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Chemistry Module 5

Chemical Equilibrium
WORKSHEETS

Worksheet 1 The Basics

Student Name..

1.
a) When any chemical reaction reaches an equilibrium in a closed system, what becomes true about the concentration of all the chemical species present?

b) Explain why this is so, in the case of a:
i) static equilibrium.

ii) dynamic equilibrium.

2.
What are the thermodynamic reasons why some reactions (eg combustion) are never reversible?

3.
What is meant by “open” or “closed” chemical systems?

4.
Why can a dynamic equilibrium NOT occur in an open system?

5.
Write an ionic equation to represent the dynamic equilibrium reached between the solid and the dissolved ions in each of these species, when a solution reaches saturation.

a) potassium bromide

b) magnesium chloride

c) iron (III) nitrate

d) ammonium sulfate

e) calcium carbonate

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Worksheet 2 Le Chatelier's Principle Practice Questions

Student Name.....................................

1. $NO_{2(g)}$ reacts with itself as follows:

$$2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$$

The reaction to the right is exothermic, so heat can be considered as a "product".

$$2NO_{2(g)} \rightleftharpoons N_2O_{4(g)} + \text{heat}$$

Note that as the reaction proceeds to the right, 2 moles of gas form 1 mole of gas, so in a fixed volume container the pressure would drop as the reaction proceeds to the right.

Imagine a sealed container in which a mixture of these gases has reached equilibrium.

State which way the equilibrium would shift if each of the following disturbances were made to the mixture. Explain each answer.

i) Increase in temperature.

ii) Compress the mixture, thereby increasing pressure.

iii) Injecting extra N_2O_4, without changing pressure.

iv) Decrease the temperature.

v) Spray in a little water.
(NO_2 dissolves, N_2O_4 does not.)

vi) Decreasing the total gas pressure by expanding the volume of the container.

2. If hydrogen iodide (covalent molecular) is dissolved in water, some of the molecules ionise, and an equilibrium is reached:

$$HI_{(aq)} \rightleftharpoons H^+_{(aq)} + I^-_{(aq)}$$

What is the effect on this equilibrium of:
(Explain each)

i) adding $NaI_{(aq)}$ solution, which increases the concentration of iodide ions.

ii) Adding NaOH, which reacts with H^+ ions, and reduces their concentration.

iii) Dissolving extra HI in the solution.

iv) It is found that raising the temperature of an equilibrium mixture has the effect of increasing the concentration of ions. Deduce whether the reaction as written is exo- or endothermic.

3. Ammonia is manufactured from its elements by the reaction

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons NH_{3(g)} + \text{heat}$$

i) To maximize the yield of ammonia, the reaction is carried out under very high pressure. Explain how this helps.

ii) The temperature of the reaction is kept fairly high to speed up the <u>rate</u> of the reaction. What effect does higher temperature have on the equilibrium?

iii) During the reaction, ammonia is constantly removed from the reaction vessel, and more reactant gases constantly pumped in. Explain the effect this has.

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Worksheet 3 Chemical Equilibrium

Fill in the blanks

Student Name......................................

Many chemical reactions do not go to completion, but reach a a)........................ .... in which both forward and reverse reactions are running at b)..

According to c)..............................'s Principle, if an equilibrium system is disturbed, the equilibrium will shift in the direction which d).............................. ....

The main factors which can disturb an equilibrium are e)............................ and .... If gases are involved, a change in f)............................. or .... of the container will change the concentration and therefore will shift the equilibrium.

For any reaction, the equilibrium can be described mathematically by "Keq", the "g).............................. ...." If this value is very high, it means the equilibrium favours the h)............................, while if it is very low the equilibrium favours the i)....................................

The value of K for the "reverse equation" is the j)............................... of the original. The value of Keq is constant only at a given k)..............................

The values of K for an exothermic reaction l)...................................... as temperature increases. The values for an m)............................... reaction will n).................................. as temp. increases.

Worksheet 4 Equilibrium Constant K_{eq}

Student Name......................................

Each chemical species is in the gas state, unless indicated otherwise.

