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1 A map is drawn to a scale of 1 : 20 000.

- (a) (i) This scale can be expressed as 1 cm represents n km.
Find n . [1]
- (ii) The distance between two towns on the map is 20 cm.
Find the actual distance, in kilometres, between the two towns. [1]
- (iii) A garden has a map area of 0.25 cm^2 .
Find the actual area, in square kilometres, of the garden. [2]
- (b) Lee is making a pond in the garden.
He has a maximum of \$100 to spend on a water pump for the pond.
The pump must have a flow rate of at least 250 litres per minute.

His local garden centre has four water pumps for sale.

Pump	Cost	Flow rate
A	\$92.50	4.2 litres per second
B	\$104.99	4.4 litres per second
C	\$80.75	13 000 litres per hour
D	\$89.99	15 120 litres per hour

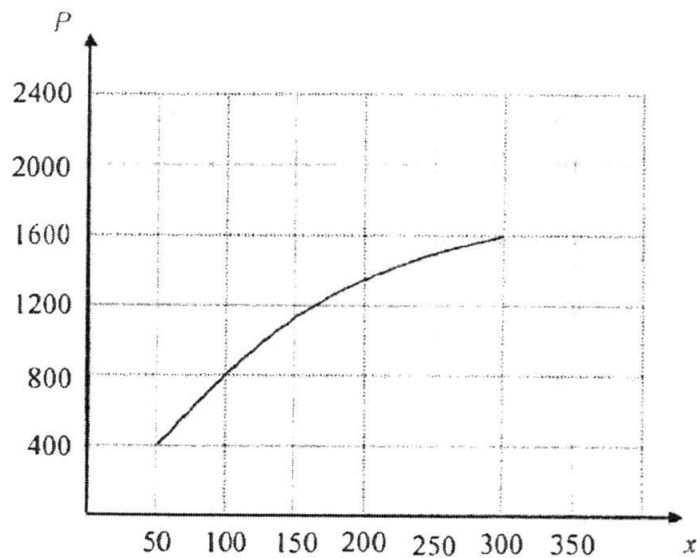
Explain which pump he should buy. [2]

2 The table below shows information about the population and area of four different countries in 2016.

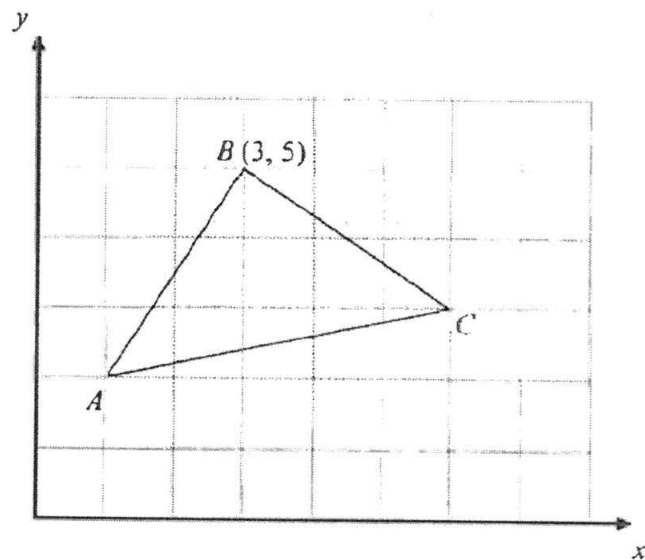
	Singapore	Malaysia	UK	Australia
Population	5.6×10^6	2.9×10^7	6.4×10^7	2.8×10^7
Area (km^2)	700	3.4×10^5	2.4×10^5	7.7×10^6

- (a) Find the ratio of the population of Singapore to the population of Australia.
Give your answer in the form of 1 : n . [1]
- (b) How many more people live in UK than in Singapore?
Give your answer in standard form. [2]
- (c) Calculate the average number of people per square kilometres in Malaysia. [2]

- 3 (a) A company earns a weekly profit of P dollars by selling x items. The graph below shows how P varies with x .



