PASCAL'S LAW & ARCHIMEDES PRINCIPLE
LEARNING OUTCOMES

Students should be able to

1. define pressure and Pascal's law.

2. understand the application of Pascal's law.

3. define and understand Archimedes principle.

4. calculate the upthrust force.
PRESSURE

The perpendicular force exerted on the unit area of an object is called pressure.

FORMULA

\[ P = \frac{F}{A} \]

UNIT

In S.I unit of pressure is \( N / m^2 \) and it is also called pascal (Pa).
PRESSURE OF LIQUID

If "A" is the base area, "h" is the height of the cylinder and density of the liquid is "ρ", then the pressure exerted by the liquid on the cylinder is given by,

\[
\begin{align*}
P &= \frac{F}{A} \\
\therefore F &= \omega \\
\rho &= \frac{\omega}{A} \\
\therefore \omega &= mg \\
P &= \frac{mg}{A}
\end{align*}
\]
\[ S = \frac{m}{V} \]

\[ SV = m \]

\[ P = \frac{SV \theta}{A} \]

\[ P = \frac{9A h \theta}{A} \]

\[ P = 9 h \theta \]
PASCAL'S LAW

"If pressure is exerted on a liquid, the liquid transmits itself equally in all directions."
APPLICATION OF PASCAL'S LAW

In a hydraulic jack, if pressure due to a small force $F_1$ on a piston of area $A_1$ is applied and $F_2$ be the force acting on the larger piston of area $A_2$. Then according to Pascal's law,
\[ P = \frac{F_1}{A_1} = \frac{F_2}{A_2} \]

\[ \frac{F_2}{F_1} = \frac{A_2}{A_1} \]

\[ F_2 = F_1 \times \frac{A_2}{A_1} \]

If \( A_2 > A_1 \), then \( F_2 > F_1 \)
ARCHIMEDES PRINCIPLE

"When a body immersed completely or partially in a liquid, it will experience an upthrust (upward force) equal to the weight of the liquid (or fluid) displaced by the body."
**Derivation for upthrust force**

Consider a liquid of density $\rho$ in a container. An object of height $h$ and area of cross section $A$ is immersed in the liquid.

The resultant vertical force on the top surface $F_1$ is

$$F_1 = A \rho g h_1$$

The resultant vertical force on the bottom surface $F_2$ is

$$F_2 = A \rho g h_2$$

The net force acting on the object in the upward direction is $F_2 - F_1$.
(upthrust force) \( F = F_2 - F_1 \)

\[ = A P_a + A \rho g h_2 - (A P_a + A \rho g h_1) \]

\[ = A P_a + A \rho g h_2 - A P_a - A \rho g h_1 \]

\[ = A \rho g h_2 - A \rho g h_1 \]

\[ = A \rho g (h_2 - h_1) \]

\[ = A \rho g h \quad \because h_2 - h_1 = h \]

\[ = V \rho g \]

\[ = m g \quad \because \rho = \frac{m}{V} \Rightarrow \rho V = m \]
Upthrust force = mg = \( \omega \)

Upthrust = weight of liquid displaced by object.
HOW DOES A SUBMARINE WORK

Submarine (cross section)

Periscope

Compressed Air Tanks

Valves

Ballast Tank (partly full)

Interior (where the crew lives and works)
MULTIPLE
CHOICE
QUESTIONS
MCQ

1. The S.I unit of pressure is

A. newton.
B. pascal.
C. newton / meter.
D. pascal / meter.
2. An object appears lighter in liquid because of its

A. density.
B. viscosity.
C. upthrust force.
D. surface tension.
MCQ

3. Ships float on the surface of sea due to a force known as

A. frictional force.
B. upthrust force.
C. downward force.
D. gravitational force.