

Mensuration 4024
Compiled by: Mustafa Asif

35. Mensuration	<ul style="list-style-type: none">• solve problems involving:<ul style="list-style-type: none">(a) the perimeter and area of a rectangle and triangle(b) the perimeter and area of a parallelogram and a trapezium(c) the circumference and area of a circle(d) arc length and sector area as fractions of the circumference and area of a circle(e) the surface area and volume of a cuboid, cylinder, prism, sphere, pyramid and cone(f) the areas and volumes of compound shapes	Formulae will be given for the surface area and volume of the sphere, pyramid and cone.
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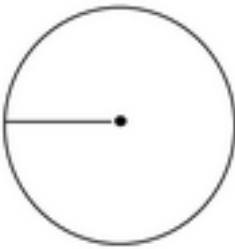
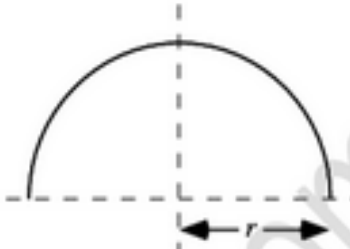
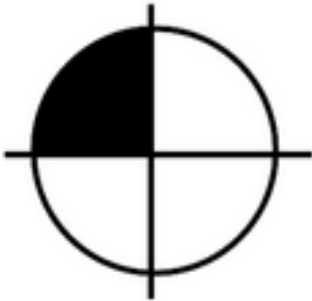
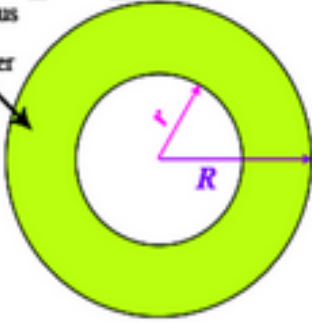
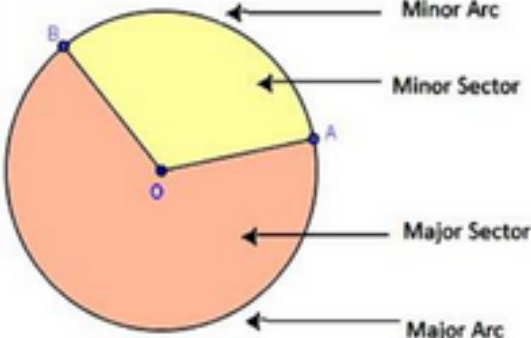
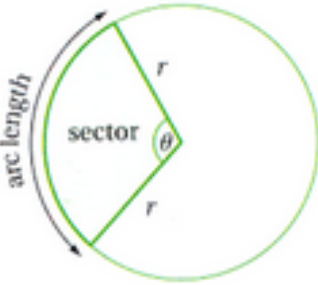
Links for understanding

https://www.youtube.com/watch?v=WPYNjbl4_G8



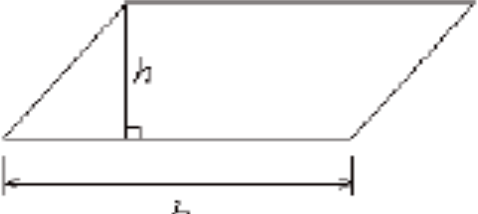
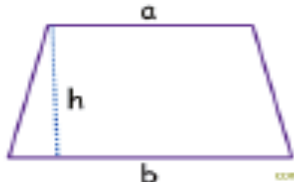
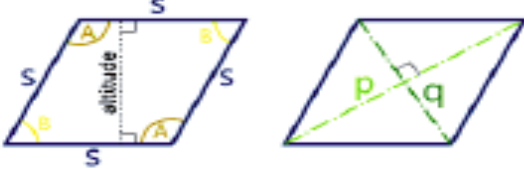
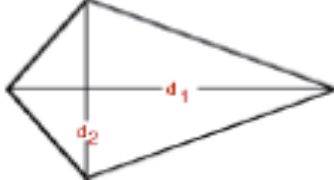
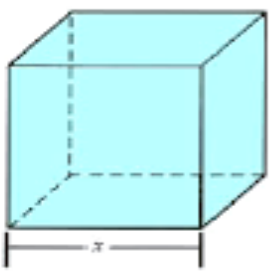

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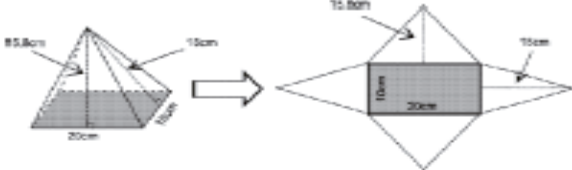
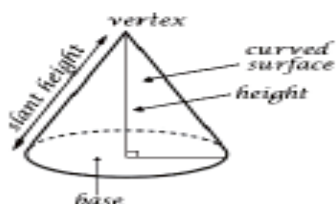
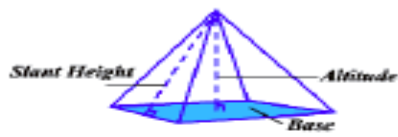
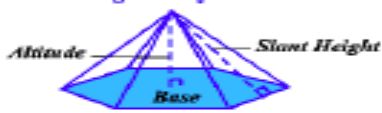

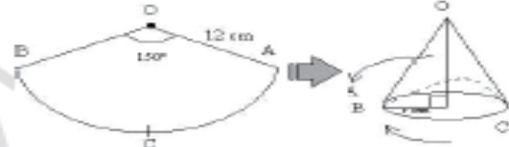

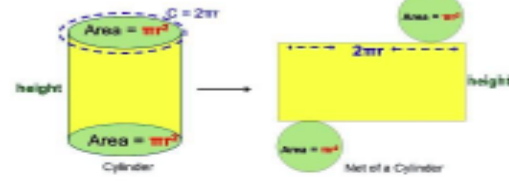

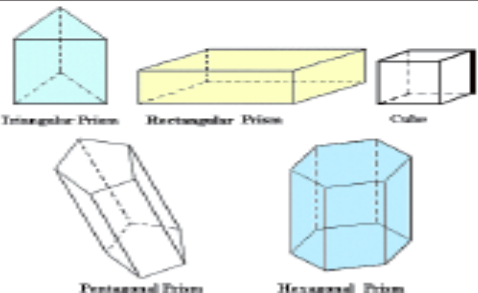
<https://www.youtube.com/watch?v=S4l9ekP5kLc>

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 <p>Area of circle = πr^2 Circumference of circle = $2\pi r = 2d$</p>	 <p>Area of Semi circle = $\frac{1}{2} \times \pi r^2$ Circumference of semi circle = $\frac{1}{2} \times 2\pi r$</p>
 <p>Area of Quad circle = $\frac{1}{4} \pi r^2$ Circumference of Quad circle = $\frac{1}{4} \times 2\pi r$</p>	 <p>Area of washer = $\pi R^2 - \pi r^2$ Perimeter of washer = $2\pi R + 2\pi r$</p>
 <p>Minor Arc Minor Sector Major Sector Major Arc</p>	 <p>Area of sector = $\frac{\theta}{360} \times \pi r^2$ Length of arc = $\frac{\theta}{360} \times 2\pi r$ Perimeter of sector = $\frac{\theta}{360} \times 2\pi r + 2r$</p>

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 <p>Area of Square = x^2 Perimeter of Square = $4x$</p>	 <p>Area of Rectangle = $L \times W$ Perimeter of Rectangle = $2(L + W)$</p>
 <p>Area of Parallelogram = $b \times h$ Perimetr of Parallelogram = sum of all sides</p>	 <p>Area of Trapezium = $\frac{1}{2} h (a + b)$ Perimetr of Trapezium = sum of all sides</p>
 <p>Area of rhombus = $h \times s$ Or Area of rhombus = $\frac{p \times q}{2}$ Perimeter of rhombus = $4s$</p>	 <p>Area of kite = $\frac{d_1 \times d_2}{2}$ Perimeter of kite = sum of sides</p>
 <p>Surface area (S.A.) = $6x^2$ Volume (V) = x^3</p>	<p>SUFACE AREA AND VOLUME OF CUBOID</p>  <p>cuboid</p> <ul style="list-style-type: none"> • Total Surface Area: $2(lb + bh + hl)$ • Lateral Surface Area: $2h(l + b)$ • Volume: $l \times b \times h$ <p>Picture: Shant</p>