- (i) Find the weekly profit per item for 100 items. [1]
- (ii) Estimate the weekly profit for 350 items. [1]
- (b) Find the area of triangle ABC below. [2]



- 4 Part of a number grid is shown below.

A square can be placed anywhere on the grid outlining four numbers.

The numbers in opposite corners of the square are multiplied together and the difference between the products is found.

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20				

$$9 \times 14 - 8 \times 15 = 126 - 120$$

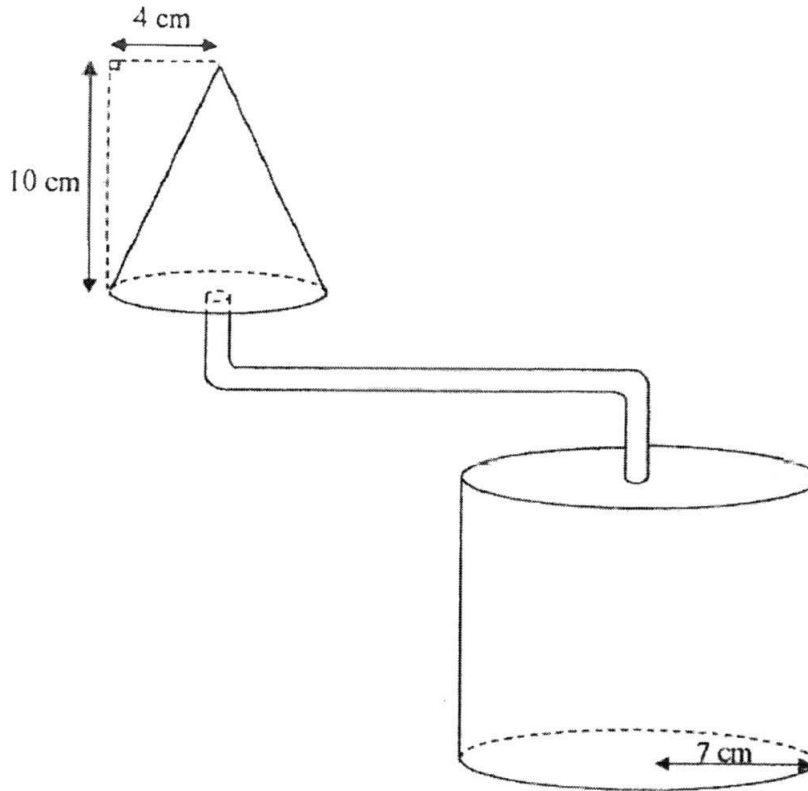
$$= 6$$

The grid is continued downwards.

- (a) If n represents the number in the top left corner of the square, write down an expression in terms of n , for the number in the bottom right corner of the square. [1]
- (b) Show that the difference between the products of the numbers in the opposite corners of the square is always 6. [2]
- (c) Show that the sum of the four numbers in the square cannot be 260. [3]

- 5 The diagram shows a cone with radius 4 cm and height 10 cm which is full of water. A pipe connects the cone to a cylinder.

The cylinder has a radius of 7 cm.



- (a) Calculate the volume of water in the cone. [1]
- (b) Water flows from the cone through the pipe into the empty cylinder at a constant rate of 2 cm^3 per second.
- (i) Calculate the time taken to empty the cone in seconds. [1]
- (ii) Find the height of the water in the cylinder when the cone is empty. [2]

