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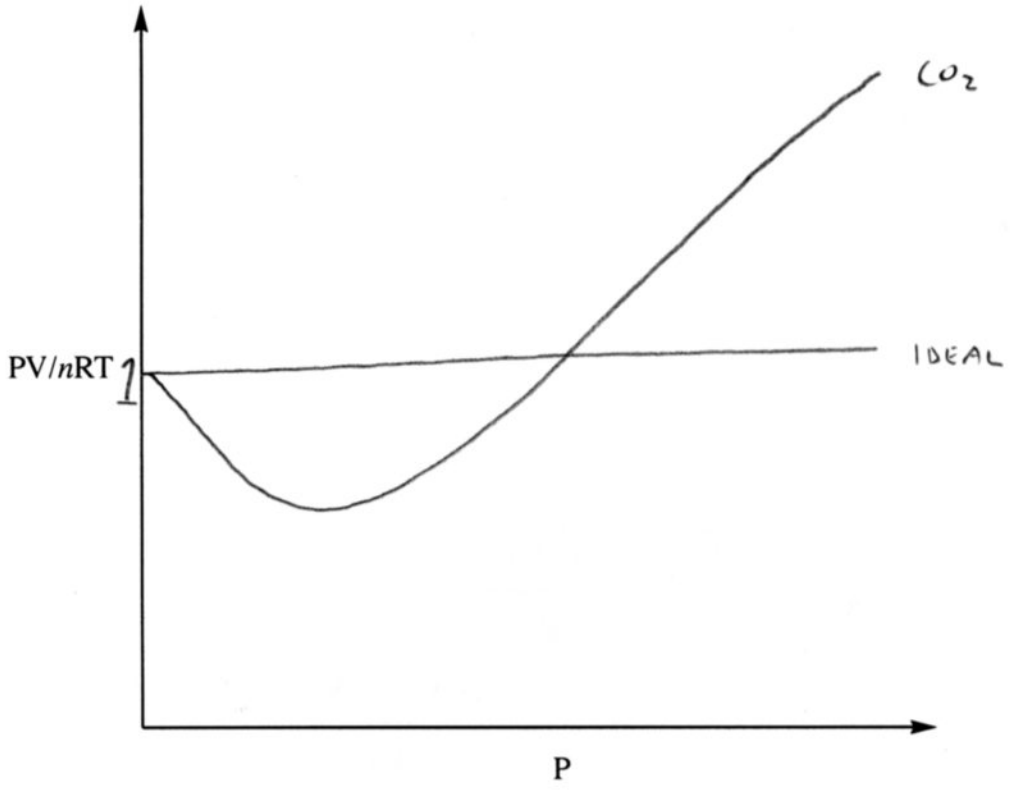
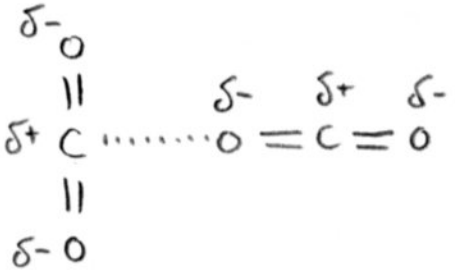
CHEM 024b 2008
Tutorial Quiz #2 – Group A
Friday, February 8th 2008

YOUR NAME: JONES **TA'S NAME:** _____

(1) On the axes below, sketch the dependence of PV/*n*RT on P, for the ideal gas, and for (real) CO_2 gas. In the space below the axes, illustrate the attractive forces between CO_2 molecules at intermediate pressure. [6 marks]





(2) In an experiment, 8.0 L of methane gas (CH_4) is burned completely in the stoichiometrically correct quantity of dioxygen (O_2). The temperature is sufficiently high that the water produced is a vapour.

a. Assuming that the gases behave ideally, what volume of water vapour is produced? [2 marks]

$$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g)$$
$$8.0\,L \qquad\qquad\qquad\qquad 16.0\,L$$

b. What is the partial pressure of water vapor in the product mixture if the final pressure of this mixture is 4 atm? [2 marks]

