Key

1. Which of the following produces a molecular solution when dissolved in water?

   A. RbClO
   B. $CH_3OH$
   C. $NH_4SCN$
   D. $NaCH_3COO$

2. Which of the following dissolves in water to form an ionic solution?

   A. $O_2$
   B. $SiO_2$
   C. $KMnO_4$
   D. $C_{12}H_{22}O_{11}$

3. When dissolved in water, which of the following forms a molecular solution?

   A. $HCl_{(g)}$
   B. $NaNO_{3(s)}$
   C. $CH_3OH_{(l)}$
   D. $K_2SO_{4(s)}$

4. Molecular solutions do not conduct electricity because they contain

   A. molecules only.
   B. cations and anions.
   C. molecules and anions.
   D. molecules and cations.

5. In a 200 mL sample of 0.030 M $Na_3PO_4$, the $[Na^+]$ is

   A. 0.006 M
   B. 0.010 M
   C. 0.018 M
   D. 0.090 M

6. In a saturated solution of $KNO_3$, the rate of crystallization is

   A. equal to zero.
   B. equal to the rate of dissolving.
   C. less than the rate of dissolving.
   D. greater than the rate of dissolving.



7. In an experiment, 0.500 mol of $Fe(NO_3)_3$ is dissolved in water to produce a 2.00 L solution. The $[NO_3^-]$ in this solution is

   A. 0.250 M
   B. 0.500 M
   C. 0.750 M
   D. 1.50 M

8. What is the $[Co^{2+}]$ and $[Cl^-]$ when 0.35 mol of $CoCl_2$ is dissolved in enough water to make 100.0 mL of solution?

   A. $[Co^{2+}] = 3.5$ M and $[Cl^-] = 3.5$ M
   B. $[Co^{2+}] = 3.5$ M and $[Cl^-] = 7.0$ M
   C. $[Co^{2+}] = 0.35$ M and $[Cl^-] = 0.35$ M
   D. $[Co^{2+}] = 0.35$ M and $[Cl^-] = 0.70$ M

9. The equation that represents the equilibrium in a saturated solution of $Fe_2(SO_4)_3$ is

   A. $Fe_2(SO_4)_{3(s)} \rightleftarrows 3Fe^{2+}_{(aq)} + 2SO_4^{3-}_{(aq)}$
   B. $Fe_2(SO_4)_{3(s)} \rightleftarrows 2Fe^{2+}_{(aq)} + 3SO_4^{3-}_{(aq)}$
   C. $Fe_2(SO_4)_{3(s)} \rightleftarrows 3Fe^{3+}_{(aq)} + 2SO_4^{2-}_{(aq)}$
   D. $Fe_2(SO_4)_{3(s)} \rightleftarrows 2Fe^{3+}_{(aq)} + 3SO_4^{2-}_{(aq)}$

10. When 250 mL of 0.36 M $Sr(OH)_2$ are added to 750 mL of water, the resulting ion concentrations are

    A. $[Sr^{2+}] = 0.12$ M and $[OH^-] = 0.12$ M
    B. $[Sr^{2+}] = 0.12$ M and $[OH^-] = 0.24$ M
    C. $[Sr^{2+}] = 0.090$ M and $[OH^-] = 0.090$ M
    D. $[Sr^{2+}] = 0.090$ M and $[OH^-] = 0.180$ M

11. A saturated solution of $NiCO_3$ was evaporated to dryness. A 250.0 mL sample was found to contain $1.1\times10^{-2}$ g $NiCO_3$. The molar mass of $NiCO_3$ is 118.7 g/mol. The molar solubility of $NiCO_3$ is

    A. $9.3\times10^{-5}$ M
    B. $3.7\times10^{-4}$ M
    C. $4.4\times10^{-2}$ M
    D. $1.4\times10^{-7}$ M

12. A student evaporated 200.0 mL of a saturated solution of $SrCrO_4$ to dryness. The residue contained $1.2\times10^{-3}$ mol $SrCrO_4$. The solubility of $SrCrO_4$ is

