SOLUBILITY STUDY GUIDE- Multiple Choice Section

Multiple Choice Section: This study guide is a compilation of questions from provincial exams since 2000. I urge you to become intimately familiar with question types. You will notice that questions from one year to another are very similar in their composition. Identification of question types will allow you to be more efficient in answering these questions on the provincial examination. My recommendations for using this study guide are as follows :

1. **DO ALL THE QUESTIONS** in this booklet. These are actual Provincial Exam questions! Your own provincial exam and unit test will include questions similar to the ones in this booklet!
2. **RESIST THE URGE TO LOOK AT THE ANSWER KEY** until you have given all the questions in the section your best effort. Don't do one question, then look at the key, then do another and look at the key, and so on. Each time you look at one answer in the study guide, your eye will notice other answers around them, and this will reduce the effectiveness of those questions in helping you to learn.
3. **LEARN FROM YOUR MISTAKES**! If you get a question wrong, **figure out why**! If you are having difficulty, **talk to your study partner**, or maybe **phone someone in your Peer Tutoring group**. Get together with group members or other students from class and work on these questions together. Explain how you got your answers to tough questions to others. In explaining yourself to someone else, you will learn the material better yourself (try it!) Ask your teacher to explain the questions to you during tutorial or after school. **Your goal should be to get 100% on any Chemistry 12 multiple choice test**- learning from your mistakes in this booklet will really help you in your efforts to meet this goal!
4. **This is REALLY CRUCIAL**: **DO NOT mark the answer anywhere on the questions themselves**. For example, do not circle any of options A B C or D-instead use a different sheet of paper to place your answers on. By avoiding this urge, you can re-use this study guide effectively again, when preparing for your final exam. In the box to the left, put an asterisk or small note to yourself to indicate that you got the question wrong and need to come back to it. If you got the question correct initially, a check mark might be assurance that you understand this type of question and therefore can concentrate on other questions that present a challenge to you.
5. **Check Off the STATUS box on the PRESCRIBED LEARNING OUTCOMES sheet**. I have tried to organize the questions in the identical sequence to which they appear on your Acid Base Prescribed Learning Outcome sheet. By doing this, you can be confident that you know everything you need to know for both the UNIT EXAM and PROVINCIAL EXAM !

TABLE OF CONTENTS:

CONCEPT OF SOLUBILITY

1. G1 **Which of the following will dissolve in water to produce a molecular solution?**
   A. $CaCl_2$ B. NaOH C. CH_3OH D. $Sr(OH)_2$

2. G1 **Which one of the following would form an ionic solution when dissolved in water?**
   A. I_2 B. CH_3OH C. $Ca(NO_3)_2$ D. $C_{12}H_{22}O_{11}$

3. G1 **Molecular solutions do not conduct electricity because they contain**
   A. molecules only. B. cations and anions. C. molecules and anions. D. molecules and cations.

4. G1 **When dissolved in water, which of the following produces an ionic solution?**
   A. O_2 B. CH_4 C. $CaCl_2$ D. $C_{12}H_{22}O_{11}$

5. G1 **When dissolved in water, which of the following forms a molecular solution?**
   A. $HCl_{(g)}$ B. $NaNO_{3\,(s)}$ C. $CH_3OH_{(l)}$ D. $K_2SO_{4(s)}$

6. G1 Which of the following dissolves in water to form an ionic solution?
   A. O_2 B. SiO_2 C. $KMnO_4$ D. $C_{12}H_{22}O_{11}$

7. G1 **Which of the following produces a molecular solution when dissolved in water?**
   A. RbClO B. CH_3OH C. NH_4SCN D. $NaCH_3COO$

8. G1 Consider the following solutes:

I.	K_3PO_4
II.	C_2H_5OH
III.	$C_{12}H_{22}O_{11}$
IV.	KCH_3COO

Which of the solutes above form only molecular aqueous solutions?
A. I and II
B. II and III
C. II, III and IV
D. I, II, III and IV

9. G3 **Which of the following does <u>not</u> define solubility?**
A. the concentration of solute in a saturated solution
B. the moles of solute dissolved in a given volume of solution
C. the maximum mass of solute that can dissolve in a given volume of solution
D. the minimum moles of solute needed to produce one litre of a saturated solution

10. G3 **To determine the solubility of a solute in water, a solution must be prepared that is**
A. saturated. B. unsaturated. C. concentrated. D. supersaturated.

11. G3 **When Ca $(OH)_2$ attains solubility equilibrium, the**
A. solution is saturated. B. pH will be less than 7.
C. Trial K_{sp} is less than the K_{sp} . D. concentrations of the ions are equal.

12. G4 **Which of the following units is commonly used to describe solubility?**
A. mL/s B. g/°C C. mol/L D. °C/mol

13. G4 **Which of the following units can be used to represent solubility?**
A. g B. mol C. mol/L D. mL/s

14. G4 **Which of the following units could be used to describe solubility?**
A. g/s
B. g/L
C. M/L
D. mol/s

15. G5 A saturated solution of $NiCO_3$ was evaporated to dryness. A 250.0 mL sample was found to contain 1.1×10^{-2} g $NiCO_3$. The molar mass of NiCO 3 is 118.7 g mol. **The molar solubility of $NiCO_3$ is:**
A. 9.3×10^{-5} M B. 3.7×10^{-4} M C. 4.4×10^{-2} M D. 1.4×10^{-7} M

16. G5 A student evaporated 200.0mL of a saturated solution of $SrCrO_4$ to dryness. The residue contained 1.2×10^{-3} mol $SrCrO_4$. **The solubility of $SrCrO_4$ is:**
A. 1.4×10^{-6} M B. 3.6×10^{-5} M C. 2.4×10^{-4} M D. 6.0×10^{-3} M

17. G6 **In a solubility equilibrium, the**
A. rate of dissolving equals the rate of crystallization.
B. neither dissolving nor crystallization are occurring.
C. concentration of solute and solvent are always equal.
D. mass of dissolved solute is greater than the mass of the solution.

18. G6 **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.

19. G6 **In a saturated solution, the rate of dissolving is**
A. equal to zero. B. equal to the rate of crystallization.
C. less than the rate of crystallization. D. greater than the rate of crystallization.