 <p>Volume of pyramid = $\frac{1}{3} \times \text{base area} \times \text{height}$</p> <p>Surface area of pyramid = Base Area + Area of all triangles</p>  <p>Volume of cone = $\frac{1}{3} \times \pi r^2 h$</p> <p>Curved Surface of cone = $\pi r l$</p> <p>Total Surface of cone = $\pi r l + \pi r^2$</p>	<p>Square Pyramid</p>  <p>Hexagonal Pyramid</p>    <p>Figure 6a Figure 6b</p>
 <p>Volume of cylinder = $\pi r^2 h$</p> <p>Curved Area of cylinder = $2\pi r h$</p> <p>Total surface area of cylinder without top = $2\pi r h + \pi r^2$</p>	<p>Aim: How do we find the surface area of prisms and cylinders?</p>  <p>Surface Area of a Cylinder: Area of 2 circles + Area of the rectangle = $2\pi r^2 + 2\pi r h$</p>
 <p>Volume of prism = base area \times height</p> <p>Surface Area of prism = (perimeter of base \times h) + 2 \times Base area</p>	 <p>Triangular Prism Rectangular Prism Cube</p> <p>Pentagonal Prism Hexagonal Prism</p>



Volume of sphere = $\frac{4}{3}\pi r^3$
Surface area of sphere = $4\pi r^2$



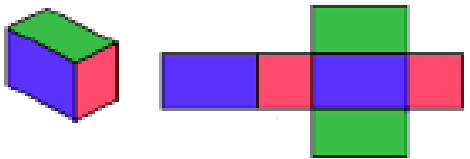
area of curved surface = $\frac{1}{2} \times 4\pi r^2$
area of flat face = πr^2

Volume of hemisphere = $\frac{1}{2} \times \frac{4}{3}\pi r^3$
= $\frac{2}{3}\pi r^3$

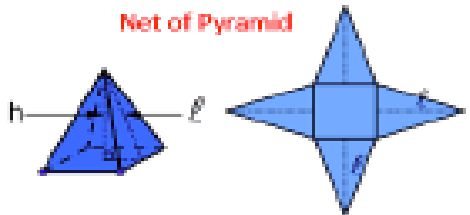
Surface area of hemisphere = $\frac{1}{2} \times 4\pi r^2 + \pi r^2$
= $3\pi r^2$

Nets of Solids

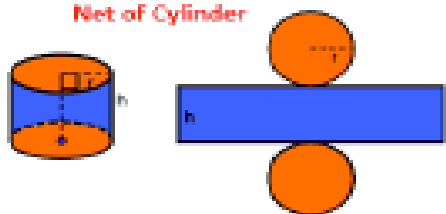
Net of Rectangular Prism



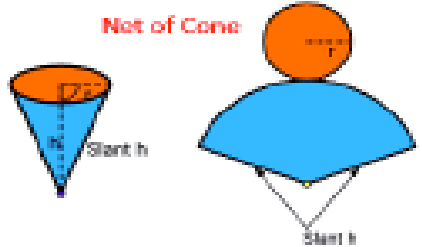
Net of Pyramid



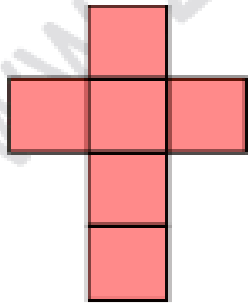
Net of Cylinder



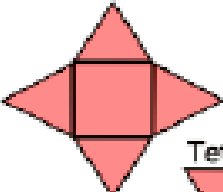
Net of Cone



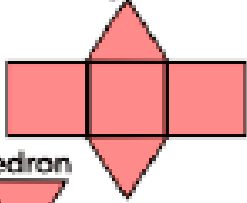
Cube



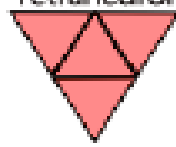
Square Based Pyramid



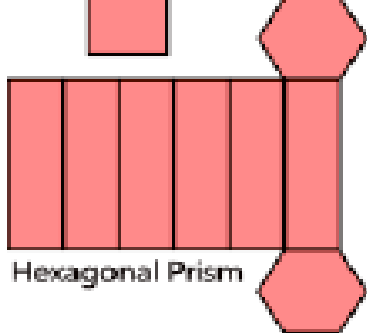
Triangular Prism



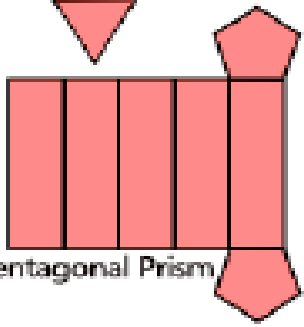
Tetrahedron



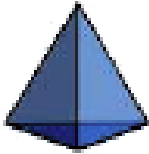

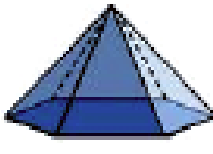
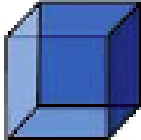
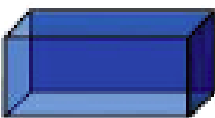
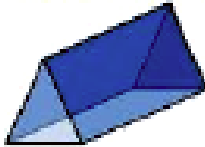
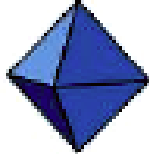




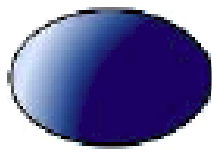



Hexagonal Prism



Pentagonal Prism



Faces, Edges and Vertices of 3D Shapes

		
Tetrahedron Faces: 4; Edges: 6; Vertices: 4	Square pyramid Faces: 5; Edges: 8; Vertices: 5	Hexagonal pyramid Faces: 7; Edges: 12; Vertices: 7
		
Cube Faces: 6; Edges: 12; Vertices: 8	Cuboid Faces: 6; Edges: 12; Vertices: 8	Triangular prism Faces: 5; Edges: 9; Vertices: 6
		
Octahedron Faces: 8; Edges: 12; Vertices: 6	Pentagonal prism Faces: 7; Edges: 15; Vertices: 10	Hexagonal prism Faces: 8; Edges: 18; Vertices: 12
		
Dodecahedron Faces: 12; Edges: 30; Vertices: 20	Sphere Faces: 1; Edges: 0; Vertices: 0	Ellipsoid Faces: 1; Edges: 0; Vertices: 0
		
Icosahedron Faces: 20; Edges: 30; Vertices: 12	Cone Faces: 2; Edges: 1; Vertices: 0 or 1	Cylinder Faces: 3; Edges: 2; Vertices: 0

Rate of Flow:

Flow rate is the amount of fluid flowing in the given time. It is expressed in m^3/s or litre/second,

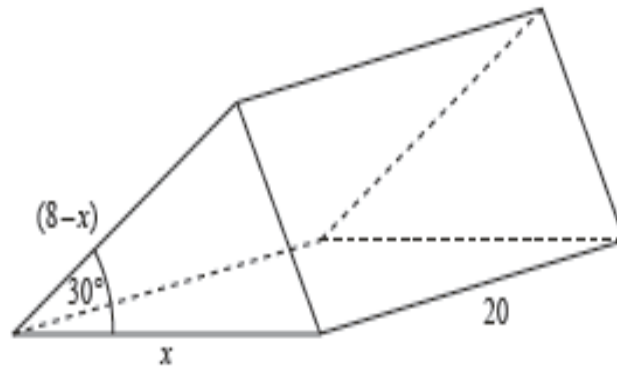
It is given by $Q = AV$

where Q = rate of flow in m^3/s , A = cross-sectional area of channel, V = Speed of fluid.

