AQA · GCSE · PHYSICS • EXERCISE SHEET

5.5 Pressure and fluids

Name: _____ Class: _____ Date: _____ **Total: 27 marks**

KEY WORDS upthrust

Objective

Use $p = F/A$, (HT) $p = h\rho g$, explain upthrust and floating, and the variation of atmospheric pressure with height. Physics only. Original questions for spec statements 4.5.5.1–4.5.5.2.

1 Key knowledge and worked examples

A **fluid** is a liquid or a gas. Fluid pressure acts **normal (at right angles)** to any surface:

$$p = \frac{F}{A}$$

- p in pascals Pa; F force normal to the surface in N; A area in m^2.
- 1 Pa = 1 N/m^2. Convert cm^2 to m^2 before substituting.

(HT) Pressure in a **column of liquid**:

$$p = h\rho g$$

- h column height in m; ρ liquid density in kg/m^3; g given.
- Pressure at a point rises with the **height** of liquid above it and with the liquid's **density**; differences in depth give differences of pressure.

Upthrust : a submerged object feels **larger pressure on its bottom than its top** → a resultant force **upwards**. Floating at rest: upthrust = weight. A released object initially accelerates downwards if weight exceeds upthrust. Once it moves, fluid drag also contributes; a sinking object may reach a constant speed.

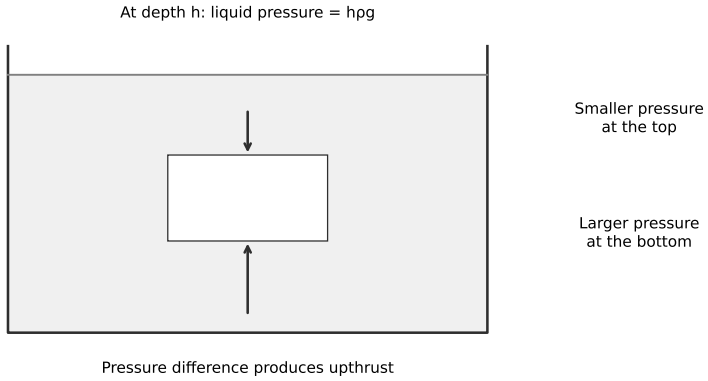
Atmospheric pressure decreases as height increases: fewer air molecules above the surface (less weight of air pressing down), and the atmosphere gets **less dense with altitude** – a thin layer relative to Earth's radius. Colliding air molecules make the pressure.

Worked example. A box of base area 0.50 m^2 is pressed down with 150 N.

$$p = \frac{F}{A} = \frac{150}{0.50} = 300 \text{ Pa}$$

Worked example (HT). A 4.0 m deep pool of water ($\rho = 1000$ kg/m^3, $g = 9.8$).

$$p = h\rho g = 4.0 \times 1000 \times 9.8 = 39\,200 \text{ Pa} \approx 39 \text{ kPa}$$



2 Practice

2.1 A force of 200 N acts on an area of 0.25 m^2. Calculate the pressure. [2]

2.2 (HT) State the two factors in the liquid column that raise the pressure at a point below the surface. [2]

2.3 A submerged balloon is released from rest and starts to rise. Explain its initial acceleration in terms of the forces on it. [2]

3 Exam-style questions

3.1 A swimming pool is filled to a depth of 2.0 m ($\rho = 1000$ kg/m^3, $g = 9.8$ N/kg; HT).

(a) Calculate the pressure due to the water at the bottom. [3]

(b) Explain why the pressure on the side walls near the bottom is greater than near the top. [2]

(c) The pool's bottom has an area of 50 m^2. Calculate the water's force on the bottom. [2]

3.2 A submarine dives.

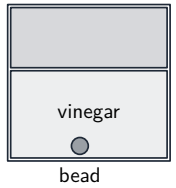
(a) Explain what happens to the pressure on the hull as the depth increases. [2]

(b) (HT) At 30 m the water pressure is 294 kPa greater than at the surface, where atmospheric pressure is 101 kPa. A sealed flexible bag initially contains 6.0 L of air. Use $p_1V_1 = p_2V_2$ to estimate its volume at this depth, assuming constant temperature. [2]

(c) Explain why the submarine's hull must be strong, using pressure and force. [2]

3.3 A jar contains oil floating on vinegar with a solid bead at the bottom (oil $\rho = 920$, vinegar $\rho = 1010$ kg/m^3).

(a) Explain, with densities, why the oil floats on the vinegar. [2]

(b) The bead (volume 1.0×10^{-6} m^3, density 2500 kg/m^3) sits in the vinegar. Calculate the upthrust on it in the vinegar ($g = 9.8$ N/kg, HT method $F = pA$ not needed: use $\rho V g$). [3]

(c) Calculate the bead's weight and state whether it stays on the bottom. [3]