Measurement: Surface Area, Volume & Scaling (Grade 10)

MARKING GUIDELINE

MARKS	DURATION	QUESTIONS
42	1 hour 5 minutes	4

Name: _____ Class: _____

Date: _____

MARK ____ / 42

INSTRUCTIONS AND INFORMATION

1. Answer **ALL** the questions in this question paper.
2. Answer QUESTION 1 by **circling** the letter (A–D) in the answer grid at the end of that section.
3. Show **ALL** calculations clearly.
4. Show all units where applicable.
5. Number the answers correctly according to the numbering system used in this question paper.
6. A non-programmable calculator may be used, unless stated otherwise.
7. Write neatly and legibly.

QUESTION 1 [10 MARKS]

Four options are given as possible answers to the following questions. Choose the correct answer and circle the letter (A–D) in the grid at the end of this section. If you want to change your choice, put a cross through the wrong letter and circle your new choice.

1.1 A cylinder has radius 5 cm and height 10 cm. Its VOLUME is ... (1)

A) 314,16 cm³ **B)** **785,40 cm³ ✓**

C) 1 570,80 cm³ **D)** 157,08 cm³

Answer: B — $V = \pi r^2 h = \pi \times 25 \times 10 = 785{,}40$ cm³.

- **A** — used $2\pi rh$, which is the CURVED SURFACE area
- **C** — doubled the correct volume
- **D** — used πrh instead of $\pi r^2 h$

1.2 A sphere has radius 6 cm. Its VOLUME is ... (1)

A) **904,78 cm³ ✓** **B)** 150,80 cm³

C) 678,58 cm³ **D)** 452,39 cm³

Answer: A — $V = \frac{4}{3}\pi r^3 = \frac{4}{3} \times \pi \times 216 = 904{,}78$ cm³.

- **B** — squared the radius instead of cubing it
- **C** — left out the factor of $\frac{4}{3}$
- **D** — that is $4\pi r^2$, the SURFACE AREA

1.3 A cone has radius 3 cm and perpendicular height 8 cm. Its VOLUME is ... (1)

A) 75,40 cm³ ✓ **B)** 226,19 cm³

C) 150,80 cm³ **D)** 25,13 cm³

> **Answer: A** — $V = \frac{1}{3}\pi r^2 h = \frac{1}{3} \times \pi \times 9 \times 8 = 75{,}40$ cm³.
>
> - **B** — used $\pi r^2 h$ — that is the CYLINDER, three times too big
> - **C** — used two thirds instead of one third
> - **D** — used $\frac{1}{3}\pi r h$, forgetting to square the radius

1.4 A closed cylinder has radius 4 cm and height 10 cm. Its TOTAL SURFACE AREA is ... (1)

A) 301,59 cm² **B)** 100,53 cm²

C) 351,86 cm² ✓ **D)** 251,33 cm²

> **Answer: C** — $TSA = 2\pi r^2 + 2\pi r h = 100{,}53 + 251{,}33 = 351{,}86$ cm².
>
> - **A** — included only ONE circular end instead of two
> - **B** — gave only the two ends, leaving out the curved surface
> - **D** — gave only the CURVED surface, leaving out the two circular ends

1.5 If every dimension of a solid is multiplied by 3, its VOLUME is multiplied by ... (1)

A) 9 **B)** 6

C) 27 ✓ **D)** 3

> **Answer: C** — Volume scales by k^3, and $3^3 = 27$.
>
> - **A** — that is the factor for an AREA
> - **B** — doubled the factor instead of cubing it
> - **D** — that is the factor for a LENGTH

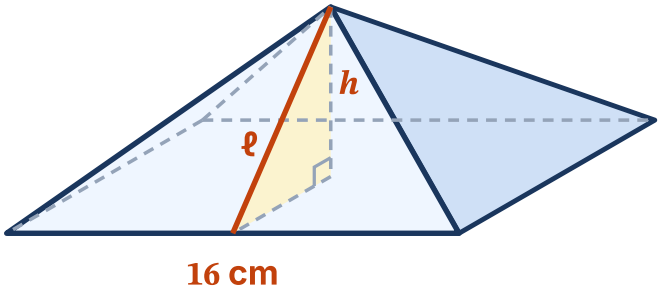
1.6 If every dimension of a solid is HALVED, its SURFACE AREA is multiplied by ... (1)

A) 4 **B)** $\frac{1}{2}$

C) $\frac{1}{8}$ **D)** $\frac{1}{4}$ **✓**

> **Answer: D** — Area scales by k^2, and $(\frac{1}{2})^2 = \frac{1}{4}$.
>
> - **A** — halving makes the area smaller, not four times as large
> - **B** — that is the factor for a LENGTH
> - **C** — that is the factor for a VOLUME

1.7 A right pyramid has a square base of side 16 cm, a perpendicular height $h = 6$ cm and a slant height $\ell = 10$ cm, as in the diagram. Its TOTAL SURFACE AREA is ... (1)



A) 448 cm²
B) **576 cm² ✓**
C) 320 cm²
D) 896 cm²

Answer: B — TSA $= 16^2 + 4 \times \frac{1}{2} \times 16 \times 10 = 256 + 320 = 576$ cm² — each face is a triangle whose height is the SLANT height.

