Pressure

Pressure is the amount of force exerted per unit area on a surface that is perpendicular to the force. In mathematical terms:

\[
\text{Pressure} = \frac{\text{Force}}{\text{Area}}
\]

Pressure is measured in Pascals, where 1 Pascal is 1 Newton per square meter. More commonly used is the Kilopascal, which is 1000 Newtons per square meter.

For example, if a person has a weight of 490 N (50 kg x 9.8 N/kg – this is gravitational force) and their feet take up an area of 400 cm\(^2\), then the pressure they exert on the ground may be calculated as follows:

\[
\begin{align*}
\text{Force} & = 490 \text{ N} \\
\text{Area} & = 400 \text{ cm}^2 = 0.04 \text{ m}^2 \\
\text{Pressure} & = ?
\end{align*}
\]

\[
\begin{align*}
\text{Pressure} & = \frac{\text{Force}}{\text{Area}} \\
& = \frac{490 \text{ N}}{0.04 \text{ m}^2} \\
& = 12250 \text{ N/m}^2 \\
& = 12.25 \text{ kPa}
\end{align*}
\]

Complete the following questions related to pressure.

1. A block, resting on the ground, has a cross sectional area of 2 m\(^2\) is being pushed with a force of 100 N. What is the pressure exerted by the block on the ground?

\[
\begin{align*}
F & = 100 \text{ N} \\
A & = 2 \text{ m}^2 \\
P & = ?
\end{align*}
\]

\[
\begin{align*}
P & = \frac{F}{A} \\
& = \frac{100 \text{ N}}{2 \text{ m}^2} \\
& = 50 \text{ Pa}
\end{align*}
\]

∴ The pressure on the ground is 50 Pa.
2. An aquarium holds 100 L of water (recall that 1 L of water has a mass of 1 kg). The base of the aquarium is 1 m by 0.5 m. What pressure is exerted on a table by the filled aquarium?

100 L of water has a mass of 100 kg.
The area of the aquarium can be calculated, as both the length and width are provided.

\[ F = 100 \, kg \times 9.8 \, \frac{N}{kg} \]
\[ F = 980 \, N \]
\[ A = 1 \, m \times 0.5 \, m \]
\[ A = 0.5 \, m^2 \]
\[ P = \frac{F}{A} \]
\[ P = \frac{980 \, N}{0.5 \, m^2} \]
\[ P = 1960 \, Pa \]

3. Tom’s handprint is 30 cm\(^2\) but Sean’s handprint is only 20 cm\(^2\). If Tom is able to push with a force of 70 N and Sean can push with a force of 50 N, who can exert a larger pressure on an object?

Tom
\[ F_T = 70 \, N \]
\[ A_T = 30 \, cm^2 \]
\[ A_T = 0.0030 \, m^2 \]
\[ P_T = \frac{F_T}{A_T} \]
\[ P_T = \frac{70 \, N}{0.0030 \, m^2} \]
\[ P_T = 23333.3 \, Pa \]
\[ P_T = 23.3 \, kPa \]

Sean
\[ F_S = 50 \, N \]
\[ A_S = 20 \, cm^2 \]
\[ A_S = 0.0020 \, m^2 \]
\[ P_S = \frac{F_S}{A_S} \]
\[ P_S = \frac{50 \, N}{0.0020 \, m^2} \]
\[ P_S = 25000 \, Pa \]
\[ P_S = 25.0 \, kPa \]

∴ Sean is capable of exerting a larger pressure on an object.

4. If a box is applying 24 kPa of pressure on a table and the area of the box is 80 cm\(^2\), what must the weight of the box be?

\[ F =? \]
\[ P = \frac{F}{A} \]
\[ A = 80 \, cm^2 \]
\[ A = 0.0080 \, m^2 \]
\[ P = 24 \, kPa \]
\[ P = 24000 \, Pa \]
\[ \therefore The \ weight \ of \ the \ box \ is \ 192 \, N. \]