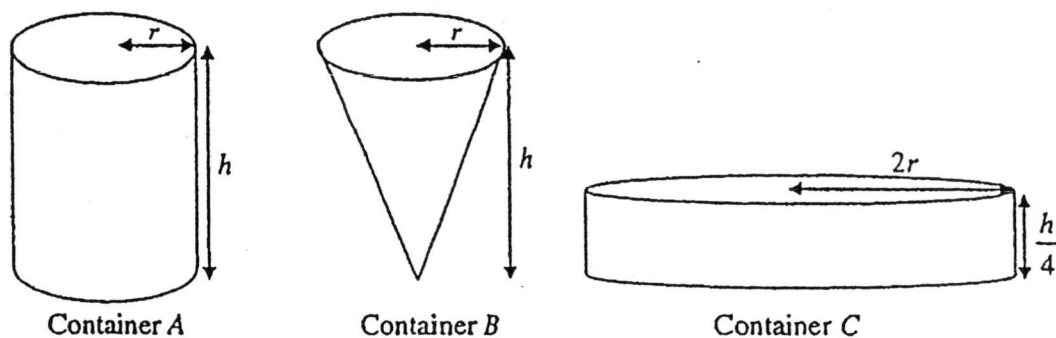
- (ii) time t , where $t > 30$, at which both objects have the same speed,

Answer (ii) s [2]

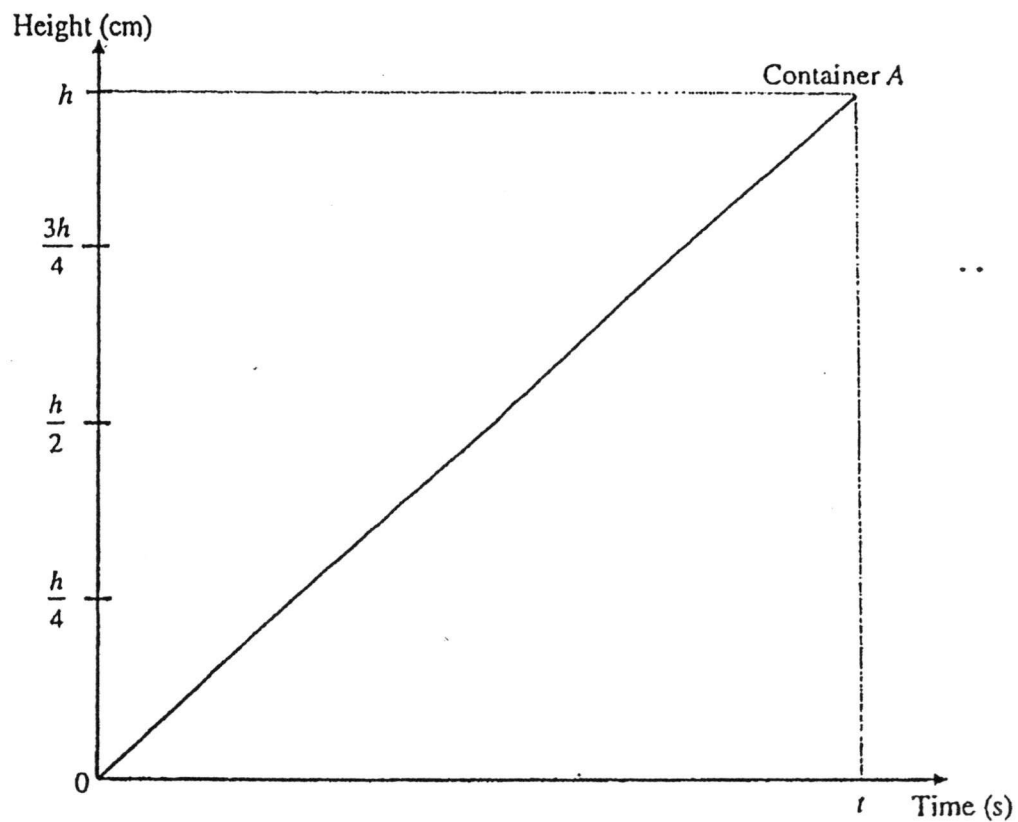
- (iii) distance between both objects at 28 s.

Answer (iii) m [2]

- 19 The diagram shows three open containers with varying heights and radii, in cm. Water is poured into the containers from the top at a constant rate until the containers are filled completely.



The graph below shows the height of the water against time as container A is filled. On the same diagram below, draw the corresponding graphs for containers B and C, labeling each graph clearly.



[2]

- 20 A coin is placed on grid square *E* as shown in the diagram below. A fair die is thrown, and the number on the surface is noted after each throw.
- If the number is 1 or 2, the coin is moved one square to the right.
- If the number is 3, the coin is moved one square to the left.
- If the number is 4, the coin is moved one square up.
- If the number is 5 or 6, the coin is moved one square down.

<i>A</i>	<i>B</i>	<i>C</i>
<i>D</i>	<i>E</i> 	<i>F</i>
<i>G</i>	<i>H</i>	<i>I</i>

The die is thrown two times. Find the probability that the coin is moved to grid square

- (a) *A*,

Answer (a)[1]

- (b) *E*,

Answer (b)[2]

- (c) *F*.

Answer (c)[1]

- (d) Justify your answer in (c).

Answer (d)

.....[1]

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- 21 $OPQR$ is a rhombus. Points R and P have position vectors $\begin{pmatrix} 4 \\ 2 \end{pmatrix}$ and $\begin{pmatrix} p+1 \\ p-1 \end{pmatrix}$, $p < 0$.

(i) Calculate the value of p .

Answer (i) $p = \dots\dots\dots$ [2]

(ii) Find the coordinates of Q .

Answer (ii) $Q(\dots\dots\dots)$ [2]

(iii) Given that D is the point on PQ produced such that $PD = 3QD$, find $\overline{RD}$.

Answer (iii) $\overline{RD} = \dots\dots\dots$ [2]

- 22 The masses, in grams, of 20 packs of sweets are shown in the ordered stem-and-leaf diagram.

(a) Find the median mass.

1		3 8 9
2		1 x 2 3 3 y
3		1 2 2 4 5 5 6 7 8
4		3 9
key 113 means 13		

Answer (a)g [1]

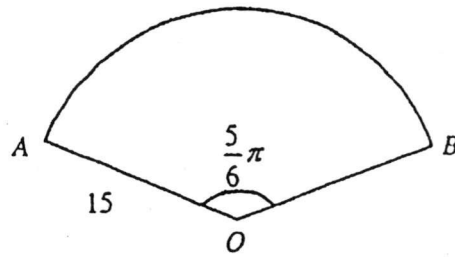
(b) Find the value of $x + y$ if the mean mass is 29.55 grams.

Answer (b)g [2]

(c) Find the value of x and of y if the lower quartile is 21.5 grams.

Answer (c) $x = \dots\dots\dots$, $y = \dots\dots\dots$ [2]

- 23 The diagram shows the sector AOB of a circle, that represents a piece of paper. The radius of the sector is 15 cm and the angle AOB is $\frac{5}{6}\pi$ radians.



- (a) Calculate the length of arc AB .

Answer (a)cm [2]

- (b) The piece of paper is used to make a hollow cone by joining the edges OA and OB . Calculate the volume of the cone.

Answer (b)cm³ [3]

- 24 Three toddlers, Ahmad, Betty and Charlie, were playing on a big triangular play-mat ABC , where $AB = 4$ m, $BC = 6$ m and $AC = 5$ m. After some time, Ahmad and Charlie rested at Points A and C respectively, while Betty sat at a position equidistant from Ahmad and Charlie, and equidistant from AB and AC .

- (a) Using a scale of 1: 50, construct the triangular play-mat ABC . [1]
- (b) By constructing suitable lines, locate and label the position of Betty. Label this position Q . [2]

Answer (a) and (b)

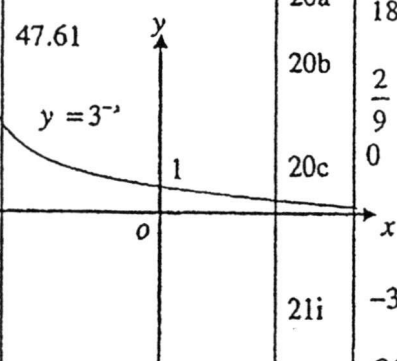
79

End of Paper

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2015 Victoria School Prelim 2 Mathematics Paper 1 Answer Key

1	40 000	14i	25
2	0916	14ii	$k = 18.75$
3	2	15i	$-\frac{3}{4}$
4	$\sqrt{0.01}, 0.5^{\frac{8}{3}}, 0.33, \frac{1}{3}$	15ii	$\frac{1}{2}$
5	4.4×10^{-1}	16i	5.7
6a	The new value of y is halved.	16ii	3.49
6b	8	17a	$\angle DAB = \angle DEC$ (corresponding angles, $AB \parallel EC$) $\angle ADB = \angle EDC$ (common angle) $\therefore$ Triangles ABD and ECD are similar.
7a	27, 28, 29, 30	17b	$\frac{4}{21}$
7b	$-\frac{1}{55}$	18i	$\frac{3}{5}$
8	$\frac{27}{4x^{\frac{19}{6}}}$	18ii	$36\frac{2}{3}$
9a	2	18iii	659.2 or 1340.8
9b	3	20a	$\frac{1}{18}$
9c	47.61  $y = 3^{-x}$	20b	$\frac{2}{9}$
10	$y = 2.5$ $x = -1$	20c	0
11	7827	21i	-3
12	21	21ii	$Q(2, -2)$
13a	$y = -2x + 8$	21iii	$\begin{pmatrix} 0 \\ -3 \end{pmatrix}$
13b	III	22a	31.5
		22b	10
		22c	$x = 1$ $y = 9$
		23a	39.3
		23b	558

Name

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15/S4PR2/EM/1

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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.

238



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Turn over

*Mathematical Formulae**Compound interest*

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

Mensuration

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

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

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

..

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

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

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

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 school with an area of 0.4 km^2 is represented by an area of 2.5 cm^2 on a map. Find the scale of the map, in the form of $1:n$.

$$\text{Area scale} = 2.5 \text{ cm}^2 : 0.4 \text{ km}^2$$

$$= 1 \text{ cm}^2 : 0.16 \text{ km}^2$$

$$\text{Linear Scale} = 1 \text{ cm} : 0.4 \text{ km}$$

$$= 1:40\,000$$

Answer 1 : 40 000.....[2]

- 2 Three light bulbs flicker at intervals of 4 seconds, 12 seconds and 15 seconds respectively. If all three bulbs flicker together at 0915, at what time will they next flicker together again?

$$\text{LCM of 4s, 12s and 15s} = 2^2 \times 3 \times 5$$

$$= 60\text{s}$$

$$= 1 \text{ min}$$

$$0915 + 0001 = 0916$$

Answer 0916.....[2]

- 3 21 tins of biscuits can last 3 days for a camp of 70 students. What is the number of additional tins of biscuits required if 10 extra students join in the last 2 days of the camp?

$$\begin{aligned} \text{No. of tins required for 70 students in 2 days of camp} &= \frac{2}{3} \times 21 \\ &= 14 \end{aligned}$$

$$\begin{aligned} \text{No. of additional tins required for 10 students in 2 days of camp} &= \frac{10}{70} \times 14 \\ &= 2 \end{aligned}$$

Answer 2.....additional tins[2]

- 4 Write the following numbers in order of size, starting with the smallest.

$$\frac{1}{3}, \sqrt{0.01}, 0.33, 0.5^{\frac{2}{3}}$$

$$\sqrt{0.01}, 0.5^{\frac{2}{3}}, 0.33, \frac{1}{3}$$

Answer ... $\sqrt{0.01}$... $0.5^{\frac{2}{3}}$... 0.33 ... $\frac{1}{3}$ [2]

- 5 A bookshop sells two types of drawing papers, each with thickness 1.6×10^{-3} cm and 2 mm. If Victor bought 2 sheets of drawing papers of the thicker type and 25 sheets of drawing paper of the other type, what is the total thickness of the papers, in cm, when bound together? Express your answer in standard form.

$$\begin{aligned}\text{Total thickness} &= 2(2 \times 10^{-1}) + 25(1.6 \times 10^{-3}) \\ &= 0.44 \text{ cm} \\ &= 4.4 \times 10^{-1} \text{ cm}\end{aligned}$$

Answer 4.4×10^{-1} cm [2]

- 6 It is given that y varies inversely as the square root of x . It is known that $x = 32$ for a particular value of y .

