BCI SCIENCE
SCH 3U

Solutions & Solubility
Practice Test

Name: **ANSWERS**

70/70

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question. (20 marks)

1. What term is associated with the part of a solution that is present in the smallest amount?
a. ionic compound
c. solute
b. covalent compound
d. solvent

2. A solution is saturated at $25°C$. It is then slowly cooled to $20°C$ with no change to the appearance of the liquid. What term would be associated with this solution?
a. saturated
c. supersaturated
b. unsaturated
d. oversaturated

3. Ice that contains a small amount of dissolved air is an example of what type of solution?
a. a liquid dissolved in a liquid
c. a solid dissolved in a gas
b. a gas dissolved in a liquid
d. a gas dissolved in a solid

4. A saturated solution is made by dissolving 36.8 g of a solid in 200 mL of water. A second solution is made by dissolving 19.1 g of the same solid in 100 mL of water. How would this solution be classified?
a. unsaturated
c. supersaturated
b. saturated
d. hypersaturated

5. Which of the following tests can be used to distinguish between an ionic solution and most molecular solutions?
a. pH measurement
c. test for saturation
b. solubility test
d. conductivity test

6. Which type(s) of molecule(s) are polar solvents more likely to be able to dissolve?
a. ionic molecules
c. polar and ionic molecules
b. polar molecules
d. ionic, polar and non-polar molecules

7. Which forces affect solubility?
a. intramolecular forces
c. hydrogen bonding
b. intermolecular forces
d. intramolecular and intermolecular forces

8. Which of the following is the least soluble in water?
a. lead(II) nitrate
c. lithium phosphate
b. magnesium sulfide
d. silver acetate

9. What is the ionic equation for the reaction of nitric acid with sodium hydroxide?
a. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
b. $H^+(aq) + NO_3^-(aq) + Na^+(aq) + OH^-(aq) \rightarrow NaNO_3(aq) + H_2O(l)$
c. $H^+(aq) + NO_3^-(aq) + Na^+(aq) + OH^-(aq) \rightarrow Na^+(aq) + NO_3^-(aq) + H_2O(l)$
d. $H^+(aq) + NO_3^-(aq) + Na^+(aq) + OH^-(aq) \rightarrow$ no reaction

10. What can be added to a solution containing $Pb^{+2}(aq)$ ions to precipitate the ions from the solution?
a. lithium chloride
c. sodium acetate
b. potassium hydroxide
d. Two of the above are correct

11. Which solution will contain the higher concentration of iodide ions?

0.25 mol/L calcium iodide or 0.45 mol/L potassium iodide

a. potassium iodide
b. calcium iodide
c. They contain the same concentration of iodide ions.
d. This must be determined experimentally.

12. Which of the following expressions best describes the term *net ionic equation*?

a. an equation where all reactants and products are ions
b. an equation listing all ions that are not spectator ions
c. an equation where soluble substances are written in dissociated form
d. an equation where only products are written in dissociated form

13. When 325 mL of a lead(II) nitrate solution of unknown concentration had an excess of sodium chloride added, 6.34 g of solid was filtered out of the solution. What was the molar concentration of the lead(II) nitrate solution?

a. 0.035 mol/L
b. 0.70 mol/L
c. 0.070 mol/L
d. 0.080 mol/L

14. What property allows a compound to be classified as an Arrhenius acid?

a. the production of water in a chemical reaction
b. the release of hydroxide ions in a water solution
c. the release of release hydrogen ions in a water solution
d. the neutralization of a base

15. Which of the following is the best description of an acid-base indicator?

a. a substance that indicates the pH of a solution
b. a substance that changes colour beyond a threshold pH level
c. a substance that is colourless in one solution but has a colour in the other
d. a substance that has one colour in one solution but a different colour in the other

16. What is *true* of the pH of a solution that is an Arrhenius acid?

a. the solution will have a pH that is less than 5
b. the solution will have a pH that is less than 7
c. the solution will have a pH that is more than 5
d. the solution will have a pH that is more than 7

17. Which of the following best describes a weak base?

a. a base that is not very strong
b. a dilute strong base
c. a base with a very low concentration
d. a base that dissociates very slightly in a water solution

18. Which of the following best describes the term *end point*?

a. the point at which the amount of titrant is slightly less than the amount of reactant in the sample
b. the point at which the amount of titrant is slightly larger than the amount of reactant in the sample
c. the point at which the amount of titrant is enough to react with all of the reactant in the sample
d. the point at which the indicator in a titration changes colour