1.
Write the expression for the equilibrium constant for:

a) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

b) $2H_2O \rightleftharpoons 2H_2 + O_2$

c) $2NO + Cl_2 \rightleftharpoons 2NOCl$

d) $Al(OH)_{3(s)} \rightleftharpoons Al^{3+}_{(aq)} + 3OH^-_{(aq)}$

e) $2H_2S \rightleftharpoons 2H_2 + S_2$

2.
The reaction $H_{2(g)} + I_{2(g)} + \text{heat} \rightleftharpoons 2HI_{(g)}$

reached equilibrium at 400°C.
Predict the effect on the equilibrium concentration of $HI_{(g)}$ of: (explain each answer)

i) increasing the temperature

ii) compressing the mixture to a higher pressure

iii) increasing pressure by pumping in extra $H_{2(g)}$

iv) adding a catalyst

v) increasing pressure by pumping in argon gas

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Worksheet 5 Calculating K_{eq}
Practice Problems

Student Name....................................

1.
The reaction $H_{2(g)} + I_{2(g)} + \text{heat} \rightleftharpoons 2HI_{(g)}$

has reached equilibrium at 400°C.
The concentrations at equilibrium are:
$[H_2]$= 0.0195molL^{-1}, $[I_2]$ = 0.0211molL^{-1} and
$[HI]$ = 0.153molL^{-1}.

a) Calculate the value of K_{eq}.

b) The temperature of this same gas mixture was changed, and the new value for K = 22.3.
Was the mixture heated or cooled? Explain.

2.
A sample of pure hydrogen iodide gas (HI) was placed into a container and heated to 400°C. It decomposed in the reverse reaction to that described in Q1, and the mixture reached an equilibrium.

a) Write an equation for the reaction.

b) Write an expression for the equilibrium constant, and predict its value for equilibrium at 400°C.
(Use answer Q1)

2. (cont)
c) At equilibrium, the concentration of hydrogen iodide gas [HI]=0.0552molL^{-1}. Find the concentrations of H_2 and I_2 gases.
(Hint: they will be equal to each other)

3.
Carbon monoxide reacts with steam as follows:

$$CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$$

A mixture containing 10.0 moles each of CO gas and steam was introduced at high pressure and temperature into a 4.00 litre container. After equilibrium was reached it was found that there were 6.50 moles of CO_2 in the container.

a) Calculate the equilibrium concentrations of each reactant and product.

b) Calculate the value of the equilibrium constant for this temperature.

c) What would have been different if the reaction had been carried out in the presence of a catalyst?

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Worksheet 6 Ionic Precipitations
Practice Problems

Student Name....................................

Each pair of ionic compounds below will produce a precipitate if solutions are mixed together.

For each pair:
a) name the precipitating compound.
b) write a full ionic equation for the reaction, including all states.
c) write the net ionic equation for the equilibrium.
d) write an expression for the "Solubility Product" (K_{sp}) for the equilibrium.

1. calcium chloride & silver nitrate

a)

b)

c)

d)

2. lead(II) nitrate & sodium carbonate

a)

b)

c)

d)

3. sodium sulfate & barium chloride

a)

b)

c)

d)

4. calcium hydroxide & potassium carbonate

a)

b)

c)

d)

5. silver nitrate & magnesium sulfate

a)

b)

c)

d)

6. potassium bromide & lead(II) nitrate

a)

b)

c)

d)

7. iron(III) chloride & calcium hydroxide

a)

b)

c)

d)

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Worksheet 7 K_{sp} and Solubility Practice Problems

Student Name.....................................

Refer to the reactions in Worksheet 6.

The K_{sp} value (at 25°C) for each of the insoluble products will be found in your Chem Data Sheet.

For each substance, calculate its max. solubility in water at 25°C. Show working.

Q1.

Q2.

Q3.

Q4.

Q5.

Q6.

Q7.

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Worksheet 8 Practice Problems — Predicting a Precipitate with K_{sp}

Student Name.....................................

In each case, equal volumes of the two solutions were mixed together. Would a precipitate form at 25°C? Show all working & reasoning.

1.
copper (II) sulfate, 0.005 $molL^{-1}$
and
sodium carbonate, 0.001 $molL^{-1}$.

