Solutions

Topic 3 – Thermal physics

PROBLEM SET

THIS IS A PRACTICE ASSESSMENT. Show formulas, substitutions, answers, and units!

Topic 3.2 – KMT and The Mole PROBLEM SET#1

20. A 16-pound bowling ball having a mass of 7.27 kg is placed on a dime (coin) having a diameter of 1.80 cm. = .018 m The ball-dime combo is then placed on the floor. What is the pressure in N m^{-2} exerted on the floor? Why is the dime even used? → To allow area to be large enough to measure (flat surface)

Area of dime $= \pi r^2 = \pi(.009 m)^2 = 2.5 \times 10^{-4} m^2$

Weight of bowling ball $= mg = (7.27 kg)(9.81 \frac{m}{s^2}) = 71.3 N$

$P = \frac{F}{A} = \frac{71.3 N}{2.5 \times 10^{-4} m^2} = $ **285,200 Pa**

$1 \text{ Pascal} = \frac{1 N}{1 m^2}$

The following questions are about the kinetic model of an ideal gas.

24. List the four assumptions of the kinetic model of an ideal gas.

① Constant movement

② Negligible inter-molecular forces / attractions / repulsions

③ Undergo perfectly elastic collisions

④ Negligible Volume

25. Using the assumptions of the kinetic model of an ideal gas: Explain why 1 mol of an ideal gas in a fixed container has a higher pressure at a higher temperature.

Higher temp = higher avg. KE = higher $\frac{1}{2}mv^2$

If mass hasn't changed, the velocity must have increased. This would create more forceful and more frequent collisions with other molecules and most especially the walls of the container.

*Both containers have same average KE

26. Using the assumptions of the kinetic model of an ideal gas: Explain why 1 mol of an ideal gas in a fixed container has a ~~lower~~ higher pressure than 2 mol in the same container at the same temperature.

2 moles has twice as many atoms/molecules = twice the mass

1 mole	2 moles
$\frac{1}{2} m v_1^2$ =	$\frac{1}{2} \cdot 2 m v_2^2$

$\frac{v_1^2}{2} = v_2^2$

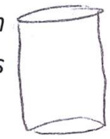
$v_2 = \frac{v_1}{\sqrt{2}}$

★ Larger mass has ~~higher~~ lower pressure (at same temp)

The internal volume of a gas cylinder is 2.75×10^{-3} m^3. The cylinder head has a diameter of 12.5 cm. An ideal gas is pumped into the cylinder until the pressure becomes 350. kPa. The temperature of the gas is 58.6 °C. + 273 = 331.6 K

= .125 m

Area = $\pi \left(\frac{.125m}{2}\right)^2$ = .0123 m^2



27. What force does the gas exert on the cylinder head?

$P = \frac{F}{A}$ F = P × A = 350×10^3 Pa × .0123 m^2 = **4305 N**

28. Determine how many moles of the gas are there in the cylinder. Use PV = nRT

$n = \frac{PV}{RT} = \frac{(350\times10^3\ Pa)(2.75\times10^{-3}\ m^3)}{(8.31\ J\cdot K^{-1} mol^{-1})(331.6\ K)}$ = **0.35 moles**

29. Determine the number of gas atoms in the cylinder.

$0.35\ \text{moles} \times \frac{6.02\times10^{23}\ \text{atoms}}{1\ \text{mole}}$ = **2.1 × 10^{23} atoms**