CHE1031 Module 3 examples: Composition of substances & solutions

These are the problems I'll have you work during lecture. While the problems are presented on lecture slides you may find it useful to print them in this format and bring them to class. The problem number is shown in a green circle in the upper right of slides.

3.1: Formula mass & mole concept

1. Calculate the formula masses (aka molecular weights) of:
- Aspirin, $C_9H_8O_4$ (acetylsalicylic acid)
- Ibuprofen, $C_{13},H_{18}O_2$

2. Calculate the formula masses (aka molecular weights) of:
- Aluminum sulfate, $Al_2(SO_4)_3$, used to purify water & make paper
- Calcium phosphate, $Ca_3(PO_4)_2$, used to 'inject' DNA into cells

3. USDA nutritional guidelines suggest a daily intake of 4.7 g of potassium. What's the requirement in moles of K?

4. Beryllium, a very light element, is used to make transparent x-ray windows for imagining devices. How many moles of Be are in a thin window that weighs 3.24 g?

5. Copper is used to make electrical wire. How many copper atoms are there in 5.00 g of wire?

6. A prospector collects 15.00 g of pure gold from a river. How many gold atoms (Au) are there?

7. Vitamin C has the molecular formula C6H8O6. The recommended daily dose for kids aged 4-8 years is 1.42 E-4 moles.
How many grams should you give them?

8. Our bodies make amino acids, the building blocks of proteins. The simplest amino acid is glycine, C2H5O2N.
How many moles of glycine molecules are there in 28.35 g?
How many hydrogen atoms in the 28.35 g?

9. Saccharin, C7H5NO3S, is the old 'pink' sugar substitute.
   How many g of sacchirin have 9.20 E21 carbon atoms?

3.2: Determining empirical & molecular formulas

10. For example, a gas is found to contain only carbon and hydrogen. Analysis of a 10.0-g sample finds 2.5 g are C & 7.5 g are H. *What's the compound's percent composition?*

11. A 12.04-g sample of an unknown liquid is analyzed & found to contain 7.34 g C, 1.85 g H and 2.85 g N.
   Calculate its percent composition.

12. To add nitrogen to a crop, farmers can use several different fertilizers: ammonia (NH3); ammonium nitrate (NH4)(NO3); or urea (CH4N2O). If prices were equal, which delivers the most N per formula weight?

13. Aspirin's formula is C9H8O4. *Calculate its percent composition.*

14. A sample contains 1.71 g of C and 0.287 g of H. *What's its empirical formula?*

15. Nicotine, responsible for the addictive nature of cigarettes is 74.02% C, 8.710% H, 17.27% N. And 40.57 g contains 0.2500 moles. *What is the molecular formulas of nicotine?*

16. What's the molecular formula of a compound with 49.47 % C, 5.201 % H, 28.84 % N and 14.48% O. The formula mass is 194.2 g/mol.

3.3: Molarity

17. A 335-mL soft drink contains 0.133 mol of sucrose (table sugar). *What is the molar concentration of sucrose in the drink?*

18. A teaspoon of sugar has 0.01 mol of sucrose. *What's the molarity of sucrose if the sugar is dissolved in a cup of tea with a volume of 200 mL?*

19. A sip of tea has a volume of 10 mL. *How many moles of sucrose are there in one sip?*

20. How many grams of NaCl are there in 0.250 L of a 5.30 M solution?

21. What volume (mL) of this salt solution contains 20.0 g of NaCl?

22. If 0.850 L of a 5.00 M solution of copper (II) nitrate is diluted to a volume of 1.80L by the addition of water, what is the molarity of the diluted solution?

23. What volume of 0.12 M HBr can be prepared from 11 mL of 0.45 M solution?

3.4: Other units for solution concentration
24. A 5.0-g sample of spinal fluid contains 3.75 mg of glucose.
What is the percent by mass of glucose in spinal fluid?

25. Concentrated hydrochloric acid is a 37.2% aqueous solution with a density of 1.19 g/mL. What mass of HCl is there in 0.500 L of concentrated HCl solution?

26. Rubbing alcohol (isopropanol) is usually sold as a 70% (v/v) aqueous solution. If the density of isopropanol is 0.785 g/mL, how many grams of isopropyl alcohol are present in 355 mL of rubbing alcohol?

27. EPA rules say that if lead levels in drinking water reach 15 ppb, remedies must be taken.
    (a) Convert this to ppm.
    (b) What mass of lead (ug) would be in a 300-mL glass of water?