N4 EXPRESSIONS & FORMULAE 1.2

This resource is to support pupils in passing the appropriate National 4 Assessment Standard. The questions and marking schemes used are from SQA past papers and as such test the topics in their entirety from grade A to C and *may* include other areas from the course. In addition the questions from **Paper 1** (P1) should be completed **without** the use of a calculator and questions from **Paper 2** (P2) permit the use of a calculator.

Each Assessment Standard is used to ensure pupils have the minimum competency on the specified sub-skills for the National 4 course. As such each Assessment Standard will test grade C work on that specific topic.

This resource is divided into two sections:

- Section A has an example on each sub skill for the relevant Assessment Standard and the marking scheme for these questions
- Section B has extra practice questions on this Assessment Standard and the marking scheme for these questions

Unit Assessment Standard	Sub skills	Section A – Question Number
Expressions & Formulae 1.2 Applying geometric skills to circumference, area and volume	The sub-skills are:	
	calculating the circumference of a circle	Q1
	calculating the area of a circle	Q2
	calculating the area of a parallelogram	Q3
	calculating the area of a kite	Q4
	calculating the area of a trapezium	Q5
	investigating the surface of a prism	Q6
	calculating the volume of a prism	Q7
	using rotational symmetry	Q8

FORMULAE LIST

Circumference of a circle: $C = \pi d$

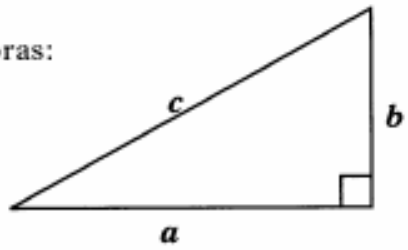
Area of a circle: $A = \pi r^2$

Curved surface area of a cylinder: $A = 2\pi rh$

Volume of a cylinder: $V = \pi r^2 h$

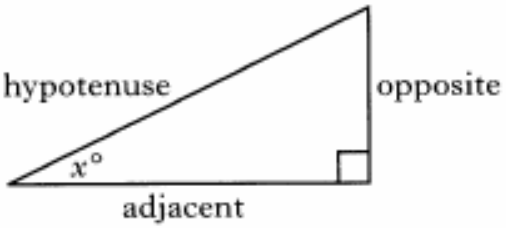
Volume of a triangular prism: $V = Ah$

Theorem of Pythagoras:



$$a^2 + b^2 = c^2$$

Trigonometric ratios in a right angled triangle:

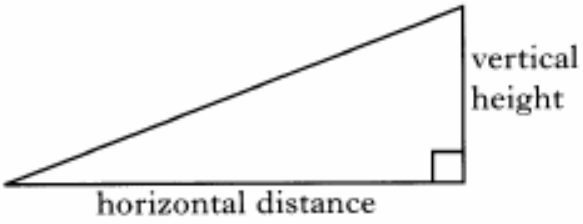


$$\tan x^\circ = \frac{\text{opposite}}{\text{adjacent}}$$

$$\sin x^\circ = \frac{\text{opposite}}{\text{hypotenuse}}$$

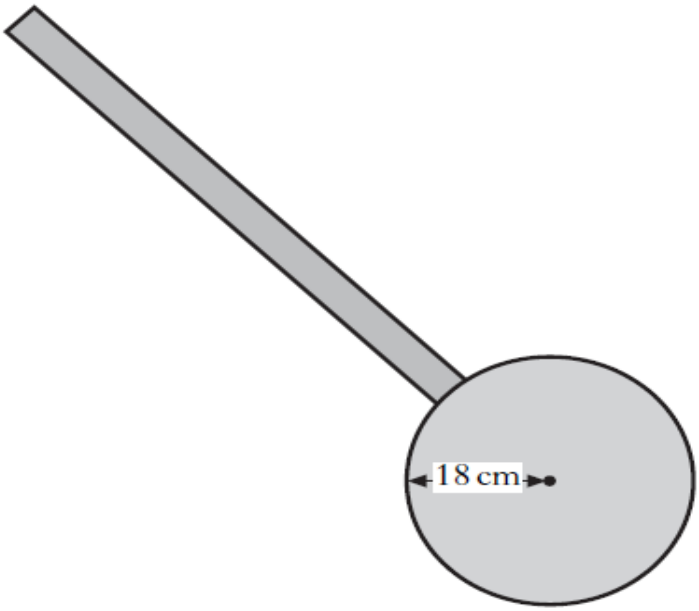
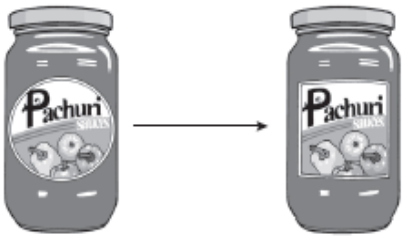
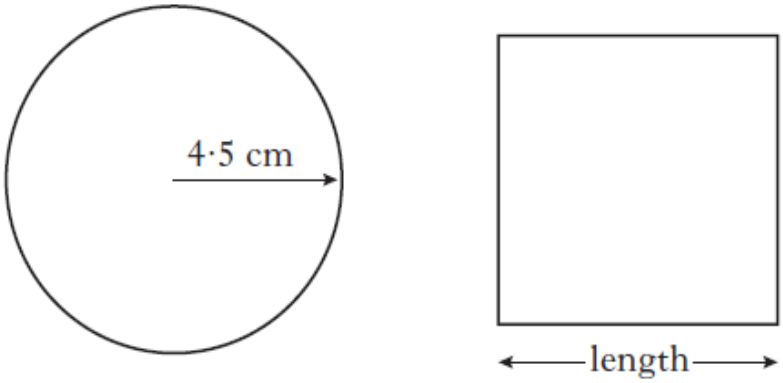
$$\cos x^\circ = \frac{\text{adjacent}}{\text{hypotenuse}}$$

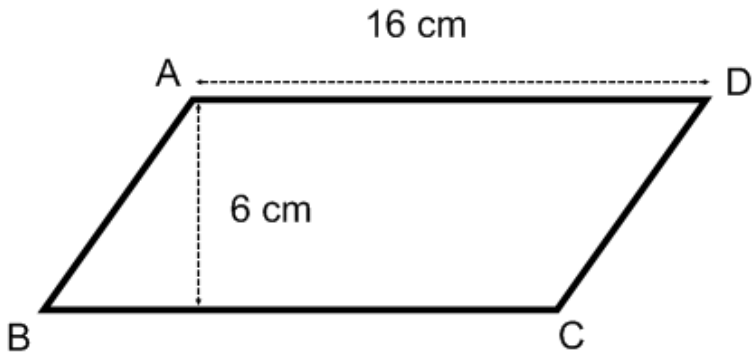
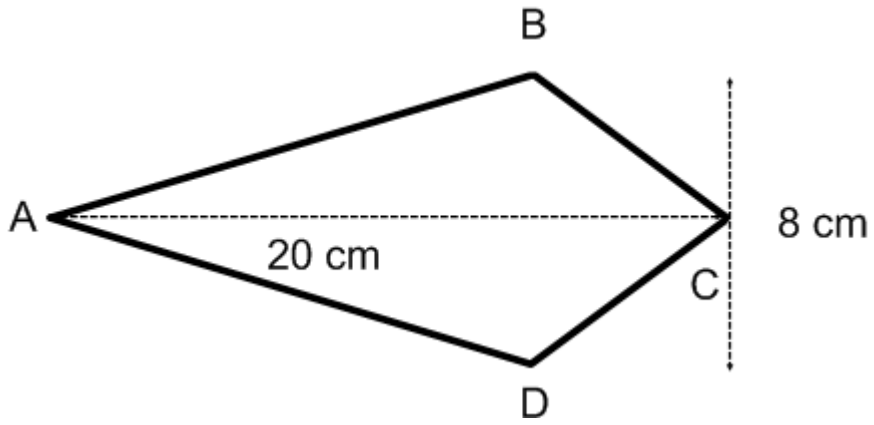
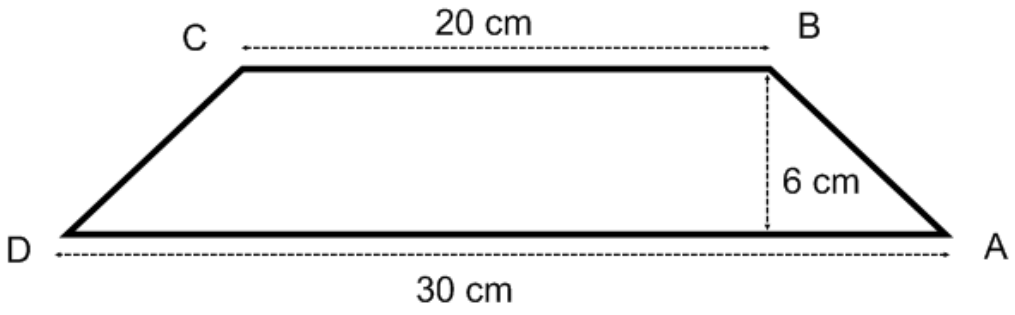
Gradient:

