Solution Review

1. How many moles of KNO_3 are required to make 0.50 liter of a 2.0 M solution of KNO_3?

   1) 1.0

   2) 2.0

   3) 0.50

   4) 4.0

2. In an aqueous solution of potassium chloride, the solute is

   1) Cl

   2) K

   3) KCl

   4) H_2O

3. How many grams of ammonium chloride (gram formula mass = 53.5 g) are contained in 0.500 L of a 2.00 M solution?

   1) 10.0 g

   2) 26.5 g

   3) 53.5 g

   4) 107 g

4. Based on Reference Table G, when 100 grams of water saturated with KNO_3 at 70°C is cooled to 25°C, the total number of grams of KNO_3 that will precipitate is

   1) 40

   2) 45

   3) 80

   4) 95

5. As the pressure on a gas confined above a liquid increases, the solubility of the gas in the liquid

   1) decreases

   2) increases

   3) remains the same

6. A 0.100-molal aqueous solution of which compound has the *lowest* freezing point?

   1) $C_6H_{12}O_6$

   2) CH_3OH

   3) $C_{12}H_{22}O_{11}$

   4) NaOH

7. According to Reference Table *G*, how many grams of KNO_3 would be needed to saturate 200 grams of water at 70ºC?

   1) 43 g

   2) 86 g

   3) 134 g

   4) 268 g

8. According to your Reference Tables, which substance forms an unsaturated solution when 80 grams of the substance is dissolved in 100 grams of H_2O at 10°C?

   1) KI

   2) KNO_3

   3) $NaNO_3$

   4) NaCl

9. What is the total mass of solute in 1000. grams of a solution having a concentration of 5 parts per million?

   1) 0.005 g

   2) 0.05g

   3) 0.5 g

   4) 5g

10. A 1 kilogram sample of water will have the highest freezing point when it contains

    1) 1×10^{17} dissolved particles

    2) 1×10^{19} dissolved particles

    3) 1×10^{21} dissolved particles

    4) 1×10^{23} dissolved particles

11. What is the concentration expressed in parts per million of a solution containing 15.0 grams of KNO_3 in 65.0 grams of H_2O?

    1) 1.88×10^5 ppm

    2) 2.00×10^5 ppm

    3) 2.31×10^5 ppm

    4) 5.33×10^6 ppm

12. Based on Reference Table *F*, which of these saturated solutions has the lowest concentration of dissolved ions?

    1) NaCl(aq)

    2) $MgCl_2$(aq)

    3) $NiCl_2$(aq)

    4) AgCl(aq)

13. What is the total number of grams of NaI(s) needed to make 1.0 liter of a 0.010 M solution?

    1) 0.015

    2) 0.15

    3) 1.5

    4) 15

14. The solubility of $KClO_3$(s) in water increases as the

    1) temperature of the solution increases

    2) temperature of the solution decreases

    3) pressure on the solution increases

    4) pressure on the solution decreases

15. According to Reference Table *G*, which of these substances is most soluble at 60°C?

    1) NaCl

    2) KCl

    3) $KClO_3$

    4) NH_4Cl

16. A 2.0-molal sugar solution has approximately the same freezing point as a 1.0-molal solution of

    1) $CaCl_2$

    2) CH_3COOH

    3) C_2H_5OH

    4) NaCl

17. Which saturated solution would be the most dilute at 0°C?

    1) KI

    2) NaCI

    3) $NaNO_3$

    4) $KClO_3$

18. When an equilibrium exists between the dissolved and the undissolved solute in a solution, the solution must be

    1) diluted

    2) saturated

    3) supersaturated

    4) unsaturated

19. According to Reference Table G, which solution is saturated at 30°C?

    1) 12 grams of $KClO_3$ in 100 grams of water

    2) 12 grams of $KClO_3$ in 200 grams of water

    3) 30 grams of NaCl in 100 grams of water

    4) 30 grams of NaCl in 200 grams of water

20. How do the boiling point and freezing point of a solution of water and calcium chloride at standard pressure compare to the boiling point and freezing point of water at standard pressure?

    1) Both the freezing point and boiling point of the solution are higher.

    2) Both the freezing point and boiling point of the solution are lower.

    3) The freezing point of the solution is higher and the boiling point of the solution is lower.

    4) The freezing point of the solution is lower and the boiling point of the solution is higher.

