Week 5

Detailed learning goals

By completing this topic, you should be able to:

- Explain the three main states of matter
- Define a fluid
- Define and calculate density
- Define pressure
- Explain the relationship between pressure and force
- Do calculations involving force, pressure, and area
- Define fluid pressure in terms of weight
- Explain the variation of pressure with depth in a fluid
- Do calculations involving pressure, density and depth
- Explain Pascal's principle
- Define gauge pressure and absolute pressure
- Explain the working of manometers and barometers
- Define buoyant force
- Explain Archimedes' principle
- Explain why objects float or sink
- Explain the relationship between density and Archimedes' principle.

Prescribed readings for SLE123 content

Please read the following sections from Giambattista Physics (5th ed.). New York: McGraw-Hill:

- Section 9.1 States of Matter.
- Section 9.2 Pressure.
- Section 9.3 Pascal's Principle.
- Section 9.4 The Effect of Gravity on Fluid Pressure.
- Section 9.5 Measuring Pressure.
- Section 9.6 The Buoyant Force.

Practice questions:

1) A 1 x 10-3 m3 chunk of material has a mass of 3 kg.
a. What is the material's density?
b. Would a 2 x 10-3 m3 chunk of the same material have the same mass? Explain.
c. Would a 2 x 10-3 m3 chunk of the same material have the same density? Explain.

2) A standard gold bar is 177.8 mm long, 92.2 mm wide and 44.45 mm tall. Gold has a density of 19,300 kg/m3. What is the mass of such a gold bar?

3) Steve has a mass of 85 kg and wears size 11 shoes. The bottom of each of Steve's shoes has an area of 0.03 m^2 (approximately 30 cm by 10 cm). What pressure do the soles of Steve's shoes exert on the ground when
(a) he is standing still?
(b) he is standing on one leg?
(c) he is in the process of jumping (with both feet on the ground), and thus accelerating upwards at a rate of 5 ms^{-2}?
Answer: (a) 14.2 kPa (b) 28.3 kPa (c) 21.3 kPa

4) Water has a density of 1×10^3 kgm^{-3}. How many litres of water would weigh as much as an 80 kg man? ***Answer: 80 litres***

5) Blood has a density of 1060 $kg.m^{-3}$ whereas the density of the cerebrospinal fluid is 1007 $kg.m^{-3}$. What *mass* of cerebrospinal fluid will have the same *volume* as 50.0 g of blood?
Answer: mcsf = 47.5 g

6) Given that the density of water is 1×10^3 $kg.m^{-3}$, how deep would you have to dive to experience an absolute pressure of 2 atm? How deep would you have to dive to experience an absolute pressure of 5 atm? (Note that 1 atm= 101.3 kPa.)
Answer: 10 m and 40 m, respectively

7) What would you estimate that the difference in average blood pressure between the top of 1.7 m tall person's head and the bottom of their feet is? (density of blood = 1060 $kg.m^{-3}$)
Answer: 18 kPa