20. G6 Which of the following represents the equilibrium in a saturated solution of $Cr_2(SO_4)_3$?

A. $Cr_2(SO_4)_{3(s)} \rightleftarrows Cr^{2+}_{(aq)} + SO_4^{3-}{}_{(aq)}$
B. $Cr_2(SO_4)_{3(s)} \rightleftarrows Cr^{3+}_{(aq)} + SO_4^{2-}{}_{(aq)}$
C. $Cr_2(SO_4)_{3(s)} \rightleftarrows 2Cr^{2+}_{(aq)} + 3SO_4^{3-}{}_{(aq)}$
D. $Cr_2(SO_4)_{3(s)} \rightleftarrows 2Cr^{3+}_{(aq)} + 3SO_4^{2-}{}_{(aq)}$

21. G6 The equation representing the equilibrium in a saturated solution of $CaSO_4$ is

A. $CaSO_{4(s)} \rightleftarrows Ca^{2+}_{(aq)} + SO_4{}^{2-}_{(aq)}$

B. $CaSO_{4(s)} \rightleftarrows Ca^{2+}_{(aq)} + S^{2-}_{(aq)} + 4O^{2-}_{(aq)}$

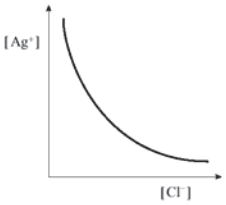
C. $CaSO_{4(s)} + H_2O_{(\ell)} \rightleftarrows CaO_{(aq)} + H_2SO_{4(aq)}$

D. $CaSO_{4(s)} + 2H_2O_{(\ell)} \rightleftarrows Ca(OH)_{2(aq)} + H_2SO_{4(aq)}$

22. G6 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.


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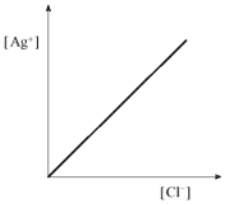
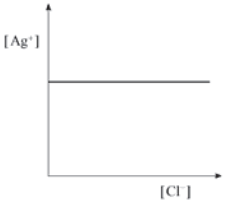
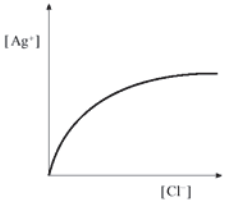


C.


D.


23. G7 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. $Fe_2(SO_4)_{3(s)} \rightleftarrows 2Fe^{3+}_{(aq)} + 3SO_4{}^{2-}_{(aq)}$

24. G8 The ion concentrations in 0.25 M $Al_2(SO_4)_3$ are

	$[Al^{3+}]$	$[SO_4{}^{2-}]$
A.	0.25 M	0.25 M
B.	0.50 M	0.75 M
C.	0.75 M	0.50 M
D.	0.10 M	0.15 M

25. G8 Which of the following solutions would have $[Fe^{3+}] = 0.020\ M$?

A. $0.40\ L$ of $0.050\ M\ Fe(NO_3)_3$

B. $0.80\ L$ of $0.020\ M\ Fe_2(SO_4)_3$

C. $0.50\ L$ of $0.040\ M\ FeC_6H_5O_7$

D. $0.50\ L$ of $0.010\ M\ Fe_2(C_2O_4)_3$

26. G8 **In a 200 mL sample of 0.030M Na_3PO_4, the $[Na^+]$ is:**
A. 0.006 M B. 0.010 M C. 0.018 M D. 0.090 M

27. G8 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

28. G8 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 $[Cl^-] = 0.70\ M$

29. G8 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 $[OH^-] = 0.180\ M$

30. G8 **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

31. G8 In 1.5 M $(NH_4)_2SO_4$, the ion concentrations are

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 $[SO_4^{2-}] = 3.0\ M$

32. G8 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

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. $[Pb^{2+}] = 6.43 \times 10^{-4}\ M$ and $[OH^-] = 1.29 \times 10^{-3}\ M$

D. $[Pb^{2+}] = 6.43 \times 10^{-4}\ M$ and $[OH^-] = 6.43 \times 10^{-4}\ M$

33. G8 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. 0.30 M B. 0.60 M C. 0.90 M D. 1.2 M

34. G8 **In 0.20 M Na_2CrO_4 , the ion concentrations are**

	$[Na^+]$	$[CrO_4^{2-}]$
A.	0.40 M	0.20 M
B.	0.20 M	0.20 M
C.	0.20 M	0.40 M
D.	0.40 M	0.80 M

35. G8 The ion concentrations in 2.00 L of 0.32 M K_3PO_4 are

	$[K^+]$	$[PO_4^{3-}]$
A.	0.16 M	0.16 M
B.	0.32 M	0.32 M
C.	0.48 M	0.16 M
D.	0.96 M	0.32 M

36. G8 At a certain temperature, 7.0×10^{-4} mol $MgSO_4$ is present in 100.0 mL of solution.
The concentration of the Mg^{2+} in this solution is
A. 7.0×10^{-5} M B. 7.0×10^{-4} M C. 7.0×10^{-3} M D. 7.0×10^{-6} M

SOLUBILITY AND PRECIPITATION

37. H1 **Which of the following substances has the lowest solubility?**
A. BaS B. CuS C. FeS D. ZnS

38. H1 **In a saturated solution of $Zn(OH)_2$, the $[Zn^{2+}]$ is:**
A. less than 0.10 M B. more than 10.0 M
C. more than 0.10 M, but less than 1.0 M D. more than 1.0 M, but less than 10.0 M

39. H1 Which one of the following salts is soluble?
A. $BaSO_4$ B. $CaCO_3$ C. K_3PO_4 D. Fe(OH)2

40. H1 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

41. H1 **Which of the following salts has the <u>lowest</u> solubility?**
A. copper(I) chloride B. ammonium sulphide C. potassium hydroxide D. mercury(II) sulphate