2.
sodium phosphate, 0.0004 $molL^{-1}$.
and
iron(III) chloride, 0.0005 $molL^{-1}$.

3.
lead (II) nitrate, 0.05 $molL^{-1}$
and
sodium chloride, 0.008 $molL^{-1}$.

4.
potassium hydroxide, 0.002 $molL^{-1}$.
and
magnesium chloride, 0.006 $molL^{-1}$.

5.
sodium phosphate, 0.004 $molL^{-1}$.
and
silver nitrate, 0.05 $molL^{-1}$.

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Answer Section

Worksheet 1

1.
a) The concentrations remain constant & do not change over time.
b)
i) In a static equilibrium this is because all reaction has ceased.
ii) In a dynamic equilibrium, the concentrations do not change because the forward and reverse reactions are running at the same rate.

2.
Reactions such as combustions are strongly exothermic and may also result in a large increase in entropy. These energy considerations make it almost impossible that they could run in reverse.

3.
An open system is one in which substances and/or energy can readily flow in or out from/to the surroundings.

A closed system is one in which no substances or energy can exchange with the environment. Although there can be no "perfect" closed system, a sealed, insulated container can be a very good approximation to one.

4.
In an open system, the products and heat energy of the reaction may be lost from the system and disperse into the environment. In such case it becomes impossible to establish a dynamic equilibrium because the temperature keeps changing and/or substances are no longer present to take part.

5.
a) $KBr_{(s)} \rightleftharpoons K^+_{(aq)} + Br^-_{(aq)}$

b) $MgCl_{2(s)} \rightleftharpoons Mg^{2+}_{(aq)} + 2Cl^-_{(aq)}$

c) $Fe(NO_3)_{3(s)} \rightleftharpoons Fe^{3+}_{(aq)} + 3NO_3^-{}_{(aq)}$

d) $(NH_4)_2SO_{4(s)} \rightleftharpoons 2NH_4^+{}_{(aq)} + SO_4^{2-}{}_{(aq)}$

e) $CaCO_{3(s)} \rightleftharpoons Ca^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)}$

Worksheet 2

1.
i) Left, to try to use heat & reduce temp.
ii) Right, to reduce the pressure again.
iii) Left, to decrease concentration of product.
iv) Right, to release heat & increase temp.
v) Left, to make more reactant & increase pressure.
vi) Left, to increase pressure again.

2.
i) Equilib. shifts left, to decrease conc. of iodide ion.
ii) Equilib. shifts right, to increase conc. of hydrogen ion.
iii) Equilib. shifts right, to decrease conc. of HI.
iv) Endothermic (heat is a reactant), since higher temp causes shift to right to consume heat.

3.
i) High pressure causes equilibrium to shift right to reduce the total moles of gas and pressure.
ii) Shifts equilibrium to left.
iii) Removing product & adding reactant keeps shifting equilib. to right, so yield is maximised.

Worksheet 3

a) dynamic equilibrium b) the same rate
c) Le Chatelier's
d) counteracts the disturbance
e) temperature & concentration
f) volume or pressure g) Equilibrium Constant
h) products i) reactants
j) reciprocal k) temperature
l) decreases m) endothermic
n) increase

Worksheet 4

1.
a) $K_{eq} = [PCl_3] \times [Cl_2] / [PCl_5]$
b) $K_{eq} = [H_2]^2 \times [O_2] / [H_2O]^2$
c) $K_{eq} = [NOCl]^2 / [Cl_2] \times [NO]^2$
d) $K_{eq} = [OH^-]^3 \times [Al^{3+}] / [Al(OH)_3]$
e) $K_{eq} = [H_2]^2 \times [S_2] / [H_2S]^2$

2.
i) [HI] would increase as equilibrium shifts to the right in an attempt to use heat to counteract temp. increase.
ii) no effect, since there are equal gas volumes on each side of the equation... compression increases all concentrations equally.
iii) [HI] would increase as equil. shifts right to counteract greater $[H_2]$.
iv) Catalysts have no effect on equil... only shorten the time to reach equil.
v) No effect. Increasing pressure with another gas has no effect on concentrations of reactants or product.

