GASES AND EQUILIBRIUM ESSAYS

14a) 2 pts

CO_2

Because all the balloons contain the same number of molecules (moles) and CO_2 molecules are the heaviest.

14b) 2 pts

All are equal

Because same temperature, therefore same average kinetic energy

Note: restatement of "same conditions" does not earn 2 points

14c) 2 pts

CO_2

Either:

It has more e-, hence it is most polarizable

It has the strongest intermolecular (London) forces

Note: -also allowable are "polar bonds" inelastic collisions"

-claiming larger size or larger volume does not earn 2 points

14d) 2 pts

He

-greatest movement through balloon wall

-smallest size

-greatest molecular speed

-most rapid effusion (Graham's Law)

-2 pts

Reducing temperature of a gas reduces the average kinetic energy (or velocity) of the gas molecules. This would reduce the number (or frequency) of collisions of gas molecules with the surface of the balloon (or decrease the momentum change that occurs when the gas molecules strike the balloon surface). In order to maintain a constant pressure vs the external pressure, the volume must decrease.

-2 pts

The molecules of the gas do have volume (1 pt for this) when they are cooled sufficiently, the forces of attraction that exist between them cause them to liquify or solidify (2^{nd} pt)

-2 pts

The molecules of gas are in constant motion, so the HCl and NH_3 diffuse along the tube. Where they meet NH_4Cl is formed. Since HCl has a higher molar mass, its velocity (ave) is lower. Therefore, it doesn't diffuse as fast as NH_3.

a) $PV = nRT$

$P_{H_2} = 745 - 23.8 = 721.2 \text{ mmHg}$

$(721 \text{ mmHg})(0.09002) = n\left(62.4 \frac{\text{mmHg}\cdot\text{L}}{\text{mol K}}\right)(298\text{K})$

$n = 3.49 \times 10^{-3} \text{ mol } H_2$

b) $PV = nRT$

$(23.8 \text{ mmHg})(0.09002) = n\left(62.4 \frac{\text{mmHg}\cdot\text{L}}{\text{mol K}}\right)(298\text{K})$

$n = 1.15 \times 10^{-4} \text{ mol } H_2O$

$1.15 \times 10^{-4} \text{ mol } H_2O \left(\frac{6.02 \times 10^{23} \text{ part}}{1 \text{ mol } H_2O}\right) = 6.93 \times 10^{19}$ molecules H_2O

c) $\frac{v_{H_2}}{v_{H_2O}} = \sqrt{\frac{M_{H_2O}}{M_{H_2}}} = \sqrt{\frac{18.02}{2.02}}$

$\frac{v_{H_2}}{v_{H_2O}} = \frac{2.99}{1}$

d) H_2O deviates the most from ideal behavior because of the polar covalent bonds within the molecule which leads to greater intermolecular attractions.

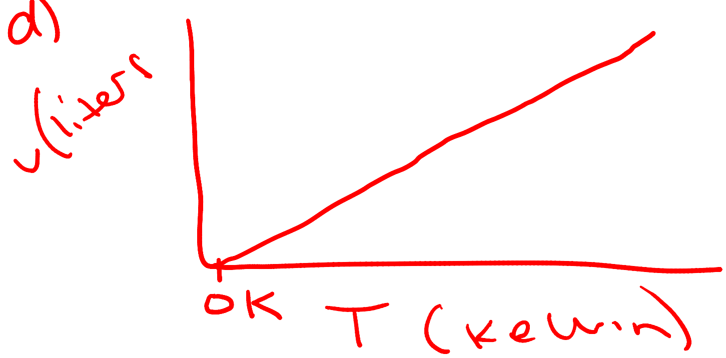
17a) $:C \equiv O:$ $\quad$ $:\ddot{O}=C=\ddot{O}:$

b) carbon dioxide has a linear shape

c) $CO_2 + H_2O \rightarrow H_2CO_3$

carbonic acid is a weak acid

d)



6 pts

18 given: moles $O_{2(g)}$ = moles $H_{2(g)}$

0.500L container

25°C

2 ml $H_2O_{(l)}$

P_T = 1,146 mmHg

P_{H_2O} = 24 mmHg

a) 6pts $2H_2 + O_2 \longrightarrow 2H_2O$

Initially: moles O_2 = moles H_2

But: 2 moles $H_{2(g)}$ reacts for every mole $O_{2(g)}$

* O_2 is left over

$P_T = P_{H_2} + P_{O_2} + P_{H_2O}$

$1146 = P_{H_2} + P_{O_2} + 24$

$P_{H_2} + P_{O_2} = 1122$

$\frac{1122}{4} = P_{O_2}$ left (½ of initial O_2 which is ½ of total)

P_{O_2} = 280.5 mmHg = 0.369 atm

$PV = nRT$

$(0.369\,atm)(0.5\,L) = n\left(0.0821\,\frac{L \cdot atm}{mol \cdot K}\right)(298\,K)$

$n = 7.54 \times 10^{-3}$ moles

b) (2 pts)

$$\frac{P_{O_2} @ 90°C}{363\,K} = \frac{280.5\,mmHg}{298\,K} = 342\,mmHg$$

or

$$PV = nRT$$

$$P(0.5L) = (7.54 \times 10^{-3}\,mole)(0.0821\,\frac{L \cdot atm}{mol \cdot K})(363K)$$

$$P = 0.45\,atm = 342\,mmHg$$

$$P_T = P_{O_2} + P_{H_2O} = 342 + 526 = \boxed{868\,mmHg}$$

c) $PV = nRT$

$$(0.692\,atm)(0.50L) = n(0.0821\,\frac{L \cdot atm}{mol \cdot K})(363K)$$

$$n = \boxed{0.0116\,mole}$$

(19) $SbCl_{5(g)} \rightleftharpoons SbCl_{3(g)} + Cl_{2(g)}$

given: 89.7g $SbCl_5$ (mw = 299.0)