It is also given by $Q = \frac{\text{Volume}}{\text{Time}}$

1

M/J19/21/10



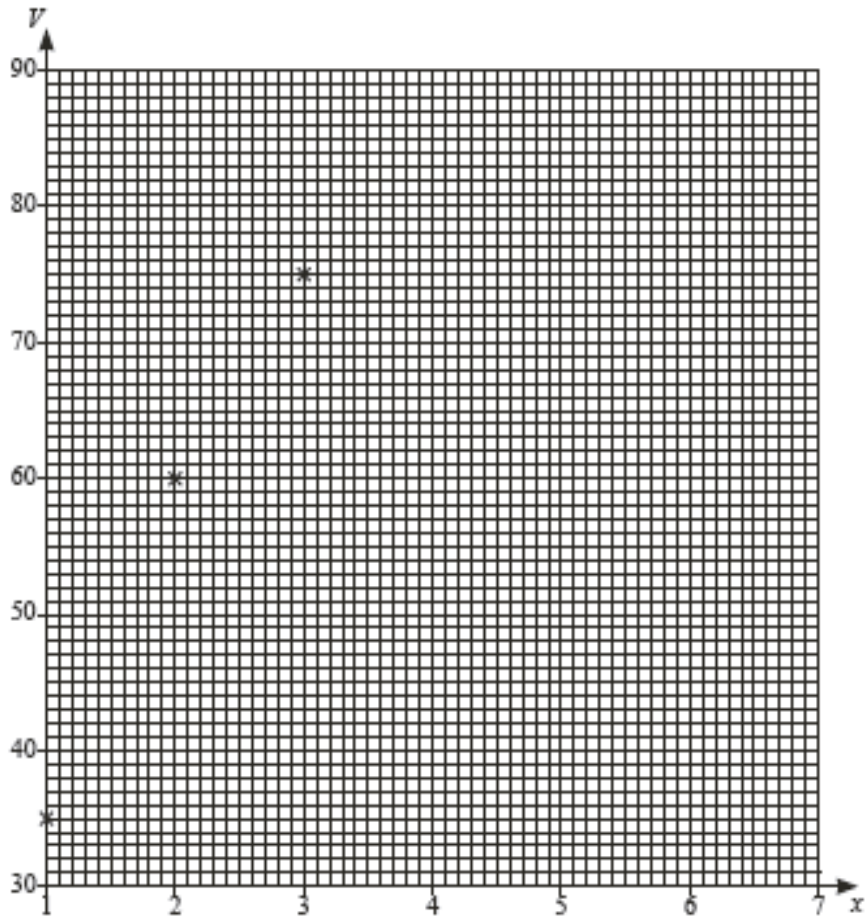
The diagram shows a triangular prism.
All lengths are in centimetres.

- (a) Show that the volume, $V \text{ cm}^3$, of the prism is given by $V = (40x - 5x^2)$.

[3]

- (b) On the grid on the next page, draw the graph of $V = 40x - 5x^2$ for $1 \leq x \leq 7$.
Three of the points have been plotted for you.

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[3]

- (c) Use your graph to find the possible values of x for one of these prisms with a volume of 50 cm^3 .

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

- (d) A cuboid has length 4 cm, width 3 cm and height x cm.

By drawing a suitable line on your graph, find the value of x when the prism and the cuboid have the same volume.

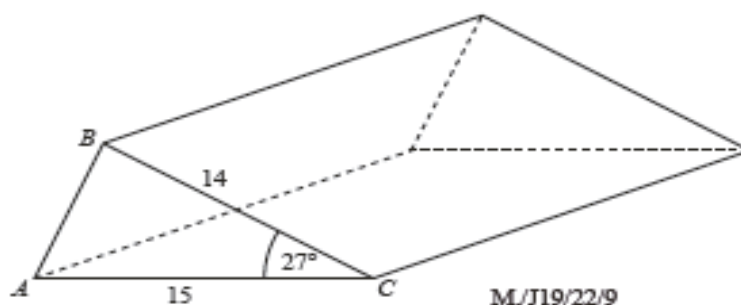
$x = \dots\dots\dots$ [3]

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1(a)	$\frac{1}{2}(8-x)x \times \frac{1}{2} \times 20$	M2	M1 for $\frac{1}{2}(8-x)x \times \sin 30$ isw
	$(40x - 5x^2)$ nfw	A1	
1(b)	Curve through (1, 35) (2, 60) (3, 75) (4, 80) (5, 75) (6, 60) (7, 35)	3	B2 for 3 or 4 more correct points plotted or B1 for at least 2 more correct points soi
1(c)	1.5 to 1.6 and 6.4 to 6.5	2	B1 for either
1(d)	$V = 12x$ ruled	M2	M1 for $V = 4 \times 3 \times x$ soi
	5.5 to 5.6	B1	

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2



The diagram shows a triangular prism.
 $AC = 15$ cm, $BC = 14$ cm and angle $ACB = 27^\circ$.

(a) Calculate AB .

$AB = \dots\dots\dots$ cm [3]

(b) The length of the prism is p cm and the volume of the prism is 1000 cm^3 .

Calculate p .

$p = \dots\dots\dots$ [3]

(c) The prism is to be packed in a carton.
The carton is a cuboid of size 15 cm by p cm by h cm.

Calculate the smallest possible value of h .

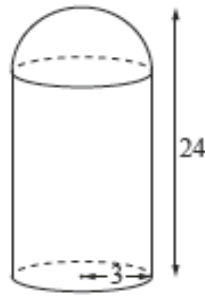
$h = \dots\dots\dots$ [2]

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2(a)	6.84 or 6.839 to 6.84[0]	3	B2 for 46.7 to 46.8 or M1 for $15^2 + 14^2 - 2 \times 14 \times 15 \times \cos 27$
2(b)	21[.0] or 20.97 to 20.98	3	M2 for $\frac{1000}{\frac{1}{2} \times 14 \times 15 \times \sin 27}$ oe or M1 for $\frac{1}{2} \times 14 \times 15 \times \sin 27$ oe isw
2(c)	6.36 or 6.355 to 6.356	2	M1 for $\sin 27 = \frac{h}{14}$ oe

- 3 (a) [Volume of a sphere = $\frac{4}{3} \pi r^3$] O/N18/21/9
[Surface area of a sphere = $4\pi r^2$]



The diagram shows lamp *A*.
It is made in the shape of a cylinder with a hemisphere on top.
The radius of the hemisphere and the radius of the cylinder are both 3 cm.
The total height of the lamp is 24 cm.

- (i) Show that the volume of lamp *A* is 650 cm^3 , correct to 3 significant figures.

[4]

- (ii) Calculate the curved surface area of lamp *A*.

Answer cm^2 [3]

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- (iii) Lamp *B* is mathematically similar to lamp *A*.
The volume of lamp *B* is 450 cm^3 .

Calculate the total height of lamp *B*.

Answer cm [2]

- (b) The mass of lamp *C* is 340 g, correct to the nearest 10 g.
8 of these lamps are placed in a packing case.
The total mass of the packing case and the 8 lamps is 4.2 kg, correct to the nearest 0.1 kg.

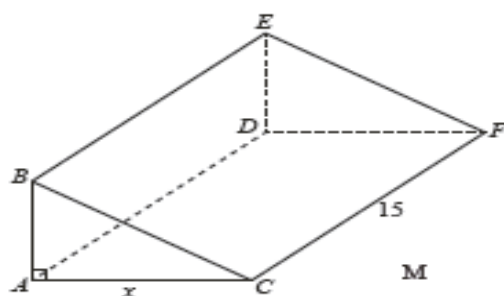
Calculate the upper bound of the mass of the packing case when empty.
Give your answer in kilograms.