42. H1 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
B. CuS
C. SnS_2
D. Al_2S_3

43. H1 **A soluble magnesium salt is**
A. $MgSO_3$ B. $MgCO_3$ C. $Mg(NO_3)_2$ D. $Mg_3(PO_4)_2$

44. H1 **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. $Zn(OH)_2$

45. H1 **Which of the following has a solubility of less than 0.10 M?**
A. SrS B. $SrCl_2$ C. $SrSO_4$ D. $Sr(OH)_2$

46. H1 **Which of the following is the least soluble in water at 25° C?**
A. $CaSO_4$ B. $BaSO_4$ C. $CuSO_4$ D. $MgSO_4$

47. H1 Which of the following will be most soluble in water at 25° C?
A. AgI B. PbS C. $MgSO_4$ D. $Ba(OH)_2$

48. H1 The **least** soluble salt in water is
A. BaS B. $AlCl_3$ C. $CaSO_3$ D. $ZnSO_4$

49. H1 **Which of the following compounds will form a saturated solution with the greatest concentration of Ag^+ ?**
A. AgI B. AgBr C. $AgIO_3$ D. $AgBrO_3$

50. H1 **Which of the following is most soluble?**
A. Na_2S B. $CaSO_4$ C. $PbCO_3$ D. $Zn(OH)_2$

51. H1 **Which of the following saturated solutions has the lowest $[SO_4^{2-}]$ at 25° C ?**
A. $SrSO_4$ B. $PbSO_4$ C. $CaSO_4$ D. $BaSO_4$

52. H1 **Which of the following compounds is the least soluble in water?**
A. H_2S B. KNO_3 C. $ZnSO_4$ D. $Ca(OH)_2$

53. H1 **Which of the following saturated solutions has the greatest $[CO_3^{2-}]$?**
A. $SrCO_3$ B. $CaCO_3$ C. $BaCO_3$ D. MgCO

54. H1 **The least soluble salt in water is**
A. CaS B. $CaSO_4$ C. CaC_2O_4 D. $Ca(NO_3)_2$

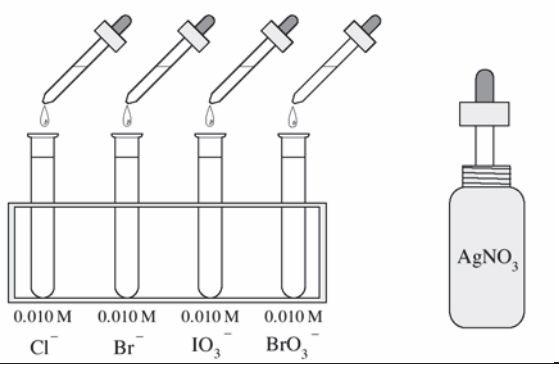
55. H1 **At 25° C, which of the following compounds would dissolve to form a saturated solution with the greatest $[Pb^{2+}]$?**
A. PbI_2 B. $PbCl_2$ C. $PbBr_2$ D. $Pb(IO_3)_2$

56. H1 **Which of the following compounds is the least soluble in water?**
A. CaS B. $Fe(OH)_3$ C. $KMnO_4$ D. $NH_4HC_2O_4$

57. H2 Which of the following will **not** produce a precipitate when equal volumes of 0.20M solutions are combined?

A. KOH and $CaCl_2$
B. $Zn(NO_3)_2$ and K_3PO_4
C. $Sr(OH)_2$ and $(NH_4)_2S$
D. Na_2SO_4 and $Pb(NO_3)_2$

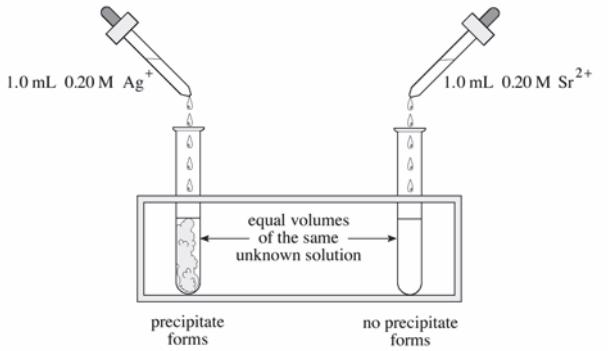
58. H2 Consider the following 0.10mL solutions:



Equal moles of $AgNO_3$ are added to each solution. It is observed that a precipitate forms in all but one solution. **Which solution does <u>not</u> form a precipitate**?

A. Cl^- B. Br^- C. IO_3^- D. BrO_3^-

59. H2 Consider the following experiment:



The unknown solution could contain:

A. 0.20M OH^-
B. 0.20M NO_3^-
C. 0.20M PO_4^{3-}
D. 0.20M SO_4^{2-}

60. H2 The mixture that could produce a precipitate of **two** compounds is

A. 0.2 M $HgSO_4$ and 0.2 M $FeCl_2$
B. 0.2 M $AgNO_3$ and 0.2 M $MgCl_2$
C. 0.2 M K_2CO_3 and 0.2 M $CuSO_4$
D. 0.2 M $ZnSO_4$ and 0.2 M $Ba(OH)_2$

61. H2 The precipitate formed when equal volumes of 0.2 M $Sr(OH)_2$ and 0.2 M MgS are mixed is

A. SrS
B. $Mg(OH)_2$
C. a mixture of $Mg(OH)_2$ and SrS
D. a mixture of $Sr(OH)_2$ and MgS

62. H2 **If equal volumes of 0.2 M KBr and 0.2 M $FeSO_4$ are mixed, then**
A. no precipitate will be observed.
B. a precipitate of $FeBr_2$ will be observed.
C. a precipitate of K_2SO_4 will be observed.
D. a precipitate of both K_2SO_4 and $FeBr_2$ will be observed.

63. H2 **Which of the following occurs when equal volumes of 0.20M MgS and 0.20M $ZnSO_4$ are mixed?**
A. A precipitate does not form. B. A precipitate of ZnS forms.
C. A precipitate of $MgSO_4$ forms. D. Precipitates of $MgSO_4$ and ZnS form.