D

A. $1.4\times10^{-6}$ M
B. $3.6\times10^{-5}$ M
C. $2.4\times10^{-4}$ M
(D.) $6.0\times10^{-3}$ M

$\frac{1.2\times10^{-3}\ mol}{0.2000\ L} = 6.0\times10^{-3}\ M$

13. In 1.5 M $(NH_4)_2SO_4$, the ion concentrations are

C

A. $[NH_4^+] = 1.5$ M and $[SO_4^{2-}] = 1.5$ M
B. $[NH_4^+] = 1.5$ M and $[SO_4^{2-}] = 3.0$ M
(C.) $[NH_4^+] = 3.0$ M and $[SO_4^{2-}] = 1.5$ M
D. $[NH_4^+] = 3.0$ M and $[SO_4^{2-}] = 3.0$ M

14. If the solubility of $Pb(OH)_2$ is 0.155 g/L, then the concentration of each ion in a saturated solution of a $Pb(OH)_2$ is

C

A. $[Pb^{2+}] = 0.155$ g/L and $[OH^-] = 0.155$ g/L
B. $[Pb^{2+}] = 0.052$ g/L and $[OH^-] = 0.103$ g/L
(C.) $[Pb^{2+}] = 6.43\times10^{-4}$ M and $[OH^-] = 1.29\times10^{-3}$ M
D. $[Pb^{2+}] = 6.43\times10^{-4}$ M and $[OH^-] = 6.43\times10^{-4}$ M

$\frac{0.155\ g}{L}\times\frac{1\ mol}{241.2\ g} = 6.43\times10^{-4}\ M = x$

$Pb(OH)_2 \rightarrow Pb^{2+} + 2OH^-$
$x \quad x \quad 2x$

15. The equation representing the equilibrium in a saturated solution of $CaSO_4$ is

A

(A.) $CaSO_{4(s)} \rightleftarrows Ca^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)}$
B. $CaSO_{4(s)} \rightleftarrows Ca^{2+}_{(aq)} + S^{2-}_{(aq)} + 4O^{2-}_{(aq)}$
C. $CaSO_{4(s)} + H_2O_{(\ell)} \rightleftarrows CaO_{(aq)} + H_2SO_{4(aq)}$
D. $CaSO_{4(s)} + 2H_2O_{(\ell)} \rightleftarrows Ca(OH)_{2(aq)} + H_2SO_{4(aq)}$

16. A 3.0 L solution of $NiCl_2$ is found to have a chloride concentration of 0.60 M. The concentration of nickel(II) ions in this solution is

A

(A.) 0.30 M
B. 0.60 M
C. 0.90 M
D. 1.2 M

$NiCl_2 \rightarrow Ni^{2+} + 2Cl^-$
$x \quad x \quad 2x$
$= 0.30M = 0.60M$



17. At a certain temperature, $7.0\times10^{-4}$ mol $MgSO_4$ is present in 100.0 mL of solution. The concentration of the $Mg^{2+}$ in this solution is

C

A. $7.0\times10^{-5}$ M
B. $7.0\times10^{-4}$ M
(C.) $7.0\times10^{-3}$ M
D. $7.0\times10^{-6}$ M

$[Mg^{2+}] = x = \frac{7.0\times10^{-4}\ mol}{0.1000\ L}$

$MgSO_4 \rightarrow Mg^{2+} + SO_4^{2-}$
$x \quad x \quad x$

18. When equal volumes of 0.20 M $SrBr_2$ and 0.20 M $AgNO_3$ are combined,

B

A. no precipitate forms.
(B.) a precipitate of only AgBr forms.
C. a precipitate of only $Sr(NO_3)_2$ forms.
D. precipitates of both AgBr and $Sr(NO_3)_2$ form.

$SrBr_2 + 2AgNO_3 \rightarrow 2AgBr_{(s)} + Sr(NO_3)_{2(aq)}$
↑ low solubility

19. When equal volumes of 0.20 M $ZnSO_4$ and 0.20 M $Sr(OH)_2$ are combined,

D

A. no precipitate forms.
B. a precipitate of only $SrSO_4$ forms.
C. a precipitate of only $Zn(OH)_2$ forms.
(D.) precipitates of both $SrSO_4$ and $Zn(OH)_2$ form.

$ZnSO_4 + Sr(OH)_2 \rightarrow Zn(OH)_2 + SrSO_4$
Both have low solubility

20. Consider the following anions:

| | ANION |
|---|---|
| I. | 10.0 mL of 0.20 M $Cl^-$ |
| II. | 10.0 mL of 0.20 M $OH^-$ |
| III. | 10.0 mL of 0.20 M $SO_3^{2-}$ |

$Pb^{2+}$ ← Low Solubility

When 10.0 mL of 0.20 M $Pb(NO_3)_2$ are added to each of the above, precipitates form in

D

A. I and II only.
B. I and III only.
C. II and III only.
(D.) I, II and III.

positive ion reacts with negative ion.