Answer kg [3]

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4

O/N18/21/10



The diagram shows a prism with a rectangular base of length 15 cm and width x cm.
 The cross section of the prism is a right-angled triangle.
 The height of the prism is 4 cm less than its width.
 The volume of the prism is 440 cm^3 .

(a) Show that $3x^2 - 12x - 176 = 0$.

[3]

(b) Solve the equation $3x^2 - 12x - 176 = 0$.
 Show your working and give your answers correct to 2 decimal places.

Answer $x = \dots\dots\dots$ or $x = \dots\dots\dots$ [3]

(c) Find the height of the prism.

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

(d) A line is drawn on the surface of the prism from B to F .
 Another line is drawn on the surface of the prism from A to F .
 Calculate angle AFB .

Answer Angle $AFB = \dots\dots\dots$ [4]

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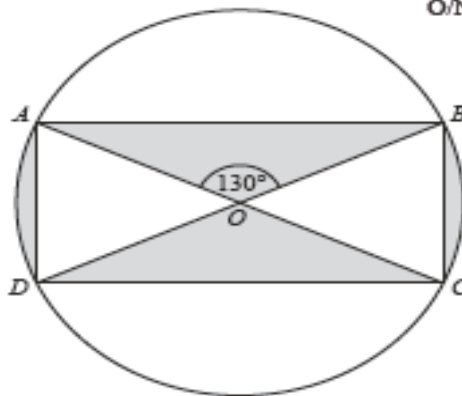
3(a)(i)	$\pi \times 3^2 \times 21 + \frac{2}{3} \times \pi \times 3^3$	M3	B1 for cylinder height = 21 soi M1 for $\pi \times 3^2 \times$ their height M1 for $\frac{2}{3} \times \pi \times 3^3$
	= 650.3[...] or 650.4	A1	
3(a)(ii)	452 or 452.3 to 452.4...	3	M2 for $2 \times \pi \times 3^2 + \pi \times 6 \times 21$ or M1 for $2 \times \pi \times 3^2$ or $\pi \times 6 \times 21$
3(a)(iii)	21.2 or 21.22 to 21.23...	2	B1 for $\sqrt[3]{\frac{450}{650}}$ soi or $\sqrt[3]{\frac{650}{450}}$ soi
3(b)	1.57	3	B1 for 4.25 or 335 used M1 for their $4.25 - 8 \times$ their $335 \div 1000$ or for their $4250 - 8 \times$ their 335

4(a)(i)	$\frac{1}{2}x(x-4) \times 15 = 440$	M2	B1 for height = (x - 4)
4(a)(ii)	Correct expansion and simplification leading to $3x^2 - 12x - 176 = 0$	A1	
4(b)(i)	$\frac{-(-12) \pm \sqrt{(-12)^2 - 4 \times 3 \times -176}}{2 \times 3}$	B2	B1 for $\sqrt{(-12)^2 - 4 \times 3 \times -176}$ or for $\frac{-(-12) \pm \sqrt{\text{their } 2256}}{2 \times 3}$
4(b)(ii)	9.92 and -5.92	B1	
4(c)	5.92	1	FT (their positive root - 4) if result positive
4(d)	18.2 or 18.21 to 18.22...	4	M2 for $[AF =]\sqrt{15^2 + \text{their } 9.92^2}$ Or for $[BF =]\sqrt{\text{their } 9.92^2 + \text{their } 5.92^2 + 15^2}$ oe or M1 for $AF^2 = 15^2 + \text{their } 9.92^2$ soi or for $BF^2 = \text{their } 9.92^2 + \text{their } 5.92^2 + 15^2$ oe AND M1 for $\tan [AFB] = \frac{\text{their } 5.92}{\text{their } 17.98}$ or $\sin [AFB] = \frac{\text{their } 5.92}{\text{their } 18.93}$

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5

O/N18/22/5



AC and BD are diameters of the circle, centre O .
 $AC = 12$ cm and $\angle AOB = 130^\circ$.

(a) Calculate the area of triangle AOB .

Answer cm^2 [2]

(b) Calculate the area of the sector AOD .

Answer cm^2 [2]

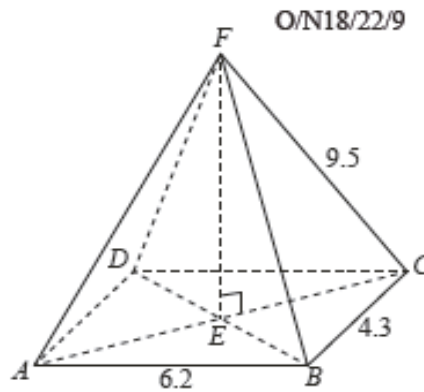
(c) Calculate the percentage of the area of the circle that is shaded.

Answer % [4]

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- 6 [Volume of a pyramid = $\frac{1}{3} \times$ base area \times height]



The diagram shows a pyramid with a rectangular, horizontal base.
Vertex F of the pyramid is vertically above the centre of the base, E .
 $AB = 6.2$ cm and $BC = 4.3$ cm.
The length of each sloping edge of the pyramid is 9.5 cm.

- (a) Show that the height, EF , of the pyramid is 8.72 cm, correct to 3 significant figures.

[4]

- (b) Calculate the volume of the pyramid.

Answer cm^3 [2]

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(c) Calculate angle AFB .

Answer [3]

(d) Calculate the angle of elevation of F from the midpoint of AB .

Answer [2]

5(a)	13.8 or 13.78 to 13.79	2	M1 for $\frac{1}{2} \times 6 \times 6 \times \sin 130$ oe After 0, SC1 for answer 55.2 or 55.15 to 55.16
5(b)	15.7 or 15.70 to 15.71	2	M1 for $\frac{180-130}{360} \times \pi \times 6^2$ oe After 0, SC1 for answer 62.8 or 62.83 to 62.84
5(c)	27.7 or 27.8 or 27.74 to 27.80... 	4	M2 for $2 \times \text{their } 13.8 + 2 \times$ $(\text{their } 15.71 - \frac{1}{2} \times 6^2 \times \sin(180-130))$ or M1 for $\text{their } 15.71 - \frac{1}{2} \times 6^2 \times \sin(180-130)$ AND M1 for $\frac{\text{their } 31.42}{\pi \times 6^2} [\times 100]$

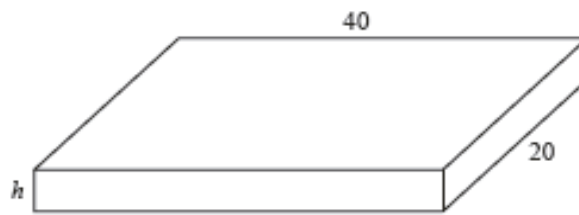
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6(a)	$AE^2 = \left(\frac{4.3}{2}\right)^2 + \left(\frac{6.2}{2}\right)^2$ oe or $FX^2 = 9.5^2 - \left(\frac{4.3}{2}\right)^2$ or $FY^2 = 9.5^2 - \left(\frac{6.2}{2}\right)^2$	M2	M1 for $AC^2 = 4.3^2 + 6.2^2$ oe or $FX^2 + \left(\frac{4.3}{2}\right)^2 = 9.5^2$ or $FY^2 + \left(\frac{6.2}{2}\right)^2 = 9.5^2$
	$[EF^2 =] 9.5^2 - \text{their } AE^2$ oe or $[EF^2 =] \text{their } FX^2 - \left(\frac{6.2}{2}\right)^2$ or $[EF^2 =] \text{their } FY^2 - \left(\frac{4.3}{2}\right)^2$	M1	Dep on M2
	8.718 to 8.719	A1	
6(b)	77.47 to 77.50	2	M1 for $\frac{1}{3} \times 6.2 \times 4.3 \times 8.72$
6(c)	38.1° or 38.09...°	3	M2 for $2\sin^{-1}\left(\frac{3.1}{9.5}\right)$ oe or M1 for $\sin^{-1}\left(\frac{3.1}{9.5}\right)$ oe Alternative method: M2 for $\cos AFB = \frac{9.5^2 + 9.5^2 - 6.2^2}{2 \times 9.5 \times 9.5}$ or M1 for $6.2^2 = 9.5^2 + 9.5^2 - 2 \times 9.5 \times 9.5 \times \cos AFB$
6(d)	76.1° or 76.2° or 76.14 to 76.18°	2	M1 for $\tan[...]=\frac{8.72}{4.3 \div 2}$ oe

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7



A paving slab is a cuboid with length 40 cm, width 20 cm and depth h cm.
Its volume is 2400 cm^3 .

