# Things to Know – Chem 1A – Exam 2

#### Chapter 4

- 1. Definitions of oxidation, reduction.
- 2. Be able to find the oxidation number of any atom (in an element or compound)
- 3. Given a reaction, determine what is oxidized and what is reduced (first find oxidation numbers).
- 4. If an element appears in a reaction, the reaction must be a redox reaction.
- 5. Understanding the activity series and how to determine relative activities:  $A + BC \rightarrow B + AC$  If this happens, A is more active than B.
- 6. Molarity = # moles solute/ L solution. Be able to calculate molarity or use it as a conversion factor.
- 7. Stoichiometry problems involving solutions (use M as a conversion factor)
- 8. Concentration of ions:  $0.1 \text{ M Na}_2\text{SO}_4$  (aq) is  $0.2 \text{ M Na}^+$  and  $0.1 \text{ M SO}_4^{-2^-}$ .
- 9. Describe how to make a solution of a given molarity. (Use a volumetric flask. Describe the process in words.)
- 10. Dilutions you can use  $M_1V_1 = M_2V_2$ , where  $V_2$  is the total final volume of solution ( $V_2 = V_1$  + water added). Why? Because # moles of solute doesn't change.
- 11. Titrations no limiting reactant. Need a balanced equation. Start with the substance you can find moles of. Convert to moles of the other substance. Finish the problem: could find molarity, volume, mass %, molar mass, etc. **DO NOT** use  $M_1V_1 = M_2V_2$ . Why not?
- 12. Be able to do limiting reactant problems involving solutions. Write the net ionic equation, find concentrations of all ions present after the reaction.

## <u>Chapter 10</u>

- 1. Properties of gases
- 2. Pressure what is it? How is it measured? How does atmospheric pressure vary? How does altitude affect atmospheric pressure? What are gas molecules doing to exert pressure?
- 3. How does a barometer work? What does it measure? Why use Hg as the liquid?
- 4. How does an open-end manometer work? What about a closed-end manometer? What does each one measure? Be able to determine the pressure of gas with an open or closed manometer.

- 5. Boyle's Law:  $P_1V_1 = P_2V_2$  As pressure increases, volume decreases. (Used if n and T are constant.) Why? Explain at the molecular level.
- 6. Charles' Law: as T increases, volume also increases. V is proportional to temp in Kelvin. (Used if n and P are constant.) Why? Explain at the molecular level.

$$\frac{\mathbf{V}_1}{\mathbf{T}_1} = \frac{\mathbf{V}_2}{\mathbf{T}_2}$$

7. Gay-Lussac's Law: as T increases, P increases (assuming n and V are constant). **Why**? Explain at the molecular level.

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

8. Combined gas law (used when n is constant but P, V and T are changing)

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

9. Avogadro's law: volume is proportional to moles of gas (assume P and T are constant). Why? Explain at the molecular level.

$$\frac{\mathbf{V}_1}{\mathbf{n}_1} = \frac{\mathbf{V}_2}{\mathbf{n}_2}$$

- 10. What is STP? What is the molar volume of an ideal gas at STP? (22.4 L/mole : can use it as a conversion factor.)
- 11. Reacting gases: if measured at the same T and P, volume is proportional to moles. (Can use volume ratios instead of mole ratios this is an important shortcut!)
- 12. Ideal gas law PV = nRT,  $R = 0.08206 L \cdot atm/K \cdot mol$  Units used must match the units of R.
- 13. Be able to derive any of the other gas laws from PV = nRT (put constants on one side, variables on the other)
- 14. Given the density of a gas at a specific temperature and pressure, calculate MM of a gas (# g/# mol) Approach: assume 1 L. Find the number of moles of gas in 1 L, then divide # g/L by #mol/L.
- 15. Given the molar mass of a gas, P, and T, calculate density. Approach: find the number of moles in 1 L, then convert to g.
- 16. Stoichiometry problems involving gases, including limiting reactant problems
- 17. Gas mixtures partial pressures  $P_{total} = P_A + P_B + P_C + ...,$
- $\mathbf{18.} \qquad \mathbf{P}_{\text{total}} = \mathbf{n}_{\text{total}} \mathbf{RT} / \mathbf{V} \qquad \mathbf{P}_{\text{A}} = \mathbf{n}_{\text{A}} \mathbf{RT} / \mathbf{V} \qquad \mathbf{P}_{\text{A}} = \mathbf{X}_{\text{A}} \mathbf{P}_{\text{total}}$
- 19. Collect a gas over water subtract vapor pressure of water from total pressure why?
- 20. In Lab 13 calculation, why did you have to subtract an extra correction factor from  $P_{total}$  to get  $P_{H_2}$ ?
- 21. Kinetic-Molecular theory **how it explains behavior of gases**