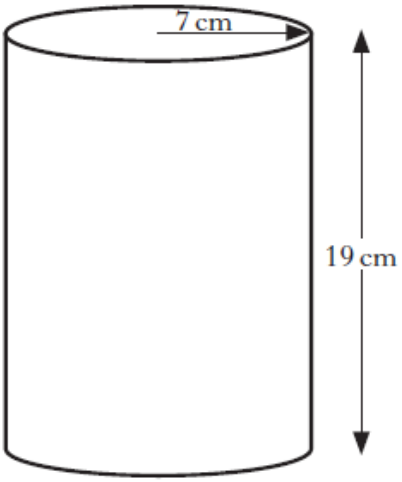
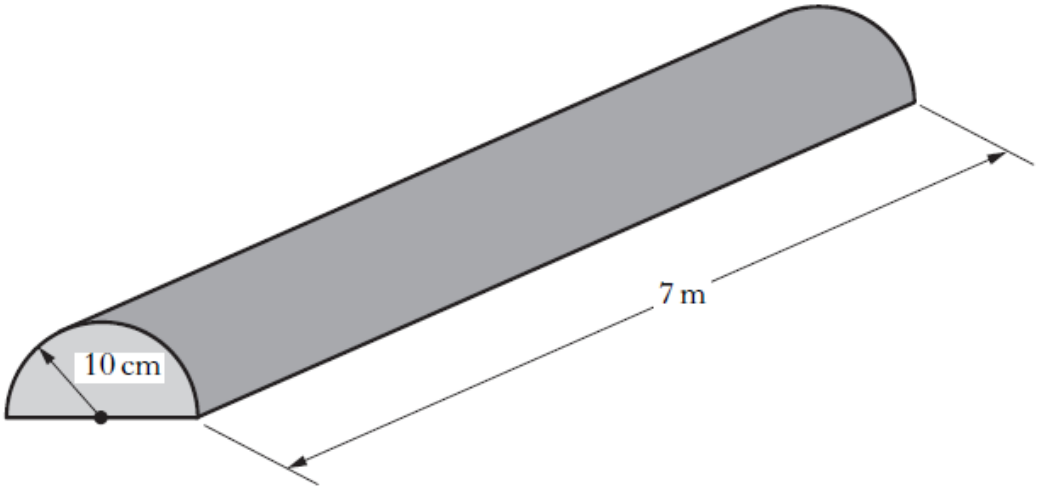


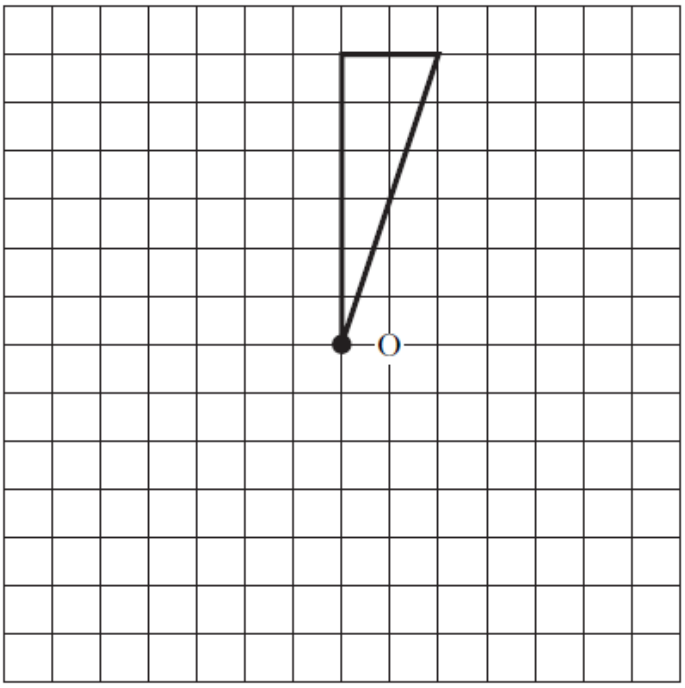
$$\text{Gradient} = \frac{\text{vertical height}}{\text{horizontal distance}}$$

Section A

Q		Marks
Q1 P2	**14.** Alex uses a circular piece of wood to make a measuring wheel. The wheel has a radius of 18 centimetres. How many complete metres are measured by 15 rotations of the wheel?  	**4**
Q2 P2	**14.** Pachuri Sauces are changing the shape of the labels on their jars from circles to squares. The labels have the same area. The circle has a radius of 4·5 centimetres.   Calculate the length of the new square label.	**3**

Q3	**Find the area of the shape ABCD.** 	**2**
Q4	**Find the area of the shape ABCD.** 	**2**
Q5	**Find the area of the shape ABCD.** 	**3**

Q6 P2	9. A cylinder has: • radius = 7 centimetres • height = 19 centimetres. Calculate the curved surface area of the cylinder. 	**2**
Q7 P2	13. A plastic speed bump in the shape of a half cylinder is used to slow traffic outside a Primary School. The speed bump has radius of 10 centimetres and a length of 7 metres as shown in the diagram below.  Calculate the volume of plastic used to make the speed bump.	**3**

Q8 P2	8. Complete this shape so that it has half-turn symmetry about O. 	**2**

Section A

MARKING SCHEME

Section A - Marking Scheme

Q		Marks
Q1 P2	**14** **Ans: 16 (complete metres)** •[1] knowing to find circumference — •[1] $C = \pi \times 36$ (= 113·04 cm) •[2] know how to find 15 rotations — •[2] $15 \times 1{\cdot}13$ or $15 \times 113{\cdot}04$ •[3] all calculations correct – must include the use of π — •[3] 16·9 or 1695·6 •[4] correct solution — •[4] 16 (complete metres) **4R** NOTES: (i) **Final answers** / **with working** / **without working** 16 — 4/4 — 2/4 8 ($15 \times \pi \times 18$) — 3/4 — 0/4 152 ($15 \times \pi \times 18^2$) — 3/4 — 0/4 610 ($15 \times \pi \times 36^2$) — 3/4 — 0/4 7 ($\pi \times 36 \div 15$) — 3/4 — 0/4 (ii) For candidates who multiply the diameter or radius by 15 and then correctly round — award 1/4	**4**

Q2 P2 — **3**

14 **Ans: 7·97 (cm)**

•1	knowing to find the area of round label	•1	$\pi \times 4{\cdot}5^2$
•2	knowing to find length of side of square label	•2	$\sqrt{63{\cdot}585}$
•3	both calculations correct , one must involve π	•3	7·97 (cm)

NOTES:

(i)

Final Answers	With Working	Without Working
7·98	3/3	2/3
8	3/3	2/3
15·9 (63·6 ÷ 4)	2/3	0/3
7·1 (28·3 ÷ 4)	2/3	0/3
5·3 ($\sqrt{28{\cdot}3}$)	2/3	0/3

(ii) The third mark is only available to candidates who calculate a length of side from an area/circumference.