M/J18/11/20

- (a) Find the value of h .

Answer $h = \dots\dots\dots$ [1]

- (b) Calculate the volume of concrete needed to make 1000 of these slabs.
Give your answer in m^3 .

Answer $\dots\dots\dots \text{m}^3$ [1]

- (c) A mathematically similar slab has length 60 cm.

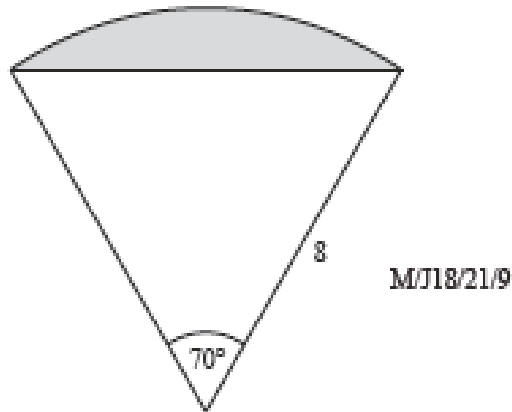
Calculate the volume of concrete, in cm^3 , needed to make **one** of these larger slabs.

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

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7(a)	3	1	
7(b)	2.4	1	
7(c)	8100	2	B1 for $\frac{27}{8}$ or $\frac{8}{27}$ soi or M1 for $30 \times 60 \times 4.5$

8



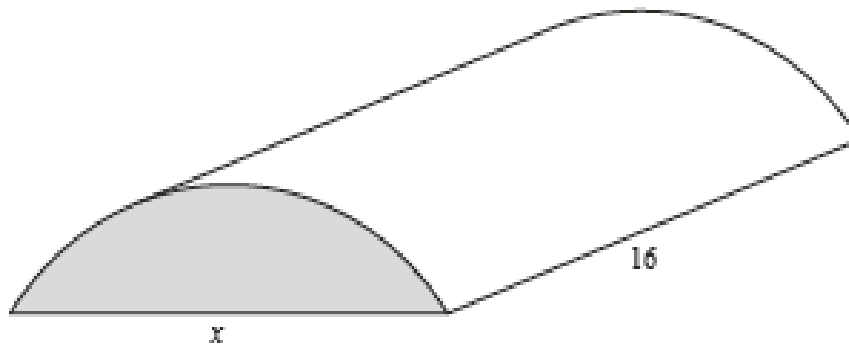
The diagram shows a sector of a circle of radius 8 cm and angle 70° .

(a) Calculate the shaded area.

ANSWER cm^2 [4]

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(b)



A piece of chocolate is in the shape of a prism with the shaded area from part (a) being its cross section.

The rectangular base of the chocolate is 16 cm by x cm.

The piece of chocolate is to be placed in a box which is a cuboid of size 16 cm by x cm by 1.5 cm.

(i) Show that the chocolate will fit inside the box.

[3]

(ii) These boxes are to be packed in cartons in the shape of a cuboid.

The size of each carton is 48 cm by $4x$ cm by 24 cm.

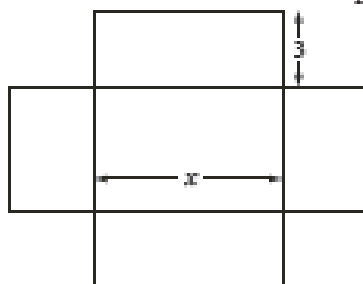
Find the maximum number of boxes that can be packed inside one carton.

Answer [2]

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9

M/J18/21/7



The diagram shows the net of an open box of height 3 cm.
The area of the base of the box is 15 cm^2 .
The length of the rectangular base is $x \text{ cm}$.
The total area of the net is $A \text{ cm}^2$.

(a) Show that $A = 15 + 6x + \frac{90}{x}$.

[2]

(b) Graham has one of these open boxes.
The total area of the net of his box is 65 cm^2 .

Write down an equation in x and solve it to find the length of the base of Graham's box.
Give your answer correct to 2 decimal places.

..... answer cm [4]

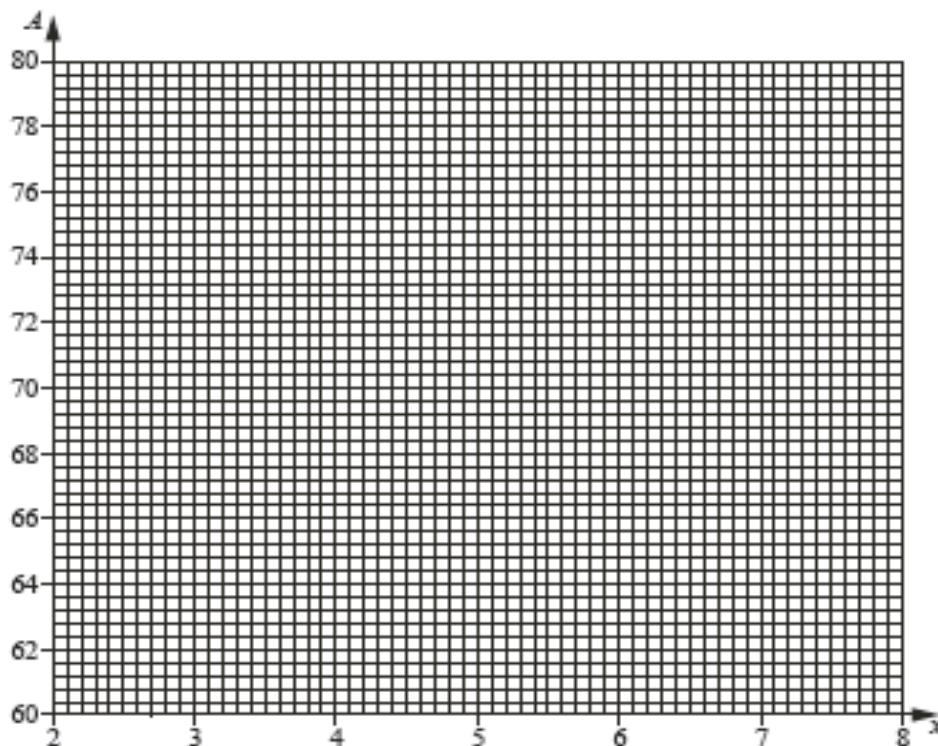
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(c) (i) Complete the table below for $A = 15 + 6x + \frac{90}{x}$.

x	2	3	4	5	6	7	8
A	72	63	61.5	63	66	69.9	

[1]

(ii) Draw the graph of $A = 15 + 6x + \frac{90}{x}$ for $2 \leq x \leq 8$.



[2]

(iii) Delilah has one of these open boxes.
 The area of the net of her box is 68 cm^2 .

Use your graph to find the length and width of Delilah's box.