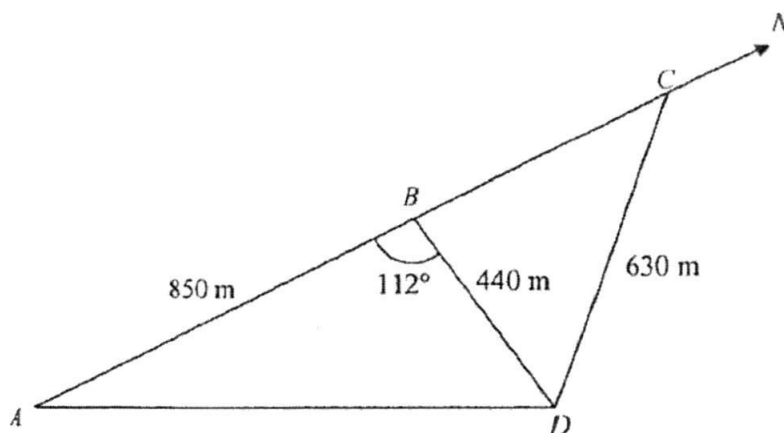
- 6 (a) (i) Solve the inequality $17 - 3x < 3x + 1 \leq 46 - 5x$. [2]
- (ii) Represent your answer on a number line. [1]
- (b) Given that $-6 \leq a \leq 10$ and $2 \leq b \leq 7$, find the smallest value of $\frac{a}{b}$. [1]
- (c) A rectangle has length 127 cm and width 87 cm, both correct to the nearest whole number. Calculate the least and greatest possible perimeter of the rectangle. [3]
- (d) Given that $7^m = 3$ and $7^n = 8$, find the value of $7^{2m - \frac{n}{3}}$. [3]

7 The distance between London and York is 320 km.

A train takes x hours to travel from London to York.

- (a) Write down an expression, in terms of x , for the average speed of the train in km/h. [1]
- (b) A car takes $2\frac{1}{2}$ hours longer than the train to travel from London to York.
Write down an expression, in terms of x , for the average speed of the car in km/h. [1]
- (c) The average speed of the train is 80 km/h greater than the average speed of the car. Form an equation in x and show that it simplifies to $2x^2 + 5x - 20 = 0$. [3]
- (d) Solve the equation $2x^2 + 5x - 20 = 0$. [3]
- (e) Find the average speed of the car correct to the nearest km/h. [2]

- 8 Four points A , B , C and D on level ground are as shown in the diagram below.



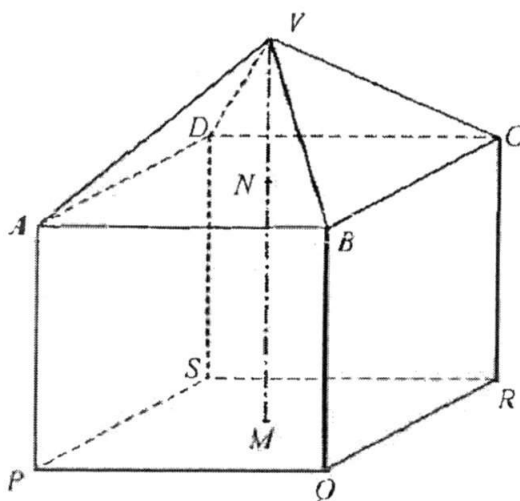
ABC is a straight line. C is due North of A and $\angle ABD = 112^\circ$. It is given that $AB = 850\text{ m}$, $BD = 440\text{ m}$ and $CD = 630\text{ m}$.

- (a) Find
- (i) AD , [3]
 - (ii) $\angle BCD$, [2]
 - (iii) the bearing of D from C , [1]
 - (iv) the bearing of C from D . [1]
- (b) A vertical building at point B has a height of 380 m .
Find the greatest angle of elevation of the top of the building from a point along AD . [4]

- 9 A man wants to build a farmhouse as shown in the diagram below.



The farmhouse can be modelled by a square pyramid sitting on a cuboid.



Its roof is represented by a square-based pyramid, $VABCD$. The vertical line, VNM , passes through the centres, N and M , of the horizontal squares $ABCD$ and $PQRS$.
 $AB = 60\text{ m}$ and $VN = 40\text{ m}$.

- (a) Show that the total surface area of the slant roof in the model is 6000 m^2 . [3]
- (b) (i) The slant roof in the model is to be covered with tiles with dimensions of 30 cm by 20 cm by 1 cm . Information about the tiles is shown below.