21. Which of the following 0.20 M solutions will **not** form a precipitate when mixed with an equal volume of 0.20 M $Sr(OH)_2$ ?

A. CaS
B. $NH_4Cl$
C. $Na_2SO_4$
D. $Ba(NO_3)_2$

| | $S^{2-}$ | $Cl^-$ | $SO_4^{2-}$ | $NO_3^-$ |
|---|---|---|---|---|
| $Sr^{2+}$ | X | X | ppt | X |

| | $Ca^{2+}$ | $NH_4^+$ | $Na^+$ | $Ba^{2+}$ |
|---|---|---|---|---|
| $OH^-$ | ppt | X | X | ppt |

22. When equal volumes of 0.2 M $NH_4Cl$ and 0.2 M $CuSO_4$ are combined,

A. a precipitate does not form.
B. a precipitate of $CuCl_2$ forms.
C. a precipitate of $(NH_4)_2SO_4$ forms.
D. a precipitate of both $(NH_4)_2SO_4$ and $CuCl_2$ forms.

23. When equal volumes of 0.2 M $K_2CO_3$ and 0.2 M $Na_3PO_4$ are mixed,

A. no precipitate will form.
B. a precipitate of $K_3PO_4$ will form.
C. a precipitate of $Na_2CO_3$ will form.
D. a precipitate of both $K_3PO_4$ and $Na_2CO_3$ will form.

24. When 0.20 M $Al_2(SO_4)_3$ is added to an equal volume of 0.20 M $CaCl_2$,

A. $AlCl_3$ precipitates.
B. $CaSO_4$ precipitates.
C. $AlCl_3$ and $CaSO_4$ precipitate.
D. no precipitate forms.

25. The **complete** ionic equation for the reaction between $MgCl_{2(aq)}$ and $AgNO_{3(aq)}$ is

A. $Ag^+_{(aq)} + Cl^-_{(aq)} \longrightarrow AgCl_{(s)}$

B. $2AgNO_{3(aq)} + MgCl_{2(aq)} \longrightarrow 2AgCl_{(s)} + Mg(NO_3)_{2(aq)}$

C. $2Ag^+_{(aq)} + Mg^{2+}_{(aq)} + 2NO^-_{3(aq)} + 2Cl^-_{(aq)} \longrightarrow MgCl_{2(s)} + 2Ag^+_{(aq)} + 2NO^-_{3(aq)}$

D. $2Ag^+_{(aq)} + 2NO^-_{3(aq)} + Mg^{2+}_{(aq)} + 2Cl^-_{(aq)} \longrightarrow 2AgCl_{(s)} + Mg^{2+}_{(aq)} + 2NO^-_{3(aq)}$

$MgCl_2 + 2AgNO_3 \longrightarrow Mg(NO_3)_2 + 2AgCl_{(s)}$ ppt



26. A precipitation reaction occurs when equal volumes of 0.2 M $Pb(NO_3)_2$ and 0.2 M KI are mixed. The net ionic equation for this reaction is

A. $Pb^{2+}_{(aq)} + 2I^-_{(aq)} \rightarrow PbI_{2(s)}$
B. $PbI_{2(s)} \rightarrow Pb^{2+}_{(aq)} + 2I^-_{(aq)}$
C. $K^+_{(aq)} + NO^-_{3(aq)} \rightarrow KNO_{3(s)}$
D. $KNO_{3(s)} \rightarrow K^+_{(aq)} + NO^-_{3(aq)}$

27. A net ionic equation for the reaction between $CH_3COOH$ and KOH is

A. $CH_3COO^-_{(aq)} + K^+_{(aq)} \rightleftarrows CH_3COOK_{(aq)}$
B. $CH_3COOH_{(aq)} + OH^-_{(aq)} \rightleftarrows H_2O_{(l)} + CH_3COO^-_{(aq)}$
C. $CH_3COOH_{(aq)} + KOH_{(aq)} \rightleftarrows H_2O_{(l)} + CH_3COOK_{(aq)}$
D. $CH_3COOH_{(aq)} + K^+_{(aq)} + OH^-_{(aq)} \rightleftarrows H_2O_{(l)} + KCH_3COO_{(aq)}$