Answer length cm

width cm [2]

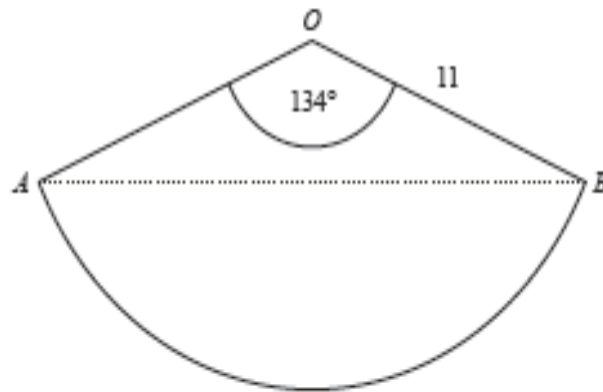
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8(a)	9.025 to 9.03	4	M3 for $\frac{70}{360} \times \pi \times 8^2 - \frac{1}{2} \times 8^2 \times \sin 70$ or M1 for $\frac{70}{360} \times \pi \times 8^2$ M1 for $\frac{1}{2} \times 8^2 \times \sin 70$
8(b)(i)	8 – 8cos 35 oe	M2	M1 for 8cos 35 (= 6.55..)
	1.45 or 1.446 to 1.447 so yes	A1	
8(b)(ii)	192	2	B1 for two of 4, 16 and 3 soi or M1 for $\frac{48 \times 4x \times 24}{16 \times x \times 1.5}$ oe
9(a)	$15 + [2 \times] 3x + [2 \times] \left(\frac{15}{x} \times 3\right)$	M1	
	Leading to $\left(15 + 6x + \frac{90}{x}\right)$ without error	A1	
9(b)	5.70 or 2.63 and $6x^2 - 50x + 90 [= 0]$ seen	4	B1 for $6x^2 - 50x + 90 [= 0]$ oe AND B2FT for $\frac{-(-50) \pm \sqrt{(-50)^2 - 4 \times 6 \times 90}}{2 \times 6}$ or B1FT for $\frac{\sqrt{(-50)^2 - 4 \times 6 \times 90}}{2 \times 6}$ or $\frac{-(-50) \pm \sqrt{r}}{2 \times 6}$ After 0, SC2 for 5.70 or 2.63
9(c)(i)	74.25	1	
9(c)(ii)	Correct smooth curve	2	B1FT for at least 5 points correctly plotted
9(c)(iii)	6.5 to 6.6 2.3 to 2.4	2	FT <i>their</i> graph B1FT for either correct

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10 (a)

M/T18/22/5



OAB is a sector of a circle, centre O , radius 11 cm.
 $\angle AOB = 134^\circ$.

(i) Calculate the length of the arc AB .

Answer cm [2]

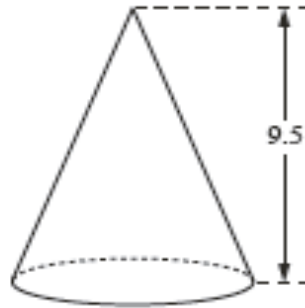
(ii) Calculate the shortest distance from O to the line AB .

Answer cm [2]

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(b) [Volume of a cone = $\frac{1}{3}\pi r^2 h$]

[Curved surface area of a cone = $\pi r l$]



A cone has height 9.5 cm and volume 115 cm^3 .

(i) Show that the radius of the base of the cone is 3.4 cm, correct to 1 decimal place.

[2]

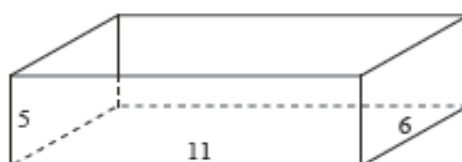
(ii) Calculate the curved surface area of the cone.

Answer cm^2 [3]

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10(a)(i)	25.7 or 25.72 to 25.73	2	M1 for $\frac{134}{360} \times 2 \times \pi \times 11$ oe
10(a)(ii)	4.3[0] or 4.298...	2	M1 for $\cos\left(\frac{134}{2}\right) = \frac{d}{11}$ or $\sin\left(\frac{180-134}{2}\right) = \frac{d}{11}$ oe
10(b)(i)	$\frac{1}{3}\pi r^2 \times 9.5 = 115$ or $r^2 = \frac{3V}{\pi h}$ or better	M1	Correct substitution into volume equation or correct rearrangement
	$r = 3.39[9\dots]$ or $3.40[00]$	A1	
10(b)(ii)	108 or 107.7 to 107.8	3	M2 for $\pi \times 3.4 \times \sqrt{9.5^2 + 3.4^2}$ or M1 for $l^2 = 9.5^2 + 3.4^2$ soi

11



An open rectangular tray has inside measurements O/N17/12/18

length 11 cm width 6 cm height 5 cm.

(a) Calculate the total surface area of the four sides and base of the inside of the tray.

Answercm² [2]

(b) Cubes are placed in the tray and a lid is placed on top.
Each cube has an edge of 2 cm.

Find the maximum number of cubes that can be placed in the tray.

Answer [1]

Mensuration 4024

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11(a)	236	2	M1 for $2 \times 5 \times 11 + 2 \times 5 \times 6 + 11 \times 6$ or or C1 for 302
11(b)	30	1	

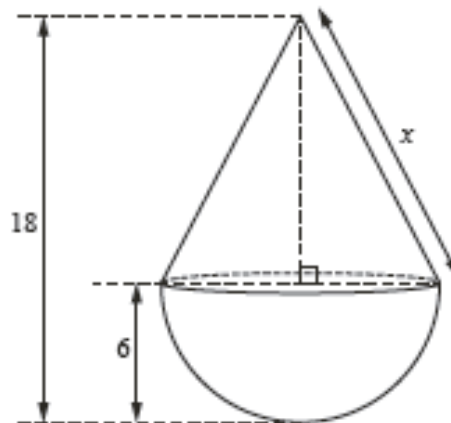
12 [Volume of a cone = $\frac{1}{3}\pi r^2 h$]

O/N17/218

[Curved surface area of a cone = $\pi r l$]

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

[Surface area of a sphere = $4\pi r^2$]



The diagram shows solid *A* which is made from a hemisphere joined to a cone of equal radius. The hemisphere and the cone each have radius 6 cm. The total height of the solid is 18 cm.

(a) Show that the slant height, *x* cm, of the cone is 13.4 cm, correct to 1 decimal place.

[2]

(b) Calculate the total surface area of solid *A*.

Answer cm² [3]

Mensuration 4024
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(c) Calculate the volume of solid *A*.

Answer cm^3 [3]

(d) Solid *A* is one of a set of three geometrically similar solids, *A*, *B* and *C*.
The ratio of the heights of solid *A* : solid *B* : solid *C* is 2 : 6 : 1.

(i) Calculate the surface area of solid *B* correct to 3 significant figures.

Answer cm^2 [2]

(ii) Calculate the volume of solid *C* correct to 3 significant figures.

Answer cm^3 [2]

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12(a)	$[x^2 =] 6^2 + 12^2$	M1	or $[x =] \sqrt{6^2 + 12^2}$
	$[x =] 13.41[6\dots]$ or 13.42	A1	
12(b)	478.7 to 479.4	3	<p>M1 for $\left[\frac{1}{2} \times\right] 4 \times \pi \times 6^2$ seen</p> <p>M1 for $\pi \times 6 \times 13.4$ seen</p> <p>After 0 scored, SC1 for consistent use of $r = 3$ in formula for [hemi]sphere and cone</p>
12(c)	904.7 to 905 nfw	3	<p>M1 for $\left[\frac{1}{2} \times\right] \frac{4}{3} \times \pi \times 6^3$ seen</p> <p>M1 for $\frac{1}{3} \times \pi \times 6^2 \times 12$ seen</p> <p>After 0 scored, SC1 for consistent use of $r = 3$ in formula for [hemi]sphere and cone</p>
12(d)(i)	4310 or FT $9 \times$ their (b)	2	M1 for $\left(\frac{6}{2}\right)^2$ soi
12(d)(ii)	113 or FT $\frac{1}{8} \times$ their (c)	2	M1 for $\left(\frac{1}{2}\right)^3$ soi

Mensuration 4024

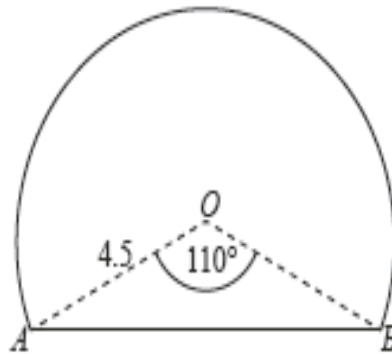
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- 13 (a) The ventilation shaft for a tunnel is in the shape of a cylinder.
The cylinder has radius 0.4m and length 15 m.

