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Answer **all** the questions.

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

$$7.\dot{3}\dot{5}, \frac{22}{3}, 7.\ddot{3}\ddot{5}, \sqrt{54}$$

Answer [1]

- 2 (a) Calculate $\sqrt{\frac{27.38 - 3.42^2}{0.076421}}$ and write down the first six digits on your calculator display.

Answer [1]

- (b) Write your answer to part (a) correct to 2 decimal places.

Answer [1]

- 3 Gary just bought a new iPhone which has a hard disk space of 128 gigabytes. Given that each application download takes up about 212 megabytes of disk space, find the number of applications he is able to download, giving your answer in standard form.

Answer [2]

- 4 The following are the first 4 terms in a sequence

37, 33, 29, 25.

- (a) Write down the 6th term of the sequence.

Answer [1]

- (b) Write down an expression, in terms of n , for the n^{th} term in the sequence.

Answer [1]

- 5 (a) Express 600 as a product of its prime factors.

Answer [1]

- (b) Given $126 = 2 \times 3^2 \times 7$, find the highest common factor of 126 and 600. Give your answer as the product of its prime factors.

Answer [1]

- (c) The smallest positive integer value of n such that $126n$ is a multiple of 600.

Answer [2]

6 Given x and y are integers such that $2 \leq x \leq 5$ and $-4 < y < 3$, find

(a) the greatest possible value of $x^2 - y^2$,

Answer [1]

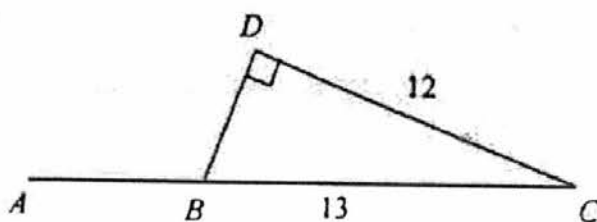
(b) the least possible value of $\frac{x}{y}$,

Answer [1]

(c) the greatest possible value of $(x - y)^2$.

Answer [1]

7



The diagram above shows triangle BCD . Given that $BC = 13$ cm, $CD = 12$ cm, $\angle BDC = 90^\circ$ and ABC is a straight line.

(a) Find BD .

Answer cm [1]

(b) Write down $\cos \angle ABD$.

Answer [1]

- 8 Given that y is inversely proportional to the square of x , find the percentage decrease in y when x is increased by 400%.

Answer% [3]

- 9 (a) Factorise completely $75x^4 - 147x^2$.

Answer [2]

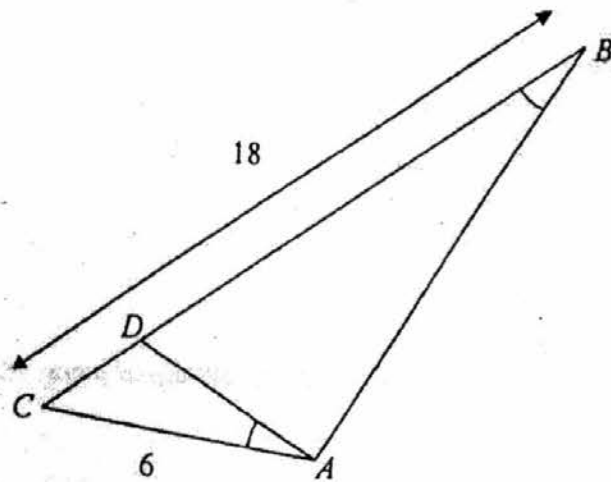
- (b) Factorise completely $2x + 8xy - 6a - 24ay$.

Answer [2]

- 10 Given that $3^3 \times 3^{k+1} \div 3^{2k} = 729$, find the value of k

Answer $k = \dots\dots\dots$ [2]

11



The diagram shows a triangle ABC such that $BC = 18$ cm and $AC = 6$ cm.

D is a point on BC such that $\angle DAC = \angle ABC$.

- (a) Show that triangle ABC is similar to triangle DAC , stating your reasons clearly.

Answer

.....

.....

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.....

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..... [3]

(b) Hence calculate

(i) CD ,

Answercm [1]

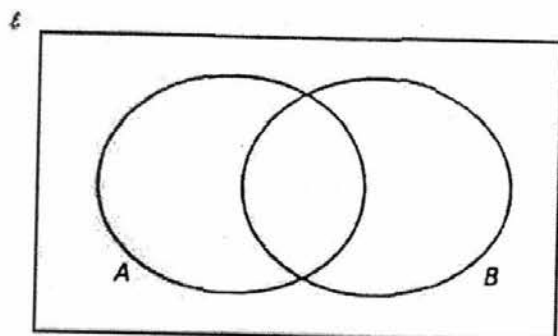
(ii) $\frac{\text{area of } \triangle DAC}{\text{area of } \triangle ABC}$,

Answer [1]

(iii) $\frac{\text{area of } \triangle DAC}{\text{area of } \triangle ADB}$,

Answer [1]

- 12 (a) On the Venn Diagram below, shade the set $A' \cap B'$.