21. A student obtained the following data in a chemistry laboratory.

Trial	Temperature (°C)	Solubility (grams of KNO_3/100 g of H_2O)
1	25	40
2	32	50
3	43	70
4	48	60

    Based on Reference Table *g*, which of the trials seems to be in error?

    1) 1

    2) 2

    3) 3

    4) 4

22. If 0.50 liters of a 2.0M HCl is diluted with H_2O to a volume of 1.0 liters, the molarity of the new solution will be

    1) 1.0 M

    2) 2.0 M

    3) .25 M

    4) .50 M

23. Which ion, when combined with chloride ions, Cl^-, forms an insoluble substance in water?

    1) Fe^{2+}

    2) Mg^{2+}

    3) Pb^{2+}

    4) Zn^{2+}

24. A solution contains 70 grams of $NaNO_3$ in 100 grams of water at 10ºC. How many additional grams of $NaNO_3$ are required to saturate this solution?

    1) 10

    2) 20

    3) 60

    4) 70

25. A solution containing 60. grams of $NaNO_3$ completely dissolved in 50. grams of water at 50ºC is classified as being

    1) saturated

    2) supersaturated

    3) dilute and unsaturated

    4) dilute and saturated

26. Under which conditions of temperature and pressure is a gas most soluble in water?

    1) high temperature and low pressure

    2) high temperature and high pressure

    3) low temperature and low pressure

    4) low temperature and high pressure

27. How many liters of a 0.5 M sodium hydroxide solution would contain 2 moles of solute?

    1) 1 L

    2) 2 L

    3) 3 L

    4) 4 L

28. Based on Reference Table G, which salt solution could contain 42 grams of solute per 100 grams of water at 40ºC?

    1) a saturated solution of $KClO_3$

    2) a saturated solution of KCl

    3) an unsaturated solution of NaCl

    4) an unsaturated solution of NH_4Cl

29. One hundred grams of water is saturated with NH_4Cl at 50°C. According to Table *G*, if the temperature is lowered to 10°C, what is the total amount of NH_4Cl that will precipitate?

    1) 5.0 g

    2) 17 g

    3) 30. g

    4) 50. g

30. Which expression represents the solubility product constant, K_{sp}, of AgCl(s)?

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

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

    3) $K_{sp} = \frac{[Ag^+]}{[Cl^-]}$

    4) $K_{sp} = \frac{[Cl^-]}{[Ag^+]}$

31. Given the equilibrium reaction:

    $AgCl(s) \leftrightarrow Ag^+(aq) + Cl^-(aq)$

    At 25ºC, the K_{sp} is equal to

    1) 6.0×10^{-23}

    2) 1.8×10^{-10}

    3) 1.0×10^{-7}

    4) 9.6×10^{-4}

Solution Review

32. A student prepares four aqueous solutions, each with a different solute. The mass of each dissolved solute is shown in the table below.

Mass of Dissolved Solute for Four Aqueous Solutions

Solution Number	Solute	Mass of Dissolved Solute (per 100. g of H_2O at 20.°C)
1	KI	120. g
2	$NaNO_3$	88 g
3	KCl	25 g
4	$KClO_3$	5 g

Which solution is saturated?

1) 1

2) 2

3) 3

4) 4

33. An unsaturated solution is formed when 80. grams of a salt is dissolved in 100. grams of water at 40.°C. This salt could be

1) KC1

2) KNO_3

3) NaC1

4) $NaNO_3$

34. At which temperature can water contain the most dissolved oxygen at a pressure of 1 atmosphere?

1) 10.ºC

2) 20.ºC

3) 30.ºC

4) 40.ºC

35. What is the concentration expressed in parts per million of a solution containing 30.0 grams of $NaNO_3$ in 70.0 grams of H_2O?

1) 2.33×10^6 ppm

2) 4.29×10^5 ppm

3) 3.00×10^5 ppm

4) 3.33×10^6 ppm

36. What is the concentration of a solution which contains 1 mole of $CaCl_2$ dissolved in 2,000 milliliters of solution?

1) 1 M

2) 2 M

3) 0.5 M

4) 0.25 M

37. If 20. milliliters of a 1.0 M solution of HCl is exactly neutralized by 40. milliliters of NaOH, the molarity of the NaOH solution is

1) 1.0 M

2) 2.0 M

3) 0.50 M

4) 4.0 M

38. Solubility data for four different salts in water at 60°C are shown in the table below.

Salt	Solubility in Water at 60°C
A	10 grams / 50 grams H_2O
B	20 grams / 60 grams H_2O
C	30 grams / 120 grams H_2O
D	40 grams/ 80 grams H_2O

Which salt is most soluble at 60°C?