28. When equal volumes of 0.20 M $K_2CrO_4$ and 0.20 M $AgNO_3$ are mixed, a red precipitate is formed. The net ionic equation for this reaction is

A. $K^+_{(aq)} + NO_3^-{}_{(aq)} \rightarrow KNO_{3(s)}$
B. $2Ag^+_{(aq)} + CrO_4^{2-}{}_{(aq)} \rightarrow Ag_2CrO_{4(s)}$
C. $K_2CrO_{4(aq)} + 2AgNO_{3(aq)} \rightarrow Ag_2CrO_{4(s)} + 2KNO_{3(s)}$
D. $2Ag^+_{(aq)} + CrO_4^{2-}{}_{(aq)} + 2K^+_{(aq)} + 2NO_3^-{}_{(aq)} \rightarrow Ag_2CrO_{4(s)} + 2KNO_{3(s)}$

29. Which of the following has a solubility of less than 0.10 M?

A. SrS
B. $SrCl_2$
C. $SrSO_4$
D. $Sr(OH)_2$

30. Which of the following units is commonly used to describe solubility?

A. mL/s
B. g/°C
C. mol/L
D. °C/mol

31. The net ionic equation for the reaction between $Sr(OH)_2$ and $H_2SO_4$ is

OMIT

A. $H^+ + OH^- \rightarrow H_2O$
B. $Sr^{2+} + SO_4^{2-} \rightarrow SrSO_4$
C. $Sr(OH)_2 + H_2SO_4 \rightarrow SrSO_4 + 2H_2O$
D. $Sr^{2+} + 2OH^- + 2H^+ + SO_4^{2-} \rightarrow SrSO_4 + 2H_2O$

32. When equal volumes of 0.20 M $CuSO_4$ and 0.20 M $Li_2S$ are combined, the complete ionic equation is

D

A. $Cu^{2+}_{(aq)} + S^{2-}_{(aq)} \rightarrow CuS_{(s)}$
B. $CuSO_{4(aq)} + Li_2S_{(aq)} \rightarrow CuS_{(s)} + Li_2SO_{4(aq)}$
C. $Cu^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} + 2Li^+_{(aq)} + S^{2-}_{(aq)} \rightarrow Li_2SO_{4(aq)} + CuS_{(s)}$
D. $Cu^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} + 2Li^+_{(aq)} + S^{2-}_{(aq)} \rightarrow CuS_{(s)} + 2Li^+_{(aq)} + SO_4^{2-}{}_{(aq)}$

33. A solution contains two cations, each having a concentration of 0.20 M. When an equal volume of 0.20 M $OH^-$ is added, these cations are removed from the solution by precipitation. These ions are

D

A. $Ba^{2+}$ and $K^+$
B. $Sr^{2+}$ and $Na^+$
C. $Mg^{2+}$ and $Sr^{2+}$
D. $Mg^{2+}$ and $Ca^{2+}$

Both cations must have low sol. with $OH^-$
$K^+$ and $Sr^{2+}$ are soluble w/ $OH^-$

34. Which one of the following salts is soluble?

C

A. $BaSO_4$
B. $CaCO_3$
C. $K_3PO_4$
D. $Fe(OH)_2$

35. Two ions found in hard water are $Ca^{2+}$ and $Mg^{2+}$. Which of the following will precipitate only one of these ions?

C

A. $I^-$ – neither
B. $S^{2-}$ – neither
C. $PO_4^{2-}$
D. $CO_3^{2-}$ – Both



ppt only 1 ion

36. Which of the following anions could be used to separate $Pb^{2+}$ from $Ba^{2+}$ by precipitation?

A

A. $Cl^-$
B. $OH^-$
C. $NO_3^-$
D. $CO_3^{2-}$

37. Which of the following causes a precipitate to form when $Sr^{2+}_{(aq)}$ is added but not when $Zn^{2+}_{(aq)}$ is added?

C

A. $S^{2-}$
B. $Cl^-$
C. $SO_4^{2-}$
D. $CO_3^{2-}$

38. A solution contains a mixture of $SO_4^{2-}$ and $S^{2-}$. Which of the following cations could be used to remove only the $SO_4^{2-}$ from the solution by precipitation?