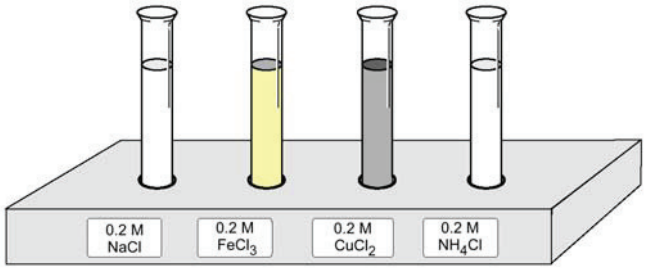
64. H2 **When a student mixes equal volumes of 0.20 M Na_2S and 0.20 M $Sr(OH)_2$,**
A. no precipitate forms. B. a precipitate of only SrS forms.
C. a precipitate of only NaOH forms. D. precipitates of both NaOH and SrS form.

65. H2 **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.

66. H2 **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.

67. H2 **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.

68. H2 A dilute solution of $AgNO_3$ is added dropwise to each of the following test tubes until a precipitate forms in each tube.



Which solution requires the lowest $[Ag^+]$ to just begin precipitation?

A. NaCl
B. $FeCl_3$
C. $CuCl_2$
D. NH_4Cl

69. H2 **Which of the following 0.20M 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. $Ba(NO_3)_2$

70. H2 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-}

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

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

71. H2 **When equal volumes of 0. 20 M $ZnSO_4$ and 0. 20 M Sr $(OH)_2$ are combined**,
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.

72. H2 **When equal volumes of 0. 20 M $SrBr_2$ and 0. 20 M $AgNO_3$ are combined**,
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.

73. H3 The complete ionic equation for the reaction between MgS and $Sr(OH)_2$ is

A. $MgS_{(aq)} + Sr(OH)_{2(aq)} \rightarrow Mg(OH)_{2(s)} + SrS_{(s)}$
B. $MgS_{(aq)} + Sr(OH)_{2(aq)} \rightarrow Mg(OH)_{2(s)} + SrS_{(aq)}$
C. $Mg^{2+}_{(aq)} + S^{2-}_{(aq)} + Sr^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Mg^{2+}_{(aq)} + 2OH^-_{(aq)} + SrS_{(s)}$
D. $Mg^{2+}_{(aq)} + S^{2-}_{(aq)} + Sr^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Mg(OH)_{2(s)} + Sr^{2+}_{(aq)} + S^{2-}_{(aq)}$

74. H3 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. $2Ag^{+}_{(aq)} + 2NO^{-}_{3(aq)} + Mg^{2+}_{(aq)} + 2Cl^{-}_{(aq)} \longrightarrow 2AgCl_{(s)} + Mg^{2+}_{(aq)} + 2NO^{-}_{3(aq)}$

75. H3 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. $KNO_{3(s)} \rightarrow K^{+}_{(aq)} + NO_3^{-}{}_{(aq)}$

76. H3 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. $2Ag^{+}_{(aq)} + CrO_4^{2-}{}_{(aq)} + 2K^{+}_{(aq)} + 2NO_3^{-}{}_{(aq)} \rightarrow Ag_2CrO_{4(s)} + 2KNO_{3(s)}$

77. H3 When equal volumes of 0.20 M $CuSO_4$ and 0.20 M Li_2S are combined, the complete ionic equation is

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. $Cu^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} + 2Li^{+}_{(aq)} + S^{2-}_{(aq)} \rightarrow CuS_{(s)} + 2Li^{+}_{(aq)} + SO_4^{2-}{}_{(aq)}$

78. H4 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. $Zn(NO_3)_2$

79. H4

A reagent that may be used to separate Cl^- from S^{2-} by precipitation is

A. KNO_3

B. $AgNO_3$

C. $Pb(NO_3)_2$

D. $Al(NO_3)_3$

80. H4 Which of the following ions could be added to an aqueous mixture containing Pb^{2+} and Ba^{2+} to separate the ions by precipitating one of them?
A. I^- B. NO_3^- C. PO_4^{3-} D. SO_4^{2-}

81. H4 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 B. AgCl C. AgBr D. $AgIO_3$

82. H4 **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+}

83. H4 **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

84. H4 **To remove Mg^{2+} from a solution by precipitation, a student should add:**
A. NaI B. KOH C. Li_2SO_4 D. $(NH_4)_2S$

85. H4 **Which of the following causes a precipitate to form when $Sr^{2+}_{(aq)}$ is added but not when $Zn^{2+}_{(aq)}$ is added:**
A. S^{2-} B. Cl^- C. SO_4^{2-} D. CO_3^{2-}

86. H4 **Which of the following anions could be used to separate Pb^{2+} from Ba^{2+} by precipitation?**
A. Cl^- B. OH^- C. NO_3^- D. CO_3^{2-}

87. H4 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**
A. Ba^{2+} and K^+ B. Sr^{2+} and Na^+ C. Mg^{2+} and Sr^{2+} D. Mg^{2+} and Ca^{2+}

88. H5

What is observed when H_2SO_4 is added to a saturated solution of $CaSO_4$?

A. the pH increases

B. the $[Ca^{2+}]$ increases

C. bubbles of H_2 are given off

D. additional $CaSO_4$ precipitates

89. H5

Which of the following could dissolve a precipitate of CaC_2O_4 in a saturated solution of CaC_2O_4 ?

A. NaOH

B. CaC_2O_4

C. $H_2C_2O_4$

D. $Ca(NO_3)_2$

90. H5 Consider the following equilibrium:

$$Fe(OH)_{2(s)} \rightleftarrows Fe^{2+}_{(aq)} + 2OH^{-}_{(aq)}$$

Which of the following will cause the equilibrium to shift to the right?

A. adding KOH

B. adding Na_2S

C. adding $Fe(OH)_2$

D. adding $Fe(NO_3)_2$

91. H5 Sodium iodide is added to a saturated solution of lead(II) iodide. The net change is

A. $[I^-]$ increases and $[Pb^{2+}]$ increases.

B. $[I^-]$ decreases and $[Pb^{2+}]$ decreases.

C. $[I^-]$ increases and $[Pb^{2+}]$ decreases.

D. $[I^-]$ decreases and $[Pb^{2+}]$ increases.

92. H5 **A student could precipitate silver chloride from a saturated solution of silver chloride by adding**

A. water. B. sodium iodide. C. sodium nitrate. D. sodium chloride.

93. H5 Consider the following equilibrium system:

$$PbI_{2(s)} + heat \rightleftarrows Pb^{2+}_{(aq)} + 2I^{-}_{(aq)}$$

Which of the following changes would result in more PbI 2 dissolving?

