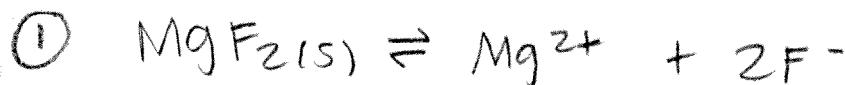
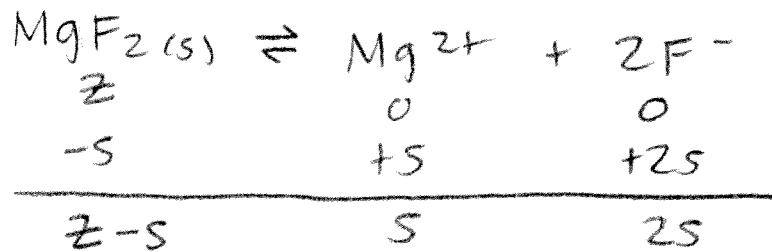


# Equilibrium Study Guide FRQ's



a)  $K_{\text{sp}} = [\text{Mg}^{2+}][\text{F}^-]^2$  [1 pt] correct ans.



\*  $[\text{Mg}^{2+}] = 1.21 \times 10^{-3} \text{ M}$   
in saturated soln

$\therefore [\text{Mg}^{2+}] = 1.21 \times 10^{-3} \text{ M}$   
at equilibrium

$\therefore s = 1.21 \times 10^{-3} \text{ M}$   
aka molar solubility

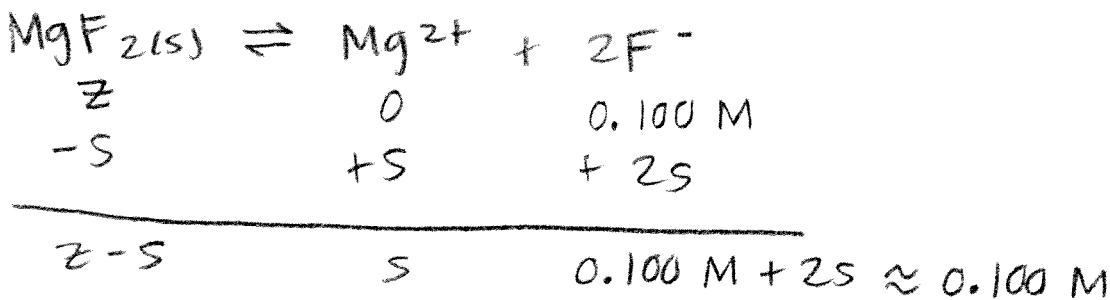
correct ans.

$$K_{\text{sp}} = (s)(2s)^2 = 4s^3$$

$$K_{\text{sp}} = 4(1.21 \times 10^{-3})^3 = \boxed{7.09 \times 10^{-9}}$$

[1 pt]

b) Initial concentration of  $\text{F}^- = \frac{0.100 \text{ mol}}{1 \text{ L}} = 0.100 \text{ M F}^-$



$$K_{\text{sp}} = [\text{Mg}^{2+}][\text{F}^-]^2$$

$$7.09 \times 10^{-9} = [\text{Mg}^{2+}] (0.100)^2$$

[1 pt] correct setup

$$\boxed{[\text{Mg}^{2+}] = 7.09 \times 10^{-7} \text{ M}}$$

[1 pt] correct ans.

c)  $(3.00 \times 10^{-3} \text{ M})(0.1 \text{ L}) = 3.00 \times 10^{-4} \text{ mol Mg(NO}_3)_2 = \text{mol Mg}^{2+}$

$$[\text{Mg}^{2+}] = \frac{3.00 \times 10^{-4} \text{ mol Mg}^{2+}}{0.3000 \text{ L}} = 1.00 \times 10^{-3} \text{ M Mg}^{2+}$$