B

A. $K^+$ – neither
B. $Sr^{2+}$
C. $Pb^{2+}$ – both
D. $Cu^{2+}$

only form ppt with $SO_4^{2-}$

39. A solution containing an unknown cation was added to three solutions and the following observations were recorded:

| | SOLUTION | OBSERVATION |
|---|---|---|
| $I^-$ | NaI | no precipitate |
| $SO_4^{2-}$ | $Na_2SO_4$ | precipitate |
| $OH^-$ | NaOH | no precipitate |

The unknown cation is

B

A. $Pb^{2+}$
B. $Sr^{2+}$
C. $Ca^{2+}$
D. $Ag^+$

| | $I^-$ | $SO_4^{2-}$ | $OH^-$ |
|---|---|---|---|
| $Pb^{2+}$ | ppt | ppt | ppt |
| $Sr^{2+}$ | X | ppt | X |
| $Ca^{2+}$ | X | ppt | ppt |
| $Ag^+$ | ppt | ppt | ppt |

40. To remove $Mg^{2+}$ from a solution by precipitation, a student should add

A. NaI
B. KOH
C. $Li_2SO_4$
D. $(NH_4)_2S$

41. A student wishes to identify an unknown cation in a solution. A precipitate does not form with the addition of $SO_4^{2-}$, but does form with the addition of $S^{2-}$. Which of the following is the unknown cation?

| | $SO_4^{2-}$ | $S^{2-}$ |
|---|---|---|
| A. $Ag^+$ | ppt | ppt |
| B. $Mg^{2+}$ | × | × |
| C. $Ca^{2+}$ | ppt | × |
| D. $Cu^{2+}$ | × | ppt |

42. A solution containing a single unknown cation is added to three test tubes. The following anions were added and observations were recorded:

| TEST TUBE | ANION ADDED | OBSERVATION |
|---|---|---|
| 1 | $SO_4^{2-}$ | precipitate |
| 2 | $S^{2-}$ | precipitate |
| 3 | $OH^-$ | precipitate |

The solution contains

A. $Sr^{2+}$
B. $Ag^+$ or $Pb^{2+}$
C. $Ca^{2+}$ or $Ba^{2+}$
D. $K^+$, $NH_4^+$ or $H^+$

43. Which of the following would precipitate the $Ca^{2+}$ and $Mg^{2+}$ found in hard water?

A. $S^{2-}$
B. $PO_4^{3-}$
C. $SO_4^{2-}$
D. $CH_3COO^-$



44. From the list of salts below, how many are considered soluble at 25°C?

$CuCl_2$ $CaSO_4$ $PbS$ $Ag_3PO_4$

A. zero
B. one
C. two
D. three

45. A solution contains $CO_3^{2-}$ and $OH^-$. Separation of these two anions by selective precipitation is accomplished by first adding $Sr(NO_3)_2$ solution, then filtering and finally adding to the filtrate a solution of

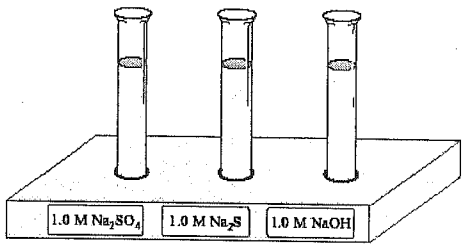
A. $HNO_3$
B. $RbNO_3$
C. $NH_4NO_3$
D. $Zn(NO_3)_2$

Cations are all soluble

46. Which of the following ions could be used to separate $Cl^-_{(aq)}$ from $SO_4^{2-}_{(aq)}$ by precipitation?

A. $Ag^+$
B. $Ca^{2+}$
C. $NH_4^+$
D. $Pb^{2+}$

47. A nitrate solution containing an unknown cation is added to each of the following three test tubes.




A precipitate forms in one test tube only. The unknown cation is

A. $Ag^+$
B. $Ca^{2+}$
C. $Sr^{2+}$
D. $NH_4^+$

48. Which of the following could be used to separate $Pb^{2+}$ from $Ba^{2+}$ by precipitation?

A. $Na_2S$
B. NaOH
C. $Na_2CO_3$
D. $Na_2SO_4$

49. Which of the following compounds could be used to prepare a 0.20 M solution of hydroxide ion?

A. KOH
B. $Fe(OH)_3$
C. $Mg(OH)_2$
D. $Zn(OH)_2$

PART B: WRITTEN RESPONSE

Value: 14 marks

Suggested Time: 15 minutes

| INSTRUCTIONS: | You will be expected to communicate your knowledge and understanding of chemical principals in a clear and logical manner.<br>Your steps and assumptions leading to a solution must be written in the spaces below the questions.<br>Answers must include units where appropriate and be given the correct number of significant figures.<br>**For questions involving calculations, full marks will NOT be given for providing only an answer.** |
|---|---|