- **A** — used the perpendicular height 6 cm for the faces; each face leans, so its height is the slant height 10 cm
- **C** — gave only the four triangular faces and left out the square base
- **D** — left out the $\frac{1}{2}$ in the area of each triangle

1.8 A cube has volume 125 cm³. Its TOTAL SURFACE AREA is ... (1)

A) 30 cm²
B) 750 cm²
C) **150 cm² ✓**
D) 25 cm²

Answer: C — The side is $\sqrt[3]{125} = 5$ cm, and a cube has 6 faces of 25 cm² each.

- **A** — multiplied the SIDE by 6 instead of the face AREA by 6
- **B** — used the volume 125 in place of the face area 25
- **D** — gave the area of ONE face only

1.9 A cylindrical tank has radius 0,5 m and height 2 m. Its capacity is ... (1)

A) 157,08 litres
B) 1,57 litres
C) 15,71 litres
D) **1 570,80 litres ✓**

Answer: D — $V = \pi r^2 h = 1{,}57$ m³, and 1 m³ = 1 000 litres.

- **A** — multiplied by 100 instead of by 1 000
- **B** — left the answer in cubic METRES instead of converting to litres
- **C** — multiplied by 10 instead of by 1 000

1.10 A square pyramid has base side 6 cm and perpendicular height 10 cm. Its VOLUME is ... (1)

A) 60 cm³
B) 360 cm³
C) 20 cm³
D) **120 cm³ ✓**

Answer: D — V = ⅓ × base area × height $= \frac{1}{3} \times 36 \times 10 = 120$ cm³.

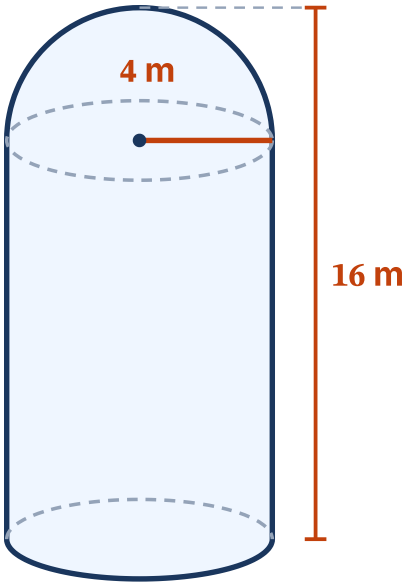
- **A** — used 6×10, forgetting both the third and the square
- **B** — used base area × height — that is the PRISM, three times too big
- **C** — used $\frac{1}{3} \times 6 \times 10$, forgetting to square the base side

ANSWER GRID — MARKING GUIDELINE

1.1	A	**B**	C	D
1.2	**A**	B	C	D
1.3	**A**	B	C	D
1.4	A	B	**C**	D
1.5	A	B	**C**	D
1.6	A	B	C	**D**
1.7	A	**B**	C	D
1.8	A	B	**C**	D
1.9	A	B	C	**D**
1.10	A	B	C	**D**

QUESTION 2 [10 MARKS]

A grain silo is made of a right cylinder with a hemispherical roof, as in the diagram below. The radius of the silo is 4 m and its total height, from the floor to the top of the roof, is 16 m. Round off your answers to TWO decimal places.



2.1 Calculate the volume of the silo. (5)

Height of the cylinder $= 16 - 4 = 12$ m *(1)*

$V = \pi r^2 h + \frac{2}{3}\pi r^3$ *(1)*

$= \pi(4)^2(12) + \frac{2}{3}\pi(4)^3$ *(1)*

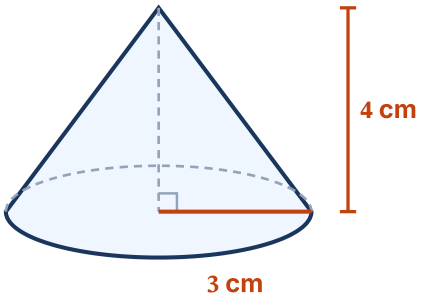
$= 603{,}19 + 134{,}04$ *(1)* $=$ **737,23 m³** *(1)*

2.2 The walls and the roof are covered with metal sheeting; the floor is concrete. Calculate the area of sheeting needed, and explain why the circle where the roof meets the walls is not included. **(5)**