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Answer Section

Worksheet 5

1.

a) $K_{eq} = [HI]^2 / [H_2] \times [I_2] = (0.153)^2/(0.0195 \times 0.0211) = 56.9$

b) K_{eq} has decreased. Endothermic reactions increase K_{eq} with temp. increase. Therefore, temp. must have decreased.

2.

a) $2HI_{(g)} \rightleftharpoons H_{2(g)} + I_{2(g)}$

b) $K = [H_2] \times [I_2] / [HI]^2$

Its value will be the reciprocal of 56.9 = 0.0176

c) $0.0176 = [H_2] \times [I_2] / (0.0552)^2$

$\therefore [H_2]$ & $[I_2] = 5.78\ molL^{-1}$

3.

a) Since all species react in equal molar quantities, then the molar <u>quantities</u> at equilibrium are:

$n(CO_2) = 6.50$ mol (given) and $n(H_2) = 6.50$ mol

$n(CO) = 3.50$ mol (since 6.50mol has been used up)

$n(H_2O) = 3.50$mol (as above)

Since in a 4.00L container, and c = n/V

$\therefore c(CO_2)$ and $c(H_2) = 6.50/4.00 = 1.625 molL^{-1}$

and $c(CO)$ and $c(H_2O) = 3.50/4.00 = 0.875 molL^{-1}$

b) $K_{eq} = [CO_2]x[H_2]/[CO]x[H_2O]$

$= 1.625 \times 1.625/(0.875 \times 0.875)$

$= 3.45$

c) Equilibrium would have been achieved faster. The equil. itself would be exactly the same, with same value for K_{eq}.

Worksheet 6

1.

a) silver chloride

b) $Ca^{2+}_{(aq)} + 2Cl^-_{(aq)} + 2Ag^+_{(aq)} + 2NO_3^-{}_{(aq)} \longrightarrow 2AgCl_{(s)} + Ca^{2+}_{(aq)} + 2NO_3^-{}_{(aq)}$

c) $Cl^-_{(aq)} + Ag^+_{(aq)} \rightleftharpoons AgCl_{(s)}$

equation may be written in reverse and that makes more sense for part (d)

d) $K_{sp} = [Ag^+]x[Cl^-]$

2.

a) lead(II) carbonate

b) $Pb^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} + 2Na^+_{(aq)} + CO_3^{2-}{}_{(aq)} \longrightarrow PbCO_{3(s)} + 2Na^+_{(aq)} + 2NO_3^-{}_{(aq)}$

c) $Pb^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightleftharpoons PbCO_{3(s)}$

equation may be written in reverse and that makes more sense for part (d)

d) $K_{sp} = [Pb^{2+}]x[CO_3^{2-}]$

3.

a) barium sulfate

b) $Ba^{2+}_{(aq)} + 2Cl^-_{(aq)} + 2Na^+_{(aq)} + SO_4^{2-}{}_{(aq)} \longrightarrow BaSO_{4(s)} + 2Na^+_{(aq)} + 2Cl^-_{(aq)}$

c) $Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightleftharpoons BaSO_{4(s)}$

equation may be written in reverse and that makes more sense for part (d)

d) $K_{sp} = [Ba^{2+}]x[SO_4^{2-}]$

4.

a) calcium carbonate

b) $Ca^{2+}_{(aq)} + 2OH^-_{(aq)} + 2K^+_{(aq)} + CO_3^{2-}{}_{(aq)} \longrightarrow CaCO_{3(s)} + 2K^+_{(aq)} + 2OH^-_{(aq)}$

c) $Ca^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightleftharpoons CaCO_{3(s)}$

equation may be written in reverse and that makes more sense for part (d)

d) $K_{sp} = [Ca^{2+}]x[CO_3^{2-}]$

5.

a) silver sulfate

b) $2Ag^+_{(aq)} + 2NO_3^-{}_{(aq)} + Mg^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \longrightarrow Ag_2SO_{4(s)} + Mg^{2+}_{(aq)} + 2NO_3^-{}_{(aq)}$

c) $2Ag^+_{(aq)} + SO_4^{2-}{}_{(aq)} \rightleftharpoons Ag_2SO_{4(s)}$

equation may be written in reverse and that makes more sense for part (d)

d) $K_{sp} = [Ag^+]^2 \times [SO_4^{2-}]$

6.