- (a) Describe the change in y when x increases by 300%.

$$\begin{aligned}y &\propto \frac{1}{\sqrt{x}} \\ y &= \frac{k}{\sqrt{x}}, \text{ where } k \text{ is a constant.} \\ x_{\text{new}} &= x + 3x \\ &= 4x \\ y_{\text{new}} &= \frac{k}{\sqrt{4x}} \\ &= \frac{k}{2\sqrt{x}} \\ &= \frac{1}{2}y\end{aligned}$$

Answer (a) The value of new y is halved. [2]

- (b) Find the value of x when the value of y is doubled.

$$\begin{aligned}y &= \frac{k}{\sqrt{x}}, \text{ where } k \text{ is a constant.} \\ y_1 \sqrt{x_1} &= y_2 \sqrt{x_2} \\ y_1 \sqrt{32} &= 2y_1 \times \sqrt{x_2} \\ \sqrt{x_2} &= \frac{\sqrt{32}}{2} \\ x_2 &= 8\end{aligned}$$

Answer (b) $x = 8$ [2]

- 7 (a) Find the integer values of x which satisfy the inequalities $\frac{3}{2}x + 4 < 2x - 9 \leq \frac{3x + 64}{3}$.

$$\begin{aligned} \frac{3}{2}x + 4 < 2x - 9 & \quad \text{and} \quad 2x - 9 \leq x + 21\frac{1}{3} \\ 13 < \frac{x}{2} & \quad \text{and} \quad x \leq 30\frac{1}{3} \\ 26 < x & \\ \therefore x = 27, 28, 29, 30 & \end{aligned}$$

Answer (a) $x = 27, 28, 29, 30$ [2]

- (b) If p and q are two of the values of x found in (a), find the least value of $\frac{1}{p^2 - q^2}$.

$$\begin{aligned} \frac{1}{p^2 - q^2} &= \frac{1}{(p - q)(p + q)} \\ &= \frac{1}{(27 - 28)(27 + 28)} \\ &= -\frac{1}{55} \end{aligned}$$

Answer (b) $-\frac{1}{55}$ [1]

- 8 Simplify $\frac{(3\sqrt{x})^3 + (xy^3)^{\frac{4}{3}}}{(2x^3y^2)^2}$, leaving your answer in positive indices.

$$\begin{aligned} \frac{(3\sqrt{x})^3 + (xy^3)^{\frac{4}{3}}}{(2x^3y^2)^2} &= \frac{\left(3^3 x^{\frac{3}{2}}\right)}{x^{\frac{4}{3}} y^4} \times \frac{1}{2^2 x^6 y^4} \\ &= 3^3 x^{\frac{3}{2} - \frac{4}{3}} x^{\frac{4}{3}} \times \frac{1}{2^2 x^6} \\ &= \frac{3^3 x^{\frac{19}{6}}}{2^2} \\ &= \frac{27}{4x^{\frac{19}{6}}} \end{aligned}$$

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Answer $\frac{27}{4x^{\frac{19}{6}}}$ [3]

240

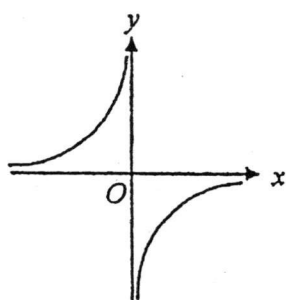


Figure 1

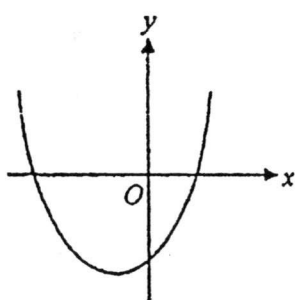


Figure 2

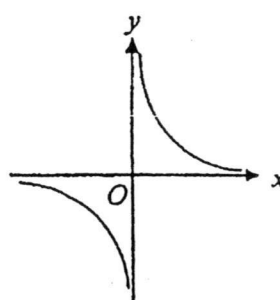


Figure 3

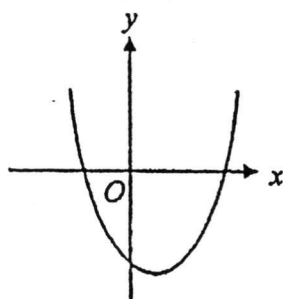


Figure 4

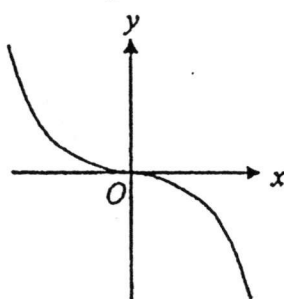


Figure 5

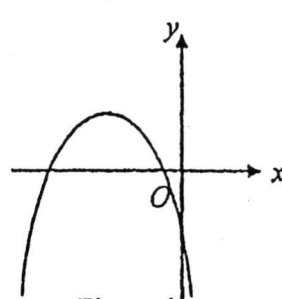


Figure 6

Which of the graphs shown above could be the graph of

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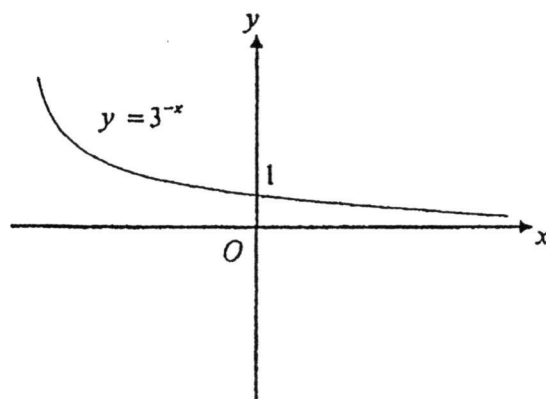
Answer (a) Figure2.....[1]

(b) $y = x^{-1}$?

Answer (b) Figure3.....[1]

(c) Sketch the graph of $y = 3^{-x}$.

Answer (c)



[1]

- 10 Solve the simultaneous equations

$$\begin{aligned}x + 2y &= 4, \\ -0.1x + 0.9y &= 2.35.\end{aligned}$$

$$\begin{aligned}x + 2y &= 4 \text{-----(1)} \\ -x + 9y &= 23.5 \text{-----(2)} \\ (1) + (2): 11y &= 27.5 \\ y &= 2.5 \\ x &= -1\end{aligned}$$

Answer $x = -1$, $y = 2.5$ [3]

- 11 Dylan would like to accumulate an interest of \$800 in his account after $3\frac{1}{2}$ years. Given that a bank pays 2.8% per annum interest compounded half yearly, how much does Dylan need to deposit in his account? Give your answer to the nearest dollar.

Let x be the original amount.

$$x + 800 = \left(1 + \frac{2.8 + 2}{100}\right)^7 \times x$$

$$0.10221x = 800$$

$$x = \$7826.76 \approx \$7827 \text{ (nearest dollar)}$$

Answer \$ 7827 [3]

- 12 In 15 years' time from 2015, Valerie's age will be the square of her age 15 years ago from 2015. Find Valerie's age in 2015.

Let x be Valerie's current age.

$$x + 15 = (x - 15)^2$$

$$x + 15 = x^2 - 30x + 15^2$$

$$x^2 - 31x + 210 = 0$$

$$x = \frac{-(-31) \pm \sqrt{(-31)^2 - 4(1)(210)}}{2(1)}$$

$$= 21 \text{ or } 10 \text{ (rej. } \because 10 - 15 < 0)$$

Valerie's current age is 21.

Answer 21 years old [3]

- 13 (a) Given that A is the point $(1, 3)$ and B is the point $(-2, 9)$, find the equation of the line PQ that is parallel to line AB and passes through the point $(3, 2)$.

$$\begin{aligned}\text{gradient of } AB &= \frac{9-3}{-2-1} \\ &= -2 \\ y-2 &= -2(x-3) \\ y &= -2x+8\end{aligned}$$

Answer (a) $y = -2x + 8$ [2]

- (b) Determine the type of solution (I, II, III) when the line PQ intersects the line $x + \frac{1}{2}y = 4$.

Type I 1 unique solution
Type II No solution
Type III Infinite number of solutions

Answer (b) Type... III [1]

- 14 Shops A and B are having sales on a particular jacket. Shop A offers a 35% discount on the original price, p , while Shop B offers a 20% discount on the same original price, with a further reduction of $x\%$ on the discounted price for members.

- (i) Given that Ali holds the membership of Shop B , the total amount of discount offered to him from Shop B can be written as $\frac{p}{125}(a+x)$. Find the value of a .

$$\begin{aligned}\text{Total discount from Shop B} &= 0.2p + \frac{x}{100}(0.8p) \\ &= p\left(0.2 + \frac{0.8}{100}x\right) \\ &= \frac{p}{125}(25+x)\end{aligned}$$

Answer (i) $a = \dots 25 \dots$ [1]

- (ii) Given that Ali is offered a higher discount from Shop B , form an inequality in x and show that it reduces to $x > k$, where k is a constant to be determined.

$$\begin{aligned}0.35p &< \frac{p}{125}(25+x) \\ 0.35(125) &< 25+x \\ x &> 18.75 \\ k &= 18.75\end{aligned}$$

[2]

- 15 In triangle ADB , $\angle ADB = 90^\circ$ and $DC = 2CB$. Given that $\cos^2 \angle ACB = \frac{16}{25}$, express as a fraction in its lowest term,

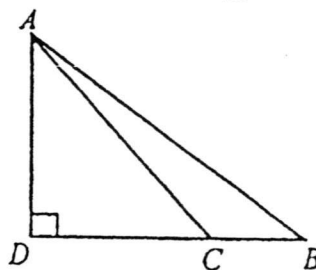
(i) $\tan \angle ACB$,

$$\cos \angle ACB = \pm \frac{4}{5}$$

$$\text{Since } \angle ACB \text{ is obtuse, } \cos \angle ACB = -\frac{4}{5}$$

$$AD = \sqrt{5^2 - 4^2} = 3$$

$$\tan \angle ACB = -\frac{3}{4}$$



$$\text{Answer (i) } \tan \angle ACB = \dots -\frac{3}{4} \dots [2]$$

(ii) $\tan \angle ABD$.

$$\tan \angle ACD = \frac{3}{4}$$

$$\begin{aligned} \tan \angle ABD &= \frac{3}{4+2} \\ &= \frac{1}{2} \end{aligned}$$

$$\text{Answer (ii) } \tan \angle ABD = \dots \frac{1}{2} \dots [2]$$

- 16 The queuing time, in minutes, of 20 customers queuing at the cashier during peak hours is shown in the table below.

Time (minutes)	1-4	5-8	9-12	13-16
Number of customers	9	7	3	1

Calculate the

(i) mean queuing time,

$$\begin{aligned} \text{Mean} &= \frac{114}{20} \\ &= 5.7 \text{ min} \end{aligned}$$

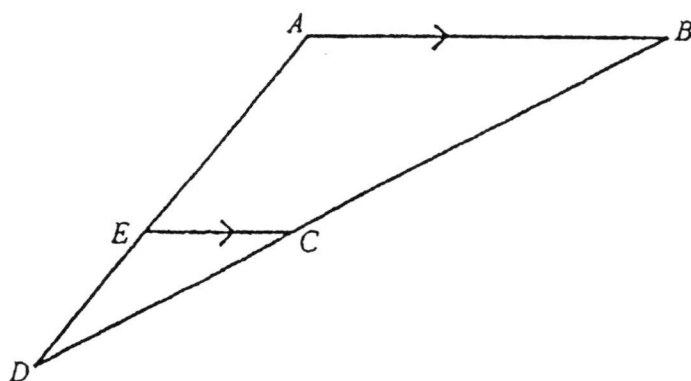
$$\text{Answer (i) } \dots 5.7 \dots \text{min [1]}$$

(ii) standard deviation.

$$\begin{aligned} \text{Standard deviation} &= \sqrt{\frac{893}{20} - (5.7)^2} \\ &= 3.49 \text{ min (to 3sf)} \end{aligned}$$

$$\text{Answer (ii) } \dots 3.49 \dots \text{min [2]}$$

- 17 In the diagram, lines AB and EC are parallel, and $DE : EA = 2 : 3$.