[1]

(b)

$U = \{x : x \text{ is an integer such that } 1 \leq x \leq 20\}$

$A = \{x : x \text{ is a prime number}\}$

$B = \{x : x \text{ is a perfect square}\}$

$C = \{x : x \text{ is multiple of 4}\}$

- (i) List the elements found in the set $B \cap C$.

Answer [1]

- (ii) Find $n(A \cap B)'$.

Answer [1]

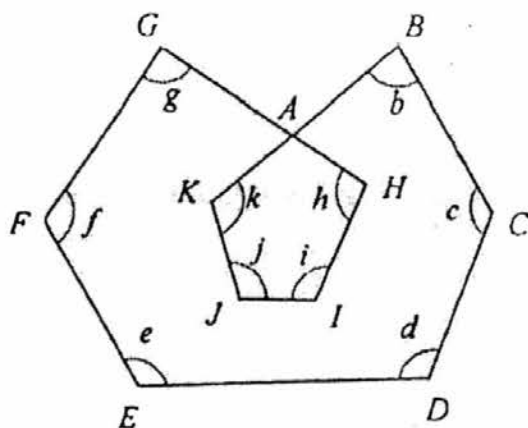
13 (a) Simplify $\frac{3a^2b^4}{4c^3d} \div \left(\frac{6a^3b}{cd}\right)^2$.

Answer [2]

(b) Simplify $(3k-2)(4k+5) + (k-4)^2$.

Answer [3]

- 14 The diagram below shows a figure $ABCDEFG$ and a pentagon $AHIJK$. Given that GAH and BAK are straight lines, calculate the sum of $\angle b + \angle c + \angle d + \angle e + \angle f + \angle g + \angle h + \angle i + \angle j + \angle k$.



Answer° [2]

- 15 (a) Express $-x^2 + 6x - 7$ in the form $-(x-a)^2 + b$.

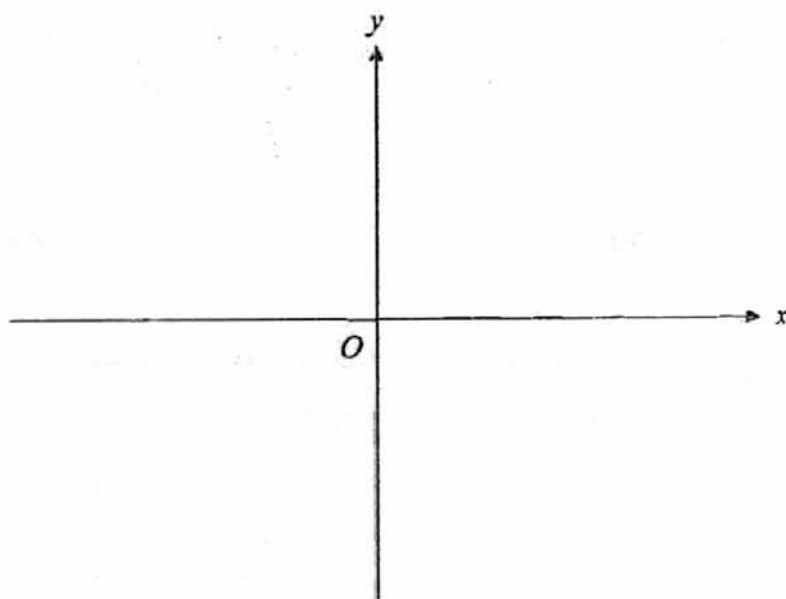
Answer [2]

- (b) Hence or otherwise, solve $-x^2 + 6x - 7 = 0$, showing your workings clearly. Give your answers correct to three decimal places.

Answer $x = \dots\dots\dots$ or $\dots\dots\dots$ [2]

- (c) Hence, sketch the graph of $y = -x^2 + 6x - 7$, labeling all x intercepts and turning points.

Answer



[2]

- (d) Write down the equation of the line of symmetry of the graph $y = -x^2 + 6x - 7$.

Answer $\dots\dots\dots$ [1]

16 The line $5x + 2y = 22$ cuts the x -axis at A and the y -axis at B .

(a) Find the coordinates of A and B .

