

IB DP MATHEMATICS

AI Topic 3 · Geometry and Trigonometry

TOPICAL WORKSHEET

3.1 Volume & Surface Area · 3.2 Trigonometry in Context

3.3 Sine & Cosine Rules · 3.4 Navigation & Construction

Standard and Higher Level · Syllabus 2025

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Section A — Multiple Choice (15 marks)

Circle the letter of the best answer to each question. Each question is worth 1 mark.

1. The volume of a cylinder with radius 2 m and height 6 m is [1]
A $12\pi \text{ m}^3$
B $24\pi \text{ m}^3$
C $36\pi \text{ m}^3$
D $48\pi \text{ m}^3$
2. The formula for the volume of a cone with base radius r and height h is [1]
A $\pi r^2 h$
B $\frac{1}{3} \pi r^2 h$
C $\frac{1}{2} \pi r^2 h$
D $2\pi r h$
3. The surface area of a sphere with radius 3 cm is [1]
A $9\pi \text{ cm}^2$
B $12\pi \text{ cm}^2$
C $27\pi \text{ cm}^2$
D $36\pi \text{ cm}^2$
4. A cube has a volume of 64 cm^3 . The side length of the cube is [1]
A 4 cm
B 8 cm
C 16 cm
D 21.3 cm
5. The angle of elevation is best described as the angle measured [1]
A downwards from the horizontal to a point below
B upwards from the horizontal to a point above
C clockwise from north to a point
D between two sides of a triangle
6. From a point 20 m from the base of a tree, the angle of elevation to the top of the tree is 40° . [1]
The height of the tree is
A 12.9 m
B 15.3 m
C 16.8 m
D 23.8 m

7. A bearing is always measured [1]
- A anticlockwise from south
 - B clockwise from north, as an angle from 000° to 360°
 - C as the shortest angle between two directions
 - D anticlockwise from east
8. If the bearing of point B from point A is 130° , the bearing of point A from point B (the 'back bearing') is [1]
- A 050°
 - B 230°
 - C 310°
 - D 130°
9. The sine rule for a triangle with sides a, b, c opposite angles A, B, C states that [1]
- A $a \div \sin A = b \div \sin B = c \div \sin C$
 - B $a \times \sin A = b \times \sin B$
 - C $a^2 = b^2 + c^2$
 - D $\sin A + \sin B + \sin C = 180^\circ$
10. The cosine rule for finding side a, given sides b, c and the included angle A, is [1]
- A $a^2 = b^2 + c^2$
 - B $a^2 = b^2 + c^2 - 2bc \cdot \cos A$
 - C $a^2 = b^2 - c^2$
 - D $a = b \cdot \cos A$
11. A triangle has angles of 50° and 70° . The third angle is [1]
- A 50°
 - B 60°
 - C 70°
 - D 120°
12. The area of a triangle with sides a, b and included angle C is given by [1]
- A $\frac{1}{2} ab \cdot \sin C$
 - B $\frac{1}{2} ab \cdot \cos C$
 - C $ab \cdot \sin C$
 - D $\frac{1}{2} (a+b) \sin C$

- 13.** A ship sails on a bearing of 040° , then changes course and sails on a bearing of 130° . The angle turned through between the two bearings is **[1]**
- A 40°
 - B 90°
 - C 130°
 - D 170°
- 14.** A ship sails 30 km east then 40 km north. The direct distance from its starting point is **[1]**
- A 10 km
 - B 35 km
 - C 50 km
 - D 70 km
- 15.** For an observer on a cliff watching a boat at sea, the angle of depression from the observer to the boat is **[1]**
- A always greater than the angle of elevation from the boat to the observer
 - B always less than the angle of elevation from the boat to the observer
 - C always equal to the angle of elevation from the boat to the observer (alternate angles)
 - D unrelated to the angle of elevation from the boat

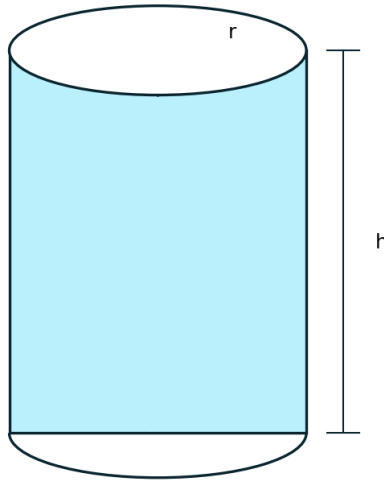
Section B — Structured Questions (65 marks)

Answer all questions in the space provided. Working must be shown for full marks.