- 22. Be able to explain any of the gas laws at the molecular level (explain what the molecules are doing and how that gives rise to the observable properties). Be able to explain these relationships: P and V, V and T, P and T, n and V, n and P.
- 23. Velocity distribution of gas molecules (Boltzmann distribution) low vs. high temp. (What does the graph look like? Are all the molecules in a sample traveling the same speed?) Be able to sketch this graph, label the sketch, and explain what it means. The x axis could be either velocities or kinetic energies of gas molecules.
- 24. Using the equation below: what units are used? What is  $u_{rms}$ ?

$$u_{rms} = \sqrt{\frac{3RT}{M}}$$

- 25. Diffusion or effusion problems comparing rates, times, # moles, etc. reason it out! Make sure your answer makes sense. Molar mass ratio goes under the square root symbol. Practice these types of problems.
- 26. Nonideal gases under what conditions do gases exhibit nonideal behavior? Explain the underlying reason for each.
- 27. Van der Waals equation what does it take into account?

### <u>Chapter 5</u>

- 1. Energy, work, conservation of energy. Kinetic vs. potential energy. Types of potential energy
- 2. Units of energy
- 3. system, surroundings, closed system
- 4. heat, thermal energy (be able to give the molecular level explanation for things next to each other ending up at the same temp.)
- 5. First law of Thermo:  $\Delta E = q + w$ . What is included in E?
- 6. Sign conventions for q and w and the physical meaning of each of the signs
- 7. Endothermic vs. exothermic
- 8. State function vs. path function. What is the significance of state functions?
- 9. Know how to calculate w for a given reaction.  $w = -P\Delta V = -\Delta n_{gas}RT$  (this gives work at constant pressure for the reaction as written)
- 10. Enthalpy  $(\Delta H)$  = heat transferred at constant pressure. Heat transferred at constant volume =  $\Delta E$ .  $\Delta E$  =  $\Delta H$   $P\Delta V$  or  $\Delta E$  =  $\Delta H$  +  $w_p$
- 11. Thermochemical equations understand the implied amounts (kJ per x moles)
- 12. Stoichiometry using  $\Delta H$  how much energy is given off per x g of reactant?

$$\frac{-572 \text{ kJ}}{2 \text{ mol } \text{H}_2} \qquad \frac{-572 \text{ kJ}}{1 \text{ mol } \text{O}_2} \qquad \frac{-572 \text{ kJ}}{2 \text{ mol } \text{H}_2 \text{O}}$$

Example: 2 H<sub>2</sub> + O<sub>2</sub>  $\rightarrow$  2 H<sub>2</sub>O  $\Delta$ H = -572 kJ (see above)

- 13. Specific heat (C) vs. heat capacity (also C) (units?) They are different!
- 14. What does it mean if a substance has a high specific heat? What about a low specific heat?
- 15. Use  $q = Cm\Delta T$  or  $q = C\Delta T$  for temperature changes.
- 16. Coffee-cup calorimetry constant P (open container) You can use this information to get  $\Delta$ H.  $q_{calorimeter} = q_{solution}$  (Usually the heat capacity of the syrofoam cup itself is ignored.) We often have to assume that the solution in the calorimeter has a density and heat capacity close to those of water, since the solution consists of mostly water.
- 17. Bomb calorimetry rigid container, so  $\Delta V = 0$ , so no work can be done. The information can be used to get  $\Delta E$  for the reaction.