Answer $A(\dots, \dots), B(\dots, \dots)$ [2]

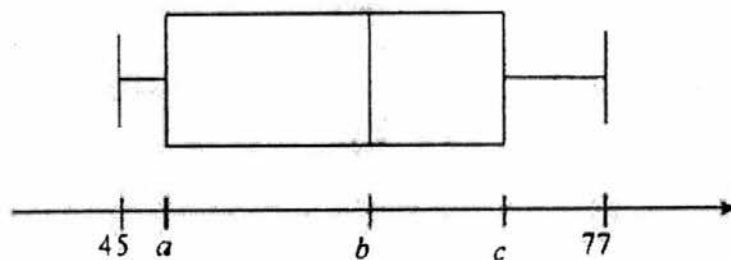
(b) Find the length of AB .

Answerunits [2]

(c) Another line L is parallel to $5x + 2y = 22$ and passes through the point $(2, 4)$. Find the equation of the line L .

Answer $y = \dots$ [2]

- 17 A box-and-whisker diagram below shows the points scored in 10 basketball games. The results were 45, 77, 60, 47, 63, 69, 71, 48, 73, and 55.



- (a) Find the values of a , b and c .

Answer $a = \dots\dots\dots$, $b = \dots\dots\dots$, $c = \dots\dots\dots$ [2]

- (b) The score 60 was accidentally left out. Using the remaining results from the 9 basketball games, find the new interquartile range of the 9 basketball games.

Answer $\dots\dots\dots$ [2]

- 18 The cash price of a new laptop is \$1500. Ash bought the laptop on hire purchase and paid a deposit of 20% of the cash price followed by 24 months installment at 2.5% per annum compound interest. Calculate

(a) the total amount of interest,

Answer \$..... [3]

(b) the monthly installment.

Answer \$..... [2]

- 19 The table below shows the tax rates on chargeable income for the year of assessment 2016.

Chargeable Income (\$)	Tax Rate (%)	Tax payable (\$)
On the first 20,000	0	0
On the next 10,000	2	200
On the first 30,000	-	200
On the next 10,000	3.5	350
On the first 40,000	-	550
On the next 40,000	7	2800
On the first 80,000	-	3350
On the next 40,000	11.5	4600

Michael paid a total of \$5 937.50 in 2016 for his income tax. He received a 3 months bonus and his tax reliefs amount to \$10 000. (Chargeable income = Annual income – total tax relief)

Calculate

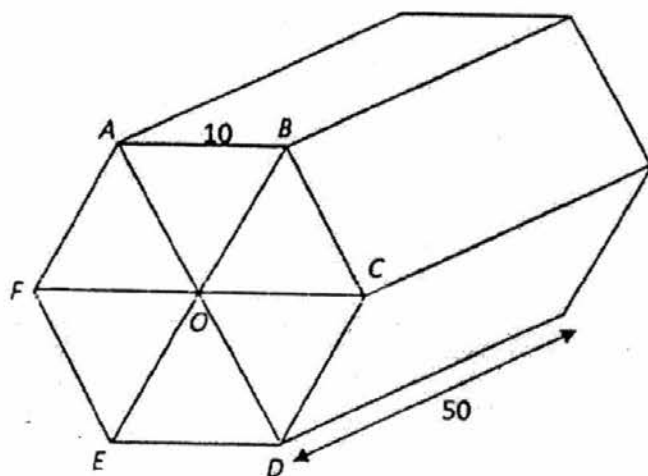
- (a) Michael's chargeable income,

Answer \$..... [3]

- (b) Michael's monthly salary.

Answer \$..... [2]

- 20 The diagram shows a closed hexagonal prism. The cross section of the prism is a regular hexagon made up of six equilateral triangles, with sides of length 10 cm. The length of the prism is 50 cm.



Calculate

- (a) the volume of the prism,

Answercm³ [2]

- (b) the surface area of the prism.

Answercm² [2]

- (c) A manufacturer wants to produce a geometrically similar giant hexagonal prism. The cross-section of the giant prism has sides of length 2 m. Given that the cost of producing one small hexagonal prism is \$20, calculate the cost of producing the giant hexagonal prism (assume that cost is directly proportional to volume).

Answer \$..... [2]

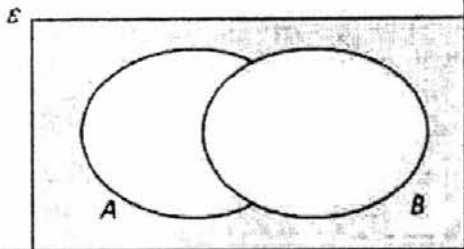
- (a) Construct a quadrilateral $ABCD$ where $BC = 7.3$ cm, $CD = 9.2$ cm and $AD = 8.1$ cm and $\angle BAD = 105^\circ$. AB has already been drawn.
- (b) Construct,
- (i) the perpendicular bisector of AD ,
 - (ii) the angle bisector of $\angle ABC$.
- (c) Mark clearly a possible point which is inside the quadrilateral $ABCD$, equidistant from A and D , and is nearer to AB than BC .
Label this point T .

