Problem Set 5 Key Chemistry 115

1. Indicate whether each of the following compounds dissolves in water to give ions, molecules, or both:
2. HF, a weak electrolyte \_\_\_\_\_both\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Gluose, a nonelectrolyte \_\_\_\_\_molecules\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. CH3CH2OH, a nonelectrolyte \_\_\_\_\_molecules\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. NaCl, a strong electrolyte \_\_\_\_\_ions\_\_\_\_\_\_\_\_\_\_\_\_
6. H2CO3, a weak electrolyte \_\_\_\_\_both\_\_\_\_\_\_\_\_\_\_\_\_\_
7. KNO3, a soluble salt \_\_\_\_\_ions\_\_\_\_\_\_\_\_\_\_\_\_\_
8. Predict whether the following will be a strong electrolyte (SE), weak electrolyte (WE), or a nonelectrolyte (NE) , when placed in water at room temperature: (circle only one for each)

|  |  |  |  |
| --- | --- | --- | --- |
| C12H22O11 | SE | WE | **NE** |
| Al(C2H3O2)3 | **SE** | WE | NE |
| H2C2O4 (aq) | SE | **WE** | NE |
| Na3PO4 | **SE** | WE | NE |

1. Explain what happens when potassium chloride, KCl, dissolves in water.

The K+ ions are attracted to the partially negative oxygen atoms of the water molecules. The Cl- ions are attracted to the partially positive hydrogen atoms of the water molecules.

1. In *The Rhime of the Ancient Mariner* the poet Samuel Taylor Coleridge wrote, “…Water, water, everywhere/And all the boards did shrink…” Explain this effect in terms of osmosis.

Water in the cells of the wood leaked out, since the osmotic pressure inside the cells was less than that of the seawater in which the wood was sitting.

1. Match each of the following properties to acids or bases.
2. Sour taste \_\_\_\_\_acid property\_\_\_\_\_
3. The ability to react with hydroxide to produce water and an ionic compound. \_\_\_\_\_acid property\_\_\_\_
4. Bitter taste \_\_\_\_\_base property\_\_\_\_\_
5. The ability to react with active metals to produce hydrogen gas. \_\_acid property\_\_\_\_
6. A slippery, soapy feeling \_\_\_\_base property\_\_\_\_\_\_
7. The ability to react with carbonates to form carbon dioxide \_\_\_\_acid property\_\_\_\_\_
8. Complete the following table:

|  |  |  |  |
| --- | --- | --- | --- |
| Acid name | Acid formula | Weak or Strong? | Major species in aqueous solution |
| Hydrocyanic acid | HCN (aq) | Weak | HCNmolecules |
| Nitric acid | HNO3 (aq) | Strong | H+and NO3- ions |
| Phosphorous acid | H3PO3 (aq) | Weak | H3PO3 molecules |

1. Write the formula for the following (4 points):
2. The conjugate base of H2C2O4 \_\_\_HC2O4- \_\_\_\_\_\_\_\_\_\_
3. The conjugate acid of HSO4- \_\_\_\_\_H2SO4\_\_\_\_\_\_\_\_\_\_
4. The conjugate base of H3PO4 \_\_\_\_H2PO4-\_\_\_\_\_\_\_\_\_\_
5. The conjugate acid of C2H3O2- \_\_\_\_HC2H3O2\_\_\_\_\_\_\_\_\_
6. For each reaction identify the acid, base, conjugate acid, and conjugate base.

a. H2CO3 (aq) + H2O (l) 🡪 H3O+(aq) + HCO3-

acid base c.a. c.b.

b. HCN (aq) + NO2-(aq) 🡪 CN-(aq) + HNO2 (aq)

acid base c.b. c.a.

1. Write an equation to illustrate the acid-base reactions that will take place between HIO and NO2-. Identify the acids, bases, and conjugate acid base pairs.
2. Answer the following questions about pancreatic fluids, which help to digest food once it has left the stomach, 6.0 x 10-9 M H+.
3. What is the pH?
4. What is the pOH?

1. What is the hydroxide ion, OH-, concentration?

or

1. Are the pancreatic fluids acidic, basic, or neutral? \_\_\_basic\_\_\_\_\_\_\_\_
2. A vinegar solution has a [H3O+] of 2.0 x 10-3 M at 25 °C. What is the [OH-] of the vinegar solution? Is the solution acidic, basic, or neutral?

[H3O+] = 2.0 x 10-3 M

[OH-] = ?

