

Pressure, Force and Area

Solutions

For AQA GCSE Mathematics (8300) • Foundation tier

Each question is shown in grey, followed by the working, one step per line. The final answer is in a box. *Marks* shows how the marks are usually given in the exam, and **Tip** points out a common mistake.

1 (1 mark)

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

A square paving slab lies flat on sand.

The area of the slab is 0.25 m^2

The pressure of the slab on the sand is 600 N/m^2

What force does the slab exert on the sand?

Circle your answer.

Options: 150 N, 599.75 N, 600.25 N, 2400 N

Rearrange the formula: $\text{force} = \text{pressure} \times \text{area}$

$$600 \times 0.25 = 150$$

Answer: 150 N

Tip: 2400 comes from $600 \div 0.25$. Force is pressure **times** area.

2 (2 marks)

A box exerts a force of 240 N on an area of 0.8 m^2

Work out the pressure.

$$\text{Pressure} = \text{force} \div \text{area}$$

$$240 \div 0.8 = 300$$

Answer: 300 N/m²

Marks: 1 mark for $240 \div 0.8$. 1 mark for 300.

3 (2 marks)

The pressure on an area of 12 cm² is 50 N/cm²
Work out the force.

Force = pressure $\times$ area

$$50 \times 12 = 600$$

Answer: 600 N

Marks: 1 mark for 50×12 . 1 mark for 600.

4 (2 marks)

A force of 350 N produces a pressure of 14 N/cm²
Work out the area.

Area = force $\div$ pressure

$$350 \div 14 = 25$$

Answer: 25 cm²

Marks: 1 mark for $350 \div 14$. 1 mark for 25.

5 (2 marks)

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

Mia pushes a drawing pin into a cork board with a force of 24 newtons.

The point of the pin has an area of 0.4 square millimetres.

Work out the pressure under the point of the pin.

Give the units of your answer.

Pressure = force $\div$ area

$$24 \div 0.4 = 60$$

The force is in newtons (N) and the area is in square millimetres (mm²).

So the units are newtons per square millimetre, N/mm²

Answer: 60 N/mm²

Tip: The units come from force $\div$ area, so here they are N/mm². Not N/mm, N $\times$ mm² or mm²/N.

Marks: 1 mark for 60. 1 mark for the units N/mm² (newtons per square millimetre).

6 (1 mark)

The force is doubled and the area is halved.

What happens to the pressure?

Circle your answer.

Options: $\div 4$, $\div 2$, no change, $\times 2$, $\times 4$

Pressure = force $\div$ area

Doubling the force (the top) multiplies the pressure by 2.

Halving the area (the bottom) also multiplies the pressure by 2.

Altogether: $2 \times 2 = 4$

Answer: $\times 4$

Tip: Test with numbers: force 10 on area 10 gives pressure 1. Force 20 on area 5 gives pressure 4.

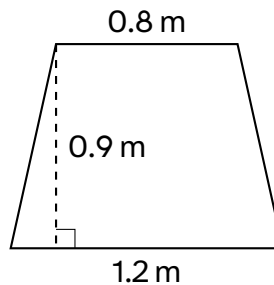
7 (3 marks)

A statue stands on a flat base.

The base is a trapezium.

The statue exerts a force of 2700 newtons (N) on the ground.

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$



Not drawn accurately

Work out the pressure of the statue on the ground.

$$\text{Area of a trapezium} = \frac{1}{2}(a + b)h$$

$$\frac{1}{2} \times (1.2 + 0.8) \times 0.9 = 0.9 \text{ m}^2$$

$$\text{Pressure} = \text{force} \div \text{area}$$

$$2700 \div 0.9 = 3000$$

Answer: 3000 N/m²

Tip: Remember the $\frac{1}{2}$ in the area of a trapezium. Using $(1.2 + 0.8) \times 0.9 = 1.8$ gives a pressure of 1500, which is wrong.

Marks: 1 mark for the area (0.9). 1 mark for $2700 \div$ their area. 1 mark for 3000.

8 (3 marks)

A solid cuboid measures 2 m by 1.5 m by 0.5 m.

It exerts a force of 900 N on the floor.

The cuboid can rest on the floor on any of its faces.

Work out the greatest possible pressure on the floor.

The force is the same whichever face it rests on.

The smallest area gives the greatest pressure.

$$\text{Smallest face: } 1.5 \times 0.5 = 0.75 \text{ m}^2$$

$$\text{Pressure} = 900 \div 0.75 = 1200$$

Answer: 1200 N/m²

Marks: 1 mark for using the smallest face (0.75). 1 mark for $900 \div 0.75$. 1 mark for 1200.

9 (3 marks)

Standing on all four feet, an elephant exerts a pressure of 12.5 tonnes per square metre on the ground.

Work out this pressure in kilograms per square centimetre.

Use

$$1 \text{ tonne} = 1000 \text{ kilograms}$$

$$1 \text{ metre} = 100 \text{ centimetres}$$

12.5 tonnes per square metre means 12.5 tonnes on every square metre.

Change tonnes to kg: $12.5 \times 1000 = 12\,500$ kg on every square metre

$$1 \text{ m}^2 \text{ is } 100 \times 100 = 10\,000 \text{ cm}^2$$

So the 12 500 kg is spread over 10 000 cm².

$$\text{On } 1 \text{ cm}^2: 12\,500 \div 10\,000 = 1.25 \text{ kg}$$

Answer: 1.25 kg/cm²

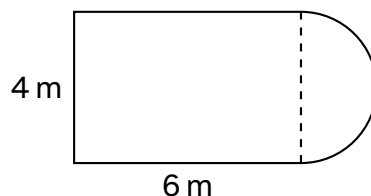
Tip: 1 m² is not 100 cm². A square 1 m by 1 m is 100 cm by 100 cm, so it is 10 000 cm².

Marks: 1 mark for multiplying by 1000. 1 mark for dividing by 10 000 (or by 100 twice). 1 mark for 1.25

10 (6 marks)

A school has a stage.

The shape of the stage is a rectangle joined to a semicircle.



Not drawn accurately

- (a) The stage exerts a force of 15 000 newtons (N) on the ground.

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

Assume that the whole base of the stage touches the ground.

Work out the pressure of the stage on the ground.

Give your answer to 3 significant figures.

$$\text{Area of the rectangle: } 6 \times 4 = 24 \text{ m}^2$$

The semicircle has diameter 4 m, so its radius is 2 m.

$$\text{Area of the semicircle: } \frac{1}{2} \times \pi \times 2^2 = 6.283 \dots \text{ m}^2$$

$$\text{Total area: } 24 + 6.283 \dots = 30.283 \dots \text{ m}^2$$

$$\text{Pressure} = \text{force} \div \text{area}$$

$$15\,000 \div 30.283 \dots = 495.32 \dots$$

To 3 significant figures: 495

Answer: 495 N/m²

Tip: Use the radius (2 m), not the diameter, in πr^2 , and remember to halve it for a semicircle.

Marks: 1 mark for 24 or 6.28. 1 mark for 30.28. 1 mark for 15 000 ÷ their total area. 1 mark for 495

- (b) In fact, the stage stands on eight legs.
Only the ends of the legs touch the ground.
How does this affect the pressure on the ground compared with your answer to part (a)?
Tick one box.
Give a reason for your answer.

The ends of the legs have a much smaller area than the whole base.

The force (15 000 N) stays the same.

The same force divided by a smaller area gives a bigger pressure.

So the actual pressure is greater.

Answer: Greater, because the area touching the ground is smaller

Marks: 2 marks for “greater” with a correct reason. 1 mark for “greater” with a partly correct reason.