Calculate the volume of the cylinder. O/N17/22/9

Answer m³ [2]

- (b) The diagram shows the cross-section of the tunnel.



The cross-section of the tunnel is a major segment of a circle, centre O .
The radius of the circle is 4.5 m and $\angle AOB = 110^\circ$.

Calculate the area of the cross-section of the tunnel.

Answer m² [4]

Mensuration 4024

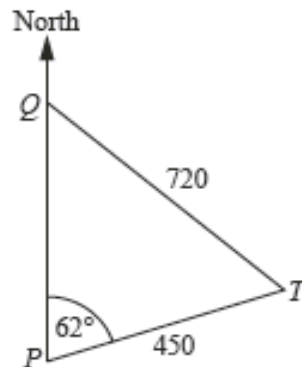
Compiled by: Mustafa Asif

- (c) The length of the tunnel is 1750 m.
A car drives through the tunnel at an average speed of 45 km/h.

Work out the time the car takes to travel through the tunnel.
Give your answer in minutes and seconds.

Answer minutes seconds [2]

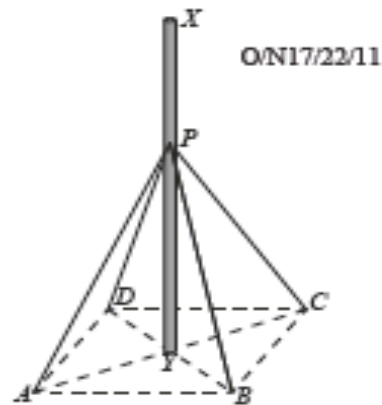
- (d) The diagram shows the position of the tunnel entrance, T , and two road junctions, P and Q , on horizontal ground.



Q is due north of P and T is on a bearing of 062° from P .
 $PT = 450$ m and $QT = 720$ m.

Calculate the bearing of T from Q .

Answer [4]



A vertical mast, XY , is positioned on horizontal ground.
The mast is supported by four cables attached to the mast at P and to the ground at points A , B , C and D .
 Y is the centre of the square $ABCD$.
 $PY = 7.50$ m.

(a) Given that $AB = 3.65$ m, show that $AY = 2.58$ m correct to 3 significant figures.

[3]

(b) Calculate the length of one of the cables used to support the mast.

Answer m [2]

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(c) Calculate \hat{APB} .

Answer [3]

(d) The angle of elevation of X from A is 77.0° .

(i) Calculate the height, XY of the mast.

Answer m [2]

(ii) Calculate the angle of elevation of X from the midpoint of AB .

Answer [2]

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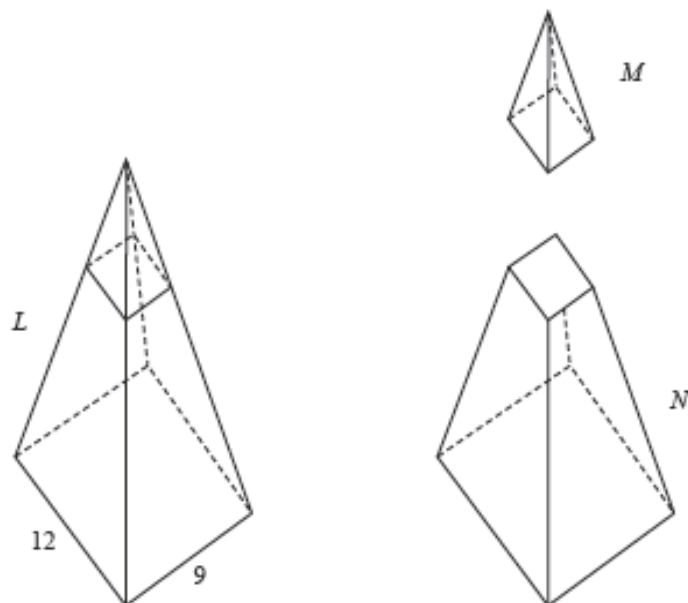
13(a)	7.54	2	M1 for $\pi \times 0.4^2 \times 15$
13(b)	53.7	4	M1 for $\frac{1}{2} \times 4.5^2 \times \sin 110$ oe M1 for $\frac{250}{360} \times \pi \times 4.5^2$ or $\frac{110}{360} \times \pi \times 4.5^2$ M1 for <i>their</i> 9.514 + <i>their</i> 44.18 oe
13(c)	2 minutes 20 seconds	2	M1 for figs 175 \div 45 soi

14(a)	Need to see 2.58 rounded from a correctly obtained 2.581 or better.	3	Method 1 M2 for $AY = 3.65 \cos 45$ or $(3.65 \div 2) \div \sin 45$ or M1 for e.g. $\frac{AY}{3.65} = \cos 45$ or $\sin 45 = \frac{3.65 \div 2}{AY}$ Method 2 M1 for such as $AY^2 + AY^2 = 3.65^2$ or $3.65^2 + 3.65^2 = AC^2$ soi M1 for $AY^2 = \frac{3.65^2}{2}$ oe A1 for $AY = 2.580[9\dots]$
14(b)	7.93	2	M1 for $7.5^2 + 2.58^2$
14(c)	26.6° or $2 \sin^{-1} \left(\frac{0.5 \times 3.65}{\text{their } 7.93} \right)$	3FT	M2 for $2 \sin^{-1} \left(\frac{0.5 \times 3.65}{\text{their } 7.93} \right)$ or $\cos [\dots] = \frac{\text{their } 7.93^2 + \text{their } 7.93^2 - 3.65^2}{2 \times \text{their } 7.93^2}$ Or M1 for $\sin [\dots] = \frac{0.5 \times 3.65}{\text{their } 7.93}$ or $3.65^2 = \text{their } 7.93^2 + \text{their } 7.93^2 - 2 \times \text{their } 7.93^2 \times \cos [\dots]$
14(d)(i)	11.18 or 11.2	2	M1 for $\tan 77 = \frac{XY}{2.58}$ oe
14(d)(ii)	80.7°	2FT	M1 for $\tan [\dots] = \frac{\text{their } 11.2}{3.65 \div 2}$

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15 [Volume of a pyramid = $\frac{1}{3} \times \text{base area} \times \text{perpendicular height}$]

M/J17/11/15



The diagrams show a solid pyramid L cut into two parts, M and N , by a plane parallel to its base. The base of pyramid L is a rectangle 9 cm by 12 cm. The perpendicular height of pyramid L is 30 cm.

(a) Work out the volume of pyramid L .

Answercm³ [1]

(b) The perpendicular height of pyramid M is $\frac{1}{3}$ of the perpendicular height of pyramid L .

(i) Express the volume of M as a fraction of the volume of L .

Answer [1]

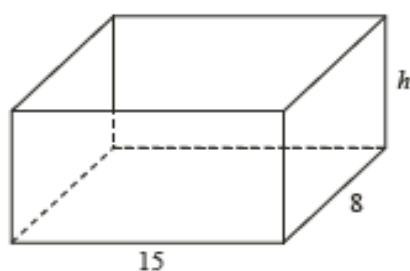
(ii) Calculate the volume of the solid N .

Answercm³ [2]

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15(a)	1080	1	
15(b)(i)	$\frac{1}{27}$ oe	1	
15(b)(ii)	1040	2	M1 for their $1080 \times$ their $\frac{1}{27}$ or 40

16



M/J17/12/22

A container is made out of thin material in the shape of a cuboid with an open top.
 The container has length 15 cm and width 8 cm.
 The volume of the container is 720 cm^3 .

(a) Calculate the height, h cm, of the container.

Answer cm [2]

(b) Calculate the surface area of the **outside** of the container.

