

Taking it Further: Pressure in Fluids

Answer the questions below.

1. Define a fluid.

A substance with no fixed shape.

2. State the equation used to calculate pressure.

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

3. Name the property of liquids that makes them useful for hydraulics.

They cannot be compressed.

4. What does the g represent in the equation $W = mg$?

Gravitational field strength

5. What are the units for the quantity g?

N/kg



Taking it Further: Pressure in Fluids

Do Now:

1. Define a fluid.
2. State the equation used to calculate pressure.
3. Name the property of liquids that makes them useful for hydraulics.
4. What does the g represent in the equation $W = mg$?
5. What are the units for the quantity g?

Drill:

1. A water bottle contains a mass of water of 500 g. Convert this to SI units.
2. The base of the water bottle has a radius of 2 cm. Calculate the area of the base in m^2 .
3. Calculate the pressure exerted by the water on the base of the bottle.



Taking it Further: Pressure in Fluids

Read Now:

According to PADI (the Professional Association of Diving Instructors) most scuba divers should only explore depths of 40 metres for periods of 10 minutes at a time. This is because as you go deeper under water, pressure increases by an atmosphere with every 10 metres of depth. The deeper you are under water, the greater the weight of the particles above pushing down on you. It can be dangerous to go too deep under water as parts of the body, such as the lungs, can start to be compressed by this pressure, which can be very dangerous.

1. Describe the relationship between pressure and depth.
2. Explain the relationship between pressure and depth.
3. Explain why PADI recommend a time and depth limit for scuba divers.
4. Explain why it can be dangerous for a person to be under high pressure.
5. Explain why specialist equipment would be needed to explore the deepest parts of the oceans.