Q3 — **2**

- 1 mark for the correct formula A = b x h
- 1 mark for substitution and correct answer 16 x 6 = <u>96 cm^2</u>

Q4 — **2**

- 1 mark for the correct formula A = ½ (D1 x D2)
- 1 mark for substitution and correct answer ½(20 x 8) = <u>80 cm^2</u>

Q5 — **3**

- 1 mark for the correct formula A = ½(a = b)h
- 1 mark for substitution ½(30 + 20) x 6
- 1 mark for correct answer <u>150 cm^2</u>

Q6 P2 — **2**

9		**Ans: 835·(2) cm²**	**2**		
		•¹ correct substitution in CSA formula		•¹	CSA = 2 × 3·14 × 7 ×19
		•² correct calculation involving π	**(KU)**	•²	835(·2)

Notes:

(i)

Final Answers	with working	without working
835(·24)	2/2	2/2
835(·66) (using π)	2/2	2/2
836	2/2	2/2
417(·62)	1/2	0/2
2923(·34) (volume)	1/2	0/2
153(·86) (area of circle)	1/2	0/2
43(·96) (circumference)	1/2	0/2

Q7 P2 — **3**

13	**Ans: 109900 (cm^3)**			
	•¹ evidence of correct conversion of units	•¹	700cm or 0·1m	
	•² correct substitution in volume formula	•²	$V = 3{\cdot}14 \times 10^2 \times 700$ (= 219800)	
	•³ correct calculation including dividing by 2 (must involve π)	•³	$V = 219800 \div 2 = 109900(cm^3)$	

NOTE:

(i)

Final answers	**with working**	**without working**
109900 (cm^3)	3/3	2/3
0·1099 (m^3)	3/3	2/3
1099 (mixing units)	2/3	0/3
2198 (mixing units)	1/3	0/3

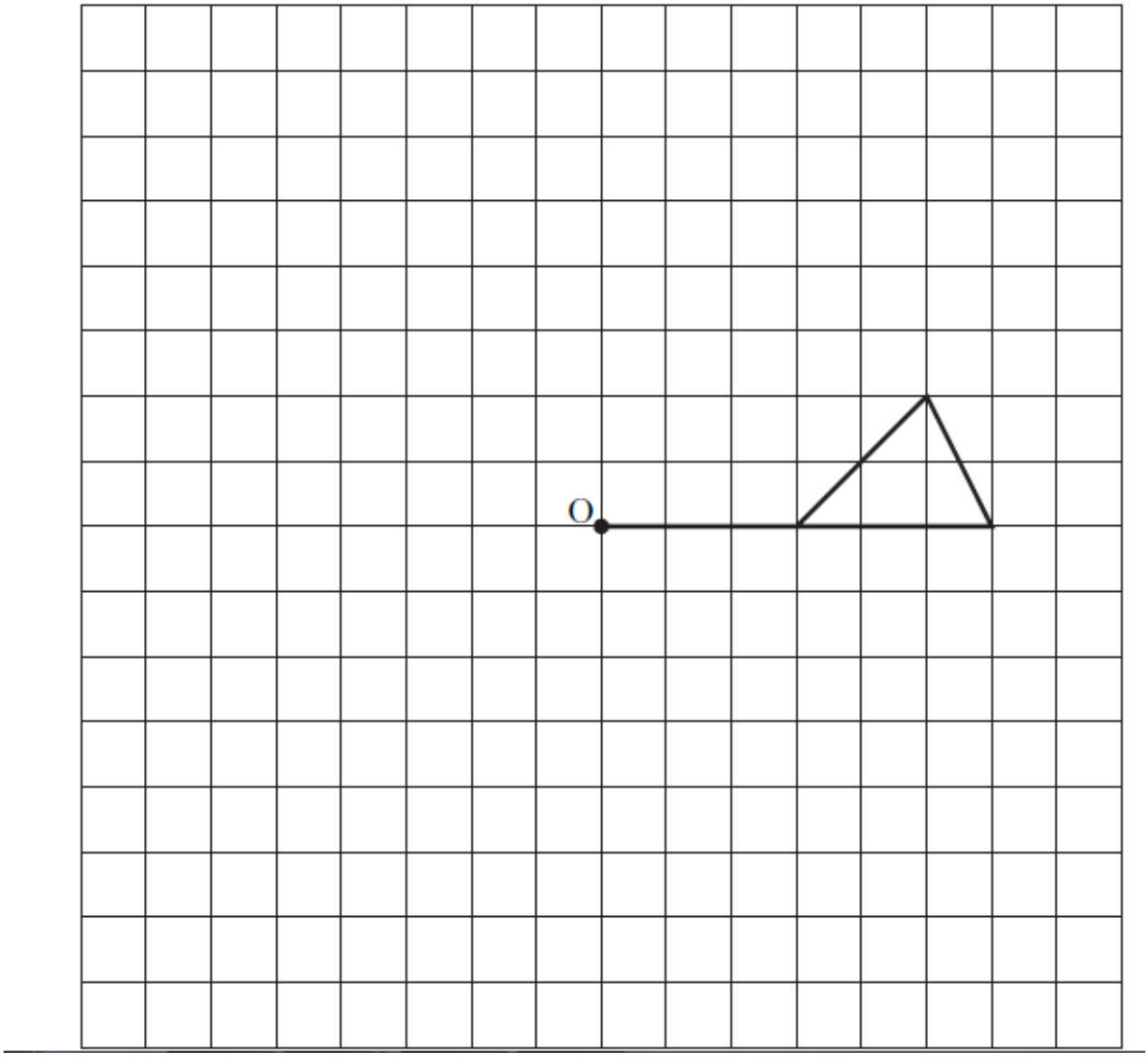
Q8 P2	**8**	**Ans: see diagram** •[1] evidence of 180° rotation •[2] diagram completed  **2R**	**2**

NOTES:

(i) Where candidates have a diagram with the correct and also extra rotations award 1/2
(ii) Where candidates reflect or rotate through an angle other than 180° award 0/2

