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HW #8

Ch 10

(16) types of attractive forces, name which dominate.

A. Ne: dispersion forces

B. ClF: dipole-dipole forces (predominate) and dispersion forces.

C. F_2: dispersion forces

D. $BaCl_2$: ion-ion forces (predominate) and dispersion forces.

(18) Which has the strongest attraction?

Ar-Ar, Ar-Ne, Ar-Kr,

Ar-Kr, more e^-, more polarizable,

(19) A. Fig. 10.9 to estimate the length of covalent bond in Cl_2 and the length of the ionic bond of K^+Cl^-

$Cl + Cl = 2.0 \times 10^{-10}$ M

$Cl^- + K^+ = \sim 2.5 \times 10^{-10}$ M

B. The bond in Cl-Cl is shorter than Cl-K, but it is also a weaker bond than Cl-K.

Cl-Cl ≈ -200 KJ/Mol

Cl-K ≈ -500 KJ/Mol

(20) Any two atoms held together by nonbonded attractions must be farther apart than any two atoms held together by a chemical bond.
False; He atoms can be quite close.

(24) List in order of increasing boiling point. Explain the reasoning: SO_2, He, HF, CaF_2, Ar

He < Ar < SO_2 < HF < CaF_2
He, is the lightest, Ar is the next lightest.
SO_2 has a dipole moment, but the bond of HF is stronger.
CaF_2 is ionic.

(28) How does the BP of H_2O_2 compare to F_2 and H_2S?
H_2O_2 (l) has a lot of hydrogen bonding which makes its boiling point higher than F_2 (l) and H_2S (l).

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Ch 9

(8) 0°C , $1.3 g L^{-1}$. Calculate the thickness of uniform atmosphere that would cause a pressure of 1 AtM.

A column of Hg at 76 cm exerts the same pressure as 1 ATM. Hg density $13.6 g\,cm^{-3}$ or $13.6 \times 10^3\ g/L^{-1}$.

$$76\ cm \left(\frac{13.6\times10^3\ g/L}{1.3 g/L}\right) = 8.0\times10^5\ cm = \boxed{8.0\ km}$$

(14) 4.00 L of gas temp increases 20°C → 40°C
Determine the volume after temp change

$V_1/T_1 = V_2/T_2$ $PV_1 = NRT_1$

$T_1 = 20 + 273.15 = 293.15$
$T_2 = 40 + 273.15 = 313.15$

$$\frac{V_1 \cdot T_2}{T_1} = V_2$$

$$4.00 L \left(\frac{313.15°C}{293.15°C}\right) = \boxed{4.27 L}$$

(18) 230°C
$2KMnO_4 (s) \rightarrow K_2MnO_4 (s) + MnO_2 (s) + O_2 (g)$
3.41 L of O_2 at 20° What about at 230°C
$V_1/T_1 = V_2/T_2$ 273.15 + 20°C = 293.15 °K
273.15 + 230°C = 503.15

$$\frac{3.41 L \cdot 503.15°K}{293.15°K} = \boxed{5.85 L}$$

(28) A. $Fe(s) + H_2SO_4(aq) \rightarrow H_2(g) + FeSO_4(aq)$

B. V of H producedat 300K at 1.0ATM using 300Kg of H_2SO_4.

H_2SO_4 MW = 98.08g/Mol

$300 \times 10^3 g \left(\frac{mol}{98.08 g/mol}\right) = 3058.72$ mol H_2SO_4 & H_2

PV=nRT

1.0ATM • V = 3058.7Mol • 0.082 • 300K

$\frac{L \cdot atm}{mol^{-1} K^{-1}}$

$V = 7.5 \times 10^4 L$

(34) Calculate the mole fraction of NH_3 and its partial pressure

13mol NH_3
31mol N_2
93mol H_2
137 total

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

Pressure = 210 Atm

$\frac{13 NH_3}{137 total} = 0.095$ = mole fraction

$P_{NH_3} = 210_{ATM} \cdot 0.095 =$ 19.95 ATM for NH_3

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(42) Compute the rms speed of the atoms in this laser confinement

$u_{rms} = \sqrt{\bar{u}^2} = \sqrt{\frac{3RT}{M}}$ M = molar mass in Kg

T = 0.00024 K

Na = 23 g/mol

$$\sqrt{\frac{3 \cdot (8.314\ J\ K^{-1}\ mol^{-1})(0.00024\ K)}{0.023\ Kg/mol}} = \boxed{0.51\ m/s}$$

(51) 50g CO_2 in a 1.0 L vessel at 25°C
Do attractive or Repulsive forces dominate? Calculate the Pressure

A. Ideal Gas Law $PV = nRT$ $P = \frac{nRT}{V}$

$CO_2 = 44.0\ g/mol$

$\frac{50g}{44} = 1.14\ mol\ CO_2$

$25 + 273.15 = 298.15°K$

$$\boxed{27.89\ ATM} = \frac{(1.14\ moles) \cdot 0.08206\ L \cdot atm \cdot mol^{-1} \cdot K^{-1}) \cdot 298.15°K}{1.0L}$$

B. Vander Waals equation

	CO_2	
	A	B
	3.592	0.04267

$$P = \frac{nRT}{V - nb} - a\frac{n^2}{V^2}$$

$$\frac{(1.14\ mol)(0.08206\ L \cdot ATM \cdot Mol^{-1} \cdot K^{-1})(298.15°K)}{(1.0L - 1.14\ mol \cdot 0.04267\ L \cdot mol^{-1})} - 3.592 \cdot \frac{1.14\ mol^2}{(1.0L^2)}$$

$$P = \frac{nRT}{V-nb} - a\frac{n^2}{V^2}$$

(57) B. 29.32 − 4.668 = 24.65 ATM

$IG_p > VDW_p$ — attractive forces dominate

(80) Calculate the mass in grams of CS_2 gas present before the reaction.