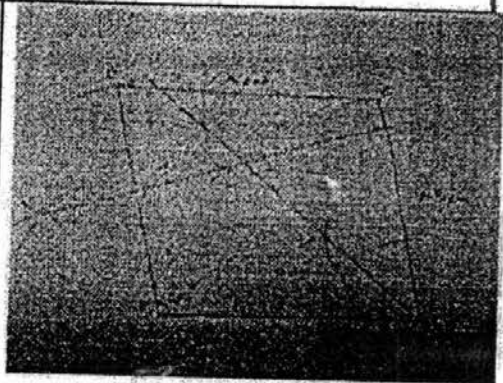
Answer



[6]

~ End of Paper ~

1	$\frac{22}{3}, \sqrt{54}, 7.\dot{3}\dot{5}, 7.3\dot{5}$	12a	
2a	14.3257	12bi	$\{4, 16\}$
2b	14.33	12bii	20
3	6.03×10^3	13a	$\frac{b^2d}{48a^2c}$
4a	17	13b	$13k^2 - k + 6$
4b	$41 - 4n$	14	1080°
5a	$2^3 \times 3 \times 5^2$	15a	$-(x-3)^2 + 2$
5b	2×3	15b	4.414 or 1.586
5c	100	15d	$x = 3$
6a	25	16a	$A(4.4, 0), B(0, 11)$
6b	-5	16b	11.8 units
6c	64	16c	$y = -\frac{5}{2}x + 9$
7a	5	17a	$a = 48, b = 61.5, c = 71$
7b	$-\frac{5}{13}$	17b	24.5
8	96%	18a	\$60.75
9a	$3x^2(5x-7)(5x+7)$	18b	\$52.53
9b	$2(x-3a)(1+4y)$	19a	\$102500

10	-2	19b	\$7500
11a	$\angle ABC = \angle DAC$ (Given) $\angle BCA = \angle ACD$ (Common angle) $\angle BAC = \angle ADC$ (Angles sum of triangle) $\therefore \triangle ABC$ is similar to $\triangle DAC$ (AAA Similarity)	20a	13000 cm ²
11bi	2	20b	3520 cm ²
11bij	$\frac{1}{9}$	20c	\$160000
11biii	$\frac{1}{8}$	21	

Answer questions 1 to 5 in Booklet A.

- 1 (a) Given that $\frac{2m}{3m+y} = \frac{x}{5n}$,
- (i) find the value of x when $m = 3$, $n = -2$ and $y = 1$, [2]
- (ii) express m in terms of n , x and y . [2]
- (b) Express as a single fraction in its lowest term, $\frac{10}{2a-3} - \frac{7}{9-6a}$. [2]
- (c) (i) Factorise completely $8p^3 - 2p$. [1]
- (ii) Hence, simplify $\frac{8p^3 - 2p}{-2p^2 + 7p - 3}$. [2]
-

- 2 In 2014, Mr Lim paid an average of \$350 for his monthly petrol bill when the price of petrol was \$ x per litre. In 2015, the price of petrol had risen by 25 cents per litre. By cutting down on usage, Mr Lim still managed to pay an average of \$350 for his petrol bill in 2015.
- (a) Write down an expression, in terms of x , for the number of litres of petrol used by Mr Lim in 2014. [1]
- (b) Write down an expression, in terms of x , for the number of litres of petrol used by Mr Lim in 2015. [1]
- (c) If the number of litres of petrol used in 2015 is 20 less than that used in 2014, form an equation in x and show that it reduces to $8x^2 + 2x - 35 = 0$. [3]
- (d) Solve the equation $8x^2 + 2x - 35 = 0$, giving your answer correct to 3 decimal places. [3]
- (e) Use the results found in part (d) to find the number of litres of petrol used by Mr Lim in 2015, giving your answer correct to the nearest 0.1 litre. [1]
-

[Turn over

- 3 Two key ingredients in a cereal bar consists of rolled oats and cocoa solids. Jessica made two types of cereal bars, Type A and Type B. In total, she made 25 cups of Type A and 32.5 cups of Type B. The table below shows the number of cups of rolled oats and cocoa solids found in one cup of each type.