[H3O+] > [OH-], therefore the solution is acidic.

1. What is the pH and pOH of a solution prepared by dissolving 2.5 g hydrochloric acid, HCl, in water to make 425 mL of solution?

pH = - log[H+] = - log(0.16) = 0.792

pH + pOH = 14.000 🡪 pOH = 14.000 – pH = 14.000 – 0.792 = 13.208

1. A 15.00 mL sample of sulfuric acid, H2SO4, solution required 24.57 mL of 0.4821 M sodium hydroxide, NaOH, solution for complete neutralization (8 points).
2. Write the balanced neutralization reaction.

H2SO4 (aq) + 2 NaOH (aq) 🡪 2 H2O (l) + Na2SO4 (aq)

1. What is the molarity of the sulfuric acid?
2. Consider the reaction of potassium hydroxide and nitrous acid. Calculate

the mL of 0.122 M potassium hydroxide required to neutralize 36.0 mL of 0.250 M nitrous acid.

KOH (aq) + HNO2 (aq) 🡪 KNO2 (aq) +H2O (l)

1. Determine the acid and base that were neutralized to produce each of the following salts:

a. potassium bromide, KBr (aq)

KOH (aq) + HBr (aq) 🡪 KBr (aq) + H2O (l)

b. sodium phosphate, Na3PO4 (aq)

3 NaOH (aq) + H3PO4 (aq) 🡪 Na3PO4 (aq) + 3 H2O (l)

1. In the following solutions, is the [OH-] greater than, less than, or equal to the [H3O+]?
2. Acid \_\_\_\_\_less than\_\_\_\_\_\_\_\_\_\_
3. [H3O+] = 1 x 10-7 M \_\_\_\_\_equal to\_\_\_\_\_\_\_\_\_
4. pH = 13 \_\_\_\_\_greater than\_\_\_\_\_\_\_\_\_\_
5. pH = 2 \_\_\_\_\_less than\_\_\_\_\_\_\_\_\_\_
6. Write balanced nuclear equations for the decay of the nuclides:
   1. (by alpha decay)
   2. (by beta decay)
   3. (by electron capture)
   4. (by gamma emission)
7. The isotope gallium-68 has a half-life of 68 minutes.

If a diagnostic test is begun with 15 mCi of this isotope, how much is left after a test that runs approximately 2 hours and 15 minutes?

Gallium-68 decays by electron capture. Write the nuclear equation.

Gallium-68 decays by positron emission. Write the nuclear equation.

1. Indicate whether each of the following is characteristic of the fission or fusion process or both :
2. This process produces radioactive by-products. Fission
3. Two small nuclei combine to form a larger nucleus. Fusion
4. Large amounts of energy are released. Both
5. This nuclear process provides the energy of the sun. Fusion
6. A large nucleus is split into smaller nuclei. Fission
7. Very high temperatures must be achieved to initiate Fusion

the reaction.

1. Californium-252 (Cf-252) can spontaneously undergo fission to produce barium-142, molybedenium-106 (Mo-106), some neutrons and energy. Write the balanced the balanced chemical equation. (Hint: There may be more than one neutron produced.)
2. Crater Lake in Oregon was formed by volcanic explosion. If a tree charred by the explosion gave an activity of less than 7.7 dpm and the half-life of carbon-14 is about 5730 years, what is the approximate age of Crater Lake?

t1/2 t1/2 t1/2 t1/2

100 dpm 🡪 50 dpm 🡪 25 dpm 🡪 12.5 dpm 🡪 6.25 dpm

7.7 dpm > 6.25 dpm, therefore about 22, 900 years have passed.

1. List alpha particles, beta particles, positrons, and gamma rays in order of each of the following:
2. increasing ionizing power;

gamma rays < beta particles ~ positron < alpha particles

1. increasing penetrating power.

alpha particles < beta particles ~ positrons < gamma rays

1. Identify the following statements as true or false:

|  |  |  |
| --- | --- | --- |
| True |  | Exposure to radiation is unavoidable because some radioactive elements occur naturally. |
| False |  | One symptom of radiation sickness is an increased production of red blood cells. |
| False |  | If the half-life of hydrogen-3 is 11.8 years, after two half-lives the radioactivity of a sample will be reduced to one-half the original amount. |
| True |  | One mCi of a radioactive substance emits more radiation that one µCi of the same substance. |
| False |  | X-rays are generated by the nucleus during radioactive decay. |
| False |  | A nuclear equation is balanced when the masses of the reactants equal the masses of the products. |