Taking it Further: Pressure in Fluids

P4.1.6

Science
Mastery

P4.1.1 Prior Knowledge Review

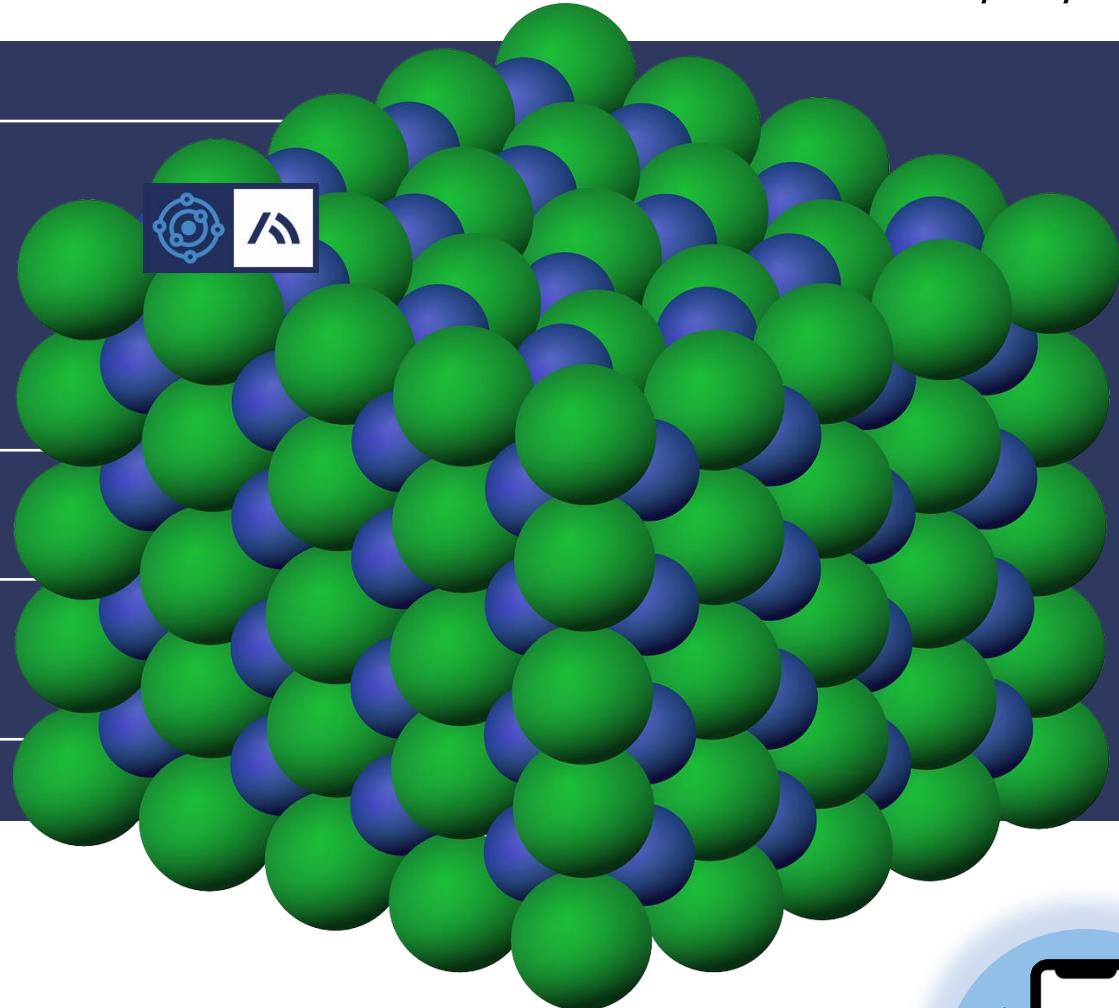
P4.1.2 Density

P4.1.3 Measuring Density

P4.1.4 Gas Pressure

P4.1.5 Taking it Further: Pressure

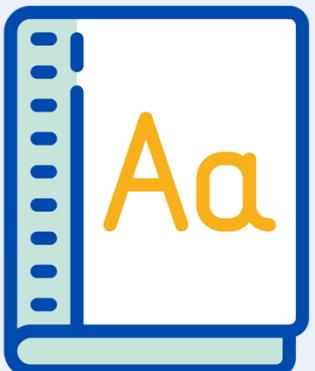
➤ **P4.1.6 Taking it Further: Pressure in Fluids**



Following this lesson, students will be able to:

- Describe and explain the relationship between pressure and depth of a fluid
- Calculate the pressure exerted on an object at different depths
- Describe the forces acting on an object when they float or sink

Key Words:



depth

height

density

gravitational field strength

upthrust

altitude

This is the fix-it portion of the lesson

The **fix-it** is an opportunity to respond to gaps in knowledge, especially those identified by the previous lesson's exit ticket.

- The teacher should customise this slide as needed, to facilitate
 - **reteach, explanation, demonstration or modelling** of ideas and concepts that students have not yet grasped or have misunderstood.
 - **practise** answering specific questions or of key skills.
 - **redrafting** or **improving** previous work.

Answer the questions below.

1. What property of liquids makes them suitable for using in hydraulics?
 A. They can be compressed
 B. They cannot be compressed
 C. They do not have a fixed shape
2. Pressure is exerted by a fluid on a surface. If the area of the surface remains constant but a greater force is applied, what happens to the pressure?
 A. The pressure would increase
 B. The pressure would decrease
 C. The pressure would stay the same
3. What force would be exerted by a liquid with pressure 50 N/cm^2 on an area of 0.1 cm^2 ?
 A. 5 N
 B. 0.002 N
 C. 500 N

Pressure and Depth

The **deeper** you go in water the **greater the pressure** becomes, because the greater the **weight** of water above you.

Higher Tier only

The pressure depends on the height of liquid above a point, density of liquid, and the gravitational field strength:

$$p = h\rho g$$

Pressure (Pa)

Height of column (m)

Density (kg/m^3)

Gravitational field strength (N/kg)

This is an equation you will need to apply.

Worked Example

What is the pressure at each point in this water bottle?

Point A is 0.05 m from the surface, Point B is 0.12 from the surface and Point C is 0.25 from the surface.

The density of water is 997 kg/m³ and the gravitational field strength is 9.8 N/kg.

At point A:

$$p = h\rho g$$

$$p$$

$$\bar{p} = 0.05 \times 997 \times 9.8$$

$$\bar{p} = 488.53 \text{ Pa}$$

At point B:

$$p = h\rho g$$

$$p$$

$$\bar{p} = 0.12 \times 997 \times 9.8$$

$$\bar{p} = 1172.48 \text{ Pa}$$

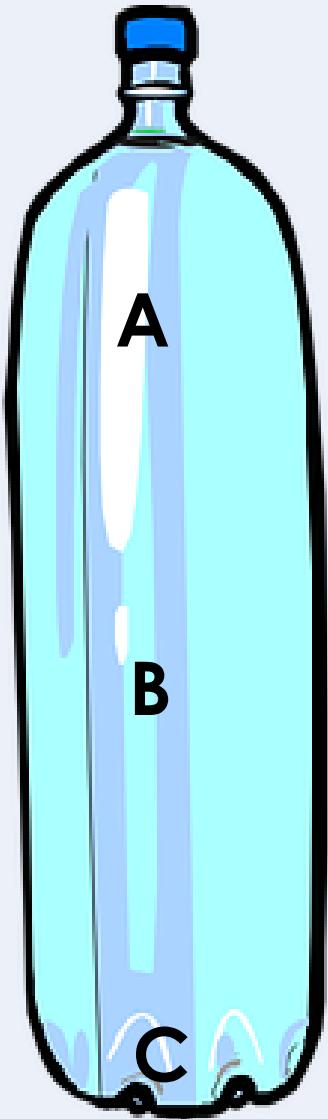
At point C:

$$p = h\rho g$$

$$p$$

$$\bar{p} = 0.25 \times 997 \times 9.8$$

$$\bar{p} = 2442.65 \text{ Pa}$$



Why do objects float?