- (a) Prove that triangles ABD and ECD are similar.

Answer (a)

$\angle DAB = \angle DEC$ (corresponding angles, $AB \parallel EC$)

$\angle ADB = \angle EDC$ (common angle)

$\therefore$ Triangles ABD and ECD are similar.

..... [2]

- (b) Find $\frac{\text{area of } \triangle ECD}{\text{area of } ABCE}$.

$$\frac{\text{area of } \triangle ECD}{\text{area of } \triangle ABD} = \left(\frac{2}{5}\right)^2$$

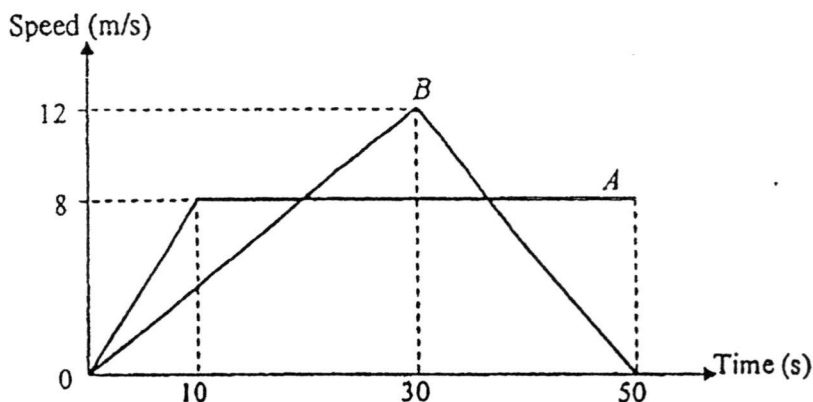
$$= \frac{4}{25}$$

$$\frac{\text{area of } \triangle ECD}{\text{area of } ABCE} = \frac{4}{25 - 4}$$

$$= \frac{4}{21}$$

Answer (b) $\frac{4}{21}$ [2]

- 18 The diagram shows the speed-time graph for the motion of two objects *A* and *B* travelling in opposite directions. Both objects are 1 km apart at $t = 0$ s.



Calculate the

- (i) deceleration of object *B* in the last 5 seconds of the motion,

$$\begin{aligned} \text{Acceleration} &= \frac{0-12}{50-30} \\ &= -\frac{3}{5} \text{ m/s}^2 \\ \text{Deceleration} &= \frac{3}{5} \text{ m/s}^2 \end{aligned}$$

Answer (i) $\dots\dots\dots \frac{3}{5}$ or $\dots\dots\dots 0.6 \dots\dots \text{m/s}^2$ [1]

- (ii) time t , where $t > 30$, at which both objects have the same speed,

$$\begin{aligned} \frac{8-12}{t-30} &= -\frac{3}{5} \\ t &= 36\frac{2}{3} \text{ s} \end{aligned}$$

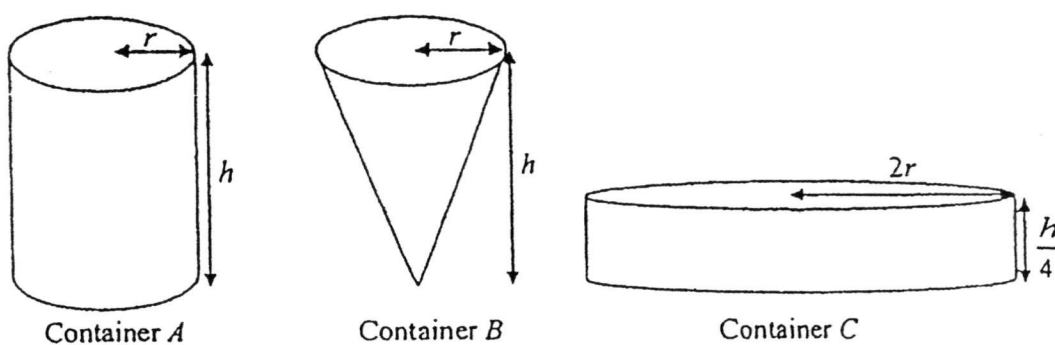
Answer (ii) $\dots\dots\dots 36\frac{2}{3} \dots\dots\dots \text{s}$ [2]

- (iii) distance between both objects at 28 s.

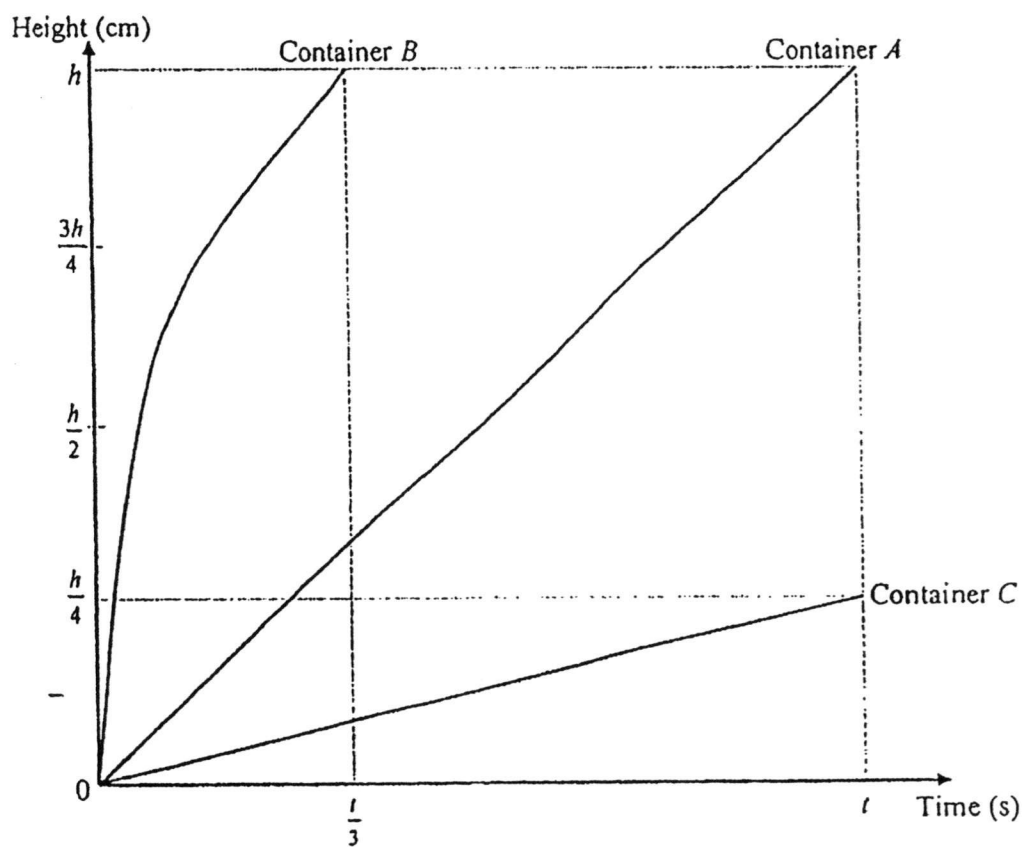
$$\begin{aligned} \text{Distance covered by A} &= \frac{1}{2}(10)(8) + (18 \times 8) = 184 \text{ m} \\ \text{Distance covered by B} &= \frac{1}{2}(28)\left(\frac{12}{30} \times 28\right) = 156.8 \text{ m} \\ \text{Distance apart} &= 1000 - 184 - 156.8 = 659.2 \text{ m} \\ \text{Or} \\ \text{Distance apart} &= 1000 + 184 + 156.8 = 1340.8 \text{ m} \end{aligned}$$

Answer (iii) $\dots\dots\dots 659.2$ or $\dots\dots\dots 1340.8 \dots\dots \text{m}$ [2]

- 19 The diagram shows three open containers with varying heights and radii, in cm. Water is poured into the containers from the top at a constant rate until the containers are filled completely.



The graph below shows the height of the water against time as container A is filled. On the same diagram below, draw the corresponding graphs for containers B and C , labeling each graph clearly.



[2]

20. A coin is placed on grid square E as shown in the diagram below. A fair die is thrown, and the number on the surface is noted after each throw.

If the number is 1 or 2, the coin is moved one square to the right.

If the number is 3, the coin is moved one square to the left.

If the number is 4, the coin is moved one square up.

If the number is 5 or 6, the coin is moved one square down.

A	B	C
D	E	F
G	H	I

The die is thrown two times. Find the probability that the coin is moved to grid square

- (a) A ,

(a) Required prob. = $P(\text{up, left}) + P(\text{left, up})$

$$= \frac{1}{6} \times \frac{1}{6} + \frac{1}{6} \times \frac{1}{6}$$

$$= \frac{1}{18}$$

Answer (a) $\frac{1}{18}$ [1]

- (b) E ,

(b) Required prob. = $P(\text{left, right}) + P(\text{right, left}) + P(\text{up, down}) + P(\text{down, up})$

$$= 4 \left(\frac{1}{6} \times \frac{2}{6} \right)$$

$$= \frac{2}{9}$$

Answer (b) $\frac{2}{9}$ [2]

- (c) F .

(c) Required prob. = 0

Answer (c) 0 [1]

- (d) Justify your answer in (c).

Answer (d).....Odd number of throws is required to move coin to square F . [1]

83

244

- 21 $OPQR$ is a rhombus. Points R and P have position vectors $\begin{pmatrix} 4 \\ 2 \end{pmatrix}$ and $\begin{pmatrix} p+1 \\ p-1 \end{pmatrix}$, $p < 0$.

(i) Calculate the value of p .

$$\sqrt{(p+1)^2 + (p-1)^2} = \sqrt{4^2 + 2^2}$$

$$p^2 + 2p + 1 + p^2 - 2p + 1 = 20$$

$$p^2 = 9$$

$$p = \pm 3$$

$$\text{Since } p < 0, p = -3$$

Answer (i) $p = \underline{\quad -3 \quad}$ [2]

(ii) Find the coordinates of Q .

$$\overrightarrow{OQ} = \overrightarrow{OP} + \overrightarrow{PQ}$$

$$= \begin{pmatrix} -3+1 \\ -3-1 \end{pmatrix} + \begin{pmatrix} 4 \\ 2 \end{pmatrix}$$

$$= \begin{pmatrix} 2 \\ -2 \end{pmatrix}$$

$$Q(2, -2)$$

Answer (ii) $\underline{\quad Q(2, -2) \quad}$ [2]

(iii) Given that D is the point on PQ produced such that $PD = 3QD$, find $\overrightarrow{RD}$.

$$\overrightarrow{RD} = \overrightarrow{OD} - \overrightarrow{OR}$$

$$= \overrightarrow{OP} + \overrightarrow{PD} - \overrightarrow{OR}$$

$$= \begin{pmatrix} -2 \\ -4 \end{pmatrix} + \frac{3}{2} \overrightarrow{PQ} - \begin{pmatrix} 4 \\ 2 \end{pmatrix}$$

$$= \begin{pmatrix} -2 \\ -4 \end{pmatrix} + \frac{3}{2} \begin{pmatrix} 4 \\ 2 \end{pmatrix} - \begin{pmatrix} 4 \\ 2 \end{pmatrix}$$

$$= \begin{pmatrix} 0 \\ -3 \end{pmatrix}$$

Answer (iii) $\overrightarrow{RD} = \underline{\quad \begin{pmatrix} 0 \\ -3 \end{pmatrix} \quad}$ [2]

- 22 The masses, in grams, of 20 packs of sweets are shown in the ordered stem-and-leaf diagram.