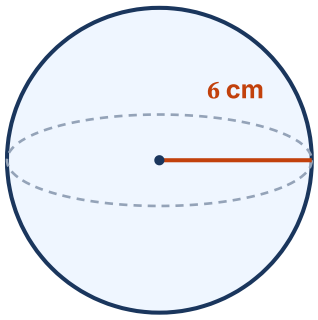
> Walls: $2\pi rh = 2\pi(4)(12) = 301{,}59\ \text{m}^2$ *(1)*
> Roof: $2\pi r^2 = 2\pi(4)^2 = 100{,}53\ \text{m}^2$ *(1)*
> No area is added for the floor (it is concrete) *(1)*
> Sheeting $= 301{,}59 + 100{,}53 =$ **402,12 m²** *(1)*
> The joined circle is inside the silo, not on its outside, so no sheeting covers it *(1)*

QUESTION 3 [13 MARKS]

The diagram below shows a cone with a base radius of 3 cm and a perpendicular height of 4 cm, and a sphere with a radius of 6 cm. Use $\pi \approx 3{,}14$, $V_{cone} = \frac{1}{3}\pi r^2 h$, $V_{sphere} = \frac{4}{3}\pi r^3$ and $SA_{sphere} = 4\pi r^2$.



cone (not to scale)



sphere (not to scale)

3.1 Calculate the volume of the cone. **(3)**

> $V = \frac{1}{3} \times 3{,}14 \times 9 \times 4$ *(2)* $=$ **37,68 cm³** *(1)*

3.2 Calculate the volume and the surface area of the sphere. **(4)**

> $V = \frac{4}{3} \times 3{,}14 \times 216 =$ **904,32 cm³** *(2)*
> $SA = 4 \times 3{,}14 \times 36 =$ **452,16 cm²** *(2)*

3.3 ALL the dimensions of the cone are doubled. Determine by what factor its volume increases, and justify your answer. **(4)**

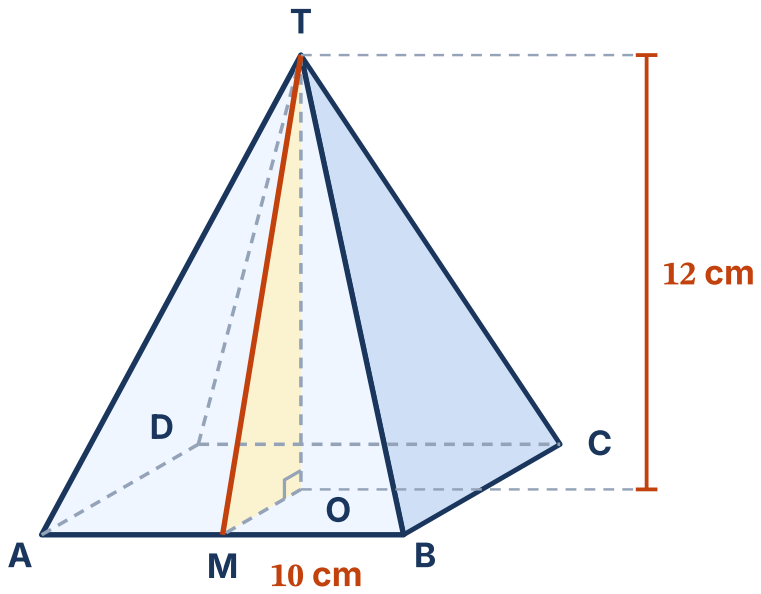
> Both r and h double *(1)*
> V depends on r^2h, so the factor is $2^2 \times 2$ *(2)*
> The volume becomes **8 times** as big *(1)*

3.4 Explain why doubling the dimensions multiplies the SURFACE AREA by only 4. **(2)**

> Surface area depends on TWO dimensions *(1)*, so it grows by the square of the factor, 2^2 *(1)*

QUESTION 4 [9 MARKS]

The diagram below shows a right pyramid TABCD with a square base ABCD. O is the centre of the base and M is the midpoint of AB. AB = 10 cm and the perpendicular height TO = 12 cm.



4.1 Show that the slant height TM = 13 cm. **(3)**

OM = $\frac{1}{2} \times 10 = 5$ cm *(1)*

$TM^2 = TO^2 + OM^2 = 12^2 + 5^2 = 169$ *(1)*

TM = 13 cm *(1)*

4.2 Calculate the total surface area of the pyramid. **(3)**

Base = $10^2 = 100$ cm^2 *(1)*

Four faces = $4 \times \frac{1}{2} \times 10 \times 13 = 260$ cm^2 *(1)*

TSA = **360 cm^2** *(1)*

4.3 Calculate the volume of the pyramid, and explain why TO, and not TM, is used. **(3)**

V = $\frac{1}{3} \times 100 \times 12$ *(1)* = **400 cm^3** *(1)*

Volume needs the PERPENDICULAR height, straight down from the apex to the base; TM leans along a face *(1)*

TOTAL: 42 marks

This question paper consists of 4 questions.

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