

Q- (a) If the pressure of a gas is increased by a factor of 9, while its volume is held constant, by what factor does rms speed change?

At constant volume if the pressure is increased 9 times the absolute temperature of the gas will also increased 9 times  $\left(\frac{P_1}{T_1} = \frac{P_2}{T_2}\right)$ .

The rms speed of the molecules are related to temperature as

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

Thus the rms speed is proportional to square root of absolute temperature.

Hence rms speed will increase  $\sqrt{9} = \mathbf{3 \text{ times}}$ .

(b) In Joule's experiment, the mass of the weights is 2.99 kg, and the insulated tank is filled with 0.137 g of water. What is the increase in the temperature of the water after the weights fall through a distance of 4.85 m?

This experiment based on the energy conservation

Gain in thermal energy of water = loss in potential energy of weights

Or  $m_{water}c_{water} \Delta t = Mgh$

Or  $0.137 * 4200 * \Delta t = 2.99 * 9.8 * 4.85$

Or  $\Delta t = \frac{2.99*9.8*4.85}{0.137*4200} = 0.24698$

Or  $\Delta t = \mathbf{0.247 \text{ K}}$