	Rolled Oats (cups)	Cocoa solids (cups)
Type A	1.5	2
Type B	2.5	1.5

- (a) Write down a 2×2 matrix P to represent the above table. [1]

Given a matrix $Q = \begin{pmatrix} x \\ y \end{pmatrix}$,

- (b) find PQ in terms of x and y , [2]

- (c) use $PQ = \begin{pmatrix} 25 \\ 32.5 \end{pmatrix}$ to find the values of x and y . [3]

- (d) explain what the elements in Q represent. [1]

- 4 (a) A survey was carried out to find out how many television programmes a group of 50 teenagers watched during a week in June. The results collected is shown in the table below.

Number of programmes	0	1	2	3	4
Number of teenagers	7	10	12	8	13

- (i) Calculate
- (a) the mean number of programmes watched, [1]
- (b) the standard deviation. [1]

- (ii) The results for another group of teenagers are summarised below.

Mean	2.46
Standard deviation	3

Make two comparisons between the number of programmes watched by the two groups of teenagers.

[2]

- (b) Five cards are numbered 1, 4, 6, 7 and 9 respectively. Two cards are drawn, one by one without replacement, and the sum of the numbers are recorded.

(i) Show all the possible outcomes in a possibility diagram. [1]

Hence, find the probability that the sum is

(ii) an even number, [1]

(iii) a multiple of 3, [1]

A third card is drawn.

(iv) Find the probability that the sum of the three cards is 14. [2]

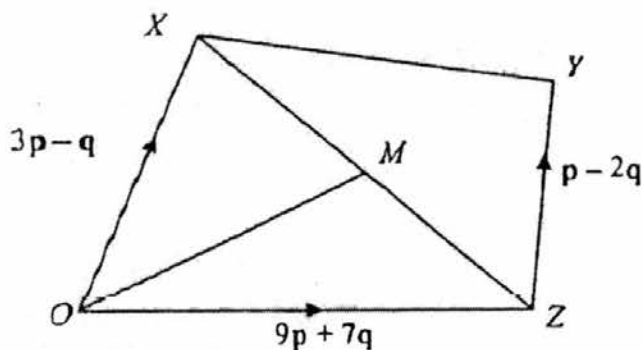
- 5 (a) R is the point $(3, 5)$ and S is the point $(-2, 6)$.

(i) Write down the column vector $\overrightarrow{RS}$. [1]

(ii) Find $|\overrightarrow{RS}|$. [2]

(iii) If $\overrightarrow{PR} = \begin{pmatrix} 8 \\ -5 \end{pmatrix}$, find the coordinates of the point P . [2]

- (b) In the diagram, M is the midpoint of XZ , $\overrightarrow{OX} = 3\mathbf{p} - \mathbf{q}$, $\overrightarrow{OZ} = 9\mathbf{p} + 7\mathbf{q}$ and $\overrightarrow{ZY} = \mathbf{p} - 2\mathbf{q}$.



- (i) Express as simply as possible in terms of $\mathbf{p}$ and/or $\mathbf{q}$,

(a) $\overrightarrow{XZ}$, [1]

(b) $\overrightarrow{XM}$, [1]

(c) $\overrightarrow{OM}$, [1]

(d) $\overrightarrow{MY}$. [2]

- (ii) Show that OM , when produced, will pass through Y . [2]

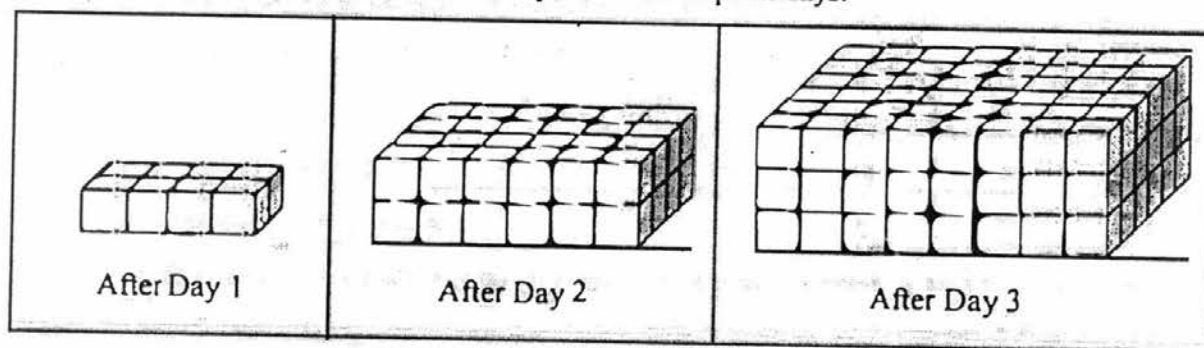
Answer questions 6 to 8 in Booklet B.