$P_{TOT} = P_{O_2} + P_{CO_2} = 4\ atm \Rightarrow P_{H_2O} = \frac{16}{24} \times 4.0$

$V_{TOT} = 16.0 + 8.0 = 24.0\ L \qquad = \frac{8}{3}\ atm.$

(wl O_2 present.) $\qquad (2.6\ atm)$

1.000 $\qquad$ 10.00

(3) What is the observed pressure (P_{obs}) of ~~1~~ mole of ammonia (NH_3) gas confined to a ~~10~~ L container at 0 °C assuming real gas conditions. [5 marks]

precisely

$$\left[P_{obs} + a\left(\frac{1}{V}\right)^2\right](V - nb) = nRT$$

$$\left[P_{obs} + 4.17\left(\frac{1}{10}\right)^2\right](10 - 1 \times 0.0371) = 1 \times 0.08206 \times 273\,K$$

$$\left(P_{obs} + 4.17 \times 10^{-2}\right) \times 9.9629 = 22.40$$

$$P_{obs} = \frac{22.40}{9.9629} - 4.17 \times 10^{-2} = 22.07\ atm$$

(4) At 298 K, the r.m.s. velocity of dihydrogen (H_2) is 1.92×10^3 m s^{-1}. What is the r.m.s velocity of dinitrogen (N_2) at the same temperature? [4 marks]

$$\frac{\bar{u}_{H_2}}{\bar{u}_{N_2}} = \sqrt{\frac{MM_{N_2}}{MM_{H_2}}}$$

$$\therefore \frac{1}{\bar{u}_{N_2}} = \sqrt{\frac{MM_{N_2}}{MM_{H_2}}} \cdot \frac{1}{\bar{u}_{H_2}} = \sqrt{\frac{2 \times 14.01}{2 \times 1.008}} \cdot \frac{1}{1.92 \times 10^3}$$

$$\therefore \bar{u}_{N_2} = 5.15 \times 10^2 \text{ m s}^{-1}$$

(5) Write balanced equations for the following reactions: [4 marks each]

(a) $ClO^-(aq) + CrO_2^-(aq) \rightarrow Cl^-(aq) + CrO_4^{2-}(aq)$ in *basic* solution

$$(2e^- + 2H^+ + \overset{I}{Cl}O^- \longrightarrow \overset{-I}{Cl}^- + H_2O) \times 3$$

$$(2H_2O + \overset{III}{Cr}O_2^- \longrightarrow \overset{VI}{Cr}O_4^{2-} + 4H^+ + 3e^-) \times 2$$

$$6H^+ + 3ClO^- + 4H_2O + 2CrO_2^- \longrightarrow 3Cl^- + 3H_2O + 2CrO_4^{2-} + 8H^+ + 2OH^-$$

$$2H_2O \leftarrow 8H^+ + 2OH^-$$

$$\Rightarrow \quad 3ClO^- + 2CrO_2^- + 2OH^- \longrightarrow 3Cl^- + 2CrO_4^{2-} + H_2O$$

(b) $O_2(g) + Br^-(aq) \rightarrow H_2O(l) + \cancel{H_2}\overset{Br}{(g)}$ in *acidic* solution

$$4e^- + 4H^+ + O_2 \longrightarrow 2H_2O$$

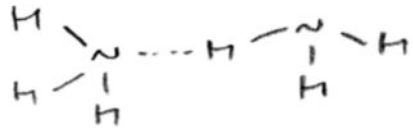
$$(2Br^- \longrightarrow Br_2 + 2e^-) \times 2$$

$$4H^+_{(aq)} + O_{2(g)} + 4Br^-_{(aq)} \longrightarrow 2H_2O_{(l)} + 2Br_{2(l)}$$

(6) Consider the ammonia molecule, NH_3.

a. What is the primary attractive force between NH_3 molecules in a sample of NH_3 gas? [1 mark]

Dipole-dipole interactions, or H-bonding, or



b. Draw the NH_3 molecule and clearly indicate both the dipole moments of individual bonds as well as the resultant dipole moment of the molecule as a whole. [2 marks]

Resultant: