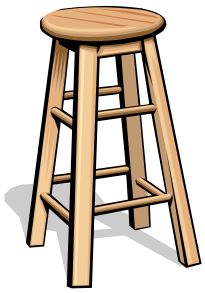
Homework: Pressure, Density & Gas Laws

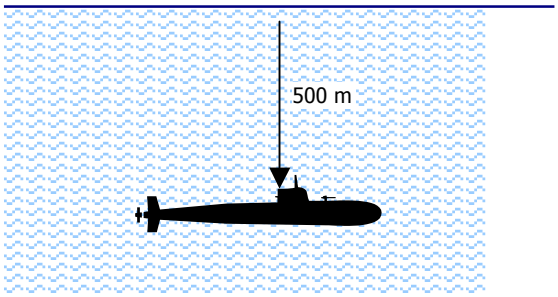
1. The stools in the physics rooms have four round feet, each with a surface area of approximately 1 cm^2. The physics teachers complain that when people swing onto just one leg of the stool, the flooring under it is damaged. For the purposes of this problem, take the average mass of a pupil to be 60 kg.



   (a) Calculate the area of one of the stool's feet in $\mathbf{m^2}$.
   (b) Calculate the pressure exerted on the floor when all four feet are on the ground (as they should be!)
   (c) Calculate the pressure exerted on the floor when just one foot is on the ground.

2. What is the mass of a block of steel that is 2 cm x 2 cm x 2 cm? (Density of steel = 8000 kgm^{-3})

3. A submarine, mass 50 000 kg, is 500 m under the surface of a freshwater loch. The density of the water is 1000 kgm^{-3}. When the submarine's air tanks are full, it experiences an upthrust of 550 000 N.



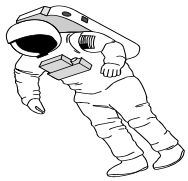
   (a) Calculate the pressure from the water at this depth.
   (b) Will the submarine rise to the surface, sink, or float at a constant depth? Explain your answer.

4. A car has its tyres inflated to a pressure of 240 kPa on a day when the temperature is 5 °C. The car is then driven for several hours, and the temperature of the tyres is found to have risen to 35 °C.

   (a) Assuming the mass and volume of the air in the tyres has remained constant, calculate the new pressure in the tyres.
   (b) Explain why this happens to the pressure as the temperature rises, making reference to the kinetic theory of gases.

PTO for Q5.

5. An astronaut on a spacewalk has an oxygen tank strapped to his suit. The oxygen in it is pressurised to 5 atmospheres (5.0×10^5 Pa), and the volume of the tank is 15 litres.



(a) The oxygen is pumped to his mouth at atmospheric pressure (1.0×10^5 Pa). What is the maximum volume of oxygen available to the astronaut at this pressure?
(b) What assumptions are made about the gas that allow us to perform this calculation?
(c) In reality, the astronaut would find that he had less oxygen available to him than calculated in part (a). Why would this be the case? (**Problem solving!**)

Homework is due on Friday 27 August.