- 6 In a large warehouse, cubical boxes of identical sizes are stacked in a particular pattern. The length of each side of a box is 40 cm.

On Day 1, 8 boxes are placed to form a rectangular block at the centre of the warehouse, as shown in the diagram below.

On Day 2, the rectangular block is enlarged by adding boxes to surround the previous day's block, as show below.

Similar arrangement are carried out in Day 3 and subsequent days.



The total number of boxes in the rectangular block formed after completion of each day's stacking, is calculated and recorded in the table below.

Day	Total number of boxes	Number of boxes added
1	$4 \times 2 \times 1 = 8$	8
2	$6 \times 4 \times 2 = 48$	40
3	$8 \times 6 \times 3 = 144$	96
4	T_4	a
...	...	...

(a) Find

(i) T_4 , [1]

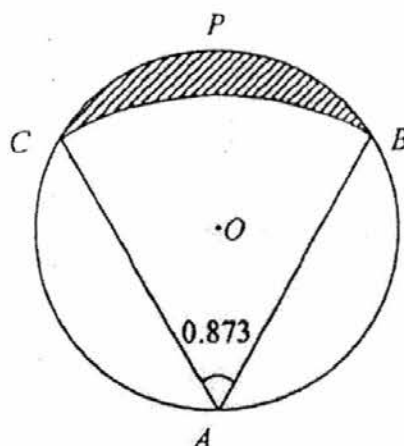
(ii) an expression in terms of n , for T_n . [1]

(b) (i) Find the value of a . [1]

(ii) Show that the formula for the number of boxes added on Day n is $4n(3n-1)$. [3]

(iii) Given that the total number of boxes added on Day n is 1408, calculate the value of n . [2]

- 7 The diagram shows a circle $ABPC$ with centre O and radius 10 cm. A sector ABC with centre A is inscribed in the circle as shown.



Given that $\angle BAC = 0.873$ radians, find

- (a) AC , [2]
 (b) the area of the shaded region. [6]

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

The variables x and y are connected by the equation

$$y = \frac{x^3}{4} - \frac{3x^2}{2} + x + 1$$

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

x	-1	0	1	2	3	4	5	6
y	-1.75	1	0.75	-1	-2.75	-3	p	7

- (a) Calculate the value of p . [1]
 (b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x -axis for $-2 \leq x \leq 6$.
 Using a scale of 2 cm to represent 1 unit, draw a vertical y -axis for $-4 \leq y \leq 7$.
 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 solutions of the equation $\frac{x^3}{4} - \frac{3x^2}{2} + x + 1 = 0$. [2]
 (d) Find the x -coordinate(s) of the point(s) where the curve has a gradient of 1. [2]
 (e) By drawing a suitable straight line on your graph, solve $\frac{x^3}{4} - \frac{3x^2}{2} + 2x - 1 = 0$. [2]

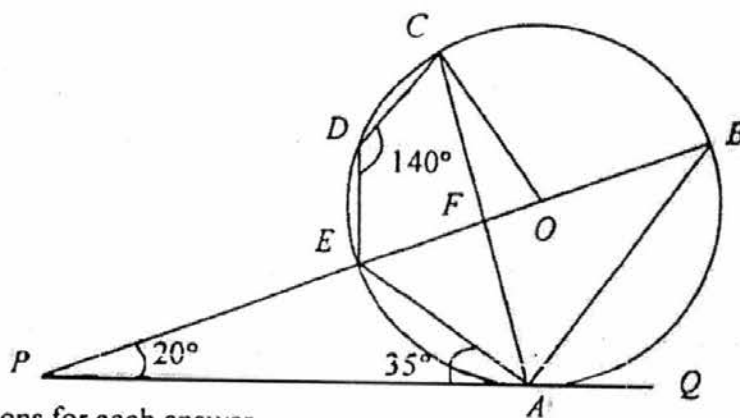
Answer questions 9 to 11 in Booklet C.

- 9 The diagram shows a circle with centre O and passes through A, B, C, D and E .

PAQ is a tangent to the circle.