19. What is the resulting pH of a solution that forms when 15.00 mL of a 0.150 mol/L hydrochloric acid solution combined with 10.00 mL of a 0.150 mol/L sodium hydroxide solution?

a. greater than 7
b. less than 7
c. equal to 7
d. the pH must be determined experimentally

20. 18.35 g of magnesium hydroxide are added to 0.75 L of 2.25 mol/L hydrochloric acid. What is best description of the pH of the resulting solution?

a. the pH is just over 7
b. the pH is well under 7
c. the pH is well over 7
d. the pH is 7

Short Answer and Calculations: *Answer the questions you can do the best on **FIRST**! Only work on the **Foolscap** will be marked. For each question, show **ALL** your work if you want part marks.*

50/50

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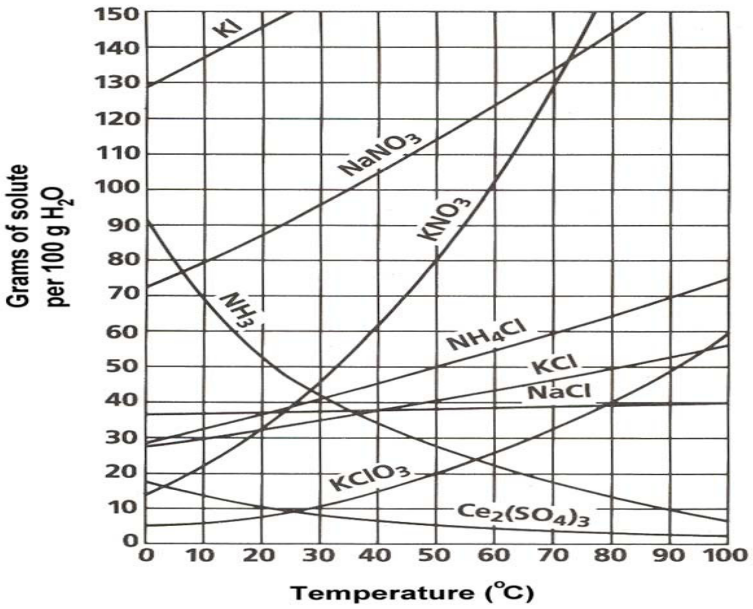
21. Answer the following questions based on the solubility curve below. (5)



a) Which compound is the most soluble at 10°C? **KI**
b) Which compounds show a *decrease* in solubility from 0°C to 100°C? **NH_3**
c) If $KClO_3$ is cooled from 90°C to 60°C how much precipitate, in grams, is expected? **24 g**
d) A saturated solution of NH_4Cl is formed from one hundred grams of water. If the saturated solution is cooled from 80°C to 40°C, how many grams of precipitate are formed? **20 g**
e) How much of 30 g of $Ce_2(SO_3)_3$ will dissolve and how much will remain undissolved at the bottom of the test tube in 100 g of water at 10°C? **6 g dissolved, 24 g undissolved**

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22. A solution has a concentration of copper(II) sulfate that is 0.25 mol/L. What mass of sulfate ions would be present in 225 mL of the solution? **(5)**

✓**$CuSO_{4(aq)} \rightarrow Cu^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)}$**

✓**n = CV**
= (0.25M)(0.225L)
✓ **= 0.05625 mol $CuSO_4$**

✓$\frac{1 mol CuSO4}{0.05625 mol} = \frac{1 mol SO_4^{2-}}{x}$
✓**x = 0.05625 mol SO_4^{2-}**

✓**m=nM**
=(0.05625mol)(96.06g/mol)
✓**=5.40 g**

✓**Therefore 5.40 g of SO_4^{2-} would be present**

23. Cooper's pen metal is a solution made up of 50% m/m of copper, 25% m/m of gold, and 25% m/m of silver.

a. Which is the solvent in this solution? **(1) copper**

b. In a sample of 450 g of Cooper's pen metal, what is the mass of each component in the solution? **(5)**

✓ $m_{Cu} = \frac{m_{solution} m/m\%}{100}$ $m_{Au} = \frac{m_{solution} m/m\%}{100}$ $m_{Ag} = \frac{m_{solution} m/m\%}{100}$

$m_{Cu} = \frac{(450g)(50)}{(100)}$ $m_{Au} = \frac{(450g)(25)}{(100)}$ $m_{Ag} = \frac{(450g)(25)}{(100)}$

✓m_{Cu} = 225 g **✓m_{Au} = 112.5 g Au** **✓m_{Ag} = 112.5 g Ag**

✓Therefore Cooper's pen metal is 225 g Cu, 112.5 g Au, and 112.5 g Ag

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23. 77.5 g of lead(II) nitrate is dissolved in enough water to make a final volume of 375 mL. What is the molar concentration of the solution? **(5)**

