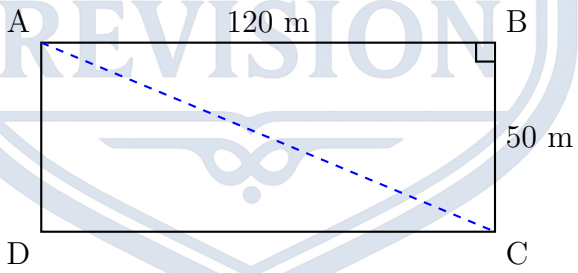
Topic: Pythagoras' Theorem & Right-Angled Trigonometry
IB Math AI SL

Answer all questions. Show all working where appropriate. Total: 79 marks.

1. **[Short Answer, Easy, 4 marks]**
   A rectangular park ABCD has a length of $AB = 120$ m and a width of $BC = 50$ m. A straight path runs diagonally across the park from point A to point C.

   (a) Calculate the length of the path AC.

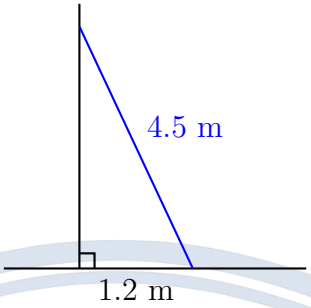
   (b) Calculate the angle $C\hat{A}B$ that the path makes with the longer side of the park.



2. **[Short Answer, Easy, 4 marks]**
A straight ladder of length 4.5 m leans against a vertical wall. The base of the ladder is placed 1.2 m away from the wall on horizontal ground.

   (a) Calculate the angle the ladder makes with the ground.

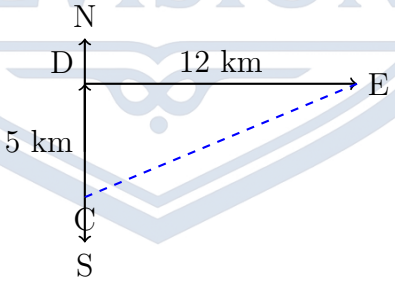
   (b) Calculate exactly how high up the wall the ladder reaches.



3. **[Short Answer, Easy, 4 marks]**
A hiker leaves camp C and walks 5 km due North to point D. The hiker then turns and walks 12 km due East to point E.

   (a) Calculate the direct distance from camp C to point E.

   (b) Calculate the three-figure bearing of point E from camp C.



4. **[Short Answer, Medium, 5 marks]**
From a point P on horizontal ground, 40 m from the base of a vertical tower, the angle of elevation to the top of the tower is 35°.

   (a) Calculate the height of the tower.

   (b) A person walks 15 m from point P directly towards the tower to a new point Q. Calculate the new angle of elevation from point Q to the top of the tower.

5. **[Short Answer, Medium, 4 marks]**
A kite is flying at a height of 42 m vertically above horizontal ground. The string attached to the kite is taut and makes an angle of 55° with the ground.

   (a) Calculate the length of the taut string.

   (b) The string is released by another 10 m while the angle remains at exactly 55°. Calculate the new vertical height of the kite above the ground.

6. **[Short Answer, Medium, 4 marks]**
A vertical pole casts a shadow 18 m long on horizontal ground. At that exact moment, the angle of elevation of the sun is 52°.

   (a) Calculate the height of the pole.

   (b) Later in the day, the length of the shadow lengthens to 25 m. Calculate the new angle of elevation of the sun.

7. **[Longer Question, Medium, 7 marks]**
Boat A leaves a harbour H and travels due North at a constant speed of 18 km/h. At exactly the same time, Boat B leaves the same harbour H and travels due East at a constant speed of 24 km/h.

   (a) Calculate the distance each boat has travelled after exactly 2.5 hours.

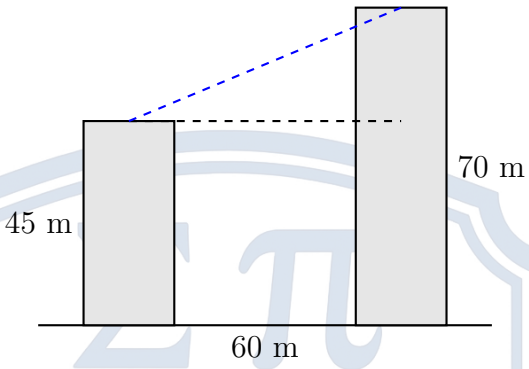
   (b) Calculate the direct straight-line distance between the two boats after 2.5 hours.