(a) Find the median mass.

1	3 8 9
2	1 x 2 3 3 y
3	1 2 2 4 5 5 6 7 8
4	3 9

key 1|3 means 13

$$\text{median mass} = \frac{31+32}{2} = 31.5 \text{ grams}$$

Answer (a)31.5.....g [1]

(b) Find the value of $x + y$ if the mean mass is 29.55 grams.

$$29.55 = \frac{13+18+19+21+20+x+22+23+23+20+y+31+32+32+34+35+35+36+37+38+43+49}{20}$$

$$x + y = 10$$

Answer (b)10.....g [2]

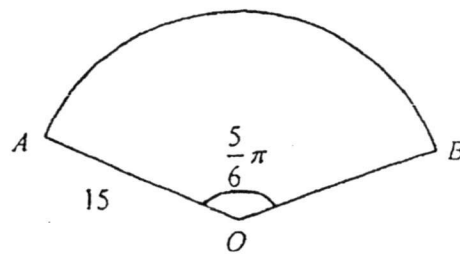
(c) Find the value of x and of y if the lower quartile is 21.5 grams.

$$21.5 = \frac{20+x+22}{2}$$

$$\left. \begin{array}{l} x=1 \\ y=9 \end{array} \right\}$$

Answer (c) $x = \dots\dots 1 \dots\dots, y = \dots\dots 9 \dots\dots$ [2]

- 23 The diagram shows the sector AOB of a circle, that represents a piece of paper. The radius of the sector is 15 cm and the angle AOB is $\frac{5}{6}\pi$ radians.



- (a) Calculate the length of arc AB .

$$\begin{aligned} S &= r\theta \\ &= 15 \left(\frac{5}{6} \pi \right) \\ &= 39.3 \text{ cm (to 3sf)} \end{aligned}$$

Answer (a)39.3.....cm [2]

- (b) The piece of paper is used to make a hollow cone by joining the edges OA and OB . Calculate the volume of the cone.

$$\begin{aligned} \text{Let } R \text{ be the radius of cone} \\ 15 \left(\frac{5}{6} \pi \right) &= 2\pi R \\ R &= 6.25 \\ \text{Volume of cone} &= \frac{1}{3} \pi 6.25^2 \sqrt{15^2 - 6.25^2} \\ &= 558 \text{ cm}^3 \text{ (to 3sf)} \end{aligned}$$

Answer (b)558.....cm³ [3]

- 24 Three toddlers, Ahmad, Betty and Charlie, were playing on a big triangular play-mat ABC , where $AB = 4$ m, $BC = 6$ m and $AC = 5$ m. After a while, Ahmad and Charlie rested at Points A and C respectively, while Betty sat at a position equidistant from Ahmad and Charlie, and equidistant from AB and AC .

(a) Using a scale of 1: 50, construct the triangular play-mat ABC . [1]

(b) By constructing suitable lines, locate and label the position of Betty. Label this position Q . [2]

Answer (a) and (b)

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8
4

- 24 Three toddlers, Ahmad, Betty and Charlie, were playing on a big triangular play-mat ABC , where $AB = 4$ m, $BC = 6$ m and $AC = 5$ m. After some time, Ahmad and Charlie rested at Points A and C respectively, while Betty sat at a position equidistant from Ahmad and Charlie, and equidistant from AB and AC .

- (a) Using a scale of 1:50, construct the triangular play-mat ABC . [1]
 (b) By constructing suitable lines, locate and label the position of Betty. Label this position Q . [2]

Answer (a) and (b)

1 cm : 50 cm

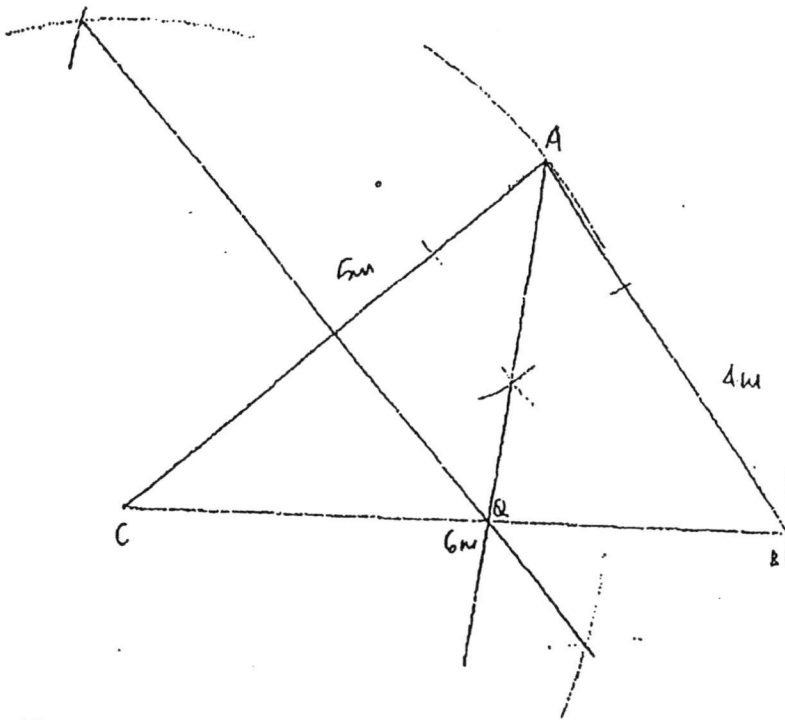
4 m : 8 cm

1 cm : 0.5 m

6 m : 12 cm

2 cm : 1 m

5 m : 10 cm



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VICTORIA SCHOOL

15/S4PR2/EM/1

[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

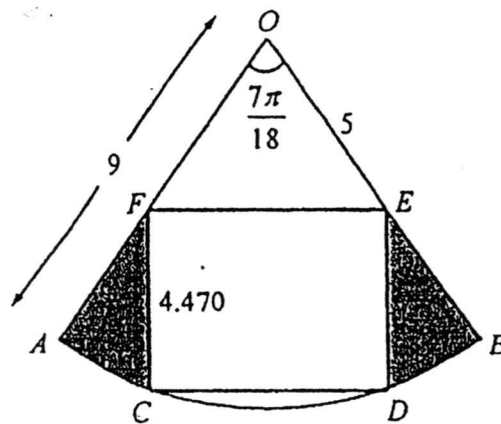
$$\text{Mean} = \frac{\sum fx}{\sum f}$$

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

Answer all the questions.

- 1 (a) Solve the equation $x(3x-8) = -3$. [2]
- (b) Given that $\frac{v}{3} = \sqrt{\frac{2(2s-v)}{s+3}}$, express s in terms of v . [3]
- (c) Express $\frac{1}{4x^2-11x-3} - \frac{3}{4x+1} - \frac{2}{3-x}$ as a single fraction in its simplest form. [4]

2



In the diagram, OAB is a sector of a circle, centre O and radius 9 cm. Rectangle $CDEF$ is inscribed in the sector. Given that angle $AOB = \frac{7\pi}{18}$ radians, $OE = OF = 5$ cm and $CF = DE = 4.470$ cm,

- (a) find the length of CD , [2]
- (b) show that angle COD is approximately 0.6486 radians, [2]
- (c) find the arc length DB , [2]
- (d) find the area of the shaded region. [3]

- 3 Given that $\varepsilon = \{x : x \text{ is an integer, } 20 \leq x \leq 99\}$

$$A = \{x : x = 2m + 1, \text{ where } m \text{ is a positive integer}\}$$

$$B = \{x : x \text{ is divisible by } 7\}$$

$$C = \{x : x \text{ is a multiple of } 6\}$$

$$D = \{x : x \text{ has a remainder of } 2 \text{ when divided by } 4\}$$

- (a) State the value of $n(\varepsilon)$ and $n(A \cap D)$. [2]
- (b) List the elements in B . [1]
- (c) Describe, as simply as possible, the meaning of $B \cap C \neq \emptyset$ in words. [1]

- 4 At a fund raising event, a class ran a fast food store and had 4 serving counters A , B , C and D . The store sold cheeseburgers, French fries and drinks. Each cheeseburger was sold at \$2.00, a packet of French fries for \$1.50 and a drink for \$1.20. The table below shows the number of items sold by each counter during the event.

Counter \ Items	A	B	C	D
Cheeseburger	61	55	58	84
French fries	74	81	84	77
Drinks	59	52	64	58

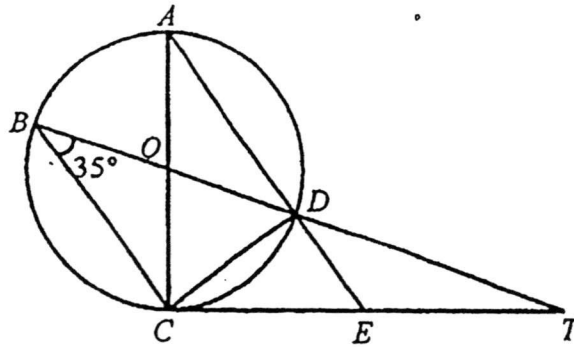
- (a) Write down a 1×3 matrix P to represent the selling price of each cheeseburger, French fries and drink sold. [1]
- (b) Write down a matrix Q such that PQ will give the total sales at each serving counter. [1]
- (c) Evaluate PQ . [1]

Matrix C is given by $C = \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \end{pmatrix}$.

- (d) Evaluate PQC . [1]
- (e) State what the element of PQC represent. [1]
- (f) If the total profit made by the class is 45% of the total sales at the event, calculate the total profit made. [2]

- 5 (a) In a n -sided regular polygon, its exterior angle is $\frac{1}{11}$ of its interior angle.
Find n . [2]

(b)



The diagram shows a circle $ABCD$, centre O .
 CET is a tangent to the circle at C .
 AC and BD passes through O .
 AE and BT intersect at D .
 $\text{Angle } CBD = 35^\circ$.

(i) Find, giving reasons for each answer,

- (a) angle COD , [1]
 (b) angle ODA , [1]
 (c) angle BTC . [1]

(ii) Given that the chord $CD = 3.3$ cm.

- (a) Show that the radius of the circle is 2.877 cm, correct to 4 significant figures. [2]
 (b) Calculate the length of the chord AD . [2]

- 6 Consider the following pattern.

$$R_1: 1 \times \frac{1}{2} = 1 - \frac{1}{2} = \frac{1}{2}$$

$$R_2: 2 \times \frac{2}{3} = 2 - \frac{2}{3} = \frac{4}{3}$$

$$R_3: 3 \times \frac{3}{4} = 3 - \frac{3}{4} = \frac{9}{4}$$

$$R_4: 4 \times \frac{4}{5} = 4 - \frac{4}{5} = \frac{16}{5}$$

.