 $q_{calorimeter} = (q_{water} + q_{bomb})$  Often, the heat capacity of the entire calorimeter is given with the water already included. In that case,

 $q_{calorimeter} = C_{calorimeter} \Delta T.$ 

- 18. For both of the above types of calorimetry,  $q_{calorimeter} = -q_{reaction}$ . In order to get  $\Delta H$  or  $\Delta E$ , divide by the number of moles of the limiting reactant. Then check the stoichiometry of the reaction adjust for coefficients.
- Manipulating thermochemical equations (reverse a rxn, multiply a rxn by N, add reactions) what happens to ΔH in each case?
- 20. Hess's Law: given several reactions and their  $\Delta H$  values, determine the  $\Delta H$  value for a new reaction by rearranging and adding up the given reactions.
- 21. Heat of formation know how it's defined, be able to write the corresponding reaction.
- 22. Given  $\Delta H^{\circ}_{f}$  values, calculate  $\Delta H_{rxn}$  (products reactants)
- 23. OR Given  $\Delta H^{\circ}_{f}$  values and  $\Delta H_{rxn}$ , calculate a missing  $\Delta H^{\circ}_{f}$  value. (Don't forget: for elements, the  $\Delta H^{\circ}_{f}$  = 0. Why?)
- 24. Phase changes constant temp (Why? Be able to explain at the molecular level). Be able to draw a heating curve.
- 25. Calculating total energy involved in a process that has phase changes and temperature changes (calculate them separately, then add): It helps to sketch a heating curve and to use it to figure out how many separate processes there are to calculate.
- 26.  $\Delta H_{vap}$ ,  $\Delta H_{fus}$  What are they? Which one is higher? Why? Be able to explain this at the molecular level.
- 27. Which phase changes have a positive q? Which have a negative q?
- 28. Lab 15 calculation!
- 29. Heat involved in phase changes practice worksheet!

- 30. Calorimetry problems involving phase changes: First, decide which processes are happening and whether each one is exothermic or endothermic. Write an expression for each process. Then, total q for all of the endothermic processes = (total q for all exothermic processes). Solve for the missing variable.
- 31. Heat is also involved in making a solution and diluting. (given calorimetry data, calculate  $\Delta H$  of solution.) ex: NaCl (s)  $\rightarrow Na^+(aq) + Cl^-(aq)$  Be able to calculate  $\Delta H$  for these processes too.

### <u>Chapter 6</u>

- 1. Wave properties: wavelength, amplitude, velocity, frequency
- 2. Types of electromagnetic radiation which ones are high energy? Which are low energy? Which color of visible light has the highest frequency and which color has the lowest frequency? What is the order of energy of the different types of electromagnetic radiation?
- 3. c = υλ
- 4. What is a node?
- 5. What is a standing wave? What is the significance of a standing wave?
- 6. What is quantization?
- 7. Failures of classical physics: blackbody radiation, photoelectric effect. (No need to explain these experiments.) What new assumption was used to resolve these issues?
- 8. General relationship between E, v, and  $\lambda$ .
- 9. Calculate E per photon or E per mole of photons, calculate wavelength from E, etc.
- 10. Bohr model for H: allowed energy levels for the electron are:

$$E = -2.18 \times 10^{-18} J\left(\frac{1}{n^2}\right)$$
$$\Delta E_{e_{-}} = -2.18 \times 10^{-18} J\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

11. What are possible values of n in the above equation?

12. 
$$|\Delta E_{\text{electron}}| = E_{\text{photon}}$$

- 13. Ground state vs. excited state be able to identify each.
- 14. Energy levels get closer together as you go up.
- 15. emission vs. absorption (sign of  $\Delta E$ )
- 16. Calculate E or  $\lambda$  of a certain transition (for H) use above equation. Which transitions occur in the visible region?
- 17. Why are only <u>certain</u> wavelengths of light emitted/absorbed?