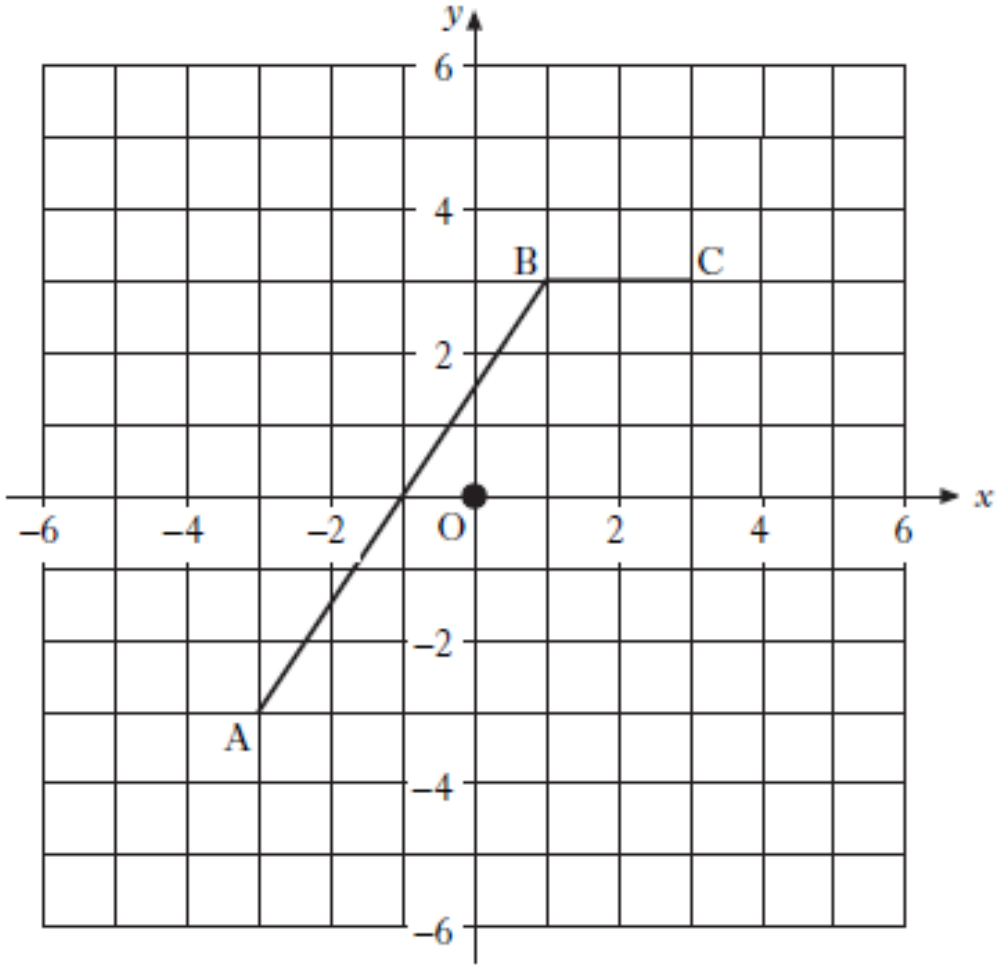
Section B

Section B – Paper 1 – Questions

Q		Marks
1	4. Complete this shape so that it has quarter-turn symmetry about O. 	3

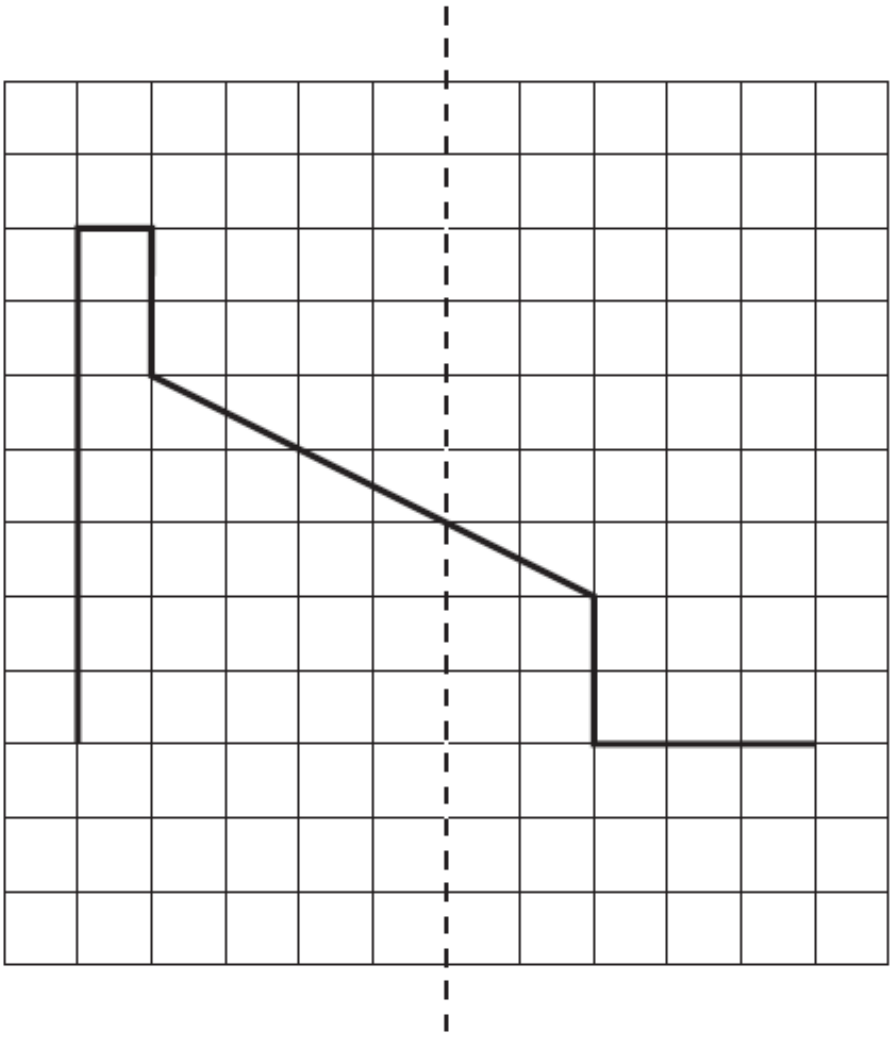
2

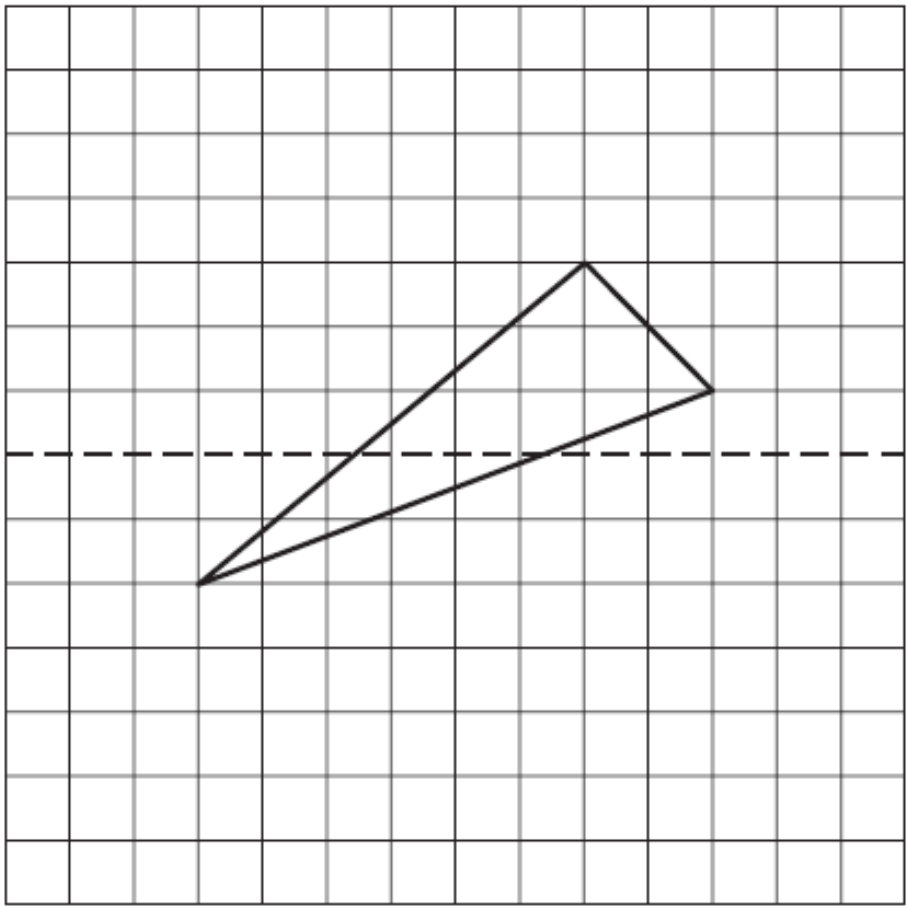
3. AB and BC are two sides of a kite ABCD.