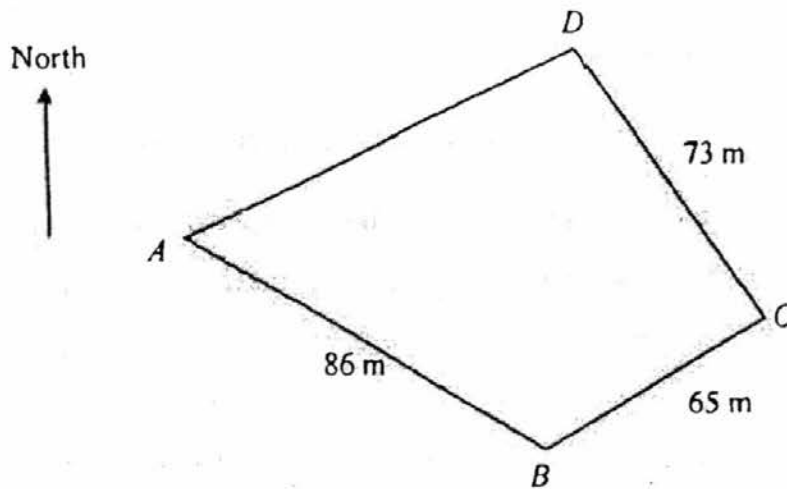
The diameter BE is extended to meet the tangent at P .

Angle $CDE = 140^\circ$, angle $BPQ = 20^\circ$ and angle $PAE = 35^\circ$.



Find, giving reasons for each answer,

- angle BAE , [1]
- angle CAE , [1]
- angle COE , [1]
- angle ACB . [2]
- A point X , is to be marked on the diagram, on the same side of BE as A so that angle $CXE = 30^\circ$. Deduce whether X lies on the circumference of the circle, inside the circle or outside the circle, giving a reason for your answer. [2]



In the diagram, $ABCD$ is a horizontal plot of land.

$AB = 86$ m, $BC = 65$ m and $CD = 73$ m.

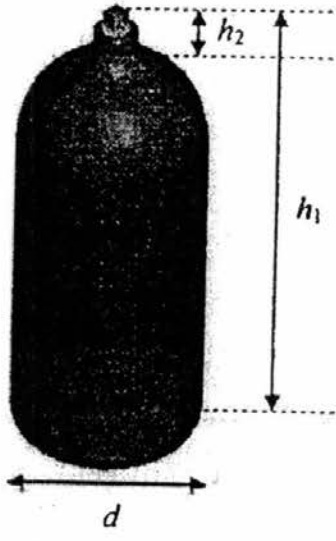
The bearing of B from A is 143° ; the bearing of C from B is 051° and the bearing of D from C is 314° .

- (a) Calculate AC . [3]
- (b) Find the bearing of C from A . [3]
- (c) Calculate the area of $\triangle ACD$. [3]
- (d) The base of a vertical mast is at B .

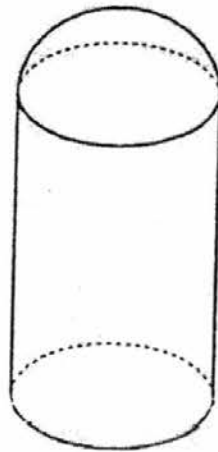
The angle of elevation of the top of the mast from A is 15.6° .

Calculate the angle of elevation of the top of the mast from C . [3]

- 11 Information about a container for a liquid is given below.

Container Mass of empty container: 500 g Bottle Diameter (d): 131 mm Bottle Height (h_1): 366 mm Neck Height (h_2): 36 mm	
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The above container, excluding the neck, can be modelled as a cylinder with a hemisphere on top as shown in the diagram below.

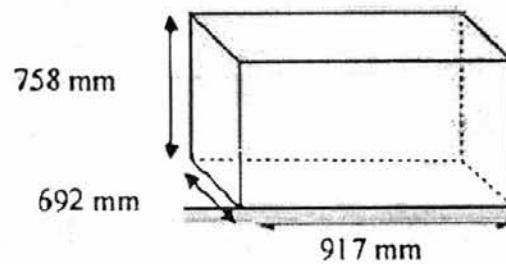


- (a) Workout
- the height, in centimetres, of the cylinder, [1]
 - the volume, in cubic centimetres, of the container, excluding the neck. [2]
- (b) The container is filled up with a liquid of density 0.75 g/cm^3 until the bottom of the neck. Calculate the total mass of the liquid. _ [2]

- (c) A transport basket is used to transport the containers filled with the liquid. The containers will be placed lying down in the basket. The maximum load that the transport basket can carry is 150 kg.



Assume that the basket can be modelled in the form of a cuboid below.