   (c) Calculate the true three-figure bearing of Boat B from Boat A after 2.5 hours.

8. **[Short Answer, Hard, 5 marks]**
Two office buildings are standing vertically on horizontal ground. Building A is 45 m tall and Building B is 70 m tall. The horizontal distance between the two buildings is 60 m.

   (a) Calculate the angle of elevation from the top of Building A to the top of Building B.

   (b) Calculate the direct straight-line distance from the top of Building A to the top of Building B.



9. **[Short Answer, Hard, 4 marks]**
An isosceles triangle ABC has side lengths $AC = 14$ cm, $AB = 14$ cm, and a base length $BC = 10$ cm.

   (a) Find the perpendicular height of the triangle from point A down to the base BC.

   (b) Calculate the size of the internal angle $A\hat{B}C$.

10. **[Longer Question, Hard, 6 marks]**
An observer stands at the top of a vertical cliff, 60 m above sea level. The observer spots two boats, Boat 1 and Boat 2, lined up directly directly in front of them on the water. The angle of depression to Boat 1 is 42° and the angle of depression to Boat 2 is 25°.

   (a) Draw a clear, labelled diagram to represent this situation.

   (b) Calculate the horizontal distance from the base of the cliff to Boat 1.

   (c) Calculate the horizontal distance from the base of the cliff to Boat 2.

   (d) Hence, find the exact distance between the two boats.

11. **[Longer Question, Hard, 5 marks]**
A flagpole stands vertically at the edge of the flat roof of a building. From a point on the horizontal ground 40 m away from the base of the building, the angle of elevation to the bottom of the flagpole is 29°, and the angle of elevation to the top of the flagpole is 31°.

    (a) Calculate the height of the building.

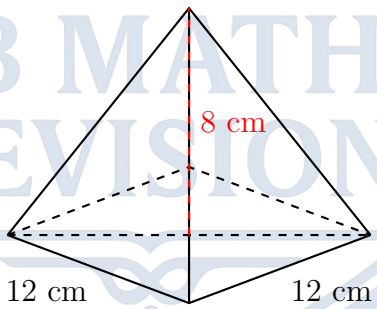
    (b) Calculate the length of the flagpole.

12. **[Longer Question, Very Hard, 6 marks]**
A right square-based pyramid has a base side length of 12 cm. The vertical height of the pyramid, from the centre of the square base straight up to the apex, is 8 cm.

    (a) Calculate the exact distance from the centre of the base to any one of the four corners of the square base.

    (b) Calculate the length of one of the slant edges of the pyramid.

    (c) Calculate the angle that a slant edge makes with the flat horizontal base of the pyramid.

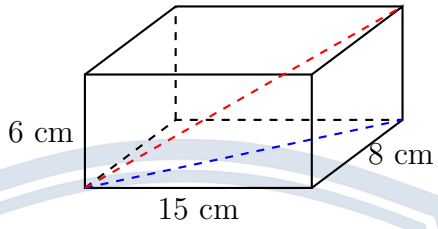


13. [**Longer Question, Very Hard, 6 marks**]
A rectangular box (cuboid) has a length of 15 cm, a width of 8 cm, and a height of 6 cm.

(a) Calculate the length of the diagonal across the rectangular base.

(b) Calculate the length of the main space diagonal of the cuboid (the straight line from the bottom front corner to the opposite top back corner).

(c) Calculate the angle this space diagonal makes with the rectangular base.



14. [**Longer Question, Very Hard, 5 marks**]
From a sailboat moored at sea, the angle of elevation to the top of a 20 m high vertical cliff is 22°. Directly on the edge of the cliff top, there is a tall coconut tree. The angle of elevation from the sailboat to the very top of the coconut tree is 29°.

(a) Calculate the horizontal distance from the sailboat to the base of the cliff.

(b) Hence, calculate the height of the coconut tree.

15. [**Longer Question, Very Hard, 10 marks**]
A tall communications tower, T, stands vertically above a point O on horizontal ground. An observer at point A, which is due South of the tower, measures the angle of elevation to the top of the tower T as 40°. A second observer at point B, which is due East of the tower, measures the angle of elevation to the top of the tower T as 25°. The direct horizontal distance between observer A and observer B is exactly 100 m. Let the height of the tower be h metres.

(a) Find an expression for the distance OA in terms of h.

(b) Find an expression for the distance OB in terms of h.

(c) Using the triangle OAB on the ground, set up an equation in terms of h.

(d) Solve your equation to find the height of the tower h.