

Exercise walk-through

8.2

Pressure

AP Physics 1

Pressure

Pressure is force spread over an area:

Two key formulas

$$P = \frac{F}{A}, \quad P = \rho gh$$

- smaller area $\Rightarrow$ bigger pressure (a sharp knife)
- fluid pressure grows with **depth**, and pushes equally in **all directions**



Pressure is force per unit area

Gauge pressure and absolute pressure

Gauge pressure

The extra pressure the fluid column adds: $P_{\text{gauge}} = \rho gh$. It reads zero at the surface.

Absolute pressure

The total: $P = P_0 + P_{\text{gauge}}$, with P_0 usually atmospheric. Never negative.

The tyre

A gauge reading 200 kPa is *gauge* pressure – the air inside is really about 300 kPa absolute.

Gas-law and buoyancy problems need **absolute** pressure; a pressure *difference* across a wall is the gauge value.

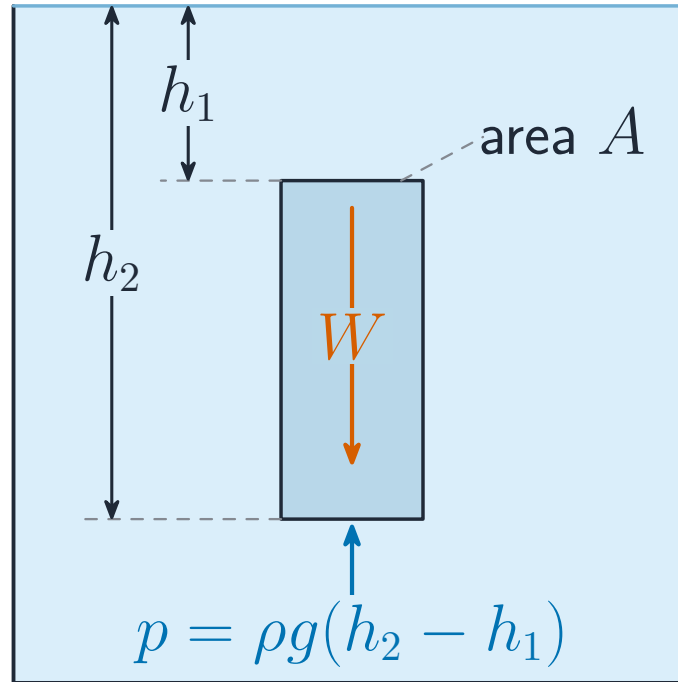
Worked example – pressure on a diver

Find the total pressure on a diver 10 m below the surface. ($\rho = 1000 \text{ kg/m}^3$, surface pressure $1.0 \times 10^5 \text{ Pa}$)

- **gauge pressure** : $P_{\text{gauge}} = \rho gh = (1000)(9.8)(10) = 9.8 \times 10^4 \text{ Pa}$
- **absolute pressure** :
 $P = P_0 + \rho gh$
- $= 1.0 \times 10^5 + 9.8 \times 10^4 = 2.0 \times 10^5 \text{ Pa}$

Gauge pressure is what the *column* adds; absolute pressure includes the atmosphere on top. Read the question for which it wants – the two differ by a whole atmosphere.

The weight of a liquid column sets



The weight of a liquid column sets the extra pressure at a depth

Exercises 2.1-2.3

2.1 A force of 200 N acts on an area of 0.50 m^2 . Find the pressure. [1]

2.2 Find the pressure 5.0 m below the surface of a lake ($\rho = 1000 \text{ kg m}^{-3}$, $g = 10 \text{ m s}^{-2}$). [2]

2.3 State how the pressure in a fluid changes with depth. [1]

Exercises 2.1·2.3

2.1 A force of 200 N acts on an area of 0.50 m². Find the pressure. [1]

2.1

- $P = \frac{F}{A} = \frac{200}{0.50} = 400 \text{ Pa}$

2.2 Find the pressure 5.0 m below the surface of a lake ($\rho = 1000 \text{ kg m}^{-3}$, $g = 10 \text{ m s}^{-2}$). [2]

2.2

- $P = \rho gh = 1000 \times 10 \times 5.0 = 5.0 \times 10^4 \text{ Pa}$

2.3 State how the pressure in a fluid changes with depth. [1]

2.3

- it increases with depth

Exercises 3.1·3.2

3.1 Pressure is defined as

[1]

☐

A force $\times$ area

B force $\div$ area

C mass $\div$ volume

D density $\times$ depth only

3.2 The pressure due to a column of fluid depends on

[1]

☐

A the shape of the container

B the surface area

C the depth and the fluid density

D the total volume

Exercises 3.1·3.2

3.1 Pressure is defined as

[1]

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A force $\times$ area

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3.1 B

- force $\div$ area.

3.2 The pressure due to a column of fluid depends on

[1]

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A the shape of the container

B the surface area

C the depth and the fluid density

D the total volume

3.2 C

- the depth and the fluid density.

Exercise 3.3 (a)

3.3 A diver is 12 m below the sea surface ($\rho = 1030 \text{ kg m}^{-3}$, $g = 10 \text{ m s}^{-2}$).

(a) Find the pressure due to the water.

[2]

Exercise 3.3 (a)

3.3 A diver is 12 m below the sea surface ($\rho = 1030 \text{ kg m}^{-3}$, $g = 10 \text{ m s}^{-2}$).

(a) Find the pressure due to the water.

[2]

(a)

- $P = \rho gh = 1030 \times 10 \times 12 = 1.24 \times 10^5 \text{ Pa}$

Exercise 3.3 (b)

3.3 A diver is 12 m below the sea surface ($\rho = 1030 \text{ kg m}^{-3}$, $g = 10 \text{ m s}^{-2}$).

(b) Find the total pressure if atmospheric pressure is $1.0 \times 10^5 \text{ Pa}$. [1]

Exercise 3.3 (b)

3.3 A diver is 12 m below the sea surface ($\rho = 1030 \text{ kg m}^{-3}$, $g = 10 \text{ m s}^{-2}$).

(b) Find the total pressure if atmospheric pressure is $1.0 \times 10^5 \text{ Pa}$. [1]

(b)

- $\text{total} = 1.24 \times 10^5 + 1.0 \times 10^5 = 2.24 \times 10^5 \text{ Pa}$