MECH 225 Engineering Science 2

## Tutorial Sheet - Gas Laws and Specific Heat (gases)

1. A compressed air tank has a volume of 0.5m$^3$. A pressure gauge fitted to the tank reads 1.96 MPa and the barometric pressure is 103kPa. The temperature of the air in the tank is 50°C. Determine:

   (i) the absolute pressure of the air in the tank.

   (ii) the volume of air would occupy at s.t.p.
   (standard temperature and pressure, t = 0°C., p = 101.3 kPa).

   (iii) the mass of air in the tank if the gas constant for air is 0.287 kJ/kg K.

   (2.063 MPa; 8.61 m$^3$; 11.1 kg)

2. A cylindrical gas reservoir 6.7 m long contains 545 kg of gas at a pressure of 1.138 MPa (gauge) and temperature 24°C. Calculate the volume and diameter of the reservoir, given that 0.02332m$^3$ of the gas at atmospheric pressure (101.3 kPa) and 0°C has a mass of 0.0366 kg. Determine also, the volume of the gas at atmospheric pressure and 24°C required to fill the reservoir to the pressure of 1.138 MPa.

   (30.88 m$^3$; 2.42m; 377.8m$^3$.)

3. An empty steel cylinder has a volume of 0.04 m$^3$. A certain gas is pumped in until the pressure and temperature in the cylinder are 12 MPa and 45°C. The mass of the cylinder is found to have increased by 5 kg. Determine the value of the gas characteristic constant, R.

   (0.302 kJ/kg K).

4. A cylinder of internal diameter 200 mm is fitted with a freely sliding piston and contains 1 kg of air at 1 MPa and 20°C. How much heat must be transferred to the air in order to raise its temperature to 40°C:

   (a) if the piston is fixed so that the process takes place at constant volume

   (b) if the process takes place at constant pressure?

   For (b) calculate (i) the force on the piston
   (ii) the distance through which it moves.

   (c) Show that the work done by the gas is equal to the difference between (a)
   and (b).

   For air, Cp = 1.005 kJ/kg K; Cv = 0.718 kJ/kg K; R = 0.287 kJ/kg K.

   (14.36 kJ, 20.1 kJ, 31.42 kN, 182.7 mm).