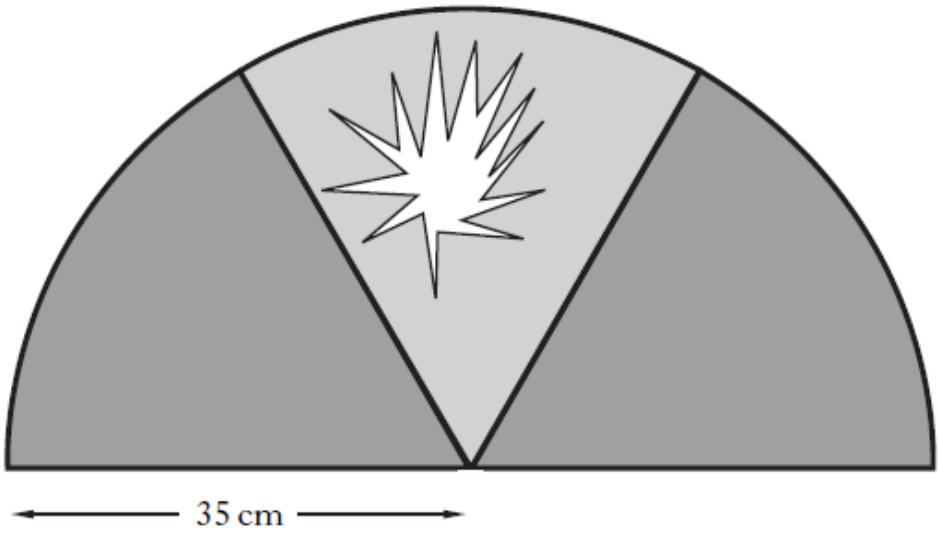
(*a*) Plot point D to complete kite ABCD. **1**

(*b*) Reflect kite ABCD in the ***y*-axis**. **3**

3	**4.** Complete this design so that the dotted line is an axis of symmetry. 	**3**

4	3. Complete the diagram so that the dotted line is an axis of symmetry. 	**2**

Section B – Paper 2 – Questions

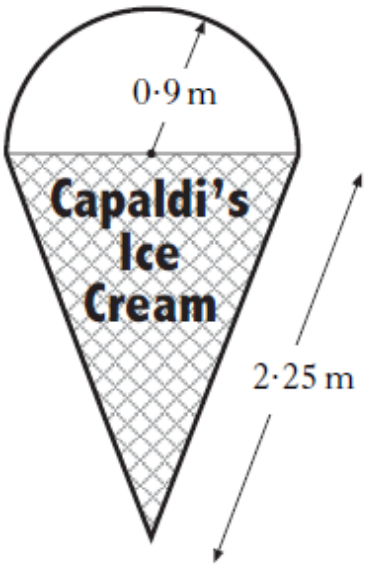
Q		Marks
5	15. In a drum kit, the diameter of the large drum is twice the diameter of the small drum. The small drum has a radius of 30 cm. Calculate the circumference of the large drum. 	3
6	3. A semi-circular window in the school assembly hall is made from three identical panes of glass. During a recent storm one pane of glass was damaged.  The semi-circle has a radius of 35 centimetres. Calculate the area of the damaged pane of glass.	3

7

9. Ian is making a sign for Capaldi's Ice Cream Parlour.

The sign will have two equal straight edges and a semi-circular edge.

Each straight edge is 2·25 metres long and the radius of the semi-circle is 0·9 metres.



Calculate the perimeter of the sign.

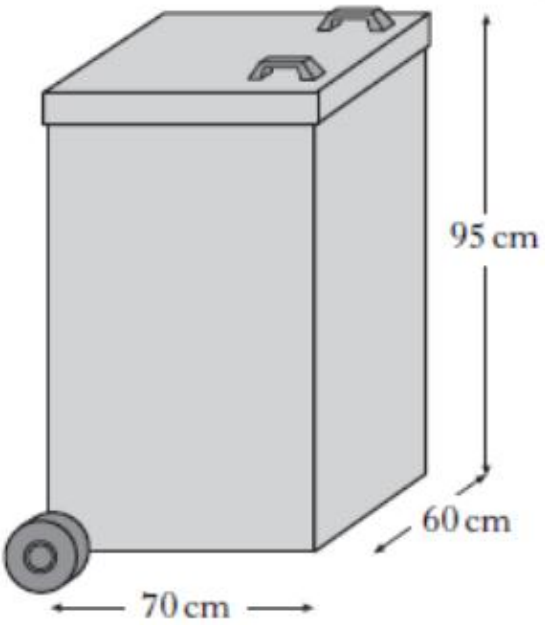
4

8

13. A wheelie bin is in the shape of a cuboid.

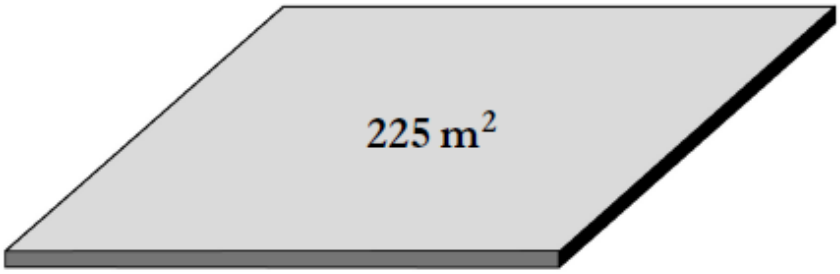
The dimensions of the bin are:

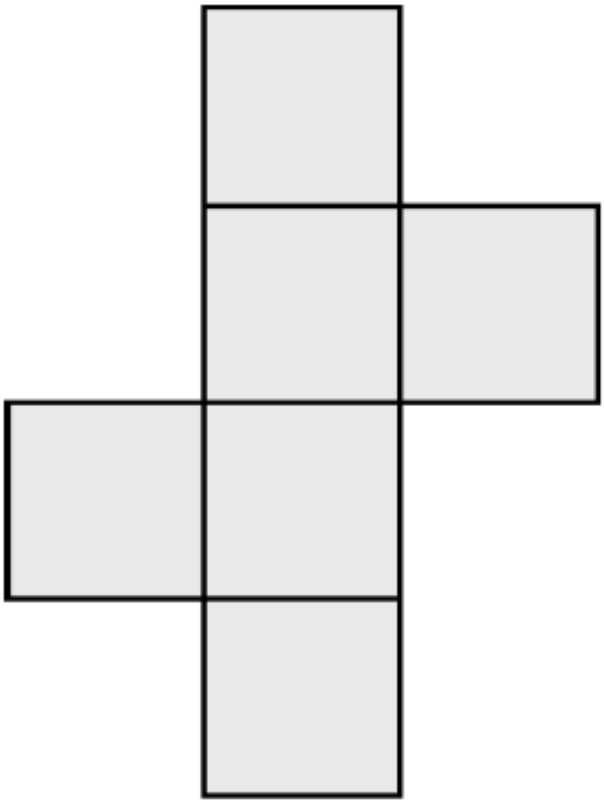
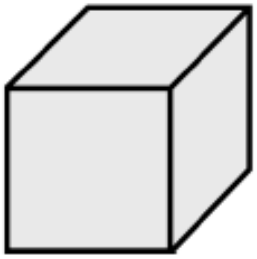
- length 70 centimetres
- breadth 60 centimetres
- height 95 centimetres.



(*a*) Calculate the volume of the bin.