1) *A*

2) *B*

3) *C*

4) *D*

39. According to Reference Table F, which compound is most soluble in water?

1) $BaCO_3$

2) $BaSO_4$

3) $ZnCO_3$

4) $ZnSO_4$

40. According to Reference Table F, which substance is most soluble?

1) AgI

2) $CaSO_4$

3) $PbCl_2$

4) $(NH_4)_2CO_3$

41. What is the concentration of $O_2(g)$, in parts per million, in a solution that contains 0.008 gram of $O_2(g)$ dissolved in 1000. grams of $H_2O(l)$?

1) 0.8 ppm

2) 8 ppm

3) 80 ppm

4) 800 ppm

42. Which K_{sp} value indicates a salt with the greatest solubility in water?

1) 1.0×10^{-4}

2) 2.0×10^{-6}

3) 3.0×10^{-8}

4) 4.0×10^{-10}

43. Which compound is *least* soluble in 100 grams of water at 40°C?

1) SO_2

2) NaCl

3) $KClO_3$

4) NH_4Cl

44. What is the total number of moles of solute in 250 milliliters of a 1.0 M solution of NaCl?

1) 1.0 mole
2) 0.25 mole
3) 0.50 mole
4) 42 moles

45. How many moles of solute would 3 liters of a 2-molar solution contain?

1) 1
2) 2
3) 3
4) 6

46. When 20. milliliters of 1.0 M HCl is diluted to a total volume of 60. milliliters, the concentration of the resulting solution is

1) 1.0 M
2) 0.50 M
3) 0.33 M
4) 0.25 M

47. At STP, which of these substances is most soluble in H_2O?

1) CCl_4
2) CO_2
3) HCl
4) N_2

48. According to Reference Table G, approximately how many grams of $KClO_3$ are needed to saturate 100 grams of H_2O at 40°C?

1) 6
2) 16
3) 38
4) 47

49. The molarity (M) of a solution is equal to the

1) $\frac{\text{number of grams of solute}}{\text{liter of solvent}}$
2) $\frac{\text{number of grams of solute}}{\text{liter of solution}}$
3) $\frac{\text{number of moles of solute}}{\text{liter of solvent}}$
4) $\frac{\text{number of moles of solute}}{\text{liter of solution}}$

50. Given the K_{sp} expression: $K_{sp} = [A^{3+}]^2 [B^{2-}]^3$
Which reaction is represented by the expression?

1) $A_2B_3(s) \leftrightarrow 3\ A^{3+}(aq) + 2\ B^{2-}(aq)$
2) $A_2B_3(s) \leftrightarrow 2\ A^{3+}(aq) + 3\ B^{2-}(aq)$
3) $A_3B_2(s) \leftrightarrow 3\ A^{3+}(aq) + 2\ B^{2-}(aq)$
4) $A_3B_2(s) \leftrightarrow 2\ A^{3+}(aq) + 3\ B^{2-}(aq)$

51. Base your answer to the following question on the information below.

Given the equation for the dissolving of sodium chloride in water:

$$NaCl(s) \xrightarrow{H_2O} Na^+(aq) + Cl^-(aq)$$

Describe what happens to entropy during this dissolving process.

_____

Solution Review

Base your answers to questions **52** and **53** on the information below.

A student is instructed to make 0.250 liter of a 0.200 M aqueous solution of $Ca(NO_3)_2$.

52. In order to prepare the described solution in the laboratory, two quantities must be measured accurately. One of these quantities is the volume of the solution. What other quantity must be measured to prepare this solution?

_____

53. Show a correct numerical setup for calculating the total number of moles of $Ca(NO_3)_2$ needed to make 0.250 liter of the 0.200 M calcium nitrate solution.

_____

_____

Base your answers to questions **54** and **55** on the information below.

A student uses 200 grams of water at a temperature of 60°C to prepare a saturated solution of potassium chloride, KCl.

54. This solution is cooled to 10°C and the excess KCl precipitates (settles out). The resulting solution is saturated at 10°C. How many grams of KCl precipitated out of the original solution?