1. Calculate the maximum mass of $BaCl_{2(s)}$ that can be added to 250 mL of 0.50 M $Pb(NO_3)_{2(aq)}$ without forming a precipitate of $PbCl_{2(s)}$. (6 marks)

$PbCl_2 \rightleftharpoons Pb^{2+} + 2Cl^-$

$K_{sp} = [Pb^{2+}][Cl^-]^2$

$1.2\times10^{-5} = (0.50M)(Cl^-)^2$

$\sqrt{\frac{1.2\times10^{-5}}{0.50}} = [Cl^-]$

$4.899\times10^{-3}M = [Cl^-]$

$4.899\times10^{-3}\ mol\ Cl^- \times \frac{1\ mol\ PbCl_2}{2\ mol\ Cl^-} = 2.45\times10^{-3}\ mol/L$

$2.45\times10^{-3}\ mol/L \times 0.250L = 6.12\times10^{-4}\ mol \times \frac{208.3g}{1mol} = \boxed{0.13g}$ (5 marks)

2. After a 50.0 mL sample of a saturated solution of $Ag_2SO_4$ was heated to dryness, $7.2\times10^{-4}$ g of solid $Ag_2SO_4$ remained. What is the value of $K_{sp}$ for $Ag_2SO_4$ ?

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

$K_{sp} = [Ag^+]^2[SO_4^{2-}]$

$K_{sp} = (2x)^2(x)$

$K_{sp} = 4x^3$

$K_{sp} = 4(4.617\times10^{-5})^3$

$= \boxed{3.9\times10^{-13}}$

$\frac{7.2\times10^{-4}g}{0.0500L} \times \frac{1mol}{311.9g} = 4.617\times10^{-5}M$

1. The compound $Ag_2S$ has a solubility of $1.3\times10^{-4}$ moles per litre at 25°C. The $K_{sp}$ for this compound is

A. $2.2\times10^{-12}$
B. $8.8\times10^{-12}$
C. $1.7\times10^{-8}$
D. $3.4\times10^{-8}$

B

$K_{sp} = 4x^3 = 4(1.3\times10^{-4}M)^3$

2. In a saturated solution of zinc hydroxide, at 40° C, the $[Zn^{2+}] = 1.8\times10^{-5}$ M. The $K_{sp}$ of $Zn(OH)_2$ is

$[Zn^{2+}] = [Zn(OH)_2]$

A. $5.8\times10^{-15}$
B. $2.3\times10^{-14}$
C. $1.8\times10^{-14}$
D. $6.5\times10^{-10}$

B

$K_{sp} = 4x^3 = 4(1.8\times10^{-5})^3$

3. Saturated solutions of $Na_2S$, $CuS$, $SnS_2$ and $Al_2S_3$ are prepared at 25°C. The $[S^{2-}]$ will be greatest in the solution of

A. $Na_2S$ – soluble
B. $CuS$ – L.S
C. $SnS_2$ – L.S
D. $Al_2S_3$ – L.S.

A

4. The $K_{sp}$ expression for calcium hydroxide is $Ca(OH)_2 \rightleftharpoons Ca^{2+} + 2OH^-$

A. $K_{sp} = [Ca^{2+}][OH^-]^2$

B. $K_{sp} = \frac{1}{[Ca^{2+}][OH^-]^2}$

C. $K_{sp} = [Ca^{2+}][2OH^-]^2$

D. $K_{sp} = \frac{1}{[Ca^{2+}][2OH^-]^2}$

A

5. What is the maximum $[Sr^{2+}]$ that can exist in a solution of 0.10 M $Na_2SO_4$ ?

A. $3.4\times10^{-7}$ M
B. $3.4\times10^{-6}$ M
C. $1.7\times10^{-6}$ M
D. $5.8\times10^{-4}$ M

$K_{sp} = [Sr^{2+}][SO_4^{2-}]$

$[Sr^{2+}] = \frac{K_{sp}}{[SO_4^{2-}]} = \frac{3.4\times10^{-7}}{0.10\,M}$

6. A solution of $AgNO_3$ is slowly added to a mixture containing 0.10 M $I^-$, $Cl^-$, $Br^-$ and $IO_3^-$. The precipitate which forms first is