✓ $n = \frac{m}{M}$ ✓ $C = \frac{n}{V}$ **✓Therefore $[Pb(NO_3)_2]$ is 0.624 M**

$n = \frac{77.5g}{331.2g/mol}$ $C = \frac{0.234mol}{0.375L}$

✓n = 0.234 mol $Pb(NO_3)_2$ **✓C = 0.624 M**

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25. A chemical reaction occurs when the following aqueous solutions are mixed: potassium dicrhromate and iron(II)sulfate. Write the balanced chemical equation. Then write the total ionic equation. Then write the net ionic equation. Then identify the spectator ions.

Balanced chemical equation: (2 marks)

$K_2Cr_2O_{7(aq)} + FeSO_{4(aq)} \rightarrow K_2SO_{4(aq)} + FeCr_2O_{7(s)}$

Total ionic equation: (1 mark)

$2K^{+1}_{(aq)} + Cr_2O_7^{2-}{}_{(aq)} + Fe^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow 2K^{+1}_{(aq)} + SO_4^{2-}{}_{(aq)} + FeCr_2O_{7(s)}$

Net ionic equation: (1 mark)

$Fe^{2+}_{(aq)} + Cr_2O_7^{2-}{}_{(aq)} \rightarrow FeCr_2O_{7(s)}$

Spectator ions: (1 mark)

$K^{+1}_{(aq)}$ $SO_4^{2-}{}_{(aq)}$

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26. A titration is performed on a 25.0 mL sample of calcium hydroxide with a 0.15 mol/L solution of nitric acid. Using the results below, calculate the concentration of the calcium hydroxide. (10 marks)

TABLE 1. Titration of $Ca(OH)_2$ with 0.15M HNO_3

Volume of $Ca(OH)_2$ (mL)	$V_{initial}$ of HNO_3 (mL)	V_{final} of HNO_3 (mL)	V_{total} of HNO_3 (mL)
25.0 mL	0.3 mL	12.6 mL	**12.3**
25.0 mL	12.6 mL	25.0 mL	**12.4**
25.0 mL	25.0 mL	37.3 mL	**12.3**
			12.33 ✓

✓$Ca(OH)_{2(aq)} + 2HNO_{3(aq)} \rightarrow Ca(NO_3)_{2(aq)} + 2H_2O_{(l)}$

C = ? **C = 0.15 M** $\frac{2molHNO_3}{0.0018495mol} = \frac{1molCa(OH)_2}{x}$ ✓ $C = \frac{n}{V}$

V = 0.025L **V = 0.01233 L** **✓x = 0.00092475 mol $Ca(OH)_2$** $C = \frac{0.00092475mol}{0.025L}$

✓n_{HNO3} = CV **✓C = 0.037M**

= (0.15)(0.01233 **✓Therefore $[Ca(OH)_2]$ is 0.037M**

✓= 0.0018495 mol HNO_3

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27. 34.50 mL of a 2.54 mol/L calcium nitrate solution is added to 47.53 mL of a 1.95 mol/L sodium sulfate solution. Find the mass of calcium sulfate that is expected to precipitate in this process. **(10)**

✓$Ca(NO_3)_{2(aq)} + Na_2SO_{4(aq)} \rightarrow CaSO_{4(s)} + 2NaNO_{3(aq)}$

C = 2.54M C = 1.95M C = ?

V = 0.0345L V = 0.04753L

✓n=CV n=CV

n=(2.54)(0.0345) n=(1.95)(0.04753) ✓m=nM

✓n=0.08763 mol ✓n=0.09267 mol m=(0.08763)(136.14)

✓$\frac{1molCa(NO_3)_2}{0.08763mol} = \frac{1molCaSO_4}{x}$ ✓$\frac{1molNa_2SO_4}{0.09267mol} = \frac{1molCaSO_4}{x}$ **✓m=11.93g**

✓x = 0.08763 mol $CaSO_4$ ✓x = 0.09267 mol ✓Therefore the mass of $CaSO_4$ is 11.93g

28. Determine the concentration of hydroxide ions in stomach acid, with a pH of 2.0 (5 marks)

✓pOH = 14-pH ✓ $[OH^-] = 10^{-pOH}$ ✓Therefore $[OH^-]$ is $1.0x10^{-12}M$

pOH = 14-2.0 $[OH^-] = 10^{-12}$

✓pOH = 12.0 ✓ $[OH^-] = 1.0 \times 10^{-12}M$