Higher Tier only

A partially or fully submerged object experiences a **greater pressure** on the bottom surface than on the top surface.

This creates a **resultant force** upwards. This force is called **upthrust**.



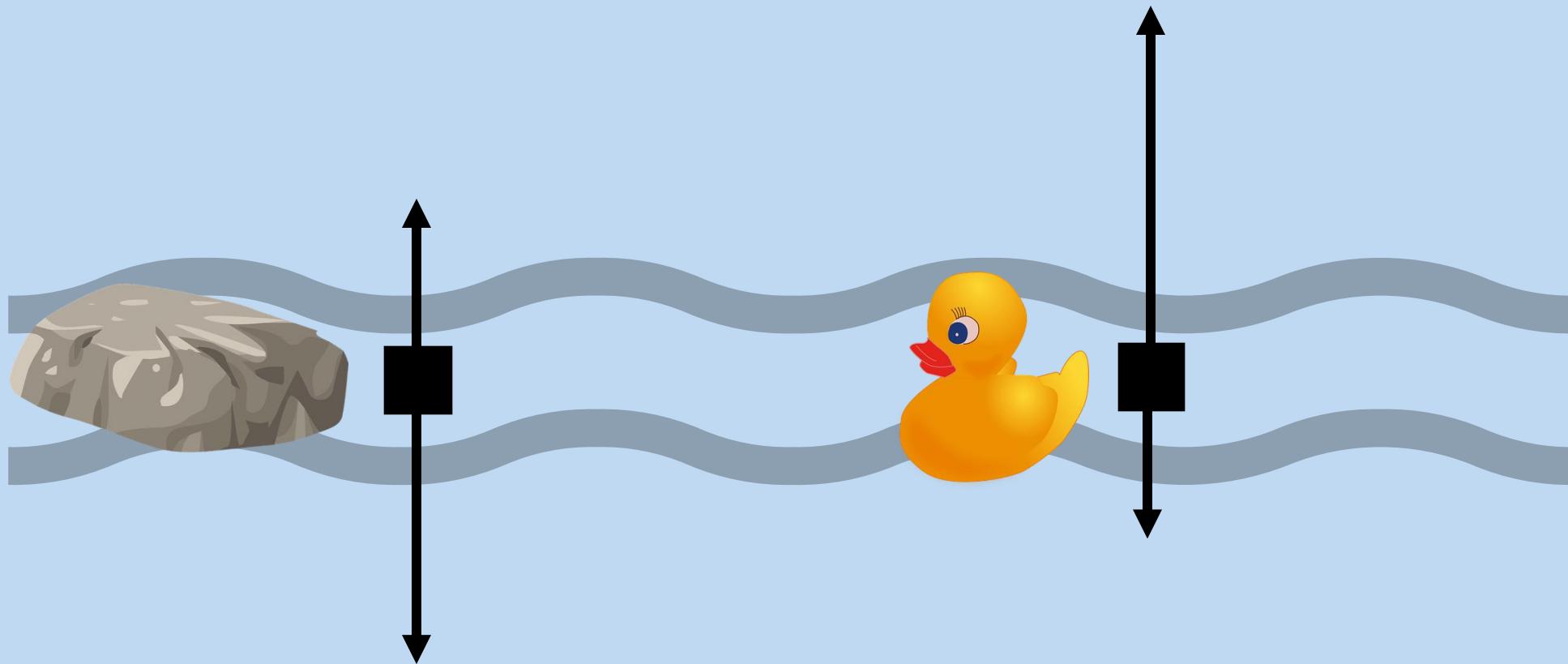
Objects float or sink in water depending on the **density** of the object compared to water.

If the object is **more dense** than the liquid it will **sink**, because **weight > upthrust**.

If **less dense** it will **float** because **weight < upthrust**.

Why do objects float?

Higher Tier only



Sink

Float

Atmospheric Pressure

Atmospheric pressure is caused by air particles **colliding** with a surface (e.g. our skin).

The higher the altitude the **less dense** the atmosphere.

So, the **number** of air particles (and so **weight** of air) above a surface decreases as the height increases.

