# Unit 1

1. Fill in the following table.

| Molecule | Lewis Diagram | VSPRE Diagram | Partial Charges | Type of molecule (polar or non-polar) |
|---|---|---|---|---|
| $NF_3$ | | | | |
| $I_2$ | | | | |
| $BeF_2$ | | | | |
| $CF_4$ | | | | |

2. Chromium exists naturally as four isotopes: Cr-50 (mass = 49.95 u), Cr-52 (mass = 51.94 u), Cr-53 (mass = 52.94 u) and Cr-54 (mass = 53.94 u). In a sample, 4.3% of the atoms are Cr-50, 83.8% of the atoms are Cr-52, 9.5% of the atoms are Cr-53 and 2.4% of the atoms are Cr-54. Calculate the average atomic mass of chromium.

3. Explain each of the following and describe the trend (as you move across the periods from left to right and as you move down a chemical family **and** explain why it happens)
   a. Electron affinity
   b. Electronegativity
   c. Atomic radius
   d. Ionization energy

4. Fill in the following table

| Molecule | ΔEN | Type of bonds (ionic, covalent, polar covalent) |
|---|---|---|
| $CaF_2$ | | |
| $CO_2$ | | |
| $CI_2$ | | |

# Unit 2

Nomeclature is found throughout the exam. You need to know how to name and write chemical formulas for ionic compounds, covalent compounds, acids, bases and hydrates.

# Unit 3

5. Predict the product or products that are likely to form in each of the following reactions. In each case, provide a **balanced** chemical equation to properly represent the reaction. States CAN NOT be accurately predicted for these products so they do not need to be included.
   a. Silver + Sulfur →
   b. Nickel + Nitrogen →
   c. Nitrogen trioxide + water →
   d. Potassium oxide + water →
   e. Sodium bromide →
   f. Zinc chloride hexahydrate →
   g. Iron (III) nitrate →
   h. Magnesium carbonate →
   i. Aluminum hydroxide

6. Explain the differences between complete and incomplete combustion.

7. Predict the products of each of the following reactions. In each case, provide a **balanced** chemical equation to properly represent the reaction. Write NR for reactions that will not proceed, and be sure to **include the states** for the products. If the reaction is combustion, assume it is complete combustion.
    a. $C_7H_{16(l)} + O_{2(g)} \rightarrow$
    b. $C_4H_{10(g)} + O_{2(g)} \rightarrow$
    c. Solid aluminum and aqueous calcium nitrate
    d. Chlorine gas and aqueous calcium bromide
    e. Solid tin and aqueous iron (II) sulphate
    f. Solid iodine and aqueous sodium chloride
    g. Solid zinc and aqueous iron (II) nitrate
    h. Solid lithium and water
    i. Aqueous sodium carbonate and hydrobromic acid
    j. Phosphoric acid and aqueous lithium hydroxide
    k. Aqueous lead (II) nitrate and aqueous silver sulphate

## Unit 4

8. A 265 g sample of an unknown compound contains 107.9 g of manganese, 63.1 g of sulphur, and the rest is oxygen. Calculate the percentage composition of the unknown compound.

9. Calculate the percentage composition of caffeine, $C_8H_{10}N_4O_2$.

10. Ethylene dibromide (EDB) was used as a grain pesticide until it was banned. Its approximate molar mass is 190 g/mol. Its percent composition is 12.7% carbon, 2.1% hydrogen, and 85.1% bromine. Determine the empirical and molecular formula for EDB.

11. Magnesium reacts violently with oxygen to form magnesium oxide according to the equation:

$$\mathbf{2\ Mg_{(s)} + O_{2(g)} \rightarrow 2\ MgO_{(s)}}$$

If 3.00g of magnesium is ignited in $4.14 \times 10^{22}$ molecules of oxygen gas, what mass of magnesium oxide will be formed?

12. Phosphorus trichloride, $PCl_{3(g)}$, reacts with water to produce hydrochloric acid according to this reaction:

$$\mathbf{PCl_{3(g)} + 3\ H_2O_{(l)} \rightarrow H_3PO_{3(aq)} + 3HCl_{(aq)}}$$

A 200 g sample of phosphorus trichloride was reacted with excess water and 120 g of hydrochloric acid was isolated. What was the percent yield of hydrochloric acid in this experiment?