A. AgI $\times10^{-17}$
B. AgCl $\times10^{-10}$
C. AgBr $\times10^{-13}$ – least soluble / smallest $K_{sp}$
D. $AgIO_3$ $\times10^{-8}$

7. The solubility product expression for a saturated solution of $Fe_2(SO_4)_3$ is

A. $K_{sp} = [Fe^{3+}]^2[SO_4^{2-}]^3$

$Fe_2(SO_4)_3 \rightarrow 2Fe^{3+} + 3SO_4^{2-}$

B. $K_{sp} = [2Fe^{3+}][3SO_4^{2-}]$

C. $K_{sp} = \frac{[Fe^{3+}]^2[SO_4^{2-}]^3}{[Fe_2(SO_4)_3]}$

D. $K_{sp} = \frac{[2Fe^{3+}][3SO_4^{2-}]}{[Fe_2(SO_4)_3]}$

8. At 25°C, the maximum $[Zn^{2+}]$ that can exist in 0.250 M $Na_2S$ is

A. $5.0\times10^{-26}$ M
B. $2.0\times10^{-25}$ M
C. $8.0\times10^{-25}$ M
D. $4.5\times10^{-13}$ M

$K_{sp} = [Zn^{2+}][S^{2-}]$

$2.0\times10^{-25} = [Zn^{2+}](0.250)$

9. The molar solubility of iron(II) sulphide is

A. $3.6\times10^{-37}$ M
B. $3.0\times10^{-19}$ M
C. $6.0\times10^{-19}$ M
D. $7.7\times10^{-10}$ M

$FeS_{(s)} \rightleftharpoons Fe^{2+} + S^{2-}$ (x, x)

$K_{sp} = [Fe^{2+}][S^{2-}]$

$K_{sp} = x^2$

$\sqrt{K_{sp}} = x$

$\sqrt{6.0\times10^{-19}} = x$



10. The solubility of barium fluoride is $3.6\times10^{-3}$ M. The solubility product constant is

A. $4.7\times10^{-8}$
B. $1.9\times10^{-7}$
C. $1.3\times10^{-5}$
D. $2.6\times10^{-5}$

$BaF_2 \rightleftharpoons Ba^{2+} + 2F^-$ (x, x, 2x)

$K_{sp} = 4x^3$

11. A 200.0 mL solution contains 0.050 mol of $Ba(NO_3)_2$. The $[NO_3^-]$ is

A. 0.050 M
B. 0.10 M
C. 0.25 M
D. 0.50 M

$M = \frac{0.050\,mol}{0.2000\,L} = 0.25\,M$

12. At 25°C, the solubility of an unknown compound is $7.1\times10^{-5}$ M. The compound is

A. CuI
B. AgI
C. $CaCO_3$
D. $CaSO_4$

$K_{sp} = x^2$

$K_{sp} = (7.1\times10^{-5})^2$

$K_{sp} = 5.0\times10^{-9}$

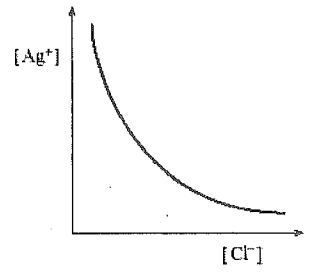
↑ look up in data booklet p. 5.

13. Consider the following equation:

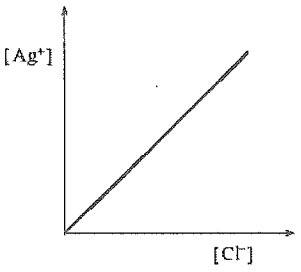
$$AgCl_{(s)} \rightleftarrows Ag^{+}_{(aq)} + Cl^{-}_{(aq)}$$

Which of the following graphs represents the relationship between $[Ag^+]$ and $[Cl^-]$ in this system at a constant temperature?

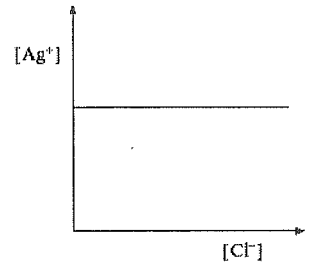
A.



