# AP Chem **Mid Term Exam Review Topics**

Chapter 1- Chemical Foundations
scientific method, units of measurement, significant figures & calculations, dimensional analysis, temperature, density, classification of matter

Chapter 2- Atoms, Molecules, and Ions
fundamental chemical laws, Dalton's atomic theory, modern atomic theory, molecules & ions, naming of simple compounds

Chapter 3- Stoichiometry
atomic masses, mole concept, molar masses, percent composition of compounds, determination of chemical formulas, balancing molecular equations, stoichiometric calculations, limiting reagent

Chapter 4- Types of Chemical Reactions & Solution Stoichiometry
strong & weak electrolytes, expressing solution concentration (molarity, molality & percent composition), precipitation reactions, complete ionic & net ionic equations, acid-base reactions, determination of oxidation number, redox reactions, balancing redox reactions (acidic & basic environments)

Chapter 5- Gases
pressure, Boyle's law, Charles' law, Avogadro's law, ideal gas law, gas stoichiometry, Dalton's law of partial pressures, kinetic molecular theory of gases, effusion & diffusion

Chapter 6- Thermochemistry
calorimetry, enthalpy, first law of thermodynamics, Hess' law, standard enthalpies of formation, law of summation

Chapter 7- Atomic Structure and Periodicity
electromagnetic radiation, atomic spectra, electron energy levels, atomic orbitals, quantum numbers, periodic trends (atomic radii, ionization energy, electron affinity,

Chapter 8 & 9- Bonding
types of chemical bonds, electronegativity, bond polarity, dipole moments, formation of binary ionic bonds, partially ionic character of covalent bonds, covalent bond energies, Lewis structures, resonance, VSEPR theory, localized electron model, hybridization

CH 16 - Spontaneity, Entropy + Free Energy

AP Chem **Mid Term Review Questions**

1. A laboratory experiment requires 12 grams of aluminum wire ($d = 2.70$ g/cm$^3$). The diameter of the wire in 0.200 in. Determine the length of the wire, in centimeters, to be used for this experiment. The volume of a cylinder is $\pi r^2 l$, where $l$ = length and $r$ = radius.

2. Calculate the average density of a single Al-27 atom by assuming that it is a sphere with a radius of 0.143 nm. The masses of a proton, electron and neutron are $1.6726 \times 10^{-24}$ g, $9.1094 \times 10^{-28}$ g, and $1.6749 \times 10^{-24}$ g, respectively. The volume of a sphere is $4\pi r^3/3$, where $r$ is the radius. Express the answer in grams per cubic centimeter. The density of aluminum is found experimentally to be 2.70 g/cm$^3$. What does that suggest about the packing of aluminum atoms in the metal?

3. Determine whether the statements given below are true or false.
   a. The mass of an atom can have the unit mole.
   b. In $N_2O_4$, the mass of the oxygen is twice that of the nitrogen is twice that of the nitrogen.
   c. One mole of chlorine atoms has a mass of 35.45 g.
   d. Boron has an average atomic mass of 10.81 amu. It has two isotopes, B-10 (10.01 amu) and B-11 (11.01 amu). There is more naturally occurring B-10 than B-11.
   e. The compound $C_6H_{12}O_2N$ has for its simplest formula $C_3H_6ON_{1/2}$.
   f. A 558.5-g sample of iron contains ten times as many atoms as 0.5200 g of chromium.
   g. If 1.00 mol of ammonia is mixed with 1.00 mol of oxygen the following reaction occurs:
   $$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$$
   All the oxygen is consumed.
   h. When balancing an equation, the total number of moles of reactants must equal the total number of moles of product molecules.

4. A sample of an oxide of vanadium weighing 4.589 g was heated with hydrogen gas to form water and another oxide of vanadium weighing 3.782 g. The second oxide was treated further with hydrogen until only 2.573 g of vanadium metal remained (with water as the other product.).
   a. What are the simplest formulas of the two oxides?
   b. What is the total mass of water formed in the successive reactions?