A. adding more PbI 2 B. increasing the pressure

C. adding some $Pb(NO_3)_2$ D. increasing the temperature

94. H5 In which of the following would solid AgCl be **most** soluble?

A. 1 M HCl B. 1 M $MgCl_2$ C. 1 M $AgNO_3$ D. 1M NH_4NO_3

95. H5 Consider the following equilibrium:

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

Which of the following reagents, when added to the equilibrium system, would cause more $CaCO_3$ to dissolve?

A. $KNO_{3\,(s)}$ B. $CaCO_{3(s)}$ C. $H_2C_2O_{4(s)}$ D. $Na_2CO_{3(s)}$

96. H5 Consider the following equilibrium:

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

Sodium chloride is added to a saturated solution of AgCl. The amount of solid AgCl will

A. increase as the equilibrium shifts to the left. B. decrease as the equilibrium shifts to the left.

C. increase as the equilibrium shifts to the right. D. decrease as the equilibrium shifts to the right.

97. H5 Consider the following equilibrium:

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

When $Br^{-}_{(aq)}$ is added to a saturated solution of AgCl,
A. more AgCl dissolves and its solubility product increases.
B. more AgCl precipitates and its solubility product decreases.
C. more AgCl dissolves and its solubility product remains constant.
D. more AgCl precipitates and its solubility product remains constant.

98. H5 **Magnesium carbonate would be most soluble in a solution of**
A. $MgCl_2$ B. $NaNO_3$ C. Na_2CO_3 D. $Mg(NO_3)_2$

99. H5 Consider the following solubility equilibrium:

$$MgCO_{3(s)} \rightleftarrows Mg^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)}$$

The addition of which of the following substances would decrease the solubility of $MgCO_3$?
A. H_2O B. NaCl C. NaOH D. Na_2CO_3

100. H5 **The greatest mass of solid SnS will dissolve in 1.0 L of**
A. H_2O B. 0.10 M MgS C. 0.10 M $(NH_4)_2S$ D. 0.10 M Sn $(NO_3)_2$

101. H5 Consider the following equilibrium:

$$MgCO_{3(s)} \rightleftarrows Mg^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)}$$

A saturated solution of MgCO 3 is in contact with undissolved solute. More MgCO 3 *s* ( ) can be dissolved by adding solid
A. oxalic acid. B. sodium carbonate. C. magnesium chloride. D. magnesium carbonate.

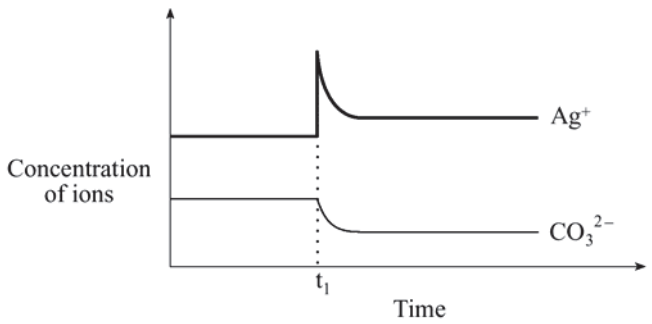
102. H5 When solid AgBr is added to a saturated solution of AgBr, the reaction rates can be described as:

	RATE OF DISSOLVING	RATE OF CRYSTALLIZATION
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	increases	no change

103. H5 Which of the following describes the changes in ion concentrations when 1.0 g of solid ZnS is added to a saturated solution of ZnS?

	$[Zn^{2+}]$	$[S^{2-}]$
A.	increases	decreases
B.	decreases	decreases
C.	increases	increases
D.	remains constant	remains constant

104. H5 Consider the following graph for a saturated Ag_2CO_3 solution: **What change occurred at time t_1 ?**



A. Water was added.
B. $AgNO_{3\,(s)}$ was added.
C. $Na_2CO_{3\,(s)}$ was added.
D. The temperature was increased.

105. H5 **The solubility of PbI_2 will increase with the addition of**
A. PbI_2 B. heat. C. water. D. $Pb(NO_3)_2$

106. H5 Consider the following equilibrium:

$$SrF_{2(s)} \rightleftarrows Sr^{2+}_{(aq)} + 2F^{-}_{(aq)}$$

The equilibrium will shift left upon the addition of
A. $H_2O_{(l)}$ B. $SrF_{2\,(s)}$ C. $SrCl_{2\,(s)}$ D. $NaNO_{3\,(s)}$

107. H5 Consider the solubility equilibrium:

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

An additional piece of solid $CaCO_3$ is added to the equilibrium above. The rate of dissolving and rate of crystallization have

	RATE OF DISSOLVING	RATE OF CRYSTALLIZATION
A.	increased	increased
B.	increased	not changed
C.	not changed	increased
D.	not changed	not changed

108. H5 **Silver chloride, AgCl, would be least soluble in**
A. 1.0 M HCl B. 1.0 M $NaNO_3$ C. 1.0 M $ZnCl_2$ D. 1.0 M $AgNO_3$

109. H5 Consider the following solubility equilibrium:

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

A student adds $NaCl_{(s)}$ to a saturated solution of $PbCl_2$. When equilibrium is reestablished, how have the concentrations changed from the original equilibrium?

A. $[Pb^{2+}]$ and $[Cl^-]$ both increased.
B. $[Pb^{2+}]$ and $[Cl^-]$ both decreased.
C. $[Pb^{2+}]$ decreased and $[Cl^-]$ increased.
D. $[Pb^{2+}]$ increased and $[Cl^-]$ decreased.