2

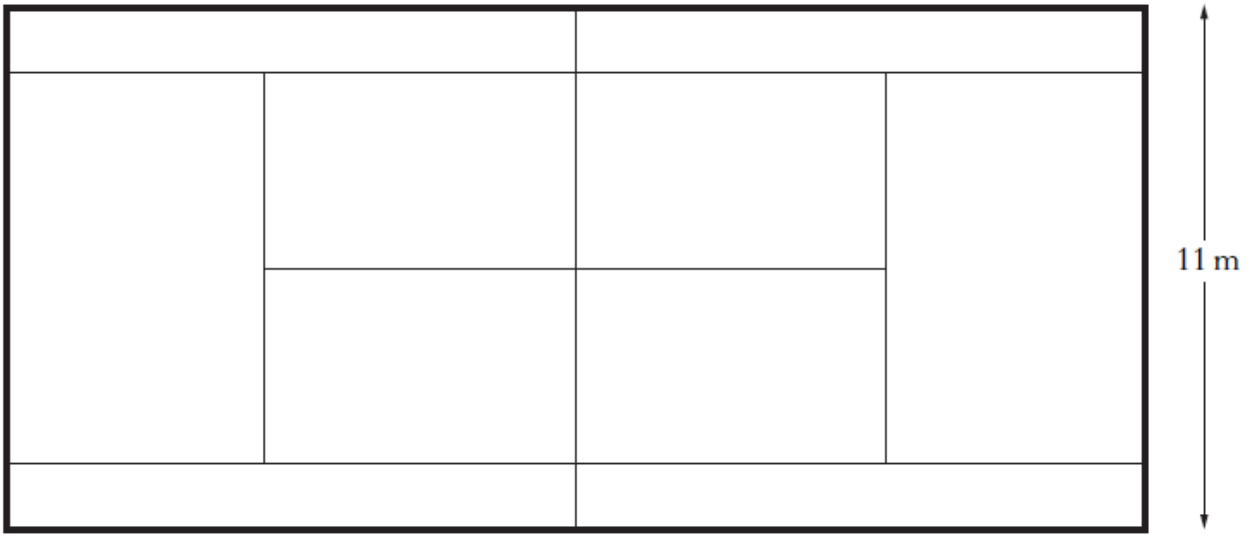
	(*b*) The council is considering a new design of wheelie bin. The new bin will have the same volume as the old one. The base of the new bin is to be a square of side 55 centimetres. Calculate the height of the new wheelie bin.	**3**
9	**12.** The local council is installing a new children's playpark using a rubberised material.   The area of the rectangular playpark is 225 square metres. The new playpark must have a depth of 12 centimetres. The council has ordered 30 cubic metres of the rubberised material for the playpark. Will this be enough? Give a reason for your answer.	**3**

10	**14.** The diagram below shows the net of a cube. The total surface area of the cube is 150 square centimetres.  Net of Cube  Cube Calculate the length of the side of the cube.	**3**

11

9. A tennis court is 11 metres wide.

It has an area of 264 square metres.



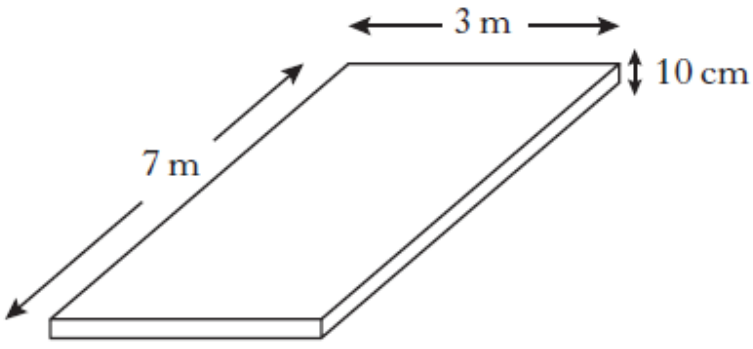
Calculate the perimeter of the tennis court.

3

12

7. Bob is building a patio with a concrete base.

The base of the patio is 7 metres long, 3 metres wide and 10 centimetres deep.



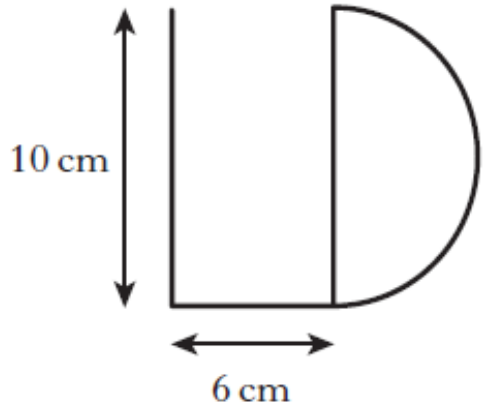
Concrete costs £60 **per cubic metre**.

Find the total cost of the concrete for the base of Bob's patio.

3

13

15. Lizzie Douglas bends a length of wire into the shape of her initials.



The letter D is a semi-circle.

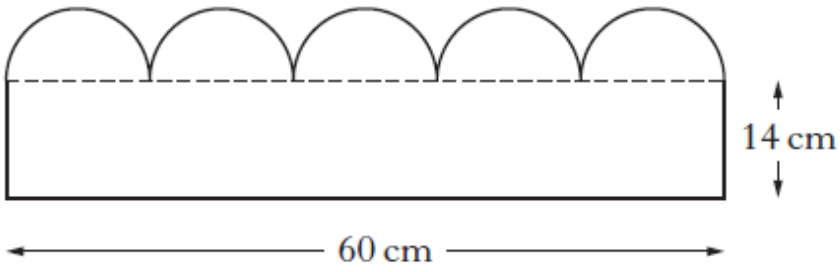
Calculate the total length of the wire.

Give your answer correct to the **nearest centimetre**.

5

14

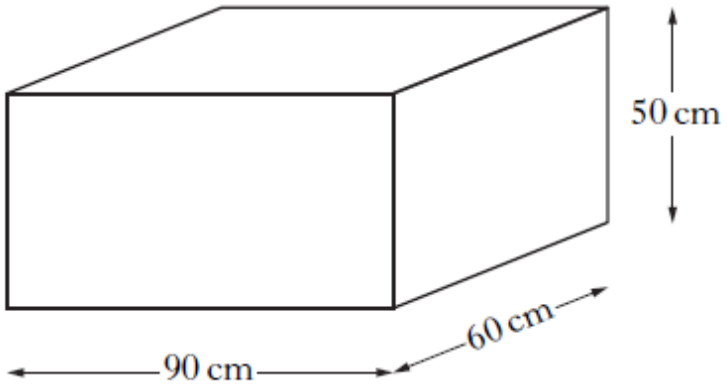
16. A section of lawn edging consists of a rectangle with five equal semi-circles at the top.

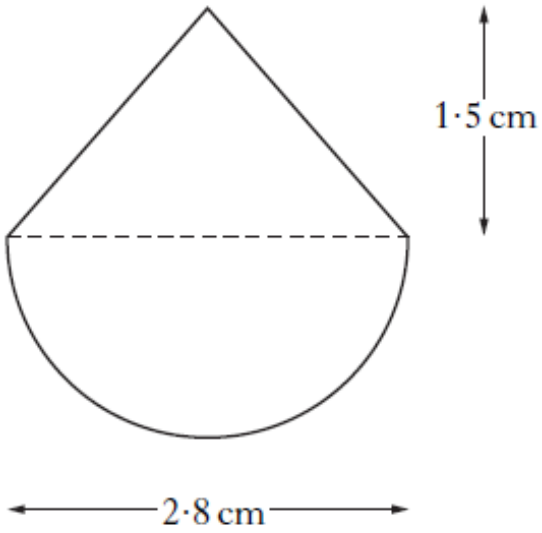


Calculate the area of the section in square centimetres.

Give your answer correct to the **nearest square centimetre**.