_____

55. According to Reference Table *G*, how many grams of KCl must be used to create this saturated solution?

_____

_____

56. Base your answers to the following questions on the information below.

Often special effects technicians at rock concerts use solid carbon dioxide, "dry ice", to create a fog-like appearance on stage. The solid carbon dioxide (CO_2) undergoes a phase change directly to the gaseous state, absorbing energy from the surrounding air.

a Write the equation showing the phase change process undergone by the $CO_2(s)$. Include the energy term.

b Is this phase change of CO_2 exothermic or endothermic?

c What is the name of the process where a solid goes directly to a gas?

_____

57. At equilibrium, nitrogen, hydrogen, and ammonia gases form a mixture in a sealed container. The data table below gives some characteristics of these substances.

Data Table

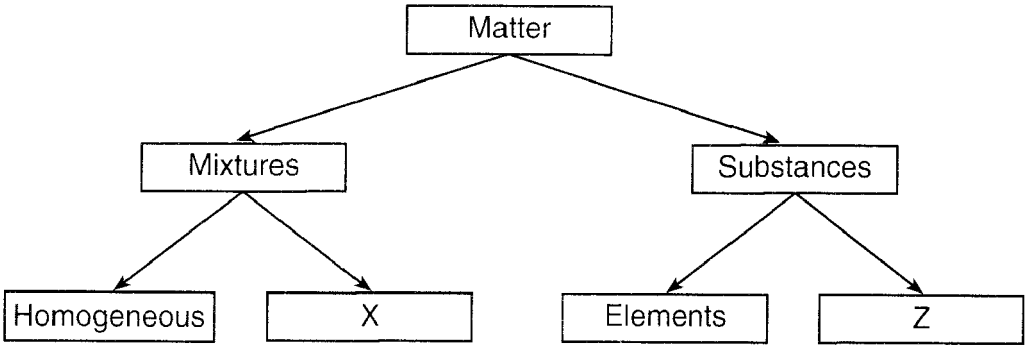
Gas	Boiling Point	Melting Point	Solubility in Water
Nitrogen	–196°C	–210°C	insoluble
Hydrogen	–252°C	–259°C	insoluble
Ammonia	–33°C	–78°C	soluble

Describe how to separate ammonia from hydrogen and nitrogen.

58. An unknown solid salt is dissolved in water to form a solution. Describe one *physical* and one *chemical* way that the salt could be separated from the water?

59. Base your answer to the following question on the diagram below concerning the classification of matter.

Classification of Matter



Given a mixture of sand and water, state *one* process that can be used to separate water from the sand.

60. Base your answer to the following question on the information below.

A soft-drink bottling plant makes a colorless, slightly acidic carbonated beverage called soda water. During production of the beverage, $CO_2(g)$ is dissolved in water at a pressure greater than 1 atmosphere. The bottle containing the solution is capped to maintain that pressure above the solution. As soon as the bottle is opened, fizzing occurs due to $CO_2(g)$ being released from the solution.

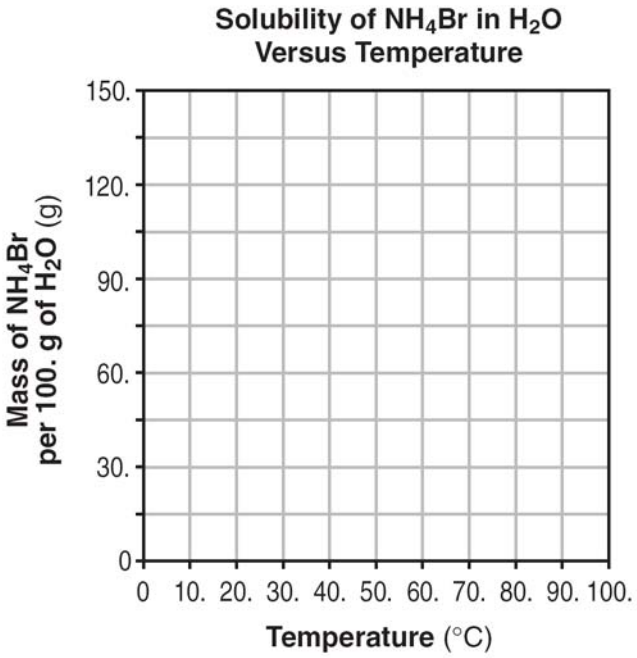
State the relationship between, the solubility of $CO_2(g)$ in water and the temperature of the aqueous solution.

61. Base your answer to the following question on the information below.

The compounds $NH_4Br(s)$ and $NH_3(g)$ are soluble in water. Solubility data for $NH_4Br(s)$ in water are listed in the table below.

