AP Exam Review 2020 Practice Exam #3

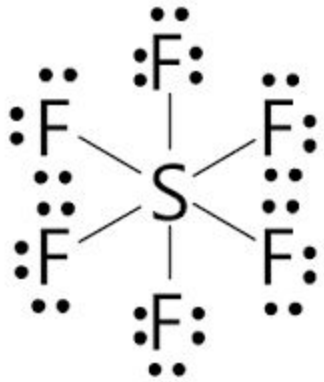
This question has two parts. The first part should take you 25 minutes to complete. The second part will take 15 minutes. Do the first question setting a timer for 25 minutes. Upon either completion of the question or the end of time, take a five minute break. Reset the timer for 15 minutes and begin the second question. Stop working when the timer goes off or you finish the question. Upload your work when completed.

Question 1

Sulfur hexafluoride can be synthesized via the following reaction using Br_2 as a catalyst.

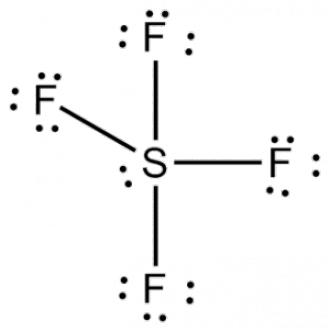
$2\ CoF_3\ (s) + SF_4\ (g) \rightarrow SF_6\ (g) + 2\ CoF_2\ (s)$

(a) Given the structure of SF_6 below:
  (i) Name the molecular geometry of this structure.
  (ii) Explain how this structure violates the octet rule.



(b) Is SF_6 polar or nonpolar? Explain.
(c) Write the complete electron configuration for sulfur.
(d) Which atom has a larger radius? S or F Explain your choice in terms the structure of each atom.

(e) Given the structure of SF_4 below:



(i) Explain why the boiling point of SF_4 is higher (-38 °C) than that of SF_6 (-58 °C). Discuss the intermolecular forces involved in each in your answer.
(ii) Would SF_6 dissolve in water? Explain in terms of intermolecular forces.

(f) The ΔH^0_f values of SF_4 (g) and SF_6 (g) are -775 kJ/mol and -1209 kJ/mol respectively. Explain why the magnitude of the value for SF_6 is higher than that of SF_4.

(g) Given the reaction equation, determine the mass of CoF_3 required to completely react with all of the SF_4 in a 2.5 L vessel containing only SF_4 at a pressure of 10.0 atm at 100 °C.

$$2\ CoF_3\ (s) + SF_4\ (g) \rightarrow SF_6\ (g) + 2\ CoF_2\ (s)$$

Question 2

A mixture of 5.000×10^{-3} mol of H_2 and 1.000×10^{-2} mol of I_2 is placed in a 5.000 L container at 448°C and allowed to come to equilibrium. Analysis of the equilibrium mixture shows that the concentration of HI is 1.87×10^{-3} M. The equilibrium system is described by the reaction equation below.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI\ (g).$$

(a) Write the expression for K_c

(b) Calculate Kc at 448°C for the reaction.

(c) If 0.0045 moles of H_2, 0.0045 moles of I_2, and 0.00055 moles of HI are placed in a 1.0 L vessel, predict if the [HI] will increase, decrease, or remain the same in order for the reaction to reach equilibrium. Justify your answer with calculations.

Exam #3

1a)

(a) octahedral
(b) S forms 6 bonds with 12 e⁻. The octet rule would limit the number of e⁻ to 8.

b) SF_6 is not polar due to being symmetrical. All bond dipoles cancel out.

c) $1s^2 2s^2 2p^6 3s^2 3p^4$

d) S has 3 layers of e⁻ and F has 2. More layers = larger radius.

e) SF_4 is polar given it dipole-dipole bonds in addition to LDF's as its IMFs. SF_6 has only LDF's. The IMF's in SF_4 are stronger than those in SF_6 as a result.

f) Since SF_6 has 6 bonds and SF_4 has 4 bonds and all the bonds are the same, more energy would be released when SF_6 formed as 6 bonds forming releases more energy than 4 forming.

g) $n = \frac{PV}{RT} = \frac{(10.0)(25)}{(0.0821)(373)}$

$= 0.82 \text{ mol } SF_4$

$0.82 \text{ mol } SF_4 \cdot \frac{2 \text{ mol } CoF_3}{1 \text{ mol } SF_4} \times \frac{76.9 \text{ g } CoF_3}{1 \text{ mol } CoF_3}$

$= 126 \text{ g } CoF_3$

2.

b)

	H_2	I_2	HI
I	$\frac{5.000\times10^{-3}}{5.00}$	$\frac{1.000\times10^{-2}}{5.00}$	0
C	$-x$	$-x$	$2x$
E	$0.00100-x$	$0.00200-x$	1.87×10^{-3}

$0 + 2x = 1.87\times10^{-3}$

$x = 0.000935$

$[H_2]_{eq} = 0.00100 - 0.000935 = 0.000065\ M$

$[I_2]_{eq} = 0.00200 - 0.000935 = 0.00107\ M$

a) $K_c = \frac{[HI]^2}{[H_2][I_2]} = \frac{(1.87\times10^{-3})^2}{(0.000065)(0.00107)}$

$= 50.3$

$$Q = \frac{[HI]^2}{[H_2][I_2]}$$

$$= \frac{(0.00055)^2}{(0.0045)(0.0045)}$$

$$= 0.015$$

$Q < K$ so the reaction will make more product to reach equilibrium. As a result, $[HI]$ will increase.