5

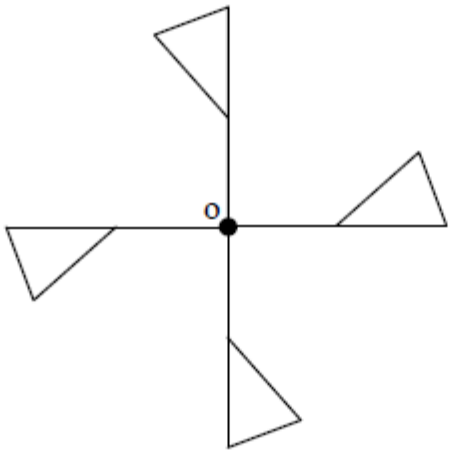
15	6. This empty tank is to be filled with water.  The tank is a cuboid, 90 centimetres long, 60 centimetres wide and 50 centimetres high. The water fills at a rate of 15 litres every minute. (1 litre = 1000 cm^3) How long will it take to fill the tank?	**4**

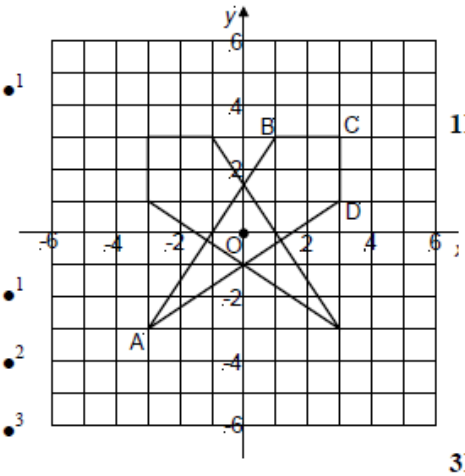
16	**14.** A badge showing a clown's head consists of a semi-circle and a triangle.   Calculate the area of the badge in square centimetres. Give your answer correct to one decimal place.	**5**

Section B

MARKING SCHEME

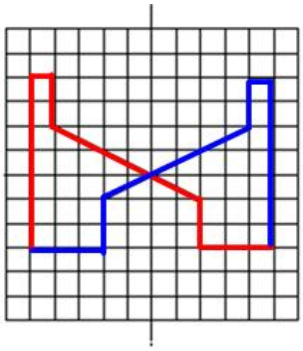
Section B – Paper 1 – Marking Scheme

<table>
<tr><th>Q</th><th></th><th>Marks</th></tr>
<tr><td>1</td><td>
4
Ans:


•1 90° rotation
•2 One correct rotation
•3 Two further correct rotations
•1 Evidence
•2 Evidence
•3 Evidence
</td><td>3</td></tr>
<tr><td>2</td><td>
3 (a) Ans: Correct point (3, 1)
•1 Point D plotted correctly
•1 1R
(b) Ans: Correct diagram ((3, -3); (-1, 3); (-3, 3); (-3, 1))
•1 One point correct
•2 A further point correct
•3 Two further points correct
•1 •2 •3 3R


Notes:
(i) For a correct reflection in a line other than the y-axis – award 2/3
(ii) When candidates draw the reflection in the space below part (b), treat as bad form and mark accordingly
</td><td>1
3</td></tr>
</table>

3

4	**Ans:**	**see diagram**		
	•1	one line correctly reflected	•1	
	•2	a further two lines correctly reflected	•2	
	•3	reflection completed	•3	
				3R

NOTES:

(i) For a correct reflection of the drawing in a line other than the dotted line
– within the grid award 2/3
– not wholly within the grid award 1/3

(ii) Where a candidate adds a line(s) to the design and reflects it, treat as working after a correct answer

3

4

3			**Ans:**	**correct diagram**	2	
			•1	correct reflection of one point		•1 see diagram
			•2	correct completion of diagram	**(RE)**	•2 see diagram

Notes:

(i) Where candidates correctly reflect in a line other than the dotted line – award 1/2

(ii) Where candidates rotate shape - award 0/2

2

Section B – Paper 2 – Marking Scheme

Q		Marks
5	**15** **Ans: 376·8 (cm)** — **3** •¹ know to find diameter of small drum — •¹ d = 2 × 30 (= 60) •² know to find diameter of large drum — •² D = 2 × 60 (= 120) •³ correct circumference of of large drum — •³ (C = 3·14 × 120 =) 376·8 **(RE)** **Notes:** (i) Final Answers: 376·8 — with working 3/3 — without working 2/3; 377 — 3/3 — 2/3; 188·5 (3·14 × 60) — 2/3 — 0/3; 94·2 (3·14 × 30) — 1/3 — 0/3 (ii) candidates who calculate the area of the large drum can be awarded 1/3 for evidence of r = 60	**3**
6	**3** **Ans: 641 (cm^2)** •¹ calculate area of circle — •¹ $Ac = \pi \times 35^2 = 3846{\cdot}5$ •² calculate area of semi-circle — •² $Asc = ½ \times 3846{\cdot}5 = 1923{\cdot}25$ •³ calculate area of 1/3 of semi-circle — •³ $A = 1/3 \times 1923{\cdot}25 = 641\ (cm^2)$	**3**

7

9 **Ans: 7.326 (m)** — **4**

•1	Finds diameter	•1	1.8
•2	Attempts to calculate length of curved edge (using diameter or radius)	•2	$0.5 \times 3.14 \times 1.8$
•3	Knows to add 2 straight edges	•3	$2.25 + 2.25$
•4	All calculations correct (must involve π)	•4	$2.826 + 4.5 = 7.326$ (m) **4R**

Notes:

(i)

Final Answers	**with working**	**without working**
7.326	4/4	2/4
10.2(πd)	3/4	0/4
5.9 ($\frac{1}{2}\pi r$)	3/4	0/4
5.77 ($\frac{1}{2}\pi r^2$)	3/4	0/4
7.04 (πr^2)	2/4	0/4

(ii) Candidates who attempt to calculate the area of a semi-circle may be awarded the 2nd mark

8

13 (a) **Ans: 399 000 (cm^3)** — **2**

•1	Correct use of formula	•1	$V = 70 \times 95 \times 60$
•2	Correct calculation	•2	$V = 399\,000$ (cm^3)

(b) **Ans: 131.9 (cm)** — **3**

•1	Knows to find area of base	•1	55×55 (= 3025)
•2	Knows to divide volume by above	•2	399 000/3025
•3	Calculations correct	•3	131.9 (cm)

Notes:

In part (a)

(i) 2nd mark can be awarded to candidates who correctly multiply at least two of the given dimensions

In part (b)

Final Answers	with working	without working
131.9	3/3	2/3
76.36 (÷ (55 × 95))	2/3	0/3
103.6 (÷ (55 × 70))	2/3	0/3
120.9 (÷ (55 × 60))	2/3	0/3
7254.5 (÷ 55)	2/3	0/3
4200 (÷ 95)	1/3	0/3
5700 (÷ 70)	1/3	0/3
6650 (÷ 60)	1/3	0/3

9

12

Ans: Yes, $3m^3$ left over — **3**

•1	knowing to change depth to metres	•1 depth = 0·12m
•2	knowing to find volume of cuboid	•2 volume = 0·12 × 225 = 27
•3	statement with reason	•3 Yes, there will be $3m^3$ left over

NOTES:

30 ÷ 225 = 0.133

yes 13cm > 12cm

10

14

Ans: 5 (cm) — **3**

•1	knowing to find area of 1 square	•1 150 ÷ 6 (= 25)
•2	knowing to find length of side	•2 $\sqrt{25}$
•3	correct solution	•3 5 (cm)

11

9	**Ans:**	**70(m)**			**3**
	•[1]	knowing to calculate length of court	•[1]	264 ÷ 11 (= 24)	
	•[2]	knowing to calculate perimeter	•[2]	(2 × 24) + (2 × 11)	
	•[3]	correct calculations in a valid strategy	•[3]	48 + 22 = 70(m)	

NOTE:

(i)	**Final answers**	**with working**	**without working**
	70	3/3	2/3
	35	2/3	0/3