Answer cm^2 [2]

(c) Liquid is poured into the container.
 The liquid fills 60% of the container.

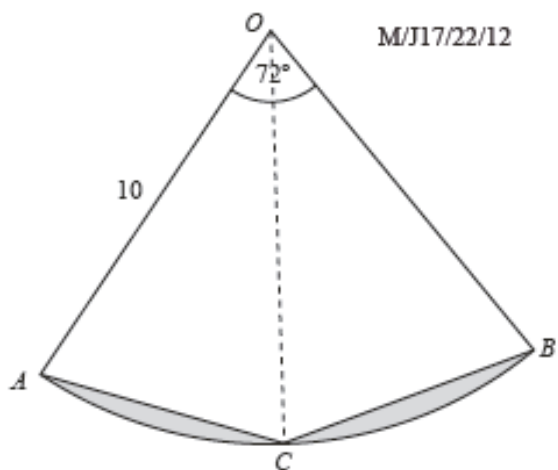
Calculate the height of the liquid in the container.

Answer cm [1]

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16(a)	6	2	M1 for $720 = 15 \times 8 \times h$ soi
16(b)	396	2	FT their h C1FT for answer 276 or for answer 516 or M1FT for $8 \times 15 + 2 \times$ their $6 \times 8 + 2 \times 15 \times$ their 6
16(c)	3.6 oe	1	FT $0.6 \times$ their 6

17



OAB is a sector of a circle, centre O , and radius 10 cm.
 $\angle AOB = 72^\circ$ and C is the point on the arc AB such that OC bisects $\angle AOB$.

(a) Calculate the perimeter of sector OAB .

Answer cm [3]

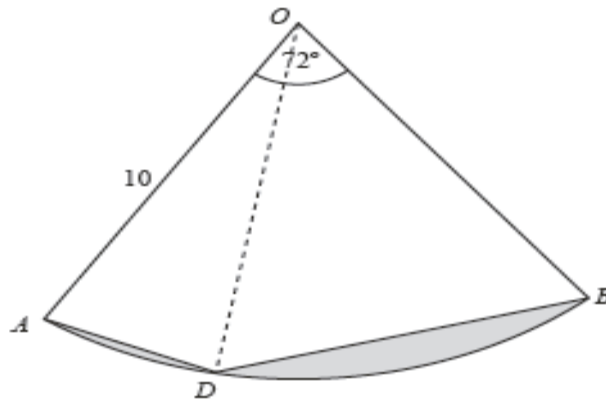
(b) (i) Calculate the area of sector OAB .

Answer cm^2 [2]

(ii) Calculate the total shaded area.

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(c)



D is the point on the arc AB such that $\widehat{AOD} : \widehat{DOB} = 1 : 2$.
Gavin says that the shaded area on this diagram is the same as the shaded area calculated in part (b)(ii).

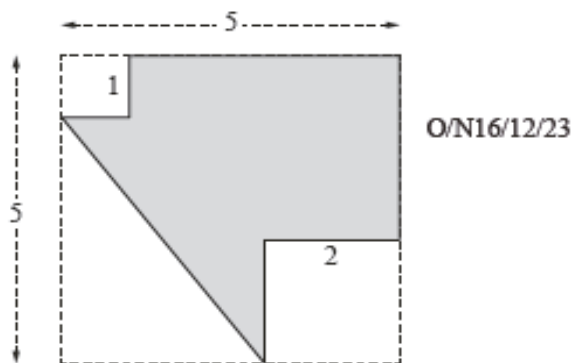
Is he correct? Show your working.

Answer

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17(a)	32.56 to 32.58 or 32.6	3	M2 for $\frac{72}{360} \times \pi \times 20 + 20$ oe or M1 for $\frac{72}{360} \times \pi \times 20$ A1 for 12.56 to 12.58 or 12.6 After 0 or 1, SC1 for <i>their</i> 'arc length' + 10 + 10 soi
17(b)(i)	62.83 to 62.84 or 62.8	2	M1 for $\frac{72}{360} \times \pi \times 10^2$
17(b)(ii)	4(.00) to 4.08 nfw	3	FT from <i>their</i> (b)(i) – (58.76 to 58.8) provided answer not negative M2 for <i>their</i> (b)(i) – $2 \times \frac{1}{2} \times 10 \times 10 \times \sin\left(\frac{72}{2}\right)$ oe or M1 for $[2 \times] \frac{1}{2} \times 10 \times 10 \times \sin\left(\frac{72}{2}\right)$ oe soi
17(c)	Add totals from (a) and (b) then divide by 2 Any half values are to be rounded down	4	

18



The diagram shows a square piece of card, from which a triangle and two small squares are removed. All lengths on the diagram are in centimetres.

(a) Calculate the area of the shaded card.

Answer cm² [2]

(b) Calculate the perimeter of the shaded card.

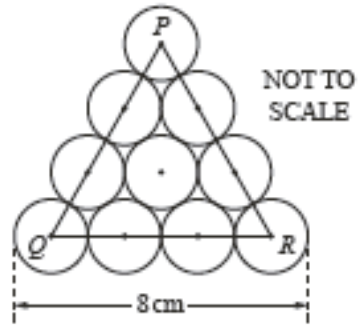
Answer cm [2]

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18	<p>(a) 14</p> <p>(b) 18 nfvw</p>	<p>2*</p> <p>2*</p>	<p>M1 for $25 - 1 \times 1 - 2 \times 2 - \frac{1}{2} \times 4 \times 3$ or dissection.</p> <p>B1 for sloping side = 5</p>
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- 19 (a) The ten circles in the diagram each have radius 1 cm. The centre of each circle is marked with a dot.

Calculate the height of triangle PQR .

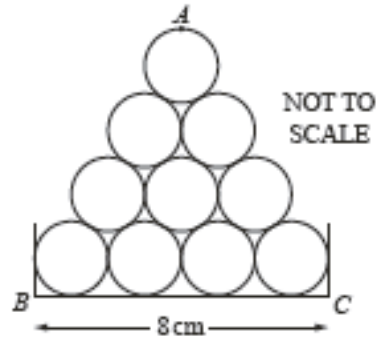


..... cm [3]

- (b) Mr Patel uses whiteboard pens that are cylinders of radius 1 cm.

- (i) The diagram shows 10 pens stacked in a tray. The tray is 8 cm wide. The point A is the highest point in the stack.

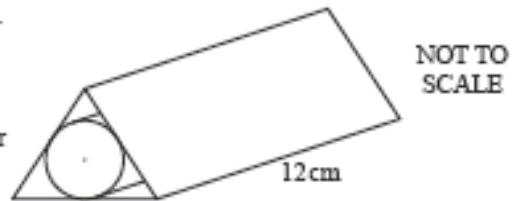
Find the height of A above the base, BC , of the tray.



..... cm [1]

- (ii) The diagram shows a box that holds one pen. The box is a prism of length 12 cm. The cross section of the prism is an equilateral triangle. The pen touches each of the three rectangular faces of the box.

Calculate the volume of this box.



..... cm^3 [5]

Mensuration 4024

Compiled by: Mustafa Asif

19 (a)	5.2[0] or 5.196...	3	<p>M2 for $[h^2=] 6^2 - 3^2$ or better</p> <p>or M1 for $h^2 + 3^2 = 6^2$</p> <p>or B1 for PR (or PQ or QR) = 6</p>
(b) (i)	7.2[0] or 7.196...	1FT	FT <i>their</i> (a) + 2
(ii)	62.4 or 62.35...	5	<p>M4 for $12 \times 6 \times \frac{1}{2} \tan 60$ oe</p> <p>or M3 for $6 \times \frac{1}{2} \tan 60$ oe</p> <p>or M2 for realising that $\frac{1}{2} \text{ base} = 1 \times \tan 60$ oe</p> <p>or B1 for angle 30 or 60 in correct position on diagram or in a calculation</p> <p>If 0 scored, SC1 for volume = an area \times 12 seen</p>