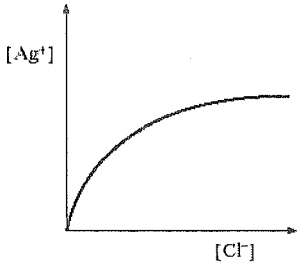

B.




C.




D.




14. The relationship between the solubility of $SrF_2$ and its $K_{sp}$ is

A. solubility $= \dfrac{\sqrt[3]{K_{sp}}}{4}$

B. solubility $= \sqrt[3]{\dfrac{K_{sp}}{2}}$

C. solubility $= \sqrt[3]{\dfrac{K_{sp}}{4}}$

D. solubility $= \sqrt{K_{sp}}$



15. The maximum $[SO_4^{2-}]$ that can exist in $1.0\times10^{-3}$ M $Ca(NO_3)_2$ without a precipitate forming is

A. $7.1\times10^{-5}$ M

B. $1.0\times10^{-3}$ M

C. $8.4\times10^{-3}$ M

D. $7.1\times10^{-2}$ M

16. If the Trial Ion Product for $AgBrO_3$ is calculated to be $1.0\times10^{-7}$, then

A. a precipitate forms because the Trial Ion Product > $K_{sp}$

B. a precipitate forms because the Trial Ion Product < $K_{sp}$

C. no precipitate forms because the Trial Ion Product > $K_{sp}$

D. no precipitate forms because the Trial Ion Product < $K_{sp}$

17. When equal volumes of 0.20 M $Pb(NO_3)_2$ and 0.20 M KI are mixed together,

A. a precipitate forms since Trial Ion Product > $K_{sp}$

B. a precipitate forms since Trial Ion Product < $K_{sp}$

C. no precipitate forms since Trial Ion Product > $K_{sp}$

D. no precipitate forms since Trial Ion Product < $K_{sp}$

18. When solutions of $Pb(NO_3)_2$ and NaCl are mixed, the trial ion product (Trial $K_{sp}$) is $9.8\times10^{-6}$. Which of the following statements is true?

A. A precipitate forms because $K_{sp} > 9.8\times10^{-6}$

B. A precipitate forms because $K_{sp} < 9.8\times10^{-6}$

C. A precipitate does not form because $K_{sp} < 9.8\times10^{-6}$

D. A precipitate does not form because $K_{sp} > 9.8\times10^{-6}$

19. When equal volumes of 2.0 M $Pb(NO_3)_2$ and 2.0 M KCl are mixed,

A. a precipitate forms because trial ion product < $K_{sp}$

B. a precipitate forms because trial ion product > $K_{sp}$

C. a precipitate does not form because trial ion product < $K_{sp}$

D. a precipitate does not form because trial ion product > $K_{sp}$

## PART B: WRITTEN RESPONSE

**Value: 6 marks** **Suggested Time: 10 minutes**

| | |
|---|---|
| **INSTRUCTIONS:** | You will be expected to communicate your knowledge and understanding of chemical principals in a clear and logical manner.<br>Your steps and assumptions leading to a solution must be written in the spaces below the questions.<br>Answers must include units where appropriate and be given the correct number of significant figures.<br>**For questions involving calculations, full marks will NOT be given for providing only an answer.** |

1. Write the net ionic equation for the reaction between $Pb(NO_3)_{2(aq)}$ and $NaCl_{(aq)}$. **(2 marks)**

$Pb(NO_3)_{2(aq)} + 2NaCl_{(aq)} \longrightarrow PbCl_{2(s)} + 2NaNO_{3(aq)}$

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

2. When a solution of $Na_2CO_{3(aq)}$ is mixed with a solution of $Ca(NO_3)_{2(aq)}$ a precipitate forms.
Write the net ionic equation for the precipitation reaction. **(1 mark)**

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

3. A 100.0 mL saturated solution of $FeF_2$ contains 0.0787 g of solute.
Determine $[Fe^{2+}]$ and $[F^-]$ in the solution. **(3 marks)**

$FeF_{2(s)} \longrightarrow Fe^{2+} + 2F^-$
$\quad X \qquad\quad X \quad 2X$

$X = \frac{0.0787\,g}{0.1000\,L} \times \frac{1\,mol}{93.8\,g} = 8.39 \times 10^{-3}\,M$

$[Fe^{2+}] = 8.39 \times 10^{-3}\,M \qquad [F^-] = 2(8.39 \times 10^{-3}\,M)$
$= 1.68 \times 10^{-2}\,M$

**END OF EXAMINATION**