12

7			**Ans:**	**£126**	**3**	**3**
			•[1]	know to multiply l × b × h: evidence of l × b × h involving 7, 3 and 10		
			•[2]	find volume in m^3: 7 × 3 × 0·1 = 2·1		
			•[3]	find total cost: 2·1 × 60 = 126		

1. Correct answer without working award 2/3

2. **BEWARE**: mixed units in volume calculation and incorrect volume conversion factor
   7 × 3 × 10 = (210 ÷ 100) = 2·1
   2·1 × 60 = 126 award 2/3 ✓×✓

3. Some common answers
   [working must be shown]
   (a) 12 600 [(7 × 3 × 10) ×60]
   award 2/3 ✓×✓
   (b) 1 260 000 [(70 × 30 × 10) × 60]
   award 2/3 ✓×✓
   (c) 126 000 000 [(700 × 300 × 10) × 60]
   award 2/3 ✓×✓
   (d) 1260 [(7 × 3) × 60, area of patio]
   award 1/3 ××✓

4. **Special cases**: V = l + b + h
   [working must be shown]
   (a) 606 [10·1 × 60] = 606
   award 2/3 ×✓✓
   (b) 1200 [20 × 60] = 1200
   award 1/3 ××✓

13

15			**Ans: 42 cm**	**5**		**5**

- $\bullet^1$ know how to calculate length of semi-circle: ½ πd or πr
- $\bullet^2$ substitute correct diameter into formula: ½ × π × 10 or π × 5
- $\bullet^3$ know to add lengths of straight edges to previously calculated value:
  previously calculated value + 10 + 6 + 10
- $\bullet^4$ carry out all calculations correctly:
  15·7… + 26 = 41·7…
  (must include a circle calculation **followed by** an addition)
- $\bullet^5$ round to nearest whole number: 42

1. Correct answer without working award 0/5
2. Where no formula is stated accept
   (a) ½ × π × 10 or 15·7….as evidence of ½ πd being used
   (b) ½ × π × 5^2 or 39·2… as evidence of ½ πr^2 being used
3. **Some** common answers (working must be shown)
   (a) 32 [$^1/_2 \times \pi \times 10 + 16$] award 4/5 ✓✓×✓✓
   (b) 57 [$\pi \times 10 + 26$] award 4/5 ×✓✓✓✓
   (c) 65 [$^1/_2 \times \pi \times 5^2 + 26$] award 4/5 ×✓✓✓✓
   (d) 99 [$^1/_2 \times \pi \times 5^2 + 60$] award 3/5 ×✓×✓✓
   (e) 183 [$^1/_2 \times \pi \times 10^2 + 26$] award 3/5 ××✓✓✓
   (f) 34 [$^1/_2 \times \pi \times 5 + 26$] award 4/5 ✓×✓✓✓
   (g) 16 [$^1/_2 \times \pi \times 10$] award 3/5 ✓✓××✓
   (h) 31 [$\pi \times 10$] award 2/5 ×✓××✓
   (i) 39 [$^1/_2 \times \pi \times 5^2$] award 2/5 ×✓××✓
   (j) 39 [$^1/_2 \times 5^2 + 26$] award 2/5 ××✓×✓
   (k) 79 [$\pi \times 5^2$] award 2/5 ×✓××✓
3. (a) 5th mark is only available where the answer to circle calculation requires rounding
   (b) Where premature rounding leads to incorrect answer, a maximum of 4/5 is available.

14 | **16** | **Ans: 1123 cm²** | **5**

- •¹ know how to calculate area of semi-circle: ½ πr²
- •² substitute correct radius into formula: ½ × π × 6²
- •³ know to add area of semi-circles and area of rectangle: (5 × area of semi-circle) + (60 × 14)
- •⁴ carry out all calculations correctly: π → 282·7… + 840 = 1122·7…. 3.14 → 282·6… + 840 = 1122·6…. (must include a circle calculation **followed by** an addition)
- •⁵ round to nearest whole number: 1123

1. Correct answer without working award 0/5
2. **Some** common answers (working must be shown)
   (a) 1405 [π × 6² × 5 + 60 × 14] award 4/5 ×✓✓✓✓
   (b) 897 [½ × π × 6² + 60 × 14] award 4/5 ✓✓×✓✓
   (c) 371 [½ × π × 6² × 5 + 14 + 60 + 14] award 4/5 ✓✓×✓✓
   (d) 1971 [½ × π × 12² × 5 + 60 × 14] award 4/5 ✓×✓✓✓
   (e) 934 [½ × π × 12 × 5 + 60 × 14] award 4/5 ×✓✓✓✓
   (f) 283 [½× π × 6² × 5] award 3/5 ✓✓××✓
   (g) 565 [π × 6² × 5] award 2/5 ×✓××✓
   (h) 94 [½ × π × 12 × 5] award 2/5 ×✓××✓
   (i) 188 [π × 12× 5] award 2/5 ×✓××✓
3. (a) 5th mark is only available where the answer to circle calculation requires rounding.
   (b) Where premature rounding leads to incorrect answer, a maximum of 4/5 is available.

5

15 | **6** | **Ans: 18 minutes** | **4**

- •¹ know how to find volume of tank: 90 × 60 × 50
- •² know how to find volume in litres: (90 × 60 × 50) ÷ 1000
- •³ know how to find time: [(90 × 60 × 50) ÷ 1000] ÷ 15
- •⁴ calculate [(volume) ÷ 1000] ÷ 15 = 18

1. Correct answer with no working award 4/4
2. Some common answers **(working must be shown)**
   (a) 270000 ÷ 15 ÷ 60 = 300 ✓×✓× award 2/4
   (b) 270000 ÷ 1000 ÷ 60 = 4.5 ✓✓×× award 2/4
   (c) [(90 + 60 + 50) ÷ 1000] ÷ 15 = 0.013 ×✓✓✓ award 3/4

4

16

14			**Ans: 5·2 cm^2** •^{1} know to calculate area of semi-circle: ½ πr^2 •^{2} substitute correct radius into formula: ½ × π × 1·4^2 •^{3} know to add area of triangle to area of semi-circle: ½ × π × 1·4^2 + ½ × 2·8 × 1·5 •^{4} carry out all calculations correctly: 3·07… + 2·1 = 5·17…. (must include a circle calculation **followed by** an addition) •^{5} round to one decimal place: 5·2	**5**	1. Correct answer without working award 0/5 2. **Some** common answers (working must be shown) (a) 8·3 [π × 1·4^2 + ½ × 2·8 × 1·5] award 4/5 ×✓✓✓✓ (b) 7·3 [½ × π × 1·4^2 + 2·8 × 1·5] award 4/5 ✓✓×✓✓ (c) 14·4 [½ × π × 2·8^2 + ½ × 2·8 × 1·5] award 4/5 ✓×✓✓✓ (d) 6·5 [½ × π × 2·8 + ½ × 2·8 × 1·5] award 4/5 ×✓✓✓✓ (e) 4·3 [½ × π × 1·4 + ½ × 2·8 × 1·5] award 3/5 ××✓✓✓ (f) 3·1 [½ × π × 1·4^2] award 3/5 ✓✓××✓ (g) 6·2 [π × 1·4^2] award 2/5 ×✓××✓ (h) 4·4 [½ × π × 2·8] award 2/5 ×✓××✓ (i) 8·8 [π × 2·8] award 2/5 ×✓××✓ (j) 2·2 [½ × π × 1·4] award 1/5 ××××✓ 3. (a) 5th mark is only available where the final answer or answer to circle calculation requires rounding. (b) Where premature rounding leads to incorrect answer, a maximum of 4/5 is available eg triangle = (½ × 1·4 × 1·5) × 2 = 1·05 × 2 = 1·1 × 2 total area = 2·2 + 3·1 = 5·3	**5**