

Please read all the questions VERY carefully before answering. If you do not understand any question, please ask. Use the reverse side of the question paper as scratch. Use the periodic table and constant chart in the last page. No outside paper is allowed. Total points = 46+(30x3)=90=136

SHORT ANSWER. Please write the set-up equation and insert the raw data with units in the equation before doing your calculations. Write the word or phrase that best completes each statement or answers the question.

- 1) At 20°C, an aqueous solution is 24.0% by mass in ammonium chloride (NH₄Cl) and the solution has a density of 1.0674 g/mL. What is the molarity (M) of NH₄Cl in the solution (8 pts.)? *assume has 100 g NH₄Cl solution.*

$$\text{mass of NH}_4\text{Cl} = 100\text{g} \times 24.0\% = 24\text{g}$$

$$V_{\text{NH}_4\text{Cl solution}} = \frac{100\text{g}}{1.0674\text{g/mL}} \times \frac{1\text{mL}}{1000\text{mL}} = 0.09369\text{L} = 0.0937\text{L}$$

$$M_{\text{NH}_4\text{Cl}} = \frac{24\text{g}}{0.0937\text{L}} \times \frac{1\text{mol}}{53.49\text{g/mol}} = 4.79\text{mol/L}$$

mass in soln
14.00
53.49 g/mol (MW of NH₄Cl)
0.0937 L
vol of NH₄Cl soln

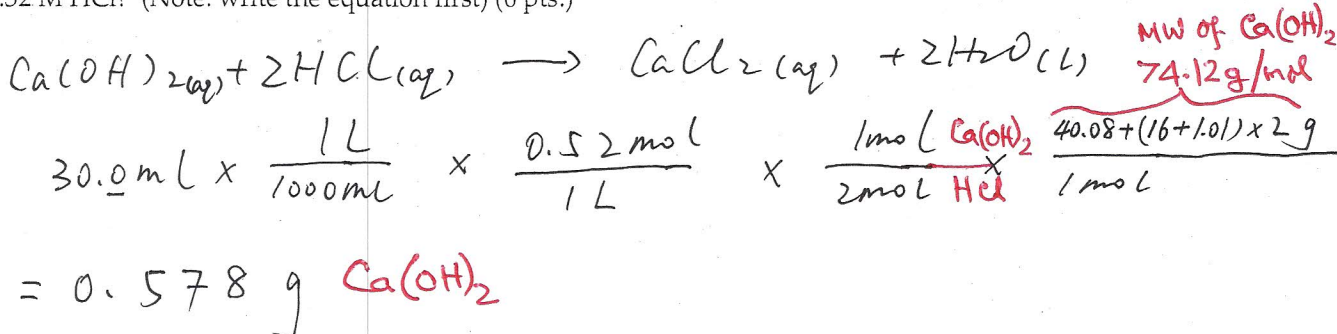
- 2) Calculate the molarity of a sulfuric acid (H₂SO₄) solution, when 1.178g of the acid is dissolved in water and diluted to a final volume of 25.0 mL. MW of H₂SO₄ = 98.1 g/mol (6 pts.)

$$1.178\text{g} \times \frac{1\text{mol}}{98.09\text{g}} \times \frac{1}{25.0\text{mL}} \times \frac{1000\text{mL}}{1\text{L}}$$

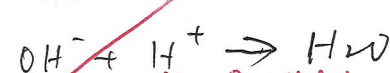
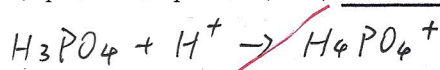
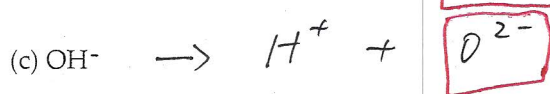
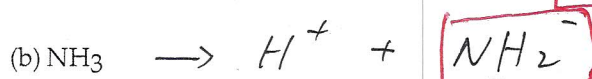
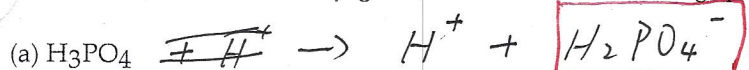
$$= 0.4804\text{mol/L}$$

$$\text{molar mass of H}_2\text{SO}_4 = 1.01 \times 2 + 32.07 + 16.00 \times 4 = 98.09\text{g/mol}$$

- 3) How many grams of Calcium hydroxide is needed to completely react with 30.0 mL of 0.52 M HCl? (Note: write the equation first) (6 pts.)



4) Write the formula of the conjugate base next to the following species (2 pts/each, 6 pts total) 4)



why this? Which are the conjugate bases then?

5) Calculate the pH of a solution where $[\text{OH}^-] = 3.0 \times 10^{-6} \text{ M}$. (6 pts.)

5) 8.8

$$[\text{H}^+] = \frac{10^{-14}}{3.0 \times 10^{-6} \text{ M}} = 3.3 \times 10^{-9} \text{ M}$$

$$= 3.33 \times 10^{-9} \text{ M}$$

$$\text{pH} = -\log(3.3 \times 10^{-9}) = 8.8$$

$$= 8.48$$

6) Calculate the mass in grams of $\text{K}_2\text{Cr}_2\text{O}_7$ is needed to make 250.0 mL of a 0.5 M $\text{K}_2\text{Cr}_2\text{O}_7$ solution (6 pts.)

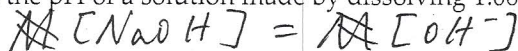
6) 36.78 g

$$250.0 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.5 \text{ mol}}{1 \text{ L}} \times \frac{\text{MW of } \text{K}_2\text{Cr}_2\text{O}_7 = 294.2 \text{ g/mol}}{(39.10 \times 2 + 52.00 \times 2 + 16.00 \times 7) \text{ g}}$$

$$= 36.78 \text{ g}$$

7) Calculate the pH of a solution made by dissolving 1.00 gram of NaOH in 300.00 mL water. (8 pts.)

7) 12.903



$$[\text{OH}^-] = 1 \text{ g} \times \frac{1 \text{ mol}}{(23.00 + 16.00 + 1.01) \text{ g}} \times \frac{1}{300.00 \text{ mL}} \times \frac{1000 \text{ mL}}{1 \text{ L}}$$

$$\text{MW of NaOH} = 40.01 \text{ g/mol}$$

$$= 0.083 \text{ M}$$

$$[\text{H}^+] = \frac{10^{-14}}{0.083 \text{ M}} = 1.25 \times 10^{-13}$$

$$= 1.2 \times 10^{-13}$$

$$\text{pH} = -\log(1.25 \times 10^{-13}) = 12.903$$

$$= 12.92$$

MULTIPLE CHOICE. On scantron, fill up the circles of the same number as that of the question number. Choose the one alternative that best completes the statement or answers the question. (3 points each)

8) Hexane, a nonpolar solvent, will dissolve which of the following substances?

- A) ammonium acetate
- B) oil
- C) vinegar (acetic acid)
- D) sodium chloride
- E) none of the above

8) B

9) Which of these compounds would you expect to be *least* soluble in water?

- A) NH_3
- B) CH_3OH
- C) NaCl
- D) N_2
- E) not enough information

9) D

10) In order for a solute to dissolve in solution:

- A) the solute-solvent forces must be greater than the solute-solute forces.
- B) the polarity of the solute and solvent must be opposite.
- C) the solute-solute forces must be greater than the solute-solvent forces.
- D) the solute-solvent forces must equal the solute-solute forces.
- E) none of the above

10) A

11) Which of the following compounds is a strong electrolyte?

- A) $\text{NaC}_2\text{H}_3\text{O}_2$
- B) NaCl
- C) HCl
- D) NH_4Cl
- E) all of the above

11) E

12) Which of the following substances is NOT a solution?

- A) soda
- B) homogenized milk
- C) bronze
- D) sea water
- E) All of the above are solutions.

12) E

13) The oxygen in the air we breath is classified as:

- A) the solvent in a simple mixture.
- B) the solvent in a homogeneous gas mixture.
- C) the solute in a heterogeneous gas-liquid mixture.
- D) the solute in a homogeneous gas mixture.
- E) none of the above

13) D

14) If the solubility of sodium chloride is 36 grams per 100 grams of water, which of the following solutions would be considered unsaturated?

14) C

- A) 3.25 moles of NaCl dissolved in 500 ml of water 6.5
 B) 1.85 moles of NaCl dissolved in 300 ml of water 6.2
 C) 5.8 moles of NaCl dissolved in 1 L of water 5.8
 D) none of the above

$$36g \times \frac{1 \text{ mol}}{58.45g} = 0.6159 \text{ mol/L}$$

$$100g \times \frac{1g}{19} = 5.26 \text{ g/mL}$$

15) The solubility of $\text{Pb}(\text{NO}_3)_2$ is 55 grams per 100 g H_2O at 20°C . Which term would properly describe a solution where 44 grams of $\text{Pb}(\text{NO}_3)_2$ is added to 100 grams of water at this temperature?

15) B

- A) supersaturated
 B) unsaturated
 C) saturated
 D) insoluble
 E) none of the above

16) Calculate the mass percent of a NaCl solution prepared by mixing 47.0 g NaCl with 125.0 mL of pure water.

16) A

- A) 27.3
 B) 47.0
 C) 72.3
 D) 37.6
 E) none of the above

$$\frac{47}{47 + 125g}$$

$$\rho = \frac{m}{v}$$

$$m = \rho v$$

$$1g/mL \times 125mL$$

17) How many moles of NaF are in 34.2 grams of a 45.5% by mass NaF solution?

17) A

- A) 0.371
 B) 75.2
 C) 0.814
 D) 15.6
 E) none of the above

$$34.2 - 45.5\% \times \frac{1 \text{ mol}}{23 + 19g}$$

18) A 90.0 g sample of NaOH is dissolved in water and the solution is diluted to give a final volume of 3.00 liters. The molarity of the final solution is _____.

18) C

- A) 0.500 M
 B) 2.25 M
 C) 0.750 M
 D) 1.00 M
 E) none of the above

$$90g \times \frac{1 \text{ mol}}{23 + 17.01g} \times \frac{1}{3L}$$

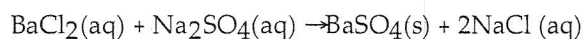
19) Which solution below contains the highest total quantity of dissolved sodium ions?

19) A

- A) 75.0 mL of 3.0 M Na_2SO_4 0.45
 B) 50.0 mL of 8.0 M NaOH 0.4
 C) 50.0 mL of 2.0 M Na_3PO_4 0.3
 D) 100. mL of 4.0 M NaCl 0.4
 E) none of the above

20) How many grams of barium sulfate are produced if 25.34 mL of 0.113 M BaCl₂ completely react given the reaction:

20) C



- A) 26.3
- B) 5.90
- C) 0.668
- D) 1039
- E) none of the above

$$0.02534 \text{ L} \times \frac{0.113 \text{ mol}}{1 \text{ L}} \times \frac{137.33 + 32.07 + 64}{1 \text{ mol}} = 2.63 \text{ g}$$

21) The solubility of gases in water:

21) A

- A) decreases with increasing temperature.
- B) increases with increasing temperature.
- C) is independent of temperature.
- D) gases are not soluble in water.
- E) none of the above

22) A 0.15 M solution of BaCl₂ contains:

22) A

- A) 0.15 M Ba²⁺ ions and 0.30 M Cl⁻ ions.
- B) 0.15 M Ba²⁺ ions and 0.15 M Cl⁻ ions.
- C) 0.30 M Ba²⁺ ions and 0.15 M Cl⁻ ions.
- D) 0.30 M Ba²⁺ ions and 0.30 M Cl⁻ ions.
- E) none of the above

23) Which of the following is NOT a property of bases?

23) B

- A) Bases turn litmus paper blue.
- B) Bases dissolve many metals.
- C) Bases have a bitter taste.
- D) Bases have a slippery feel.
- E) All of the above are properties of bases.

24) The Bronsted-Lowry definition of an acid is:

24) D

- A) produces H⁺ in solution.
- B) a proton acceptor.
- C) produces OH⁻ in solution.
- D) a proton donor.
- E) none of the above

25) Which solution below is considered to have basic character?

25) D

- A) pOH = 13
- B) pOH = 7
- C) pH = 2
- D) pOH = 4
- E) none of the above

pH 1
7
2
10

26) What is the $[H^+]$ in a solution that has a pH of 3.35?

- A) $4.5 \times 10^{-4} M$
- B) $3.35 \times 10^{-14} M$
- C) $2.2 \times 10^3 M$
- D) $1 \times 10^{3.35} M$
- E) none of the above

26) A

27) Substances that can act both as an acid and as a base are called:

- A) indicators.
- B) buffers.
- C) neutral.
- D) amphoteric.
- E) none of these

27) D

28) What is the pH of a solution that has a H^+ concentration equal to $1.7 \times 10^{-5} M$?

- A) 10.20
- B) 4.77
- C) 0.22
- D) 5.20
- E) none of the above

28) B

TRUE/FALSE. On scantron, choose "A" for a true answer and "B" for wrong answer. (3 points each)

29) A solution is a homogeneous mixture of two or more substances.

29) A

30) A sugar solution is an example of a weak electrolyte solution.

30) B

31) The minor component in a solution is called the solvent.

31) B

32) A saturated solution holds the maximum amount of solute under the solution conditions.

32) A

33) A Bronsted-Lowry acid is a proton donor.

33) A

34) An Arrhenius base is a proton acceptor.

34) B

35) Acids turn litmus paper blue.

35) B

36) The salt that forms due to neutralization of phosphoric acid by calcium hydroxide has the formula Ca_3P_2 .



36) B

37) H_2SO_3 and H_2SO_4 are considered an acid-base conjugate pair.

37) B