## Unit 5

13. A stock solution of 12 mol/L hydrochloric acid is available to make 5.0 L of 0.80 mol/L aqueous hydrochloric acid. What volume of standard solution must be used to prepare the solution?

14. A sample of 200 g of seawater contains 0.258 g of magnesium ions. What is the m/m% concentration of magnesium ions in the seawater?

15. The concentration of iron in a town's water supply is 0.35 mg/L. What is this concentration in parts per million and parts per billion?

16. Calculate the molarity of the following solutions:
    a. 0.25 g of ammonium phosphate dissolved in 135 ml of solution.
    b. 1.6 g of sodium nitrate dissolved in 85 ml of solution.

17. For the mixture of the two aqueous solutions, lead (II) nitrate and sodium sulphate. (Hint: be sure to include states)
    a. Write the word equation.
    b. Write the balanced chemical equation.
    c. Write the balanced **ionic** equation.
    d. Write the balanced **net ionic** equation.
    e. List the spectator ions for this reaction.

18. Explain the difference between strong and weak acids and bases. Give common examples of each.

19. List the characteristics of acids and bases.

20. It takes 50 ml of 0.50 mol/L potassium hydroxide solution to completely neutralize 150 ml of sulphuric acid solution. What is the concentration of the sulphuric acid?

21. Explain how the ionic substance $Na_2SO_4$ dissolves differently in water than the molecular compound $CH_3OH$ (menthanol). You may want to use diagrams with your answer.

22. List **and** explain the 3 factors that affect the rate of dissolving.

## Unit 6

23. Convert each measurement to the given units.
    a. 865 mmHg to *x* torr
    b. 2.51 atom to *x* kPa
    c. 36.75 psi to *x* atm

24. Convert each temperature to the given scale.
    a. $98.6^oC$ to K
    b. $-125^oC$ to K
    c. 798K to $^oC$
    d. 89.9K to $^oC$

25. Synthetic diamonds can be made at pressures of $6.00 \times 10^4$ atm. The pressure of 4.15 L of gas, initially at 2.00 atm, was increased to $6.00 \times 10^4$ atm. What is the new volume of the gas?

26. A plastic soda pop bottle is flexible enough so that the volume of the bottle can change without opening it. An empty, tightly sealed, 2.1 L soda bottle is placed on the counter at a room temperature of $25.0^oC$. After several hours it is place in a freezer where the temperature is set at $-4^oC$. What will be the new volume of air in the bottle? Assume the amount of air in the bottle is fixed and the air pressure in the bottle and freezer are the same.

27. A sealed canister of gas with a fixed volume and amount has a pressure of 125 kPa at $-73.15^oC$. The temperature of gas is changed so that the pressure inside the canister is now 100 kPa. What is the temperature of the gas at the reduced pressure?

28. A volume of 25 mL of gas is produced in a laboratory experiment at a temperature of 258.15K and a pressure of 700 mmHg. Predict the temperature in degree Celsius of the gas when its volume is reduced to 20 mL and the pressure is increased to 820 mmHg. Assume the amount of gas is fixed.

29. At SATP, 1 mol of chlorine gas has a volume of 24.8 L. Determine the mass and number of molecules in a 62.0 L sample of the gas.

30. Determine the molar volume for a 1.09 L sample of hydrogen gas at 255$^{o}$C and 102 kPa.

31. What is the density of acetone, $C_3H_6O_{(g)}$ at 1.00 atm and 126.85$^{o}$C?

32. What is the pressure reading on a scuba tank if the tank is filled with $N_2$ gas at a partial pressure of 115 atm and $O_2$ gas at a partial pressure of 30 atm?

33. When calcium carbonate is heated to 298 K at 1.00 atm, it decomposes to form carbon dioxide and calcium oxide.

$$\mathbf{CaCO_{3(s)} \rightarrow CO_{2(g)} + CaO_{(s)}}$$

How many grams of calcium carbonate are needed to produce 3.45 L of carbon dioxide gas?

34. An anesthetic used in hospitals after World War II was made up of 64.8% carbon, 13.67% hydrogen, and 21.59% oxygen. It was found that a 5.0 L sample of this anesthetic had a mass of 16.7 g at STP. What is the molecular formula of this gas?