110. H5 Consider the following solubility equilibrium:

$$BaSO_{3(s)} \rightleftarrows Ba^{2+}_{(aq)} + SO_3^{2-}{}_{(aq)}$$

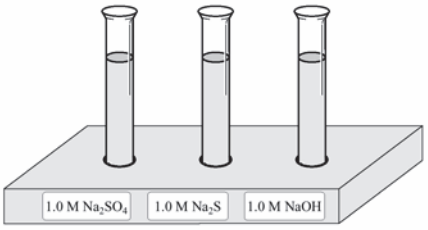
Which of the following will result in an increase of $[Ba^{2+}]$?
A. adding water B. adding $BaS_{(s)}$ C. adding $BaSO_{3\,(s)}$ D. adding $Na_2SO_{3\,(s)}$

111. H6 During a lab on qualitative analysis, an unknown solution containing one cation was analyzed and the
following data were collected:

0.2 M Anions Added to the Unknown Solution	Observation
S^{2-}	no precipitate
SO_4^{2-}	precipitate
OH^-	precipitate
CO_3^{2-}	precipitate

Which one of the following cations is found in the unknown solution?
A. Mg^{2+} B. Ca^{2+} C. Sr^{2+} D. Ba^{2+}

112. H6 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^+

113. H6 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^+

114. H6 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?**
A. Ag^+ B. Mg^{2+} C. Ca^{2+} D. Cu^{2+}

115. H6

SOLUTION	OBSERVATION
NaI	no precipitate
Na_2SO_4	precipitate
NaOH	no precipitate

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

The unknown cation is:
A. Pb^{2+} B. Sr^{2+} C. Ca^{2+} D. Ag^+

116. H6 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?**
A. K^+ B. Sr^{2+} C. Pb^{2+} D. Cu^{2+}

117. H7 **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^-

118. H7 **Which of the following could be used to precipitate both Mg^{2+} and Ca^{2+} from hard water?**
A. lithium sulphate B. sodium phosphate C. potassium sulphide D. ammonium chloride

119. H7 Two ions found in hard water are Ca^{2+} and Mg^{2+}. **Which of the following will precipitate only one of these ions?**

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

QUANTITATIVE ASPECTS

120. I1 Identify the **most** soluble sulphide.

A. HgS, $K_{sp} = 1.6 \times 10^{-54}$

B. PbS, $K_{sp} = 7.0 \times 10^{-29}$

C. FeS, $K_{sp} = 3.7 \times 10^{-19}$

D. MnS, $K_{sp} = 2.3 \times 10^{-13}$

121. I1 Consider the following equilibrium:

$$NH_4Cl_{(s)} + \text{energy} \rightleftarrows NH_{4(aq)}^{+} + Cl_{(aq)}^{-}$$

Which of the following will increase the solubility of ammonium chloride?

A.stirring the solution B.adding more water C.adding more $NH_4Cl_{(s)}$ D. increasing the temperature

122. I2 Which one of the following equilibrium systems is described by a K_{sp}?

A. $CaCO_{3(s)} \rightleftarrows CaO_{(s)} + CO_{2(g)}$

B. $CaCO_{3(s)} \rightleftarrows Ca_{(aq)}^{2+} + CO_{3(aq)}^{2-}$

C. $Ca_{(aq)}^{2+} + CO_{3(aq)}^{2-} \rightleftarrows CaCO_{3(s)}$

D. $Ca(OH)_{2(aq)} + H_2CO_{3(aq)} \rightleftarrows CaCO_{3(s)} + 2H_2O_{(l)}$

123. I2 The K_{sp} expression for calcium hydroxide is

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

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

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

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

124. I2 The solubility product expression for a saturated solution of $Fe_2(SO_4)_3$ is

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

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

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

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

125. I2 The K_{sp} expression for $Ca_3(PO_4)_2$ is

A. $K_{sp} = \dfrac{[Ca^{2+}]^3 [PO_4^{3-}]^2}{[Ca_3(PO_4)_2]}$

B. $K_{sp} = \dfrac{[2Ca^{2+}][3PO_4^{3-}]}{[Ca_3(PO_4)_2]}$

C. $K_{sp} = [Ca^{2+}]^3 [PO_4^{3-}]^2$

D. $K_{sp} = [2Ca^{2+}][3PO_4^{3-}]$

126. I2 The K_{sp} expression for a saturated solution of $Ca_3(PO_4)_2$ is

A. $K_{sp} = [Ca^{2+}][PO_4^{3-}]$

B. $K_{sp} = [Ca^{2+}]^3 [PO_4^{3-}]^2$

C. $K_{sp} = [3Ca^{2+}][2PO_4^{3-}]$

D. $K_{sp} = [3Ca^{2+}]^3 [2PO_4^{3-}]^2$

127. I2 The K_{sp} expression for a saturated solution of Ag_2CO_3 is

A. $K_{sp} = [Ag_2^{+}][CO_3^{2-}]$

B. $K_{sp} = [Ag^{+}]^2 [CO_3^{2-}]$

C. $K_{sp} = [2Ag^{+}][CO_3^{2-}]$

D. $K_{sp} = [2Ag^{+}]^2 [CO_3^{2-}]$

128. I2 Solid Ag_2CrO_4 is added to water to form a saturated solution.
The K_{sp} value can be calculated by

A. $K_{sp} = \left[CrO_4^{2-}\right]^2$

B. $K_{sp} = \left[CrO_4^{2-}\right]^3$

C. $K_{sp} = \dfrac{\left[CrO_4^{2-}\right]^3}{2}$

D. $K_{sp} = 4\left[CrO_4^{2-}\right]^3$

129. I3 The solubility of $CdS = 2.8 \times 10^{-14}$. The value of K_{sp} is

A. 7.8×10^{-28}
B. 2.8×10^{-14}
C. 5.6×10^{-14}
D. 1.7×10^{-7}

130. I3 **A compound has a solubility of 7.1×10^{-5} at 25°C. The compound is:**
A. CuS B. AgBr C. $CaCO_3$ D. $CaSO_4$

131. I3 The compound Ag_2S has a solubility of 1.3×10^{-4} moles per litre at 25°C. The K_{sp} for this compound is

A. 2.2×10^{-12}
B. 8.8×10^{-12}
C. 1.7×10^{-8}
D. 3.4×10^{-8}

132. I3 In a saturated solution of zinc hydroxide, at **40°C**, the $\left[Zn^{2+}\right] = 1.8 \times 10^{-5}$ M.
The K_{sp} of $Zn(OH)_2$ is