5. Calcium in blood or urine can be determined by precipitation as calcium oxalate, $CaC_2O_4$. The precipitate is dissolved in strong acid and titrated with potassium permanganate. The products of this reaction are carbon dioxide and manganese (II) ion.
   a. Balance this redox reaction in acidic solution.
   b. A 24-hr urine sample is collected from an adult patient, reduced to a small volume, and titrated with 26.2 mL of 0.0946 M $KMnO_4$. How many grams of calcium oxalate are in the sample?
   c. Normal range for $Ca^{2+}$ output for an adult is 100 to 300 mg per 24 hours. Is the sample within the normal range?

6. On Easter Sunday, April 3, 1983, nitric acid spilled from a tank car near downtown Denver, Colorado. The spill was neutralized with sodium carbonate:
   $$2HNO_3(aq) + Na_2CO_3(s) \rightarrow 2NaNO_3(aq) + H_2O(l) + CO_2(g)$$
   Calculate the $\Delta H^\circ$ for this reaction. Approximately $2.0 \times 10^4$ gal nitric acid was spilled. Assume that the acid was an aqueous solution containing 70% $HNO_3$ by mass with a density of 1.42 g/cm$^3$. How much sodium carbonate was required for complete neutralization of the spill, and how much heat was evolved? ($\Delta H_f$ for $NaNO_3(aq)$ = -467 kJ/mol).

7. Microwave ovens heat food by the energy given off by microwaves. These microwaves have a wavelength of $5.00 \times 10^6$ nm.
   a. How much energy in kilojoules per mole is given off by a microwave oven
   b. Compare the energy obtained in (a) with that given off by the ultraviolet rays ($\lambda$ = 100 nm) of the Sun that you absorb when you try to get a tan.

**Mid Term Review Questions**

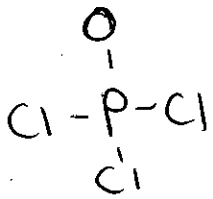
8. Given the following sets of electron quantum numbers, indicate those that could not occur and explain your answer.
   a. 1, 0, 0, -1/2
   b. 1, 1, 0, +1/2
   c. 3,2,-2, +1/2
   d. 2, 1, 2, +1/2
   e. 4, 0, 2. +1/2

9. Consider three sealed tanks all at the same temperature, pressure and volume.
   Tank A contains $SO_2$ gas. Tank B contains $O_2$ gas. Tank C contains $CH_4$ gas.
   (Complete each of the following statements with "less than," "greater than," "equal to," or "more information needed.")

   a. The mass of $SO_2$ is tank A _____ the mass of $O_2$ in tank B.
   b. The average translational energy of $CH_4$ in tank C is _____ the average translational energy of $SO_2$ in tank A.
   c. It takes 20 s for all of the $O_2$ gas in tank B to effuse out of a pinhole in the tank. The time it takes for all of the $SO_2$ to effuse out of tank A from an identical pinhole is _____ 40 s.
   d. The density of $O_2$ in tank B is _____ the density of $CH_4$ in tank C.
   e. The temperature in tank A is increased from 150 K to 300 K. The temperature in tank B is kept at 150 K. The pressure in tank A is _____ half the pressure in tank B.
   f. Calculate the density of $O_2$ gas in tank B (in g/L) if the container is at STP.

10. A compound of chlorine and fluorine, $ClF_x$, reacts at about 75 °C with uranium to produce uranium hexafluoride and chlorine fluoride, ClF. A certain amount of uranium produced 5.63 g of uranium hexafluoride and 457 mL of chlorine fluoride at 75 °C and 3.00 atm. What is $x$? Describe the geometry, polarity, and bond angles of the compound and the hybridization of chlorine. How many sigma and pi bonds are there?

11. Phosphoryl chloride, $POCl_3$, has the skeleton structure:



   a. Write a Lewis structure for $POCl_3$ following the octet rule. Calculate the formal charges in this structure.
   b. Write a Lewis structure in which all of the formal charges are zero. (The octet rule need not be followed.)

12. A typical fat in the body is glyceryl trioleate $C_{57}H_{104}O_6$. When it is metabolized in the body, it combines with oxygen to produce carbon dioxide, water and $3.022 \times 10^4$ kJ/mole of fat. How many grams of fat would have to be burned to heat 100.0 mL (d= 1.00 g/ml) of water from 22.00 °C to 25.00 °C? The specific heat of water is 4.18 J/g°C).