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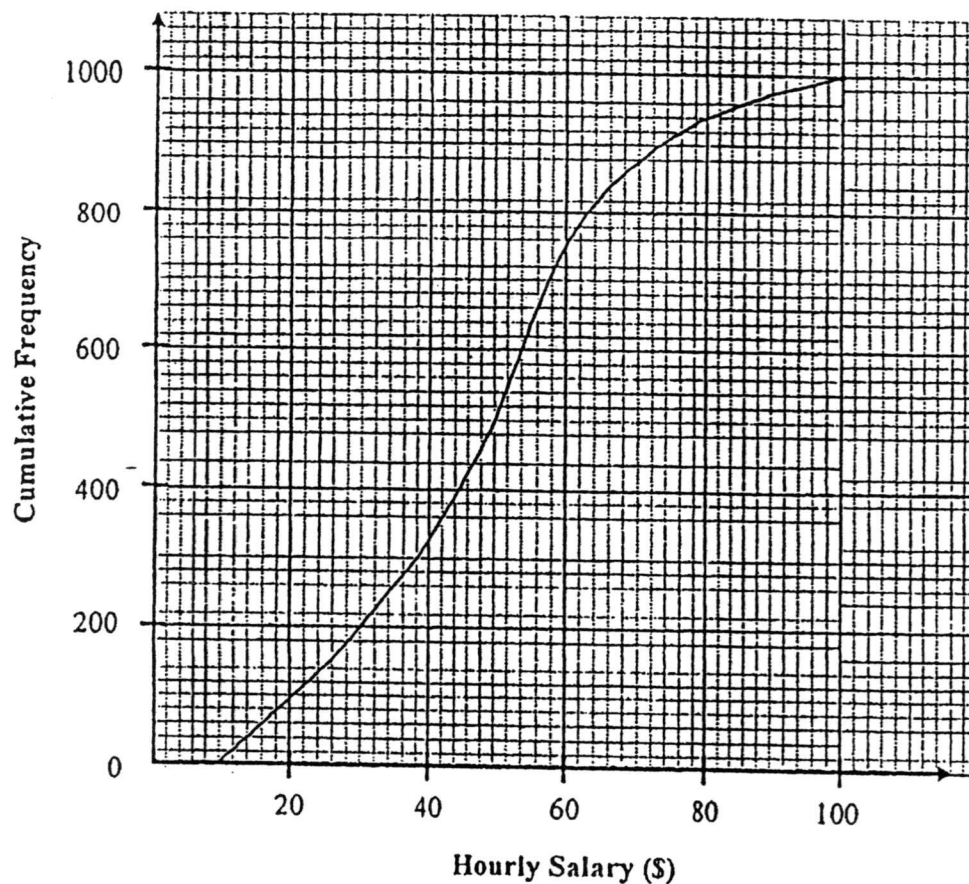
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$$R_9: 9 \times \frac{9}{y} = 9 - \frac{9}{y} = \frac{z}{y}$$

- (a) Write down the value of y and of z . [1]
- (b) If $R_a = \frac{3136}{b}$, find the value of a and of b . [2]
- (c) Write down the n^{th} line in this pattern. [1]
- (d) Given that the result of R_n is $\frac{c}{d}$, express $\frac{c}{d}$ in the form of $e + \frac{f}{n+1}$, where e is in terms of n and f is a constant. [1]
- (e) From the above pattern, express q in terms of p if $p \times q = p - q$. [1]

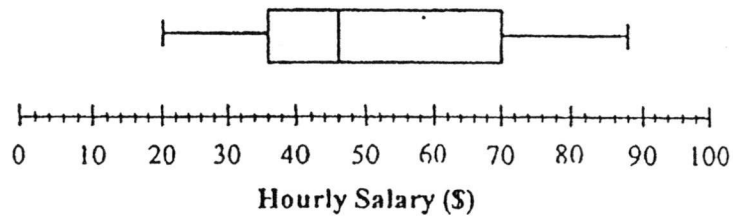
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- 7 The cumulative frequency graph below shows the distribution of hourly salary of 1000 workers in Company V.



- (a) Use the graph to estimate the
- (i) median hourly salary, [1]
 - (ii) interquartile range of the distribution, [1]
 - (iii) 60th percentile, [1]
 - (iv) value of g if 14% of the workers earn more than \$ g hourly. [1]
- (b) Two workers were selected at random from this distribution. Find the probability that one worker selected earns not more than \$30 and the other earns more than \$80 hourly. Express your answer as a fraction in its lowest terms. [2]

- (c) The hourly salary of 1000 workers in Company *S* is illustrated in a box-and-whisker diagram as shown below.



- (i) Find the median hourly salary and interquartile range of the distribution in Company *S*. [2]
- (ii) Compare and comment on the hourly salary of the workers from Company *V* and Company *S* in two different ways. [2]

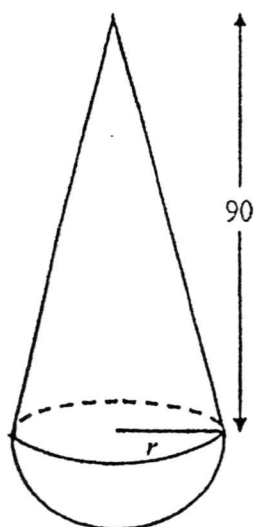


Figure A

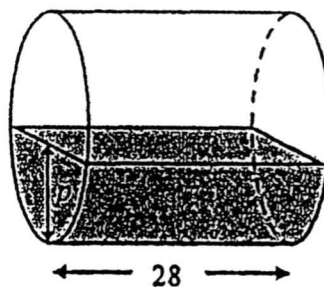


Figure B

Figure A shows a hollow container which is made by joining a hemispherical bowl of radius r cm to a right circular cone of radius r cm and height 90 cm. The capacity of the right circular cone is 4 times that of the hemispherical bowl.

(a) Calculate

- (i) the value of r , [2]
- (ii) the total exterior surface area of the container. [3]

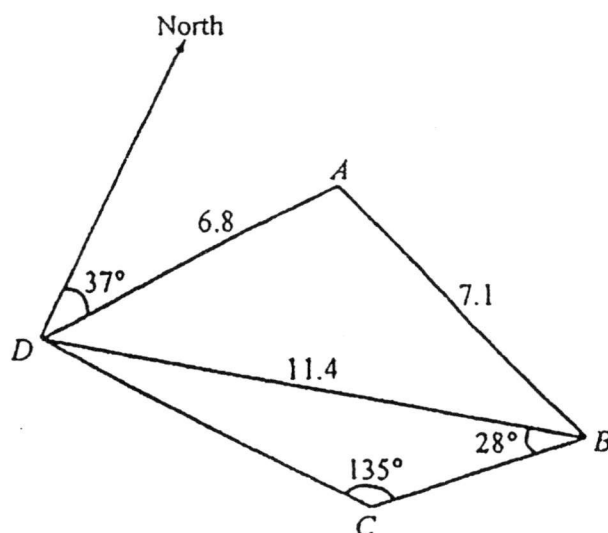
(b) The container is completely filled with water. Calculate the volume of the water in the container. [2]

Figure B shows a hollow cylindrical container which is resting on a horizontal surface. The cylinder has radius p cm and length 28 cm.

- (c) (i) If all the water from the container in Figure A is poured into the container in Figure B, it will fill up to exactly half of the capacity of Figure B. Calculate the value of p . [2]
- (ii) Find the total surface area of the inside of the container in Figure B which is in contact with the water. [2]

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The diagram shows a quadrilateral garden $ABCD$ on horizontal ground.
 $AD = 6.8$ m, $AB = 7.1$ m, $BD = 11.4$ m, angle $DBC = 28^\circ$ and angle $DCB = 135^\circ$.
 A is on a bearing of 037° from D .

(a) Calculate

- (i) angle DAB , [2]
 - (ii) the bearing of B from A , [2]
 - (iii) DC , [2]
 - (iv) the area of the garden. [3]
- (b) A vertical flagpole of height 18 m stands at A . Find the greatest possible angle of elevation of the top of the flagpole viewed from a point along BD . [3]

- 10 (a) Amos changed 4319.70 Singapore Dollars (S\$) into Japanese Yen (¥) at the bank for his trip to Tokyo. Upon returning from the trip, he has a remainder of ¥18760. The bank's exchange rates are as follows:

Singapore Dollar (S\$) to 100 Japanese Yen (¥)	Selling	Buying
	1.120	1.100

- (i) Calculate the amount of Japanese Yen Amos spent on the trip. [2]
- (ii) Find the percentage of his money that was spent on the trip. [2]

Amos decided to convert all his remaining Japanese Yen from the trip to Euro (€) at a money changer.

- (iii) Given that the exchange rate is ¥ 100 to € 0.7334, calculate the amount of euros he received from the transaction, correct to the nearest euro. [2]

- (b) The cash price of a home entertainment system is \$5799. Zayn paid for it by hire purchase, with a deposit of 15% followed by 24 equal monthly instalments, with a simple interest charged at 3.5% per annum.

Calculate the

- (i) simple interest charged, [2]
- (ii) total amount Zayn will have to pay for the home entertainment system, [2]
- (iii) amount of each instalment. [2]

11 Answer the whole of this question on a sheet of graph paper.

The table below gives some values of x and the corresponding values of y for $y = \frac{1}{4}x^2(x-3)$.

x	-2	-1	0	1	2	3	4	5
y	-5	-1	0	p	-1	0	4	q

- (a) Calculate the value of p and of q . [1]
- (b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x -axis for $-2 \leq x \leq 5$.
Using a scale of 1 cm to represent 1 unit, draw a vertical y -axis for $-6 \leq y \leq 14$.
On your axes, plot the points given in the table and join them with a smooth curve. [3]
- (c) Use your graph to find the three solutions of $\frac{1}{4}x^2(x-3) = -\frac{4}{5}$. [2]
- (d) Determine graphically the coordinate of the point S , for $-2 \leq x \leq 0$, such that the gradient of the curve at S is 1. [1]
- (e) (i) On the same axes, draw the line $y = 12 - \frac{8}{5}x$ for $0 \leq x \leq 5$. [1]
- (ii) Write down the x -coordinate of the point where this line intersects the curve. [1]
- (iii) This value of x is a solution of the equation $x^3 - 3x^2 + Ax + B = 0$.
Find the value of A and of B . [2]

End of Paper

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Answer Key:

1 (a) $x = 2.22$ or $x = 0.451$ (3 s.f.)

(b) $s = \frac{3v}{6-v}$

(c) $\frac{5x+12}{(4x+1)(x-3)}$

2 (a) $CD = 5.74$ cm (3 s.f.)

(c) Arc length $DB = 2.58$ cm (3 s.f.)

(d) 10.5 cm² (3 s.f.)

3 (a) $n(E) = 80$ and $n(A \cap D) = 0$

(b) $B = \{21, 28, 35, 42, 49, 56, 63, 70, 77, 84, 91, 98\}$

(c) There are elements which are multiples of 42.

4 (a) $P = (2 \ 1.50 \ 1.20)$ or $P = (2.00 \ 1.50 \ 1.20)$

(b) $Q = \begin{pmatrix} 61 & 55 & 58 & 84 \\ 74 & 81 & 84 & 77 \\ 59 & 52 & 64 & 58 \end{pmatrix}$

(c) $PQ = (303.80 \ 293.90 \ 318.80 \ 353.10)$

(d) $PQC = (1269.60)$

(e) The element of PQC represents the total sales from selling the cheeseburgers, French fries and drinks at all the 4 counters at the event.

(f) \$571.32

5 (a) $n = 24$

(b) (i) (a) angle $COD = 70^\circ$

(b) angle $ODA = 35^\circ$

(c) angle $BTC = 20^\circ$

 ∞

(ii) (b) $AD = 4.71$ cm (3 s.f.)

253

6 (a) $y = 10$ and $z = 81$

(b) $a = 56$ and $b = 57$

(c) $R_n: n \times \frac{n}{n+1} = n - \frac{n}{n+1} = \frac{n^2}{n+1}$

(d) $\frac{c}{d} = n - 1 + \frac{1}{n+1}$

(e) $q = \frac{p}{p+1}$

7 (a) (i) Median hourly salary = \$50

(ii) Interquartile range = \$26

(iii) 60th percentile = \$54

(iv) $g = 68$

(b) Probability = $\frac{8}{333}$

(c) (i) Median hourly salary = \$46

Interquartile range = $70 - 36$
= \$34

(ii) Workers in Company *S* earned less per hour than workers in Company *V* since the median hourly salary in Company *S* is less than that of Company *V*.

The spread of hourly salary in Company *S* is wider than that of Company *V* since the interquartile range is higher for Company *S* than that for Company *V*.

8 (a) (i) $r = 11\frac{1}{4}$ or $r = 11.25$

(ii) Total exterior surface area of container = 4000 cm^2 (3 s.f.)

(b) Total volume of water = 14900 cm^3 (3 s.f.)

(c) (i) $p = 18.4$ (3 s.f.)

(ii) Total surface area in contact with water = 2680 cm^2 (3 s.f.)