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

133. I3 In a saturated solution of manganese(II) hydroxide, $Mn(OH)_2$, $\left[Mn^{2+}\right]$ equals 4.5×10^{-5} M.
Therefore, the K_{sp} of $Mn(OH)_2$ is

A. 9.1×10^{-14}
B. 3.6×10^{-13}
C. 2.0×10^{-9}
D. 4.1×10^{-9}

134. I3 **At a certain temperature, the solubility of BaF_2 is 7.4×10^{-3} moles per litre. The K_{sp} of BaF_2 is**
A. 1.6×10^{-6} B. 5.5×10^{-5} C. 1.1×10^{-4} D. 7.4×10^{-3}

135. I3 **The solubility of manganese(II) sulphide is 1.7×10^{-7} M at 25°C. The solubility product constant is**
A. 2.9×10^{-14} B. 1.7×10^{-7} C. 3.4×10^{-7} D. 4.1×10^{-4}

136. I3 The solubility of barium fluoride is 3.6×10^{-3} M. **The solubility product constant is:**
A. 4.7×10^{-8} B. 1.9×10^{-7} C. 1.3×10^{-5} D. 2.6×10^{-5}

137. I3 **The solubility of MnS is 4.8×10^{-7} M, at 25°C. The K_{sp} value is**
A. 2.3×10^{-13} B. 4.8×10^{-7} C. 9.6×10^{-7} D. 6.9×10^{-4}

138. I3 **At 25°C, the solubility of an unknown compound is 7.1×10^{-5} M. The compound is**
A. CuI B. AgI C. $CaCO_3$ D. $CaSO_4$

139. I3 **The solubility of barium oxalate, BaC_2O_4 ,is 4.8×10^{-4} M. The value of K_{sp} is**
A. 2.3×10^{-7} B. 4.8×10^{-4} C. 2.4×10^{-4} D. 2.2×10^{-2}

140. I3 **The solubility of PbS is 2.9×10^{-14} M. What is the value of K_{sp} for PbS?**
A. 8.4×10^{-28} B. 2.9×10^{-14} C. 5.8×10^{-14} D. 1.7×10^{-7}

141. I3 **The solubility of FeF_2 is 8.4×10^{-3} M. The K_{sp} value is**
A. 5.9×10^{-7} B. 2.4×10^{-6} C. 7.1×10^{-5} D. 8.4×10^{-3}

142. I3 **The solubility of SnS is 3.2×10^{-3} M. The value of K_{sp} is**
A. 1.0×10^{-5} B. 3.2×10^{-3} C. 6.4×10^{-3} D. 5.7×10^{-2}

143. I3 The solubility of $Mn(IO_3)_2$ is 4.8×10^{-3} M. What is the value of K_{sp} ?
A. 1.1×10^{-7} B. 4.4×10^{-7} C. 7.1×10^{-6} D. 1.1×10^{-1}

144. I4 How many moles of solute are dissolved in 200.0 mL of a saturated solution of FeS?

A. 1.2×10^{-19}
B. 6.0×10^{-19}
C. 1.5×10^{-10}
D. 7.7×10^{-10}

145. I4 **The solubility of magnesium carbonate is:**
A. 4.6×10^{-11} M B. 3.4×10^{-6} M C. 6.8×10^{-6} M D. 2.6×10^{-3} M

146. I4 **The molar solubility of iron(II) sulphide is**
A. 3.6×10^{-37} M B. 3.0×10^{-19} M C. 6.0×10^{-19} M D. 7.7×10^{-10} M

147. I4 **At 25°C, the solubility of $Mg(OH)_2$ is**
A. 1.1×10^{-32} M B. 5.6×10^{-12} M C. 2.4×10^{-6} M D. 1.1×10^{-4} M

148. I4 **The solubility of $AgBrO_3$ is**
A. 2.8×10^{-9} M B. 5.3×10^{-5} M C. 1.1×10^{-4} M D. 7.3×10^{-3} M

149. I4 The relationship between the solubility of SrF_2 and its K_{sp} is

A. solubility $= \frac{\sqrt[3]{K_{sp}}}{4}$
B. solubility $= \sqrt[3]{\frac{K_{sp}}{2}}$
C. solubility $= \sqrt[3]{\frac{K_{sp}}{4}}$
D. solubility $= \sqrt{K_{sp}}$

150. I4 **The solubility of $MgCO_3$ is**
A. 4.6×10^{-11} M B. 6.8×10^{-6} M C. 1.4×10^{-5} M D. 2.6×10^{-3} M

151. I4 **At 25° C, the solubility of AgBr is**
A. 2.9×10^{-25} M B. 5.4×10^{-13} M C. 2.7×10^{-13} M D. 7.3×10^{-7} M

152. I4 **The solubility of SrF_2 is**
A. 4.3 x10^{-9} M B. 6.6 x10^{-5} M C. 1.0 x10^{-3} M D. 1.6 x10^{-3} M

153. I5 In an experiment, a student mixes equal volumes of 0.0020 M Pb^{2+} ions with 0.0040 M I^- ions. **The trial ion product is**
A. 4.0×10^{-9} B. 3.2×10^{-8} C. 1.3×10^{-7} D. 8.0×10^{-6}

154. I5 When **equal volumes** of 0.060 M $AgNO_3$ and 0.00090 M $NaBrO_3$ are mixed, the trial ion product (TIP) is
A. less than K_{sp} and a precipitate forms. B. greater than K_{sp} and a precipitate forms.
C. less than K_{sp} and no precipitate forms. D. greater than K_{sp} and no precipitate forms.

155. I5 In an experiment, 20.0 mL of 0.0060 M $CaCl_2$ and 20.0 mL of 0.0050 M Na_2SO_4 are mixed together. The trial ion product $\left(\text{trial } K_{sp}\right)$ is

A. 7.5×10^{-6} and a precipitate will form.
B. 7.5×10^{-6} and a precipitate will not form.
C. 3.0×10^{-5} and a precipitate will form.
D. 3.0×10^{-5} and a precipitate will not form.