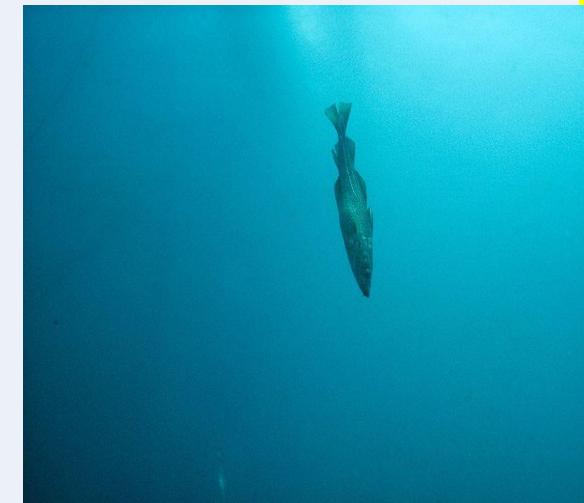
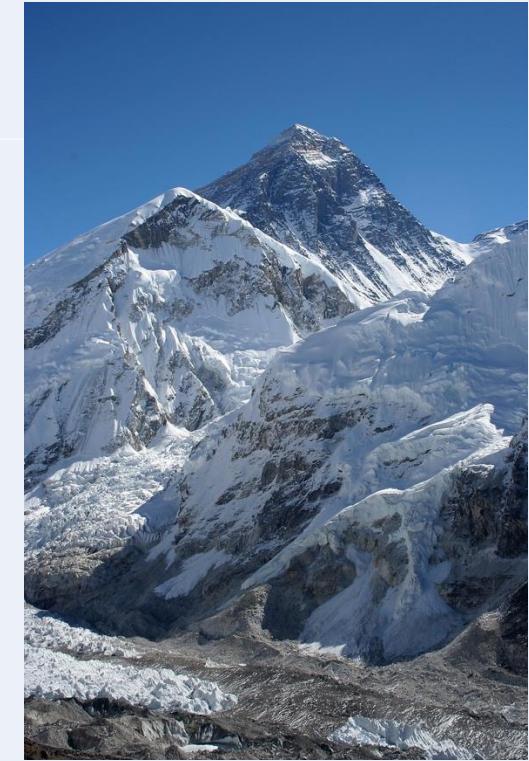
As height increases there is always less air above a surface than at a lower height.

This means **atmospheric pressure decreases with an increase in height.**



Is this correct?

Going to the top of Mount Everest would have the same effect on the body as going to the bottom of the sea.



Can you identify the mistake(s) this student has made?

A student drops a marble into a container of oil.

The marble is 14 cm below the surface of the oil and the gravitational field strength is 9.8 N/kg.

The pressure exerted on the marble is 1 064 Pa.

Calculate the density of the oil.

$$p = hpg$$

$$p = 0.14 \times 1062 \times 9.8$$

$$p = 1457.06 \text{ m}^3/\text{kg}$$

$$p = hpg$$

$$1064 = 0.14 \times \rho \times 9.8$$

$$1064 = 1.372 \rho$$

$$\rho = 775.51 \text{ kg/m}^3$$

Drill

1. Describe the relationship between pressure and depth in a liquid.
2. Explain the relationship between pressure and depth in a liquid.
3. Identify the quantity represented by p in the equation $p = h\rho g$.
4. Identify the quantity represented by h in the equation $p = h\rho g$.
5. Identify the quantity represented by ρ in the equation $p = h\rho g$.
6. Identify the quantity represented by g in the equation $p = h\rho g$.
7. Describe the relationship between pressure and altitude.
8. Explain the relationship between pressure and altitude.
9. Compare the size of upthrust and weight for an object that floats.
10. Compare the size of upthrust and weight for an object that sinks.

Drill answers

1. Pressure increases with depth in a liquid
2. The deeper the point in a liquid, the greater the weight of particles above the point.
3. Pressure
4. Height of column (depth under surface)
5. Density of liquid
6. Gravitational field strength
7. Pressure decreases with altitude
8. The higher the altitude, the fewer particles so the lower the weight of the particles
9. An object that floats: upthrust \geq weight
10. An object that sinks: upthrust $<$ weight

Answer the questions below.

1. A student cuts three holes in a bottle of water. Where is the pressure greatest?
 A. At the highest hole
 B. At the middle hole
 C. At the lowest hole

2. An inflatable toy floats on water. Which statement is correct?
 A. The inflatable toy is more dense than the water
 B. The inflatable toy does not have weight when it is on water
 C. The weight of the toy is less than or equal to the upthrust on the toy

3. How deep is an object under water if it experiences $29\ 910\ \text{N/m}^2$ of pressure? The density of water is $997\ \text{kg/m}^3$ and the gravitational field strength is $9.8\ \text{N/kg}$.
 A. $2.92 \times 10^8\ \text{m}$
 B. $3.06\ \text{m}$
 C. $3.40 \times 10^{-3}\ \text{m}$

Lesson P4.1.6

What was good about this lesson?

What can we do to improve this lesson?

[Send us your feedback by clicking this link. Thank you!](#)