- 9 (a) (i) $\angle DAB = 110.2^\circ$ (1 d.p.)
 (ii) Bearing of B from A is 106.8° .
 (iii) $DC = 7.57$ m (3 s.f.)
 (iv) Area of garden $= 35.3 \text{ m}^2$ (3 s.f.)
 (b) Greatest possible angle of elevation $= 77.5^\circ$ (1 d.p.)
- 10 (a) (i) Amount of Yen he spent on the trip $= 366\,927.50$
 (ii) Percentage $= 95.1\%$ (3 s.f.)
 (iii) Amount of Euros received $= 138$ (nearest Euro)
 (b) (i) Simple interest $= \$ 345.04$ (2 d.p.)
 (ii) Total amount to be paid $= \$ 6144.04$ (2 d.p.)
 (iii) Amount of each instalment $= \$ 219.76$ (2 d.p.)
- 11 (a) $p = -0.5$ and $q = 12.5$
 (c) $x = -0.9$ or $x = 1.4$ or $x = 2.5$
 (d) $S(-0.5, -0.2)$
 (e) (ii) $x = 4.2$
 (iii) $A = 6\frac{2}{5}$ and $B = -48$

*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 (a) Solve the equation
- $x(3x-8)=-3$
- . [2]

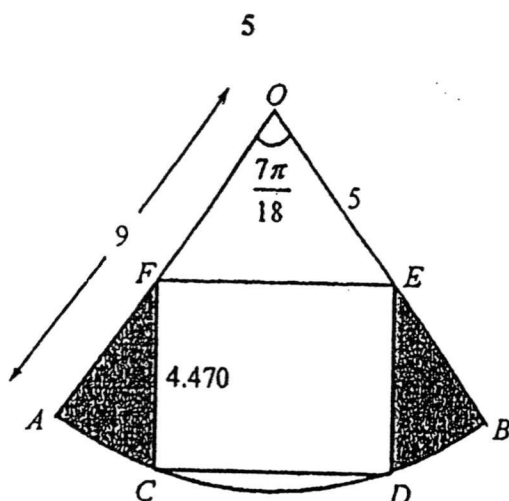
$$\begin{aligned}
 x(3x-8) &= -3 \\
 3x^2 - 8x + 3 &= 0 \\
 x &= \frac{-(-8) \pm \sqrt{(-8)^2 - 4(3)(3)}}{2(3)} \\
 &= \frac{8 \pm \sqrt{64 - 36}}{6} \\
 &= \frac{8 \pm \sqrt{28}}{6} \\
 x &= \frac{8 + \sqrt{28}}{6} \quad \text{or} \quad x = \frac{8 - \sqrt{28}}{6} \\
 x &= 2.22 \text{ (3 s.f.)} \quad \quad \quad x = 0.451 \text{ (3 s.f.)}
 \end{aligned}$$

- (b) Given that
- $\frac{v}{3} = \sqrt{\frac{2(2s-v)}{s+3}}$
- , express
- s
- in terms of
- v
- . [3]

$$\begin{aligned}
 \frac{v}{3} &= \sqrt{\frac{2(2s-v)}{s+3}} \\
 \frac{v^2}{9} &= \frac{2(2s-v)}{s+3} \\
 v^2(s+3) &= 18(2s-v) \\
 sv^2 + 3v^2 &= 36s - 18v \\
 sv^2 - 36s &= -3v^2 - 18v \\
 s(v^2 - 36) &= -3v(v+6) \\
 s &= \frac{-3v(v+6)}{v^2 - 36} \\
 s &= \frac{-3v(v+6)}{(v+6)(v-6)} \\
 s &= \frac{-3v}{v-6} \\
 s &= \frac{3v}{6-v}
 \end{aligned}$$

- (c) Express $\frac{1}{4x^2-11x-3} - \frac{3}{4x+1} - \frac{2}{3-x}$ as a single fraction in its simplest form. [4]

$$\begin{aligned} & \frac{1}{4x^2-11x-3} - \frac{3}{4x+1} - \frac{2}{3-x} \\ &= \frac{1}{(4x+1)(x-3)} - \frac{3}{4x+1} - \frac{2}{3-x} \\ &= \frac{1}{(4x+1)(x-3)} - \frac{3}{4x+1} + \frac{2}{x-3} \\ &= \frac{1-3(x-3)+2(4x+1)}{(4x+1)(x-3)} \\ &= \frac{1-3x+9+8x+2}{(4x+1)(x-3)} \\ &= \frac{5x+12}{(4x+1)(x-3)} \end{aligned}$$



In the diagram, OAB is a sector of a circle, centre O and radius 9 cm. Rectangle $CDEF$ is inscribed in the sector. Given that angle $AOB = \frac{7\pi}{18}$ radians, $OE = OF = 5$ cm and $CF = DE = 4.470$ cm,

- (a) find the length of CD ,

[2]

$$FE = \sqrt{5^2 + 5^2 - 2(5)(5)\cos\frac{7\pi}{18}}$$

$$\approx 5.736 \text{ cm}$$

$$CD = FE$$

$$CD = 5.74 \text{ cm (3 sig. fig.)}$$

- (b) show that angle COD is approximately 0.6486 radians,

[2]

$$5.736^2 = 9^2 + 9^2 - 2(9)(9)\cos COD$$

$$\cos COD = \frac{9^2 + 9^2 - 5.736^2}{2(9)(9)}$$

$$COD \approx 0.6486 \text{ (shown)}$$

- (c) find the arc length DB ,

[2]

$$BOD = \frac{1}{2}\left(\frac{7\pi}{18} - 0.6486\right)$$

$$\approx 0.28657$$

$$\text{Arc length } DB = (9)(0.2866)$$

$$= 2.58 \text{ cm (3 sig. fig.)}$$

(d) find the area of the shaded region.

[3]

Area of shaded region

$$= (\text{area of sector } AOB) - (\text{area of sector } COD) - 2(\text{area of } \triangle FOC)$$

$$= \left(\frac{1}{2} \times 9^2 \times \frac{7\pi}{18} \right) - \left(\frac{1}{2} \times 9^2 \times 0.6486 \right) - 2 \left(\frac{1}{2} \times 9 \times 5 \times \sin 0.2866 \right)$$

$$= 10.5 \text{ cm}^2 \quad (3 \text{ sig. fig.})$$

3 Given that $\varepsilon = \{x : x \text{ is an integer, } 20 \leq x \leq 99\}$

$$A = \{x : x = 2m + 1, \text{ where } m \text{ is a positive integer}\}$$

$$B = \{x : x \text{ is divisible by } 7\}$$

$$C = \{x : x \text{ is a multiple of } 6\}$$

$$D = \{x : x \text{ has a remainder of } 2 \text{ when divided by } 4\}$$

(a) State the value of $n(\varepsilon)$ and $n(A \cap D)$. [2]

$$\begin{array}{l} n(\varepsilon) = 99 - 20 + 1 \\ \quad = 80 \end{array} \quad \text{and} \quad n(A \cap D) = 0$$

(b) List the elements in B . [1]

$$B = \{21, 28, 35, 42, 49, 56, 63, 70, 77, 84, 91, 98\}$$

(c) Describe, as simply as possible, the meaning of $B \cap C \neq \emptyset$ in words. [1]

There are elements which are multiples of 42.

- 4 At a fund raising event, a class ran a fast food store and had 4 serving counters A , B , C and D . The store sold cheeseburgers, French fries and drinks. Each cheeseburger was sold at \$2.00, a packet of French fries for \$1.50 and a drink for \$1.20. The table below shows the number of items sold by each counter during the event.

Counter Items	A	B	C	D
Cheeseburger	61	55	58	84
French fries	74	81	84	77
Drinks	59	52	64	58

- (a) Write down a 1×3 matrix P to represent the selling price of each cheeseburger, French fries and drink sold. [1]

$$P = (2 \quad 1.50 \quad 1.20) \quad \text{or} \quad P = (2.00 \quad 1.50 \quad 1.20)$$

- (b) Write down a matrix Q such that PQ will give the total sales at each serving counter. [1]

$$Q = \begin{pmatrix} 61 & 55 & 58 & 84 \\ 74 & 81 & 84 & 77 \\ 59 & 52 & 64 & 58 \end{pmatrix}$$

- (c) Evaluate PQ . [1]

$$PQ = (2 \quad 1.50 \quad 1.20) \begin{pmatrix} 61 & 55 & 58 & 84 \\ 74 & 81 & 84 & 77 \\ 59 & 52 & 64 & 58 \end{pmatrix}$$

$$= (303.80 \quad 293.90 \quad 318.80 \quad 353.10)$$

Matrix $\underline{C}$ is given by $C = \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \end{pmatrix}$.

(d) Evaluate PQC.

[1]

$$\begin{aligned}
 PQC &= (2 \quad 1.50 \quad 1.20) \begin{pmatrix} 61 & 55 & 58 & 84 \\ 74 & 81 & 84 & 77 \\ 59 & 52 & 64 & 58 \end{pmatrix} \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \end{pmatrix} \\
 &= (303.80 \quad 293.90 \quad 318.80 \quad 353.10) \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \end{pmatrix} \\
 &= (1269.60)
 \end{aligned}$$

(e) State what the element of PQC represent.

[1]

The element of PQC represents the total sales from selling the cheeseburgers, French fries and drinks at all the 4 counters at the event.

(f) If the total profit made by the class is 45% of the total sales at the event, calculate the total profit made.

[2]

$$\begin{aligned}
 \text{Total profit made} &= \frac{45}{100} \times 1269.60 \\
 &= \$571.32
 \end{aligned}$$

- 5 (a) In a n -sided regular polygon, its exterior angle is $\frac{1}{11}$ of its interior angle.

Find n .

[2]

Let the exterior angle and interior angle be x and $11x$ respectively.

$$x + 11x = 180 \text{ (adj. } \angle\text{s on a str. line)}$$

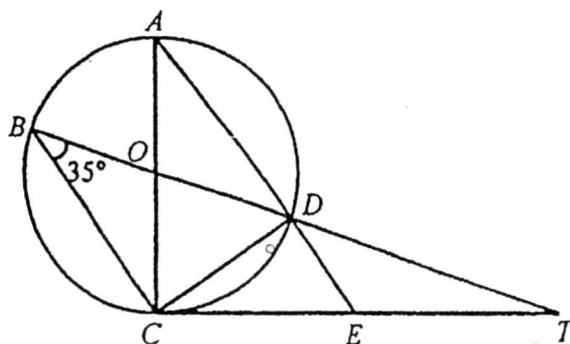
$$12x = 180$$

$$x = 15$$

$$n = \frac{360}{15}$$

$$n = 24$$

(b)



The diagram shows a circle $ABCD$, centre O .

CET is a tangent to the circle at C .

AC and BD passes through O .

AE and BT intersect at D .

Angle $CBD = 35^\circ$.

- (i) Find, giving reasons for each answer,

- (a) angle COD ,

[1]

$$\begin{aligned} \text{angle } COD &= 2 \times 35^\circ \text{ (}\angle \text{ at centre} = 2\angle \text{ at circumference)} \\ &= 70^\circ \end{aligned}$$

- (b) angle ODA ,

[1]

$$\text{angle } OAD = 35^\circ \text{ (}\angle\text{s in the same segment)}$$

$$\begin{aligned} \text{angle } ODA &= \text{angle } OAD \text{ (base } \angle\text{s of isos. } \Delta) \\ &= 35^\circ \end{aligned}$$

(c) angle BTC .

[1]

$$\text{angle } OCT = 90^\circ \text{ (tan } \perp \text{ rad)}$$

$$\begin{aligned}\text{angle } BTC &= 180^\circ - 90^\circ - 70^\circ \text{ (}\angle \text{ sum of } \Delta\text{)} \\ &= 20^\circ\end{aligned}$$

(ii) Given that the chord $CD = 3.3$ cm.

