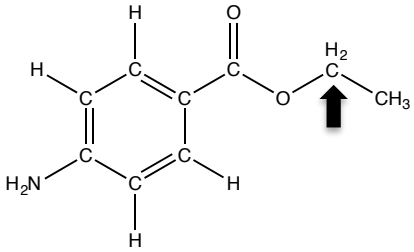
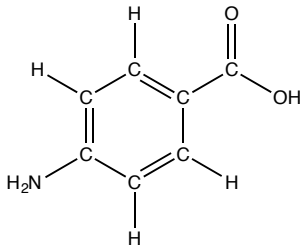
Problem Set #1, October 2019

Questions 1 - 6 refer to the following reaction and molecules below:

Benzocaine is a local anesthetic found in cough drops. It can be synthesized from the reaction of equimolar amounts of ethanol and *para*-aminobenzoic acid in the presence of concentrated sulfuric acid.



benzocaine



para-aminobenzoic acid

1. A reaction yields 1.50 g of benzocaine. How many carbon atoms are found in 1.50 g of benzocaine?

   a) 13.5 atoms b) 5.47×10^{21} atoms c) 4.92×10^{22} atoms
   d) 8.71×10^{22} atoms e) 8.13×10^{24} atoms

2. The reaction typically has a yield of 88 %. If the reaction is performed with excess ethanol, how much *para*-aminobenzoic acid should be used to synthesize 1.50 g of benzocaine?

   a) 1.25 g b) 1.42 g c) 1.50 g d) 1.72 g e) 1.83 g

3. Which of the following statements is TRUE?

   a) Benzocaine is more water-soluble than *para*-aminobenzoic acid.
   b) Benzocaine is more soluble in ethanol, CH_3CH_2OH, than in water.
   c) *Para*-aminobenzoic acid is not capable of hydrogen-bonding.
   d) The intramolecular forces between molecules of *para*-aminobenzoic acid include dipole-dipole interactions, hydrogen-bonding, dispersion forces and ion-dipole interactions.
   e) None of the above statements are true.

4. Which of the following WHMIS symbols would be best to label sulfuric acid?

   a)  b)  c)  d)  e) 

5. Which term best describes the geometry about the carbon atom indicated with an arrow in benzocaine (see above)?

   a) square planar b) T-shaped c) tetrahedral d) trigonal planar e) trigonal pyramidal

6. If 1.00 g of *para*-aminobenzoic acid is mixed with 2.0 mL of ethanol, CH_3CH_2OH, how many moles of ethanol remain after the reaction? Assume that no side reactions occur. The density of ethanol is 0.789 g/mL.

a) 0 mol b) 0.0073 mol c) 0.0095 mol d) 0.027 mol e) 0.034 mol

7. A 3.31 g sample of lead nitrate, $Pb(NO_3)_2$, molar mass 331 g/mol, is heated in an evacuated cylinder with a volume of 1.62 L. The salt decomposes when heated, according to the equation:

$2Pb(NO_3)_2\ (s) \rightarrow 2PbO\ (s) + 4NO_2\ (g) + O_2\ (g)$

Assuming complete decomposition, what is the pressure in the cylinder after decomposition and cooling to 300 K? Neglect the volume of PbO (s).

a) 0.380 atm b) 0.446 atm c) 0.0368 atm d) 1.48 atm e) 0.481 atm

8. The configuration for the valence electrons of an antimony atom is

a) $5s^2\ 5p^4$ b) $6s^2\ 6p^1$ c) $5s^2\ 5p^1$ d) $6s^2\ 6p^3$ e) $5s^2\ 5p^3$

9. The hybridization of the central atom in KrF_4O is:

a) sp b) sp^2 c) sp^3 d) sp^3d e) sp^3d^2

10. A 1.00 g mixture of KCl and Na_2CO_3 salts is dissolved to make a 355 mL solution. To this solution, excess $AgNO_3$ is added and 2.20 g of precipitate is formed. What is the mass percentage of Na in the original mixture of salts?

a) 9.72% b) 11.0% c) 17.7% d) 22.1% e) 40.8%

11. What is the molecular geometry of ClF_3?

a) trigonal pyramidal b) trigonal planar c) T-shaped d) tetrahedral
e) trigonal bipyramidal

12. You have 200 mL of solution A in one beaker and 350 mL of solution B in a second beaker. Solution A has a hydrogen ion concentration of 0.0020 M. For solution B, $[OH^-] = 0.0067M$. If the two solutions are poured together, what is the final pH of the new solution?

a) 2.45 b) 2.70 c) 11.55 d) 11.74 e) 11.99

13. The vapour pressure of pure benzene (C_6H_6) and toluene (C_7H_8) at 25 °C are 95.1 and 28.4 mm Hg, respectively. A solution of benzene and toluene is prepared with a mole fraction of toluene of 0.750. Assume the solution to be ideal and determine the total vapour pressure above the solution, in mm Hg.

a) 62.8 b) 66.7 c) 123.5 d) 45.1 e) 77.6

14. Diazepam (Valium) is an important organic compound used in the treatment of depression. One molecule of diazepam contains a single chlorine atom and the weight percentage of chlorine in diazepam is 12.45 %. What is the molecular weight of diazepam?

a) 105.4 g/mol b) 201.3 g/mol c) 242.5 g/mol d) 284.8 g/mol e) 303.6 g/mol

15. The first ionization energy of an element is the energy required to remove one electron from a gaseous atom of that element, that is, it is the energy required for the reaction

$$X(g) \rightarrow X^{+}(g) + e^{-}$$

where X stands for any element. Which of the following elements would you expect to have the lowest first ionization energy?

a) Mg b) Rb c) Li d) Ca e) Be

16. The element indium has an atomic mass of 114.8 g and an atomic number of 49. Naturally occurring indium contains a mixture of indium-112 and indium-115, respectively, in an atomic ratio of approximately

a) 6/94 b) 25/75 c) 50/50 d) 75/25 e) 94/6

17. Concentrated nitric acid has a density, d = 1.40 g mL^{-1} at 25 °C. The volume of concentrated acid required to make 2.00 L of 0.500 M aqueous nitric acid at the same temperature is:

a) 35.0 mL b) 40.0 mL c) 45.0 mL d) 50.0 mL e) 55.0 mL

18. At 27 °C and 1.00 atm, the density of a gaseous hydrocarbon is 1.22 g/L. The hydrocarbon is

a) CH_4 b) C_2H_4 c) C_2H_6 d) C_3H_8 e) C_3H_6

19. An ore contains 1.34% of the mineral argentite, Ag_2S, by weight. How many grams of this ore would have to be processed in order to obtain 1.00 g of pure solid silver, Ag ?

a) 74.6 g b) 85.7 g c) 107.9 g d) 134.0 g e) 171.4 g

20. The maximum number of electrons permitted in the O (n = 5) energy level is:

a) 8 b) 18 c) 32 d) 50 e) 72