$T_{Final} = 373.15°K$ V = 10.0 L

Unreacted O_2 = 2.4 ATM Original Pressure = 3 ATM

$$CS_{2(g)} + 3O_{2(g)} \rightarrow CO_{2(g)} + 2SO_{2(g)}$$

3 − 2.4 = 0.6 moles CS_2

$$n_{CS_2} = \frac{(0.6\ ATM_{CS_2})(10.0\ L)}{(0.08206\ L\cdot atm\cdot mol^{-1}K^{-1})(373.15°K)}$$

PV = NRT

$\frac{PV}{RT} = N$

N_{CS_2} = 0.196 moles of CS_2

CS_2 = 76.14 g/mol

$$0.196\ moles \cdot \frac{76.14\ g}{mol} = 14.92\ g\ of\ CS_2$$

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(94) Space hydrogen = 10 H per cm^3 T = 100K

A. Calculate the Pressure of gas in space, in ATM

$\frac{10 \text{ atoms}}{1 \text{ cm}^3} \cdot \left(\frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ atoms}}\right) = 1.66 \times 10^{-23} \text{ moles/mL} \cdot \frac{1000 \text{ ml}}{L}$

1.66×10^{-20} moles/L

$P = \frac{nRT}{V} = \frac{(1.66 \times 10^{-20} \text{ moles} \cdot 100 K \cdot 0.08206 \text{ L/ATM/mol}^{-1} \cdot K^{-1})}{1.0 L}$

$P_H = 1.36 \times 10^{-19}$ ATM

B.

$u_{rms} = \sqrt{\bar{u}^2} = \sqrt{\frac{3RT}{M}}$

H = 1.008 g/mol

H = 0.001008 kg/mol

$\sqrt{\frac{3 \cdot 8.314 \text{ J} \cdot K^{-1} \cdot mol^{-1} \cdot 100}{0.001008 \text{ kg/mol}}} = 1573$ m/s for H

Distance to sun 150,000,000 KM

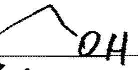
1.5×10^{11} M 150,000,000,000 M

time between Collisions = 1×10^9 seconds.

$1573 \text{ m/s} \cdot 1 \times 10^9 \text{ s} = 1.57 \times 10^{12}$ M traveled for a collision

$\frac{1.57 \times 10^{12} \text{ M distance b/t collisions}}{1.5 \times 10^{11} \text{ M Earth to sun}} = 10.5 \times$ the distance earth to sun.

Other Problems

(1) Ethanol 
Dimethyl Ether 

Which has the higher Boiling Point? Explain.
Ethanol has a higher boiling point due to dipole-dipole interactions and hydrogen bonding.

(2) Air = $\overset{14g}{N_2} + \overset{16g}{O_2}$ at 25°C = 298.15°K
Which has the highest KE?
Which has the highest Average Speed?
$KE = \bar{E} = \frac{3}{2}RT$ (no mass dependence) = **KE are the same**

average Speed: $u_{rms} = \sqrt{\frac{3RT}{M}}$
oxygen has a greater M so **N_2 will have the higher average speed**

(3). Which has a faster mean square velocity? H_2 at temp T or He at temp 1.5 T

$\bar{u}^2 = \frac{3RT}{M_{(kg)}}$ H = 1.01 g/mol, He = 4.00 g/mol

H_2: $\frac{3 \cdot 1 \cdot R}{\frac{1.01}{1000}} = 2970R$

He: $\frac{3 \cdot 1.5 \cdot R}{4.00/1000} = 1125R$

H_2 has a faster $\bar{u}^2$

Do repulsions dominate? or do attractions dominate?

(4) 298.15 °K   100 bar   1 mole of real gas has V of 0.238L

$PV = nRT$

$V_{IG} > V_{RG}$

$$V = \frac{1 \cdot (0.08314\ L\cdot Bar\cdot K^{-1}\cdot Mol^{-1}) \cdot 298.15\,°K}{100\ bar} = 0.247$$

attractions dominate

(5) Which gas behaves the most ideally? Which is least?

NH_3, CH_4, Ar

most Ideal = Ar   monatomic noble gas

least Ideal = NH_3 :NH₃ ← dipole

(6) $C_2H_{2(g)} + 2H_{2(g)}$ + catalyst → $C_2H_{6(g)}$

acetylene

(7) 5 moles → 3 moles

$1(C_2H_2) + 4(H_2) \rightarrow 1(C_2H_6) + 2(H_2)$ P = 1 ATM

What is the final volume of the Container? N=5   T = 373.15 °K

V = ?

$PV = nRT$

$PV = n_{acetylene}RT + n_{H}RT$

n =

$$V = \frac{3 \cdot 0.08206\ L\cdot ATM\cdot Mol^{-1}\cdot K^{-1} \cdot 373.15\,°K}{1\ ATM}$$

V = 91.86 L

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$$P_A = n_A \cdot \frac{RT}{V}$$

(8) Partial Pressures of gasses after the reaction

1 (C_2H_6) $P = 1 \cdot \frac{(0.08206\ ATM \cdot Mol^{-1} \cdot L \cdot K^{-1})(373.15\ K^{\circ})}{91.86\ L}$

$P_{C_2H_6} = 0.333\ ATM$

2 (H_2) $P = 2 \cdot \frac{(0.08206\ ATM \cdot L \cdot Mol^{-1} \cdot K^{-1})(373.15\ ^{\circ}K)}{91.86\ L}$

$P_{H_2} = 0.666\ ATM$