(a) Show that the radius of the circle is 2.877 cm, correct to 4 significant figures. [2]

$$\text{angle } ADC = 90^\circ \text{ (rt. } \angle \text{ in a semicircle)}$$

$$\sin 35^\circ = \frac{3.3}{AC}$$

$$AC = \frac{3.3}{\sin 35^\circ}$$

$$AC \approx 5.75337 \text{ cm}$$

$$\text{Radius} = \frac{5.75337}{2}$$

$$\text{Radius} = 2.877 \text{ cm (4 sig. fig.)}$$

Alternative working:Let the radius be r cm.

$$3.3^2 = r^2 + r^2 - 2(r)(r)\cos 70^\circ$$

$$2r^2 - 2r^2 \cos 70^\circ = 3.3^2$$

$$2r^2 (1 - \cos 70^\circ) = 3.3^2$$

$$r^2 = \frac{3.3^2}{2(1 - \cos 70^\circ)}$$

$$r \approx 2.877 \text{ (4 sig. fig.)}$$

(b) Calculate the length of the chord AD .

[2]

$$\begin{aligned}AD &= \sqrt{5.753^2 - 3.3^2} \\ &= 4.71 \text{ cm (3 sig. fig.)}\end{aligned}$$

- 6 Consider the following pattern.

$$R_1: 1 \times \frac{1}{2} = 1 - \frac{1}{2} = \frac{1}{2}$$

$$R_2: 2 \times \frac{2}{3} = 2 - \frac{2}{3} = \frac{4}{3}$$

$$R_3: 3 \times \frac{3}{4} = 3 - \frac{3}{4} = \frac{9}{4}$$

$$R_4: 4 \times \frac{4}{5} = 4 - \frac{4}{5} = \frac{16}{5}$$

...

$$R_9: 9 \times \frac{9}{y} = 9 - \frac{9}{y} = \frac{z}{y}$$

- (a) Write down the value of y and of z . [1]

$$y = 10 \text{ and } z = 81$$

- (b) If $R_a = \frac{3136}{b}$, find the value of a and of b . [2]

$$a = \sqrt{3136} \text{ and } b = 56 + 1$$

$$a = 56 \quad b = 57$$

- (c) Write down the n^{th} line in this pattern. [1]

$$\text{Row } n: n \times \frac{n}{n+1} = n - \frac{n}{n+1} = \frac{n^2}{n+1}$$

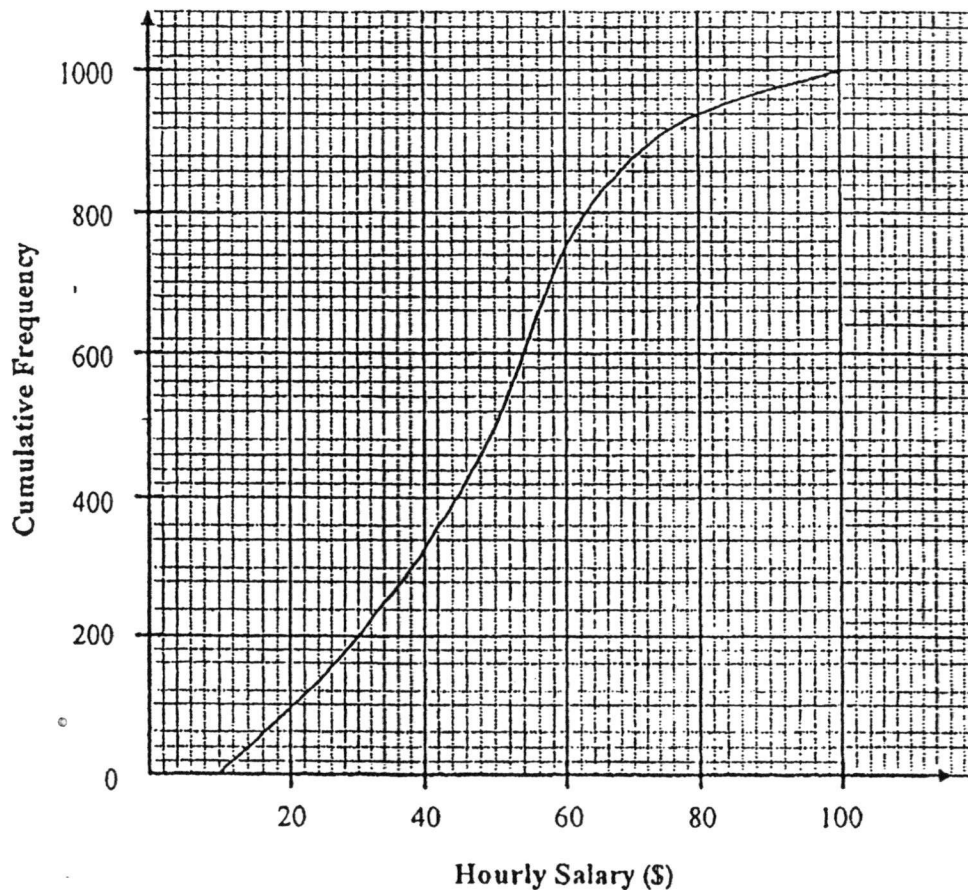
- (d) Given that the result of R_n is $\frac{c}{d}$, express $\frac{c}{d}$ in the form of $e + \frac{f}{n+1}$, where e is in terms of n and f is a constant. [1]

$$\begin{aligned}
 \frac{c}{d} &= \frac{n^2}{n+1} \\
 &= \frac{n^2-1+1}{n+1} \\
 &= \frac{n^2-1}{n+1} + \frac{1}{n+1} \\
 &= \frac{(n+1)(n-1)}{n+1} + \frac{1}{n+1} \\
 &= n-1 + \frac{1}{n+1}
 \end{aligned}$$

- (e) From the above pattern, express q in terms of p if $p \times q = p - q$. [1]

$$q = \frac{p}{p+1}$$

- 7 The cumulative frequency graph below shows the distribution of hourly salary of 1000 workers in Company V.



- (a) Use the graph to estimate the

- (i) median hourly salary, [1]

Median hourly salary = \$50

- (ii) interquartile range of the distribution, [1]

Interquartile range = 60 – 34
= \$26

- (iii) 60th percentile, [1]

$$\begin{aligned} 60\% \text{ of workers} &= \frac{60}{100} \times 1000 \\ &= 600 \end{aligned}$$

60th percentile = \$54

- (iv) value of g if 14% of the workers earn more than \$ g hourly. [1]

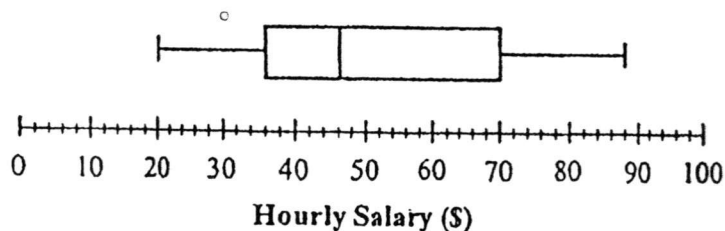
$$\begin{aligned}\text{No. of workers who earn more than } \$g &= \frac{14}{100} \times 1000 \\ &= 140\end{aligned}$$

$$g = 68$$

- (b) Two workers were selected at random from this distribution. Find the probability that one worker selected earns not more than \$30 and the other earns more than \$80 hourly. Express your answer as a fraction in its lowest terms. [2]

$$\begin{aligned}\text{Probability} &= \frac{200}{1000} \times \frac{1000 - 940}{999} \times 2 \\ &= \frac{200}{1000} \times \frac{60}{999} \times 2 \\ &= \frac{8}{333}\end{aligned}$$

- (c) The hourly salary of 1000 workers in Company S is illustrated in a box-and-whisker diagram as shown below.



- (i) Find the median hourly salary and interquartile range of the distribution in Company S . [2]

$$\text{Median hourly salary} = \$46$$

$$\begin{aligned}\text{Interquartile range} &= 70 - 36 \\ &= \$34\end{aligned}$$

- (ii) Compare and comment on the hourly salary of the workers from Company V and Company S in two different ways. [2]

Workers in Company S earned lesser per hour than workers in Company V since the median hourly salary in Company S is lesser than that of Company V .

The spread of hourly salary in Company S is wider than that of Company V since the interquartile range is higher for Company S than that for Company V .

8

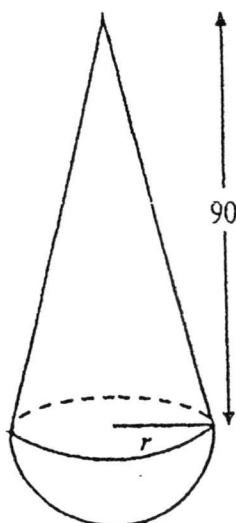


Figure A

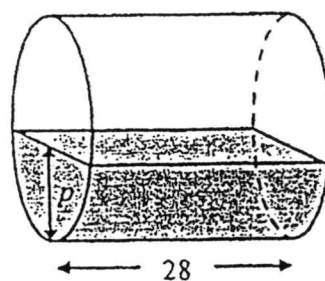


Figure B

Figure A shows a hollow container which is made by joining a hemispherical bowl of radius r cm to a right circular cone of radius r cm and height 90 cm. The capacity of the right circular cone is 4 times that of the hemispherical bowl.

(a) Calculate

(i) the value of r ,

[2]

volume of cone = 4 × volume of hemisphere

$$\frac{1}{3}\pi r^2(90) = 4 \times \frac{1}{2} \times \frac{4}{3}\pi r^3$$

$$30 = \frac{8}{3}r$$

$$r = 30 \times \frac{3}{8}$$

$$r = 11\frac{1}{4} \text{ or } r = 11.25$$

(ii) the total exterior surface area of the container.

[3]

Total exterior surface area of container

$$= \left[\pi(11.25)(\sqrt{90^2 + 11.25^2}) \right] + \left[\frac{1}{2} \times 4\pi(11.25^2) \right]$$

$$\approx 4000.83237$$

$$= 4000 \text{ cm}^2 \text{ (3 sig. fig.)}$$

- (b) The container is completely filled with water. Calculate the volume of the water in the container. [2]

Total volume of water

$$= 5 \times \frac{1}{2} \times \frac{4}{3} \pi (11.25)^3$$

$$\approx 14910.29326$$

$$= 14900 \text{ cm}^3 \text{ (3 sig.fig.)}$$

Alternative working:

Total volume of water

$$= \frac{1}{3} \pi (11.25)^2 (90) + \frac{1}{2} \times \frac{4}{3} \pi (11.25)^3$$

$$\approx 14910.29326$$

$$= 14900 \text{ cm}^3 \text{ (3 sig.fig.)}$$

Figure B shows a hollow cylindrical container which is resting on a horizontal surface. The cylinder has radius p cm and length 28 cm.

- (c) (i) If all the water from the container in Figure A is poured into the container in Figure B, it will fill up to exactly half of the capacity of Figure B. Calculate the value of p . [2]

volume of water in cylinder = 14910

$$\frac{1}{2} \pi p^2 (28) = 14910$$

$$p^2 = \frac{14910}{14\pi}$$

$$p \approx 18.41195$$

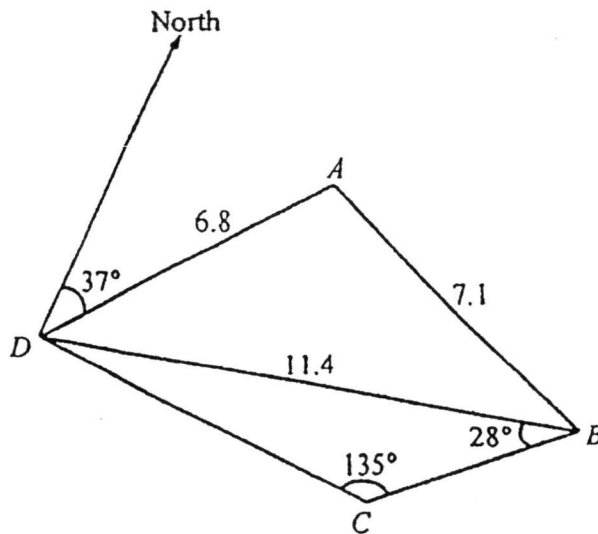
$$p = 18.4 \text{ (3 sig.fig.)}$$

- (ii) Find the total surface area of the inside of the container in Figure B which is in contact with the water. [2]

Total surface area in contact with water

$$= \pi (18.41)^2 + \frac{1}{2} (2 \times \pi \times 18.41) (28)$$

$$= 2680 \text{ cm}^2 \text{ (3 sig.fig.)}$$



The diagram shows a quadrilateral garden $ABCD$ on horizontal ground.
 $AD = 6.8$ m, $AB = 7.1$ m, $BD = 11.4$ m, angle $DBC = 28^\circ$ and angle $DCB = 135^\circ$.
 A is on a bearing of 037° from D .

(a) Calculate

(i) angle DAB ,

[2]

$$11.4^2 = 6.8^2 + 7.1^2 - 2(6.8)(7.1)\cos DAB$$

$$\cos DAB = \frac{6.8^2 + 7.1^2 - 11.4^2}{2(6.8)(7.1)}$$

$$\angle DAB \approx 110.18^\circ$$

$$= 110.2^\circ \text{ (1 dec. pl.)}$$

(ii) the bearing of B from A ,

[2]

$$\angle N_1AD = 180^\circ - 37^\circ \text{ (int. } \angle\text{s, } DN \parallel AN_1)$$

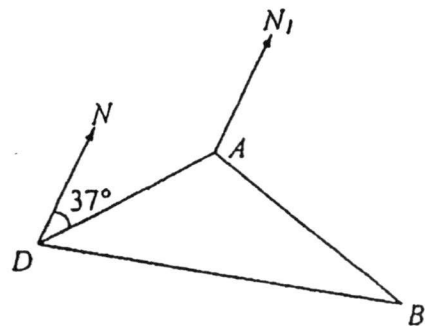
$$= 143^\circ$$

$$\angle N_1AB = 360^\circ - 143^\circ - 110.18^\circ \text{ (}\angle\text{s at a pt.)}$$

$$= 106.82^\circ$$

$$= 106.8^\circ \text{ (1 d.p.)}$$

Bearing of B from A is 106.8° .



(iii) DC,

[2]

$$\frac{DC}{\sin 28^\circ} = \frac{11.4}{\sin 135^\circ}$$

$$DC \approx 7.5688$$

$$DC = 7.57 \text{ m (3 s.f.)}$$

(iv) the area of the garden.

[3]

$$\angle BDC = 180^\circ - 135^\circ - 28^\circ \quad (\angle \text{sum of } \Delta)$$

$$= 17^\circ$$

Area of garden

$$= \left[\frac{1}{2} (6.8)(7.1) \sin 110.18^\circ \right] + \left[\frac{1}{2} (11.4)(7.569) \sin 17^\circ \right]$$

$$\approx 35.272$$

$$= 35.3 \text{ m}^2 \quad (3 \text{ s.f.})$$

- (b) A vertical flagpole of height 18 m stands at A. Find the greatest possible angle of elevation of the top of the flagpole viewed from a point along BD. [3]

Let the shortest distance from A to BD be h m.

$$\frac{1}{2} \times 11.4 \times h = \frac{1}{2} \times 6.8 \times 7.1 \times \sin 110.18^\circ$$

$$h \approx 3.975$$

Let the greatest possible angle of elevation be θ .

$$\tan \theta = \frac{18}{3.975}$$

$$\theta = 77.5^\circ \quad (1 \text{ d.p.})$$

- 10 (a) Amos changed 4319.70 Singapore Dollars (S\$) into Japanese Yen (¥) at the bank for his trip to Tokyo. Upon returning from the trip, he has a remainder of ¥18760. The bank's exchange rates are as follows:

Singapore Dollar (S\$) to 100 Japanese Yen (¥)	Selling	Buying
	1.120	1.100

- (i) Calculate the amount of Japanese Yen Amos spent on the trip. [2]

$$\begin{aligned}\text{Amount of Yen he received} &= \frac{100}{1.12} \times 4319.70 \\ &= 385\,687.50\end{aligned}$$

$$\begin{aligned}\text{Amount of Yen he spent on the trip} &= 385\,687.50 - 18\,760 \\ &= 366\,927.50\end{aligned}$$

- (ii) Find the percentage of his money that was spent on the trip. [2]

$$\begin{aligned}\text{Percentage} &= \frac{366\,927.50}{385\,687.50} \times 100\% \\ &= 95.1\% \text{ (3 s.f.)}\end{aligned}$$

Amos decided to convert all his remaining Japanese Yen from the trip to Euro (€) at a money changer.

- (iii) Given that the exchange rate is ¥ 100 to € 0.7334, calculate the amount of euros he received from the transaction, correct to the nearest euro. [2]

$$\begin{aligned}\text{Amount of Euros received} &= \frac{0.7334}{100} \times 18\,760 \\ &\approx 137.59 \\ &= 138 \text{ (nearest Euro)}\end{aligned}$$

- (b) The cash price of a home entertainment system is \$5799.
Zayn paid for it by hire purchase, with a deposit of 15% followed by 24 equal monthly instalments, with a simple interest charged at 3.5% per annum.

Calculate the

- (i) simple interest charged, [2]

$$\begin{aligned}\text{Simple interest} &= \left(\frac{85}{100} \times 5799 \right) \times \frac{3.5}{100} \times 2 \\ &\approx 345.0405 \\ &= \$ 345.04 \text{ (2 d.p.)}\end{aligned}$$

- (ii) total amount Zayn will have to pay for the home entertainment system, [2]

$$\begin{aligned}\text{Total amount to be paid} &= 5799 + 345.0405 \\ &= 6144.0405 \\ &= \$ 6144.04 \text{ (2 d.p.)}\end{aligned}$$

- (iii) amount of each instalment. [2]

$$\begin{aligned}\text{Amount of each instalment} &= \frac{\left(\frac{85}{100} \times 5799 \right) + 345.0405}{24} \\ &= \frac{4929.15 + 345.0405}{24} \\ &= \frac{5274.1905}{24} \\ &= \$ 219.76 \text{ (2 d.p.)}\end{aligned}$$

Alternative working:

$$\begin{aligned}\text{Amount of each instalment} &= \frac{6144.0405 - \frac{15}{100} \times 5799}{24} \\ &= \frac{6144.0405 - 869.85}{24} \\ &= \frac{5274.1905}{24} \\ &= \$ 219.76 \text{ (2 d.p.)}\end{aligned}$$

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- 11 Answer the whole of this question on a sheet of graph paper.

The table below gives some values of x and the corresponding values of y for

$$y = \frac{1}{4}x^2(x-3).$$

x	-2	-1	0	1	2	3	4	5
y	-5	-1	0	p	-1	0	4	q

- (a) Calculate the value of p and of q . [1]

$$p = -0.5 \text{ and } q = 12.5$$

- (b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x -axis for $-2 \leq x \leq 5$.
Using a scale of 1 cm to represent 1 unit, draw a vertical y -axis for $-6 \leq y \leq 14$.
On your axes, plot the points given in the table and join them with a smooth curve. [3]

Correct points are plotted

Smooth curve drawn

Labelling of x -axis, y -axis and equation of graph

- (c) Use your graph to find the three solutions of $\frac{1}{4}x^2(x-3) = -\frac{4}{5}$. [2]

$$x = -0.9 \text{ or } x = 1.4 \text{ or } x = 2.5$$

- (d) Determine graphically the coordinate of the point S , for $-2 \leq x \leq 0$, such that the gradient of the curve at S is 1. [1]

$$x = -0.5$$

- (e) (i) On the same axes, draw the line $y = 12 - \frac{8}{5}x$ for $0 \leq x \leq 5$. [1]

B1 for the line $y = 12 - \frac{8}{5}x$ drawn.

- (ii) Write down the x -coordinate of the point where this line intersects the curve. [1]

$$x = 4.2$$

- (iii) This value of x is a solution of the equation $x^3 - 3x^2 + Ax + B = 0$.
Find the value of A and of B .

[2]

$$\frac{1}{4}x^2(x-3) = 12 - \frac{8}{5}x$$

$$x^3 - 3x^2 = 48 - \frac{32}{5}x$$

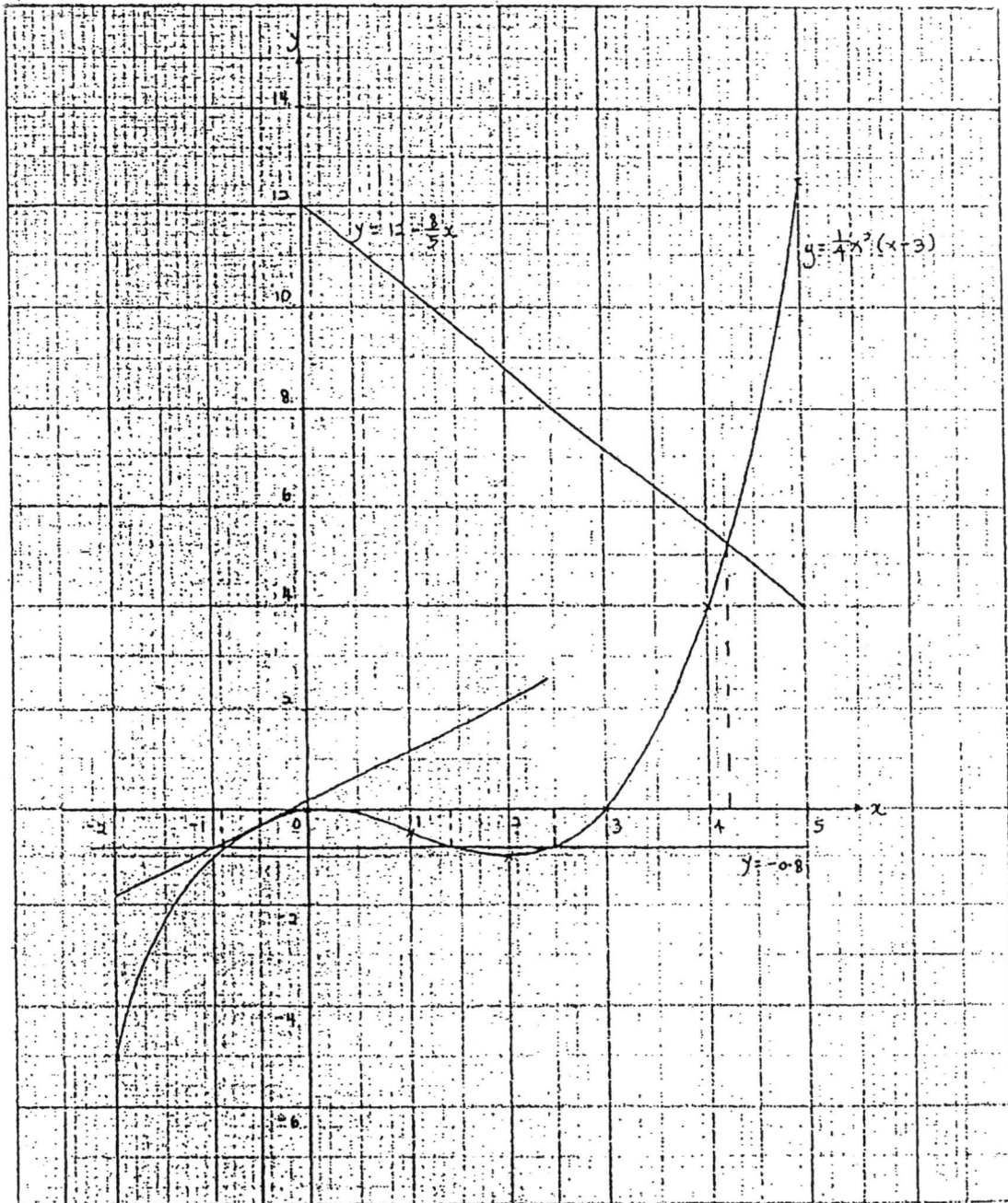
$$x^3 - 3x^2 + \frac{32}{5}x - 48 = 0$$

$$A = \frac{32}{5}$$

and

$$B = -48$$

$$A = 6\frac{2}{5}$$



End of Paper

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