1. (10 pts). Select the main intermolecular force of attraction responsible for holding together each of the following substances in the state (solid, liquid or gas) indicated. The choices are (A) London dispersion (induced dipole-induced dipole); (B) dipole-dipole; (C) hydrogen bonding; (D) ion-ion (cation-anion); (E) none of the above.
2. \_C\_\_\_ Water (l)
3. \_\_A\_\_ Hexane, C6H14 (l)
4. \_\_E\_\_ Nitrogen, N2 (g)
5. \_\_D\_\_ Barium sulfate, BaSO4 (s)
6. \_\_B\_\_ Acetonitrile, CH3CN (l)
7. (10). A 25 mL sample of vinegar was exactly neutralized by 23.81 mL of 1.00 M NaOH. What is the molarity of the vinegar? What is the (m/v)% of the vinegar? (Vinegar is an aqueous solution of acetic acid, CH3COOH).

#moles NaOH = #moles acetic acid = 0.02381 x 1.00 = 0.02381 moles

Molarity of acetic acid = 0.02381/0.025 = 0.952 M

Wt of acetic acid per Liter = 0.952 mol/L x 60 g/mol = 57.1 g/L = 5.71 % (m/v)

1. (9). Give a PROPER name each of the following compounds.

AlF3 Aluminum fluoride (Group IIIA); H2S Hydrogen sulfide; (NH4)2CO3 Ammonium carbonate

1. (5). What is the molecular weight (to 2 significant figures) of a gas sample (0.20 L at 298 K and 1.00 atm) that weighs 0.589 g?

PV = nRT; wt/MW = PV/RT = 0.20L x 1 atm/0.082 L-atm/mol-K x 298 K = 0.008185 moles

MW = 0.589g/0.008185 mol = 71.96 ~ 72 g/mol

1. (5). True (T) or (F) False.
2. \_\_F\_\_\_The concentration of dissolved CO2 in the oceans of the world has increased over the last several decades, resulting in an increase in the pH of the ocean.
3. \_\_\_F\_\_Sodium chloride is a weak electrolyte in water.
4. \_\_\_F\_\_Molarity is defined as the number of moles of solute per liter of solvent.
5. \_\_\_F\_\_Dissolving sodium chloride in water lowers the boiling point of the solution.
6. \_F\_\_\_According to Henry’s Law, the concentration of a dissolved gas decreases with increasing external pressure.
7. (5). How many grams of solute are in 1.50 L of 0.20 M aqueous KOH?

1.5 L x 0.20 M = 0.30 moles; KOH formula weight = 56 g/mol; 0.30 x 56 = 16.8 g

1. (10). A. If the concentration of nitric acid, HNO3,in water is 15.0 g/L, what is the molarity?

HNO3 formula weight = 63 g/mol; 15.0/63 = 0.238 M.

B. What is the pH of a 0.0055 M solution of nitric acid?

Antilog 5.5 x 10-3 = 2.26.

1. (3). What is the formula of the conjugate base of H2PO4−?

HPO42-

1. (3). Consider the heat of fusion of solid sulfur, S(s) 🡪 S(l) and check ***one*** of the choices.
2. \_\_x\_\_The process is endothermic and ΔHfusion is positive.
3. \_\_\_\_The process is endothermic and ΔHfusionis negative.
4. \_\_\_\_The process is exothermic and ΔHfusion is positive.
5. \_\_\_\_The process is exothermic and ΔHfusion is negative.
6. (5). What is the pH of 0.0050 M NaOH?

pOH = antilog 5.0 x 10-3 = 2.30; pH = 14 – pOH = 11.70.

1. (9). Consider the acid-base reaction between nitrous acid (HONO) and sodium bicarbonate (NaHCO3).
2. Write the balanced equation for the reaction.

HONO(aq) + NaHCO3(aq) 🡪 NaNO2(aq) + H2CO3(aq)

1. Write the net ionic equation for the reaction.

HNO2(aq) + HCO3−(aq) 🡪 NO2−(aq) + H2CO3(aq)

1. Predict whether the equilibrium equation you wrote in part (a) favors the right hand side (RHS) or the left hand side (LHS). (See Appendix).

HONO is the stronger acid, therefore RHS is favored (stronger acid + stronger base 🡪 weaker acid + weaker base).

1. (5). What is the pH of a buffer solution of NH4Cl (0.20 M) and NH3 (0.10 M)? (Hint: What is the equation defining Ka?).

NH4+ + H2O 🡪 NH3 + H3O+

Ka = [NH3][ H3O+]/[ NH4+ ] = 5.6 x 10-10

[H3O+] = 5.6 x 10-10 x 0.20/0.10 = 1.12 x 10-9 ; pH = 8.95.

1. (4). Which aqueous solution has the lowest freezing point: \_\_\_\_\_\_0.5 M ethylene glycol (HOCH2CH2OH); \_\_\_\_\_0.5 M sodium chloride; or \_\_X\_\_\_0.5 M calcium chloride (CaCl2)?
2. (3). The roots of a Giant Sequoia tree take up water from the soil and transport it to the treetop, as much as 300 feet above ground level. What is the technical term for this process, also known as “root pressure”? OSMOSIS.
3. (5). One mole of any gas at STP occupies what volume?

V = nRT/P = 1 x 0.082 x 273/1 = 22.4 L

1. (5). If 1.5 L of nitrogen (N2) and 4.5 L of hydrogen (H2) at STP react to give ammonia (NH3) at STP, what volume of ammonia gas at STP is formed? (Hint: Write the balanced equation).

N2 + 3H2 🡪 2NH3

If 1L gives 2L, then 1.5 L gives 3L ammonia.

1. (4). Write the equation for the hydrolysis (reaction with water) of sodium acetate (NaOAc), the salt of a weak acid, in aqueous solution. (Net ionic is OK).

OAc− + H2O 🡪 HOAc + OH−

**Appendix**

R = 0.082 L-atm/mol-K

**Abbreviated table of Brønsted acids**

|  |  |  |
| --- | --- | --- |
| Acid | Ka | pKa |
| H2SO4 | LARGE | LG negative |
| H3O+ | 55.5 | -1.74 |
| HSO4− | 1.2 x 10-3 | -2.08 |
| HONO | 4.5 x 10-4 | 3.35 |
| HOAc | 1.8 x 10-5 | 4.74 |
| H2CO3 | 4.3 x 10-7 | 6.37 |
| NH4+ | 5.6 x 10-10 | 9.25 |
| HCN | 4.9 x 10-10 | 9.31 |
| HCO3− | 5.6 x 10 -11 | 10.75 |
| H2O | 10-14 | 14 |