15.0 L container

182°C = 455 K

a) 4 pts

1) $89.7\text{g } SbCl_5 \left(\frac{1\text{ mole}}{299.0\text{g}}\right) = 0.300\text{ mole } SbCl_5$

$[SbCl_5]_0 = \frac{0.300\text{ mole}}{15.0\text{ L}} = 0.0200\text{ M}$

2) $P = \frac{nRT}{V} = \frac{(0.300\text{ mol})(0.0821\frac{\text{atm}\cdot\text{L}}{\text{mol}\cdot\text{K}})(455\text{ K})}{(15.0\text{ L})}$

$P = 0.747\text{ atm}$

b) 3 pts

$[SbCl_3] = [Cl_2] = (0.0200\ \frac{\text{mol}}{\text{L}})(0.292) =$

$= 5.84 \times 10^{-3}\text{ M}$

$[SbCl_5] = (0.0200\ \frac{\text{mol}}{\text{L}})(0.708)$

$= 1.42 \times 10^{-2}\text{ M}$

$K_c = \frac{[SbCl_3][Cl_2]}{[SbCl_5]} = \frac{(5.84 \times 10^{-3})^2}{(1.42 \times 10^{-2})}$

$K_c = 2.41 \times 10^{-3}$

or: $P_{SbCl_3} = P_{Cl_2} = (0.747\text{ atm})(0.292) = 0.218\text{ atm}$

$P_{SbCl_5} = (0.747\text{ atm})(0.708) = 0.529\text{ atm}$

c) 2 pts $K_p = \frac{(P_{SbCl_3})(P_{Cl_2})}{(P_{SbCl_5})} = \frac{(0.218)^2}{(0.529)} = 8.98 \times 10^{-2}$

1 mole
2.00 L

$K_c = 0.117$

add Cl_2? so $SbCl_3 = 0.700$

$K_c = \frac{[SbCl_3][Cl_2]}{[SbCl_5]} = 0.117$

	$SbCl_5$	$\rightleftharpoons$	$SbCl_3$	+	Cl_2
I	0		$\frac{1.0\ mole}{2.0\ L}$		x
C	+0.300 mole		−0.300 mole		−0.300 mole
E	$\frac{0.0300\ mole}{2.00\ L} = 0.15\ M$		$\frac{0.700\ mole}{2.00\ L} = 0.35\ M$		x

0.400 moles must be added

$K = \frac{(0.35)(x)}{0.15} = 0.117$

$x = 0.0500\ M$

$(0.0500\ M)(2.00\ L) = 0.100\ mol$ @ eq.

15) $NH_4HS_{(s)} \rightleftharpoons NH_{3(g)} + H_2S_{(g)}$

$\Delta H° = +93$ kJ

@ equilibrium at 25°C

solid NH_4HS still in container

a) 2 pts

The equilibrium pressure of NH_3 would be unaffected

$$Kp = (P_{NH3})\,(P_{H2S})$$

The amount of solid NH_4HS present does not affect the equilibrium.

b) 2 pts

The equilibrium pressure of NH_3 would decrease. In order for the pressure equilibrium constant, Kp, to remain constant, the equilibrium pressure of NH_3 must decrease when the pressure of H_2S is increases.

c) 2 pts

The mass of NH_4HS increases. A decrease in volume causes the pressure of each gas to increase. To maintain the value of the pressure equilibrium constant, Kp, the pressure of each of the gases must decrease. That decrease is realized by the formation of more NH_4HS (a complete explanation of LeChatelier's Principle is also acceptable)

d) 2 pts

The mass of NH_4HS decreases because the endothermic reaction absorbs heat and goes nearer to completion (to the right) as the temperature increases.

16) $NH_4HS_{(s)} \longrightarrow NH_{3(g)} + H_2S_{(g)}$

a) NH_4HS @ 25°C

$P_T = 0.659$ atm @ equilibrium

$K_p = (P_{NH_3})(P_{H_2S})$

$P_{NH_3} = P_{H_2S} = \frac{0.659}{2} = 0.330$ atm

$K_p = (0.330\text{ atm})(0.330\text{ atm}) = \boxed{0.109\text{ atm}^2}$

b) added NH_3

at equilibrium $P_{NH_3} = 2P_{H_2S}$

$(2x)(x) = 0.109$

$\boxed{x = 0.233\text{ atm} = P_{H_2S}}$

$\boxed{2x = 0.466\text{ atm} = P_{NH_3}}$

c) $NH_{3(g)} + H_2S_{(g)}$

1.00 L

25°C

$P_{NH_3} = 0.5$ atm

$P_{H_2S} = 0.5$ atm

equilibrium pressure of NH_3 = equilibrium pressure H_2S = 0.330 atm

P_{NH_3} that has reacted = P_{H_2S}

= 0.500 atm - 0.330 atm = 0.170 atm

$$n = \frac{PV}{RT} = \frac{(0.170\text{ atm})(1.00\text{ L})}{(0.0821\frac{\text{atm}\cdot\text{L}}{\text{mol}\cdot\text{K}})(298\text{K})} = \boxed{6.95 \times 10^{-3}\text{ moles}}$$