a) lead(II) bromide

b) $Pb^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} + 2K^+_{(aq)} + 2Br^-_{(aq)} \longrightarrow PbBr_{2(s)} + 2K^+_{(aq)} + 2NO_3^-{}_{(aq)}$

c) $Pb^{2+}_{(aq)} + 2Br^-_{(aq)} \rightleftharpoons PbBr_{2(s)}$

equation may be written in reverse and that makes more sense for part (d)

d) $K_{sp} = [Pb^{2+}]x[Br^-]^2$

7.

a) iron(III) hydroxide

b) $3Ca^{2+}_{(aq)} + 6OH^-_{(aq)} + 2Fe^{3+}_{(aq)} + 6Cl^-_{(aq)} \longrightarrow 2Fe(OH)_{3(s)} + 3Ca^{2+}_{(aq)} + 6Cl^-_{(aq)}$

c) $Fe^{3+}_{(aq)} + 3OH^-_{(aq)} \rightleftharpoons Fe(OH)_{3(s)}$

equation may be written in reverse and that makes more sense for part (d)

d) $K_{sp} = [Fe^{3+}]x[OH^-]^3$

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Answer Section

Worksheet 7

1.

$AgCl_{(s)} \rightleftharpoons Cl^-_{(aq)} + Ag^+_{(aq)}$

$K_{sp} = [Ag^+]x[Cl^-] = 1.77 \times 10^{-10}$.

Since $[Ag^+] = [Cl^-] =$ "c", then $c^2 = 1.77x10^{-10}$

$\therefore c = 1.77x10^{-10} = 1.33x10^{-5}\ molL^{-1}$.

2.

$PbCO_{3(s)} \rightleftharpoons Pb^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)}$

$K_{sp} = [Pb^{2+}]x[CO_3^{2-}] = 7.40 \times 10^{-14}$.

Since $[Pb^{2+}] = [CO_3^{2-}] =$ "c", then $c^2 = 7.40x10^{-14}$

$\therefore c = \sqrt{7.40x10^{-14}} = 2.72 \times 10^{-7}\ molL^{-1}$.

3.

$BaSO_{4(s)} \rightleftharpoons Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)}$

$K_{sp} = [Ba^{2+}]x[SO_4^{2-}] = 1.08 \times 10^{-10}$.

Since $[Ba^{2+}] = [SO_4^{2-}] =$ "c", then $c^2 = 1.08x10^{-10}$

$\therefore c = \sqrt{1.08x10^{-10}} = 1.04 \times 10^{-5}\ molL^{-1}$.

4.

$CaCO_{3(s)} \rightleftharpoons Ca^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)}$

$K_{sp} = [Ca^{2+}]x[CO_3^{2-}] = 3.36 \times 10^{-9}$.

Since $[Ca^{2+}] = [CO_3^{2-}] =$ "c", then $c^2 = 3.36 \times 10^{-9}$

$\therefore c = \sqrt{3.36x10^{-9}} = 5.80 \times 10^{-5}\ molL^{-1}$.

5.

$Ag_2SO_{4(s)} \rightleftharpoons 2Ag^+_{(aq)} + SO_4^{2-}{}_{(aq)}$

$K_{sp} = [Ag^+]^2 \times [SO_4^{2-}] = 1.20 \times 10^{-5}$.

If $[SO_4^{2-}] =$ "c", then $[Ag^+] = 2c$, so $K_{sp} = (2c)^2 \times c$

So $4c^3 = 1.20\ x10^{-5}$

$\therefore c = \sqrt[3]{\frac{1.20 \times 10^{-5}}{4}} = 1.44 \times 10^{-2} molL^{-1}$.

6.

$Pb^{2+}_{(aq)} + 2Br^-_{(aq)} \rightleftharpoons PbBr_{2(s)}$

$K_{sp} = [Pb^{2+}]x[Br^-]^2 = 6.60 \times 10^{-6}$.