156. I5 **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*

157. I5 When solutions of $Pb(NO_3)_2$ and NaCl are mixed, the trial ion product (Trial K_{sp}) is 9.8x10^{-6} .
Which of the following statements is true?
A. A precipitate forms because K*sp* > 9.8 ×10 $^{-6}$
B. A precipitate forms because K*sp* < 9.8 ×10 $^{-6}$
C. A precipitate does not form because K*sp* < 9.8 ×10 $^{-6}$
D. A precipitate does not form because K*sp* > 9.8 ×10 $^{-6}$

158. I5 **When equal volumes of 0.20M $Pb(NO_3)_2$ 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}

159. I5 **If the Trial Ion Product for $AgBrO_3$ is calculated to be 1.0×10^{-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}

160. I5 When equal volumes of 0. 20 M $Ca(NO_3)_2$ and 0.20 M Na_2SO_4 are combined,
A. a precipitate forms because Trial Ion Product > K_{sp}
B. a precipitate forms because Trial Ion Product < K_{sp}
C. no precipitate forms because Trial Ion Product > K_{sp}
D. no precipitate forms because Trial Ion Product < K_{sp}

161. I6 What is the maximum amount of sodium sulphate, Na_2SO_4, that will dissolve in 1.0 L of 0.10 M $Pb(NO_3)_2$ without forming a precipitate?

A. 1.8×10^{-8} mol
B. 1.8×10^{-7} mol
C. 1.3×10^{-4} mol
D. 1.0×10^{-1} mol

162. I6 **What is the maximum $[Sr^{2+}]$ that can exist in a solution of 0.10 M Na_2SO_4 ?**
A. 3.4×10^{-7} M B. 3.4×10^{-6} M C. 1.7×10^{-6} M D. 5.8×10^{-4} M

163. I6 **What is the maximum $[Ag^+]$ that can exist in 0. 20M $NaBrO_3$?**
A. 1.1×10^{-5} M B. 5.3×10^{-5} M C. 2.6×10^{-5} M D. 7.3×10^{-3} M

164. I6 **At 25° C, the maximum $[Zn^{2+}]$ that can exist in 0.250 M Na_2S is**
A. 5.0×10^{-26} M B. 2.0×10^{-25} M C. 8.0×10^{-25} M D. 4.5×10^{-13} M

165. I6 The maximum $[SO_4^{2-}]$ that can exist in 1.0×10^{-3} M $Ca(NO_3)_2$ without a precipitate forming is
A. 7.1×10^{-5} M B. 1.0×10^{-3} M C. 8.4×10^{-3} M D. 7.1×10^{-2} M

166. I6 **Solid $NaBrO_3$ is added to a 0. 010 M Ag + solution. What is the $[BrO_3^-]$ when a precipitate first forms?**
A. 2.8×10^{-9} M B. 5.3×10^{-7} M C. 5.3×10^{-3} M D. 1.0×10^{-2} M

167. I7 The $\left[SO_4^{2-}\right]$ in a saturated solution of $PbSO_4$ is

$$\left(K_{sp} = 1.1 \times 10^{-8}\right)$$

A. 1.2×10^{-16} M
B. 5.5×10^{-9} M
C. 1.1×10^{-8} M
D. 1.0×10^{-4} M

168. I7 The $\left[OH^-\right]$ is measured to be 3.3×10^{-3} mol/L in a 100 mL sample of a saturated solution of $Al(OH)_3$. The solubility of $Al(OH)_3$ is

A. 1.1×10^{-4} mol/L
B. 3.3×10^{-4} mol/L
C. 1.1×10^{-3} mol/L
D. 3.3×10^{-3} mol/L

169. I7 A student titrates a 25.00 mL sample of well water with 18.2 mL 0.100 M $AgNO_3$ to completely precipitate the chloride ion. The $\left[Cl^-\right]$ is

A. 1.82×10^{-3} M
B. 7.28×10^{-2} M
C. 1.37×10^{-1} M
D. 1.50×10^{-1} M

ANSWER KEY:

CONCEPT OF SOLUBILITY:

1.	C	13.	C	25.	D
2.	C	14.	B	26.	D
3.	A	15.	B	27.	C
4.	C	16.	D	28.	B
5.	C	17.	A	29.	D
6.	C	18.	B	30.	D
7.	B	19.	B	31.	C
8.	B	20.	D	32.	C
9.	B	21.	A	33.	A
10.	A	22.	A	34.	A
11.	A	23.	D	35.	D
12.	C	24.	B	36.	C

SOLUBILITY AND PRECIPITATION:

37.	B	53.	D	69.	B	85.	C	101.	A
38.	A	54.	C	70.	D	86.	A	102.	A
39.	C	55.	B	71.	D	87.	D	103.	D
40.	B	56.	B	72.	B	88.	D	104.	B
41.	A	57.	C	73.	D	89.	A	105.	B
42.	A	58.	D	74.	D	90.	B	106.	C
43.	C	59.	A	75.	A	91.	C	107.	A
44.	A	60.	D	76.	B	92.	D	108.	C
45.	C	61.	B	77.	D	93.	D	109.	C
46.	B	62.	A	78.	D	94.	D	110.	B
47.	C	63.	B	79.	D	95.	C	111.	B
48.	C	64.	A	80.	A	96.	A	112.	C
49.	D	65.	B	81.	A	97.	C	113.	B
50.	A	66.	A	82.	B	98.	B	114.	D
51.	D	67.	A	83.	A	99.	D	115.	B
52.	D	68.	B	84.	B	100.	A	116.	B

117. B | 118. B | 119. C

QUANTITATIVE ASPECTS:

120. D
121. D
122. B
123. A
124. A
125. C
126. B
127. B
128. D
129. A
130. C
131. B
132. B
133. B
134. A
135. A
136. B
137. A
138. C
139. A
140. A
141. B
142. A
143. B
144. C
145. D
146. D
147. D
148. D
149. C
150. D
151. D
152. C
153. A
154. C
155. B
156. B
157. D
158. A
159. D
160. A
161. B
162. B
163. C
164. C
165. D
166. C
167. D
168. C
169. B