1 pt correct  
[Mg<sup>2+</sup>] and  
[F<sup>-</sup>]

$$(2.00 \times 10^{-3} \text{ M})(0.2 \text{ L}) = 4.00 \times 10^{-4} \text{ mol NaF} = \text{mol F}^-$$

$$[\text{F}^-] = \frac{4.00 \times 10^{-4} \text{ mol F}^-}{0.3000 \text{ L}} = 1.33 \times 10^{-3} \text{ M F}^-$$



$$Q = [\text{Mg}^{2+}][\text{F}^-]^2$$

$$Q = (1.00 \times 10^{-3})(1.33 \times 10^{-3})^2 = 1.77 \times 10^{-9}$$

1 pt correct  
Q  
Based  
on calc.  
M's

K > Q ∴ No precipitate will form

1 pt correct  
answer  
consistent  
w/ Q value

d) At 27°C:  $[\text{Mg}^{2+}] = 1.17 \times 10^{-3} \text{ M}$

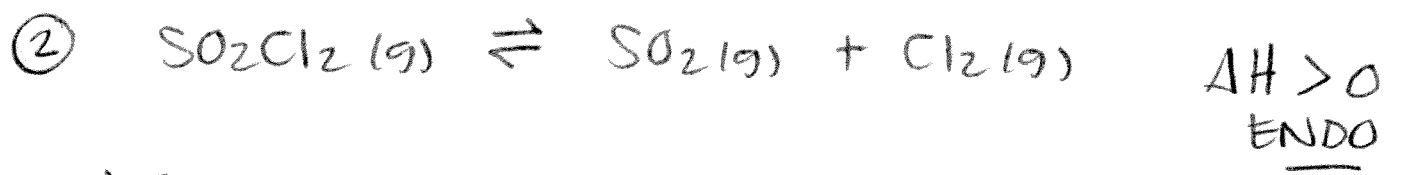
At 18°C:  $[\text{Mg}^{2+}] = 1.21 \times 10^{-3} \text{ M}$

Increasing T causes solubility to decrease,  
thus indicating a shift to left in response to increased T. Thus, heat must be a product and the rxn is exothermic.

1 pt correct  
explanation

1 pt correct  
ans.

# 1 = 9 Points Total



a)  $\frac{3.509 \text{ g } \text{SO}_2\text{Cl}_2}{134.96 \text{ g}} \left| \begin{array}{l} 1 \text{ mol } \text{SO}_2\text{Cl}_2 \\ \hline \end{array} \right. = 0.0260 \text{ mol } \text{SO}_2\text{Cl}_2$

1 pt correct  
mol's

$$PV = nRT$$

$$P = \frac{nRT}{V} = \frac{(0.0260 \text{ mol})(0.0821)(375 \text{ K})}{1.00 \text{ L}} = \boxed{0.800 \text{ atm}}$$

1 pt correct  
ans



I	0.800 atm	0	0
C	-x	+x	+x
E	0.800 atm - x	x	x

Equilibrium  $P_T = P_{\text{SO}_2\text{Cl}_2} + P_{\text{SO}_2} + P_{\text{Cl}_2}$  at equilibrium

$$P_T = (0.800 \text{ atm} - x) + x + x$$

$$1.43 \text{ atm} = 0.800 \text{ atm} + x$$

$$x = 0.63 \text{ atm}$$

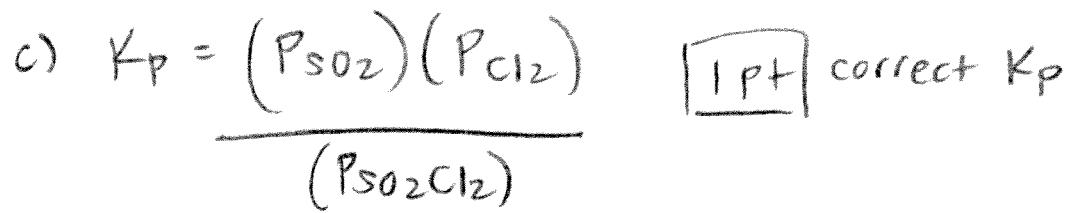
1 pt correct "x"

$$P_{\text{SO}_2\text{Cl}_2} = 0.800 \text{ atm} - x = 0.800 \text{ atm} - 0.63 \text{ atm} = \boxed{0.17 \text{ atm}}$$

$$P_{\text{SO}_2} = P_{\text{Cl}_2} = x = \boxed{0.63 \text{ atm}}$$

1 pt correct  
 $P_{\text{SO}_2} + P_{\text{Cl}_2}$

1 pt correct  
 $P_{\text{SO}_2\text{Cl}_2}$



d)  $K_p = \frac{(0.63)(0.63)}{(0.17)} = 2.3$

1 pt correct ans.  
 1 pt correct substitution into  $K_p$

e)  $K$  would increase. Increasing  $T$  from 375 K to 500 K, causes a shift right because the reaction is endothermic, thus the reaction will absorb the additional heat and more products will be made.

1 pt correct answer w/ explanation

# 2 = 9 points Total