If $[Pb^{2+}] =$ "c", then $[Br^-] = 2c$, so $K_{sp} = c \times (2c)^2$

So $4c^3 = 6.60\ x10^{-6}$

$\therefore c = \sqrt[3]{\frac{6.60 \times 10^{-6}}{4}} = 1.18 \times 10^{-2} molL^{-1}$.

7.

$Fe^{3+}_{(aq)} + 3OH^-_{(aq)} \rightleftharpoons Fe(OH)_{3(s)}$

$K_{sp} = [Fe^{3+}]x[OH^-]^3 = 2.79 \times 10^{-39}$.

If $[Fe^{3+}] =$ "c", then $[OH^-] = 3c$, so $K_{sp} = c \times (3c)^3$

So $9c^4 = 2.79\ x10^{-39}$

$\therefore c = \sqrt[4]{\frac{2.79 \times 10^{-39}}{9}} = 1.33 \times 10^{-10} molL^{-1}$.

Worksheet 8

1.

copper(II) carbonate is the possible precipitate.

$CuCO_{3(s)} \rightleftharpoons Cu^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)}$

$K_{sp} = [Cu^{2+}]x[CO_3^{2-}] = 1.4 \times 10^{-10}$.

Concentrations of each ion, after dilution by mixing equal volumes: $[Cu^{2+}] = 0.0025$, $[CO_3^{2-}] = 0.0005 molL^{-1}$.

$\therefore$ actual Sol.Prod. $= 0.0025 \times 0.0005 = 1.25 \times 10^{-6}$.

This is far higher than K_{sp}, so pptte WILL form.

2.

iron(III) phosphate is the possible precipitate.

$FePO_{4(s)} \rightleftharpoons Fe^{3+}_{(aq)} + PO_4^{3-}{}_{(aq)}$

$K_{sp} = [Fe^{3+}]x[PO_4^{3-}] = 9.91 \times 10^{-16}$.

Concentrations of each ion, after dilution by mixing equal volumes: $[Fe^{3+}] = 0.0002$, $[PO_4^{3-}] = 0.00025 molL^{-1}$.

$\therefore$ actual Sol.Prod. $= 0.0002 \times 0.00025 = 5.0 \times 10^{-8}$.

This is far higher than K_{sp}, so pptte WILL form.

3.

lead(II) chloride is the possible precipitate.

$PbCl_{2(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2Cl^-_{(aq)}$

$K_{sp} = [Pb^{2+}]x[Cl^-]^2 = 1.7 \times 10^{-5}$.

Concentrations of each ion, after dilution by mixing equal volumes: $[Pb^{2+}] = 0.025$, $[Cl^-] = 0.004 molL^{-1}$.

$\therefore$ actual Sol.Prod. $= 0.025 \times 0.004^2 = 4.0 \times 10^{-7}$.

This is less than K_{sp}, so pptte WILL NOT form.

4.

magnesium hydroxide is the possible precipitate.

$Mg(OH)_{2(s)} \quad Mg^{2+}_{(aq)} + 2OH^-_{(aq)}$

$K_{sp} = [Mg^{2+}]x[OH^-]^2 = 5.61x\ 10^{-12}$.

Concentrations of each ion, after dilution by mixing equal volumes: $[Mg^{2+}] = 0.003$, $[OH^-] = 0.001 molL^{-1}$.

$\therefore$ actual Sol.Prod. $= 0.003 \times 0.001^2 = 3.0 \times 10^{-9}$.

This is higher than K_{sp}, so pptte WILL form.

5.

silver phosphate is the possible precipitate.

$Ag_3PO_{4(s)} \rightleftharpoons 3Ag^+_{(aq)} + PO_4^{3-}{}_{(aq)}$

$K_{sp} = [Ag^+]^3x[PO_4^{3-}] = 8.89 \times 10^{-17}$.

Concentrations of each ion, after dilution by mixing equal volumes: $[Ag^+] = 0.025$, $[PO_4^{3-}] = 0.002 molL^{-1}$.

$\therefore$ actual Sol.Prod. $= 0.025^3 \times 0.002 = 3.13 \times 10^{-8}$.

This is far higher than K_{sp}, so pptte WILL form.