3.1 Volume & Surface Area of 3D Solids

Question 1 [7 marks]

A cylindrical water tank has radius 3 m and height 5 m (given data).



Cylindrical water tank, $r=3$ m, $h=5$ m (given data).

- (a)** Using the formula $V = \pi r^2 h$, calculate the volume of the tank, giving your answer to 3 significant figures. [2]

- (b)** Calculate the curved (lateral) surface area of the tank, giving your answer to 3 significant figures. [2]

- (c)** Calculate the total surface area of the tank (including the top and bottom circular ends), giving your answer to 3 significant figures. [3]

Question 2 [6 marks]

A solid cone has base radius 4 cm and height 9 cm.

- (a) Using $V = \frac{1}{3} \pi r^2 h$, calculate the volume of the cone, giving your answer to 3 significant figures. [2]

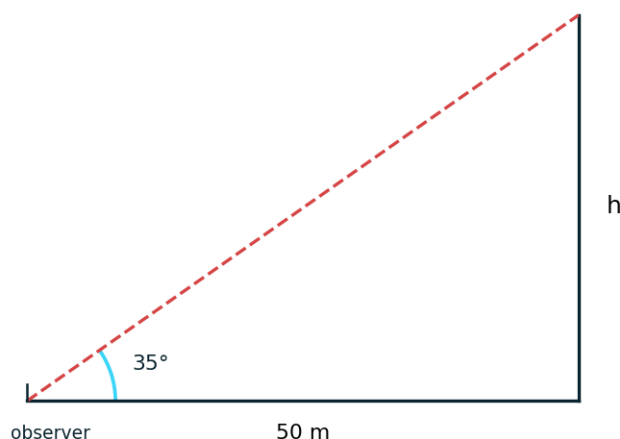
- (b) Using Pythagoras' theorem, calculate the slant height, l , of the cone, giving your answer to 3 significant figures. [2]

- (c) Using the curved surface area formula, $CSA = \pi r l$, calculate the curved surface area of the cone, giving your answer to 3 significant figures. [2]

3.2 Right-Angled Trigonometry in Context

Question 3 [7 marks]

An observer stands 50 m from the base of a tower. The angle of elevation from the observer to the top of the tower is 35° (given data).



Angle of elevation diagram, base=50 m, angle= 35° (given data).

- (a) Calculate the height, h , of the tower, giving your answer to 3 significant figures. [2]

- (b) Calculate the distance from the observer to the top of the tower (the line of sight distance), giving your answer to 3 significant figures. [2]

(c) The observer walks 20 m closer to the tower (now 30 m from the base). Calculate the new angle of elevation, giving your answer to 3 significant figures.

[3]

Question 4 [6 marks]

A hiker walks 8 km on a bearing of 065° from point A to point B.

(a) State the bearing required to walk directly back from B to A.

[2]

(b) Calculate how far east of A point B is, giving your answer to 3 significant figures.

[2]

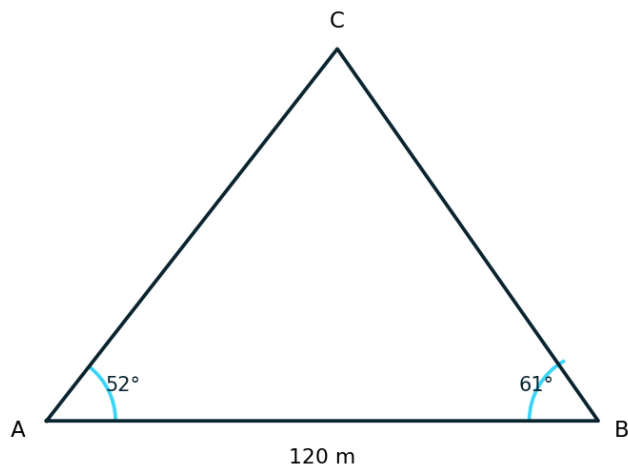
(c) Calculate how far north of A point B is, giving your answer to 3 significant figures.

[2]

3.3 Sine & Cosine Rules in Context

Question 5 [7 marks]

A triangular plot of land has vertices A, B and C, with $AB=120$ m, angle $A=52^\circ$ and angle $B=61^\circ$ (given data).



Survey triangle diagram, $AB=120$ m, $A=52^\circ$, $B=61^\circ$ (given data).

(a) Calculate the size of angle C.