Useful Information

- Density of tiles : 2.6 g/cm^3
- 1 kg is equivalent to 9.81 N

Find the weight of each tile, in N . [3]

- (ii) The roof in the model will collapse if the total weight of the tiles exceeds 1600 kN . Justify whether this type of tile is suitable. [5]

10 Answer the whole of this question on a piece of graph paper.

The table below gives some values of x and y where $y = 12 + 8x + \frac{27}{x}$.

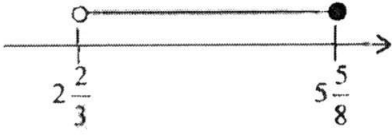
x	1	1.5	2	2.25	3	3.5
y	p	42	41.5	42	45	47.7

- (a) Find the value of p . [1]
- (b) Using a scale of 2 cm to 0.5 units, draw a horizontal x -axis for $0 \leq x \leq 4$.
Using a scale of 2 cm to 1 unit, draw a vertical y -axis for $38 \leq y \leq 48$.
On your axes, plot the points given in the table and join them with a smooth curve. [3]
- (c) Find the gradient of the curve at the point where $x = 1.5$. [2]
- (d) Use your graph to find the values of x for which $12 + 8x + \frac{27}{x} = 46$. [2]
- (e) Explain why the line $x = 1.875$ is not a line of symmetry for the curve
 $y = 12 + 8x + \frac{27}{x}$. [1]
- (f) The line AB has a gradient of -1 and passes through the point $(0, 52)$. The
 x coordinates of the points where the line AB intersects the curve
 $y = 12 + 8x + \frac{27}{x}$ are the solutions of the equation $9x^2 + ax + b = 0$.
Find the values of a and b . [4]

End of Paper

Answers

No	Solution	No	Solution
1(a)(i)	$n = 0.2$	7(a)	$\frac{320}{x}$
1(a)(ii)	4 km	7(b)	$\frac{320}{x + 2.5}$
1(a)(iii)	0.01 km ²	7(c)	$\frac{320}{x} - 80 = \frac{320}{x + 2.5}$
1(b)	Flow rate for A = 252 l/min Flow rate for C = $216\frac{2}{3}$ l/min Flow rate for D = 252 l/min He should buy pump D.	7(d)	$x = 2.15, -4.65$
2(a)	1 : 5	7(e)	69 km/h
2(b)	5.84×10^7 people	8(a)(i)	AD = 1090 or 1093.75762 or 1093 m
2(c)	85.3 people/km ²	8(a)(ii)	$\angle BCD = 40.4^\circ, 40.36^\circ, 40.35766^\circ$
3(a)(i)	\$8 per item	8(a)(iii)	$139.6^\circ, 139.64^\circ, 139.64234^\circ$
3(a)(ii)	\$1620 - \$1750	8(a)(iv)	$319.6^\circ, 319.64^\circ, 319.64234^\circ$
3(b)	6.5 units ²	8(b)	$319.6^\circ, 319.64^\circ, 319.64234^\circ$
4(a)	$n + 7$	9(b)(i)	15.30360 N
4(b)	$(n+1)(n+6) - n(n+7)$ $= 6$	9(b)(ii)	1530.36 kN < 1600 kN Tile is suitable
4(c)	$n = 61.5$ n is a whole number/natural number/positive integer/integer. Or n cannot be a fraction/decimal. Therefore the sum cannot be 260.		

No	Solution	No	Solution
5(a)	168cm^3	10(a)	$p = 47$
5(b)(i)	83.8 s	10(c)	-4
5(b)(ii)	$h = 1.09\text{cm}$	10(d)	$1.0\text{ to }1.1, 3.15\text{ to }3.25$
6(a)(i)	$2\frac{2}{3} < x \leq 5\frac{5}{8}$	10(e)	y is different at $x = 1.8$ and $x = 1.95$. $x = 1.875$ is not a line of symmetry.
6(a)(ii)		10(f)	$a = -40, b = 27$
6(b)	-3		
6(c)	$426\text{ cm}, 430\text{ cm}$		
6(d)	4.5		