IGCSE PHYSICS • EXERCISE SHEET

1.8 Pressure

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS pressure 压强 • depth 深度 • density 密度 • force 力 • weight 重力

Objective

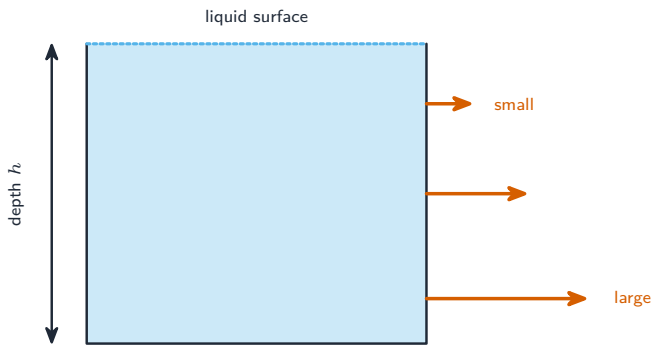
Build the skills to answer exam questions on **pressure** 压强 — $p = \dfrac{F}{A}$, and **pressure in a liquid** $\Delta p = \rho g \Delta h$.

You must be able to:

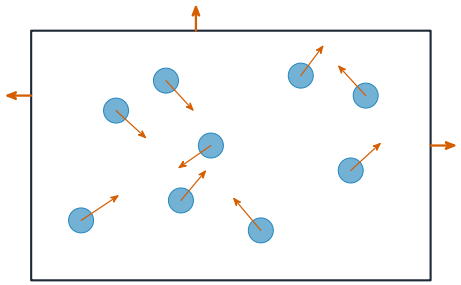
- use $p = \dfrac{F}{A}$ and explain area effects (sharp knife, snowshoes)
- use $\Delta p = \rho g \Delta h$ for pressure with depth
- state that liquid pressure acts in all directions and grows with depth

1 Worked examples

Pressure in a liquid



Pressure increases with depth and with density: $\Delta p = \rho g \Delta h$



gas particles hit the walls — each hit is a tiny force.
Pressure = force per unit area

Gas pressure comes from particles colliding with the walls

Depth 2.0 m in water ($\rho = 1000$, $g = 10$)**:** $\Delta p = 1000 \times 10 \times 2.0 = 20\,000$ Pa.

Area effect: a small area under a force gives a large pressure.

Choosing the right pressure equation

Use $p = \dfrac{F}{A}$ for a **solid pressing on a surface**: the force is the weight (or the push) and the area is the area in contact. Use $\Delta p = \rho g \, \Delta h$ for the pressure **inside a liquid** at a depth: it does not depend on the shape or the width of the container, only on the depth and the density.

△ Convert areas before substituting. An area given in cm^2 must become m^2 by dividing by 10 000, because $1\ \text{m}^2 = 100 \times 100 = 10\,000\ \text{cm}^2$.

Worked example 1 (solid). A block of weight 16 N rests on a face measuring 4.0 cm by 5.0 cm.

1. Area $= 4.0 \times 5.0 = 20\ \text{cm}^2 = 20 \div 10\,000 = 0.0020\ \text{m}^2$.
2. $p = \dfrac{F}{A} = \dfrac{16}{0.0020} = 8000$ Pa.

Worked example 2 (liquid, then force). An oil tank has a base of area 2.5 m^2 and holds oil of density 800 kg/m^3 to a depth of 1.2 m. Take $g = 10$ N/kg.

1. Pressure at the base: $\Delta p = \rho g \, \Delta h = 800 \times 10 \times 1.2 = 9600$ Pa.
2. Force on the base: rearrange $p = \dfrac{F}{A}$ to $F = pA = 9600 \times 2.5 = 24\,000$ N.

Pressure in a liquid acts in **all directions** and grows with depth, which is why a dam is thicker at the bottom.

2 Practice

2.1 A force of 200 N acts on an area of 0.50 m^2. Find the pressure. [2]

2.2 State why a sharp knife cuts more easily than a blunt one. [1]

2.3 A box of weight 60 N stands on a base of 0.25 m^2. Calculate the pressure on the floor. [2]

2.4 A block rests on a face of 20 cm^2. Convert this area into m^2. [1]

3 Exam-style questions

3.1 The pressure in a liquid increases with: [1]

- **A** depth only
- **B** density only
- **C** both depth and density
- **D** neither

3.2 A diver is 15 m below the surface of sea water of density 1030 kg/m^3 ($g = 10$ N/kg).

(a) Find the extra pressure due to the water. [2]

(b) State the direction(s) in which this pressure acts on the diver. [1]

3.3 A box weighing 240 N stands on the ground on a base of area 0.30 m^2. Find the pressure it exerts on the ground. [2]

3.4 A rectangular water tank has a base of area 3.0 m^2 and is filled with water to a depth of 1.5 m. The density of water is 1000 kg/m^3 and $g = 10$ N/kg.

(a) Calculate the pressure due to the water at the base of the tank. [2]

(b) Calculate the force the water exerts on the base. [2]

(c) A second tank has the same depth of water but twice the base area. State and explain how the pressure at its base compares with your answer to (a). [2]

(d) A concrete block of weight 750 N stands on the ground on a face measuring 50 cm by 30 cm. Calculate the pressure it exerts on the ground. [3]

(e) Explain why the walls of a dam are made thicker at the bottom than at the top. [2]

Solutions

2.1 $p = \dfrac{F}{A} = \dfrac{200}{0.50} = 400$ Pa.

2.2 its edge has a very small area, so the same force gives a very large pressure.

2.3 $p = \dfrac{F}{A} = \dfrac{60}{0.25} = 240$ Pa.

2.4 $20 \div 10\,000 = 0.0020$ m^2.

3.1 C. Liquid pressure increases with both depth and density.

3.2 (a) $\Delta p = \rho g \Delta h = 1030 \times 10 \times 15 = 154\,500$ Pa.
(b) in all directions.

3.3 $p = \dfrac{F}{A} = \dfrac{240}{0.30} = 800$ Pa.

3.4 (a) $\Delta p = \rho g\, \Delta h = 1000 \times 10 \times 1.5 = 15\,000$ Pa.
(b) $F = pA = 15\,000 \times 3.0 = 45\,000$ N.
(c) The pressure is the same, because $\Delta p = \rho g\, \Delta h$ depends only on the depth and the density, not on the area or shape of the container.
(d) Area $= 50 \times 30 = 1500$ cm$^2 = 0.15$ m^2; $p = \dfrac{750}{0.15} = 5000$ Pa.
(e) The pressure in the water increases with depth, so the wall must be thicker at the bottom to withstand the greater outward force there.