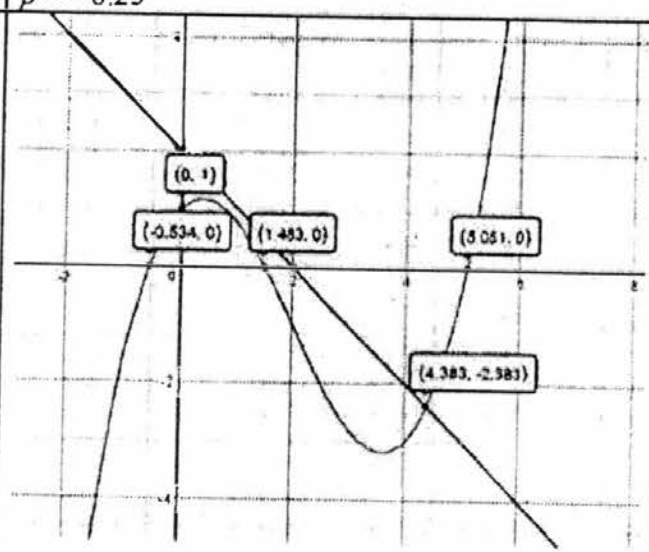
Find the maximum number of containers filled with liquid that can be transported by the basket at any one time. Justify your decision with calculations. [4]

END OF PAPER

[Turn over

E Math Paper 2 – Answer Key

1. (a)	(i)	$x = -6$																																												
	(ii)	$m = \frac{xy}{10n - 3x}$																																												
(b)		$\frac{37}{3(2a-3)}$																																												
(c)	(i)	$2p(2p+1)(2p-1)$																																												
	(ii)	$\frac{2p(2p+1)}{3-p}$ or $\frac{-2p(2p+1)}{p-3}$																																												
2. (a)		$\frac{350}{x}$																																												
(b)		$\frac{350}{x+0.25}$																																												
(d)		1.970 or -2.220																																												
(e)		157.7 litres																																												
3. (a)		$\begin{pmatrix} 1.5 & 2 \\ 2.5 & 1.5 \end{pmatrix}$																																												
(b)		$\begin{pmatrix} 1.5x+2y \\ 2.5x+1.5y \end{pmatrix}$																																												
(c)		$x = 10, y = 5$																																												
(d)		The total number of cups of oats used is x (10) and total number of cups of cocoa solids used is y (5).																																												
4. (a)	(i) (a)	Mean = 2.2																																												
	(b)	Std dev = 1.39																																												
	(ii)	1. The second group of teenagers watched more programmes than the first group as its mean (2.46) is larger than that of the first group (2.2). 2. However, the data for the first group is more consistent as it has a smaller standard deviation (2.6) than that of the second group (3).																																												
(b)	(i)	<table><tr><td></td><td colspan="6">1st Draw</td></tr><tr><td rowspan="6">2nd Draw</td><td>+</td><td>1</td><td>4</td><td>6</td><td>7</td><td>9</td></tr><tr><td>1</td><td></td><td>5</td><td>7</td><td>8</td><td>10</td></tr><tr><td>4</td><td>5</td><td></td><td>10</td><td>11</td><td>13</td></tr><tr><td>6</td><td>7</td><td>10</td><td></td><td>13</td><td>15</td></tr><tr><td>7</td><td>8</td><td>11</td><td>13</td><td></td><td>16</td></tr><tr><td>9</td><td>10</td><td>13</td><td>15</td><td>16</td><td></td></tr></table>		1 st Draw						2 nd Draw	+	1	4	6	7	9	1		5	7	8	10	4	5		10	11	13	6	7	10		13	15	7	8	11	13		16	9	10	13	15	16	
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	(ii)	$\frac{2}{5}$																																												
	(iii)	$\frac{1}{10}$																																												

	(iv)	$\frac{1}{5}$
5. (a)	(i)	$\begin{pmatrix} -5 \\ 1 \end{pmatrix}$
	(ii)	$\sqrt{(-5)^2 + 1^2} = \sqrt{26}$ or 5.10 units
	(iii)	$P(-5, 10)$
(b)	(i) (a)	$6p + 8q$ or $2(3p + 4q)$
	(b)	$3p + 4q$
	(c)	$6p + 3q$ or $3(2p + q)$
	(d)	$4p + 2q$ or $2(2p + q)$
6. (a)	(i)	$T_4 = 10 \times 8 \times 4 = 320$
	(ii)	$4n^2(n+1)$
(b)	(i)	176
	(ii)	$4n(3n-1)$ or $12n^2 - 4n$
	(iii)	$n = 11$
7. (a)		18.1 cm
(b)		20.5 cm ²
8. (a)		$\rho = -0.25$
(b)		
(c)		-0.53, 1.48, 5.05
(d)		$x = 0$ or 4
(e)		4.38
9. (a)		90°
(b)		40°
(c)		80°
(d)		55°
(e)		X must lie outside the circle.

(c)		1860 m ²
(d)		20.3°
11.(a)	(i)	26.45 cm
	(ii)	4150 cm ³
(b)		3120 g
(c)		41