- 18. Understand the connection between what the electron is doing and the light wavelength involved.
- 19. Spectrum of H (for other atoms, the spectrum is more complicated.) What is the general appearance?
- 20. Why do different atoms emit different colors of light?
- 21. De Broglie equation: used for matter, not light

$$\lambda = \frac{h}{mu}$$

- 22. Uncertainty principle: we can't know where the electron is, but we can get info on the probability of finding it in a certain region.
- 23. Ideas behind quantum mechanics
- 24. What is a wavefunction? What is the physical significance of  $\psi^2$ ?
- 25. Quantum numbers: n, *l*, m<sub>l</sub>, m<sub>s</sub>: possible values, physical meaning for each
- 26. Know the general shape of s, p, and d orbitals
- 27. Be able to sketch different types of orbitals include nodes. n-*l*-1 radial/spherical nodes, *l* nodal planes/angular nodes
- 28. For the H atom, the energy of the orbitals depends only on n.
- 29. For "many-electron" atoms, the energy depends on n and l.
- 30. Electron spin is quantized:  $m_s = +1/2$  or -1/2.
- 31. Pauli exclusion principle, Aufbau principle, Hund's rule (what are they?)
- 32. Ground state vs. excited state vs. impossible configurations
- 33. Order of energy: 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, etc. Know this order of energy (use the periodic table to remember)
- 34. Be able to write the electron configuration for any atom, listing the orbitals in order of energy.
- 35. Be able to write the arrow/orbital diagrams, spectroscopic notation, and noble gas notation for any atom.
- 36. Paramagnetic, diamagnetic, ferromagnetic what is the difference? How can you tell the difference experimentally?
- 37. Exceptions to filling order: Cr, Cu, others.
- 38. Elements in the same group have similar chemical properties. Why?

#### Chapter 7

- 1. When was the periodic table developed? How was it arranged? Who got credit for it, and why?
- 2. Understand and be able to explain screening in your own words. Be able to use a plot of  $\Psi^2$  vs. radius to point out which orbitals shield which other orbitals. What is effective nuclear charge? Which electrons are shielded the most? Least?

- 3. Size (radius) know the trend (atoms get smaller as you go across  $\rightarrow$  and larger as you go down). Be able to explain **why**. Include shielding in your explanation.
- 4. Sizes of ions: Na<sup>+</sup> is smaller than Na. Cl<sup>-</sup> is larger than Cl. Be able to explain why. When comparing isoelectronic ions, the one with more protons is smaller. Be able to explain why.
- 5. Ionization energy know the exact process this refers to. Be able to write the equation. IE gets larger as you go across  $\rightarrow$  and smaller as you go down. Explain why. Be able to explain the exceptions. (Look at the electron configurations before and after.)
- 6. What does it mean if an atom has a high ionization energy?
- 7. First IE, second IE, third IE: be able to write the equations for the exact processes. Be able to explain the trend.
- 8. Electron affinity know the exact process. Atoms have a greater electron affinity as you go across. Be able to explain exceptions.
- 9. Filled or half-filled p or d subshells are especially stable.
- Electron configurations of ions:
  Main-group like noble gases filled shell
  Transition metal ions lose electrons from the outermost s level first
- 11. Properties of metals, nonmetals, and metalloids
- 12. metal oxide +  $H_2O \rightarrow$  metal hydroxide
- 13. metal hydroxide + acid  $\rightarrow$  salt + water
- 14. nonmetal oxide +  $H_2O \rightarrow acid$
- 15. nonmetal oxide + base  $\rightarrow$  salt + water
- 16. Given the reactants, be able to write the products of the above reactions (and then balance the equation.)
- 17. General properties of groups 1A, 2A, 7A, 8A, hydrogen, oxygen, and sulfur