Solubility of NH_4Br in H_2O

Temperature (°C)	Mass of NH_4Br per 100. g of H_2O (g)
0	60.
20.	75
40.	90.
60.	105
80.	120.
100.	135



Determine the total mass of $NH_4Br(s)$ that must be dissolved in 200. grams of H_2O at 60.°C to produce a saturated solution.

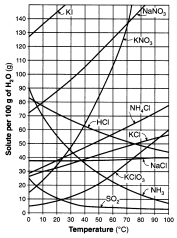
62. An aqueous solution contains 300. parts per million of KOH. Determine the number of grams of KOH present in 1000. grams of this solution.

Reference Tables

Symbol	Name	Quantity
m	meter	length
kg	kilogram	mass
Pa	pascal	pressure
K	kelvin	temperature
mol	mole	amount of substance
J	joule	energy, work, quantity of heat
s	second	time
L	liter	volume
ppm	part per million	concentration
M	molarity	solution concentration

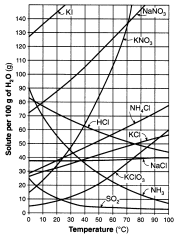
Reference Tables

Table G Solubility Curves



Reference Tables

Table G Solubility Curves



Reference Tables

Indicator	Approximate pH Range for Color Change	Color Change
methyl orange	3.2–4.4	red to yellow
bromthymol blue	6.0–7.6	yellow to blue
phenolphthalein	8.3–10	colorless to pink
litmus	5.5–8.2	red to blue
bromcresol green	3.8–5.4	yellow to blue
thymol blue	8.0–9.6	yellow to blue

Reference Tables

Table E
Selected Polyatomic Ions

H_3O^+	hydronium	CrO_4^{2-}	chromate
Hg_2^{2+}	dimercury (I)	$Cr_2O_7^{2-}$	dichromate
NH_4^+	ammonium	MnO_4^-	permanganate
$C_2H_3O_2^-$ or CH_3COO^-	acetate	NO_2^-	nitrite
		NO_3^-	nitrate
CN^-	cyanide	O_2^{2-}	peroxide
CO_3^{2-}	carbonate	OH^-	hydroxide
HCO_3^-	hydrogen carbonate	PO_4^{3-}	phosphate
		SCN^-	thiocyanate
$C_2O_4^{2-}$	oxalate	SO_3^{2-}	sulfite
ClO^-	hypochlorite	SO_4^{2-}	sulfate
ClO_2^-	chlorite	HSO_4^-	hydrogen sulfate
ClO_3^-	chlorate	$S_2O_3^{2-}$	thiosulfate
ClO_4^-	perchlorate		

Solution Review
Answer Key
[New Exam]

1. 1
2. 3
3. 3
4. 4
5. 2
6. 4
7. 4
8. 1
9. 1
10. 1
11. 1
12. 4
13. 3
14. 1
15. 4
16. 4
17. 4
18. 2
19. 1
20. 4
21. 4
22. 1
23. 3
24. 1
25. 2
26. 4
27. 4
28. 4
29. 2
30. 1
31. 2
32. 2
33. 4
34. 1
35. 3
36. 3
37. 3
38. 4
39. 4
40. 4
41. 2
42. 1
43. 1
44. 2
45. 4
46. 3
47. 3
48. 2
49. 4
50. 2

51. Examples: –Entropy increases. –more entropy –Entropy changes.

52. Examples: – mass of $Ca(NO_3)_2$ – mass of solute – mass

53.
$$0.250\ \text{L}\left(\frac{0.200\ \text{mol}}{1\ \text{L}}\right)$$

$$0.2 = \frac{x}{0.25}$$

54. Allow credit for **30** (±2). *or* Allow credit for a response consistent with the student's answer to previous question.

55. Allow credit for **90** (±2).

56. a) $CO_2(s)$ + ENERGY $\rightarrow$ CO_2 (g) b) Endothermic c) Sublimation

57. Examples:
– Lower the temperature to condense ammonia.
– Place all three gases in water. Ammonia will dissolve (is soluble).
– distillation

58. *Physical:* Allow the water to evaporate (or distillation) leaving the substance behind. *Chemical*: React the solution with a substance that will remove the salt. *or* Use electrolysis to remove the positive and negative ions.

59. Examples: – Evaporate the water. – Decant the water. - filtration

60. The solubility of CO_2(g) decreases as the temperature of the solution increases; As temperature decreases, solubility of CO_2 increases.

61. 210. g

62. 0.300 g