[2]

(b) Using the sine rule, calculate the length of BC, giving your answer to 3 significant figures.

[3]

(c) Using the sine rule, calculate the length of AC, giving your answer to 3 significant figures.

[2]

Question 6 [6 marks]

A triangular garden has two sides of length 15 m and 18 m, with an included angle of 75° between them.

(a) Using the cosine rule, calculate the length of the third side, c , giving your answer to 3 significant figures.

[3]

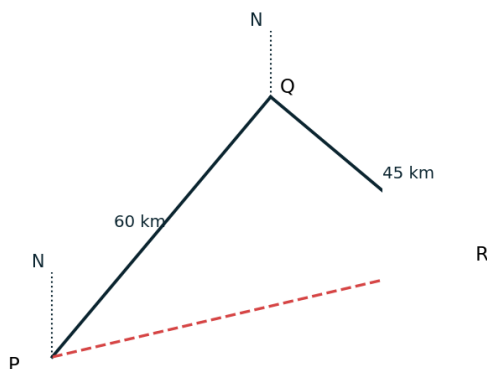
(b) Using the formula $\text{Area} = \frac{1}{2} ab \sin C$, calculate the area of the garden, giving your answer to 3 significant figures.

[3]

3.4 Applications: Navigation & Construction

Question 7 [7 marks]

A ship sails from port P on a bearing of 040° for 60 km to point Q, then changes course to a bearing of 130° and sails 45 km to point R (given data).



Navigation diagram, $PQ=60$ km (bearing 040°), $QR=45$ km (bearing 130°) (given data).

(a) Show that angle $PQR = 90^\circ$, explaining your reasoning using the given bearings. **[2]**

(b) Using Pythagoras' theorem, calculate the distance PR. **[2]**

(c) Calculate the bearing of R from P, giving your answer to 3 significant figures. **[3]**

3.1 Volume & Surface Area of 3D Solids

Question 8 [6 marks]

A spherical water storage tank has radius 2.5 m.

- (a) Using $V = \frac{4}{3}\pi r^3$, calculate the volume of the tank, giving your answer to 3 significant figures. [2]

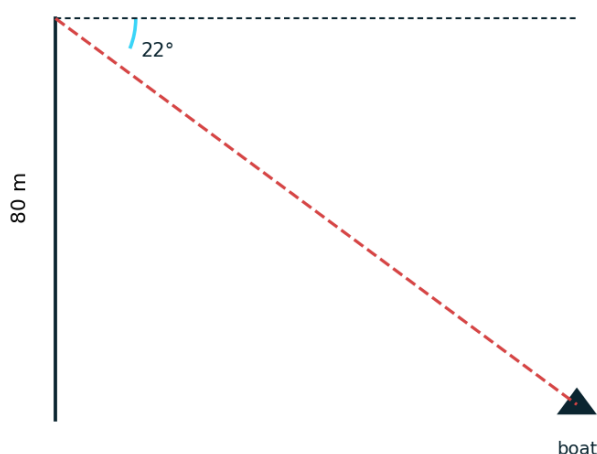
- (b) Using $SA = 4\pi r^2$, calculate the surface area of the tank, giving your answer to 3 significant figures. [2]

- (c) The tank is filled with water at a rate of 2 m^3 per minute. Calculate the time taken to fill the tank, giving your answer to the nearest minute. [2]

3.2 Right-Angled Trigonometry in Context

Question 9 [7 marks]

From the top of a cliff 80 m high, the angle of depression to a boat at sea is 22° (given data).



Angle of depression diagram, cliff height=80 m, angle= 22° (given data).

- (a) Calculate the horizontal distance from the base of the cliff to the boat, giving your answer to 3 significant figures. [2]

(b) Calculate the distance from the top of the cliff to the boat (the line of sight distance), giving your answer to 3 significant figures. **[2]**

(c) The boat sails directly away from the base of the cliff until the angle of depression becomes 15° . Calculate how far the boat has sailed, giving your answer to 3 significant figures. **[3]**

3.1 Volume & Surface Area of 3D Solids

Question 10 [6 marks]

A grain silo is made from a cylinder of radius 3 m and height 8 m, topped with a cone of the same radius and height 2 m.

(a) Calculate the volume of the cylindrical part of the silo, giving your answer to 3 significant figures. **[2]**

(b) Calculate the volume of the conical part of the silo, giving your answer to 3 significant figures. **[2]**

(c) Calculate the total volume of the silo, giving your answer to 3 significant figures. **[2]**