

The Topics

Unit 1

- Chemical nomenclature (ionic, covalent, acids/bases)
- Calculate molar mass (g/mol)
- Convert g to mol to molecules and visa versa
- Avagadro's number
- Percent composition calculations

Unit 2

- balance and identify the 5 types of chemical reactions

Unit 3

- Stoichiometry mathematics including limiting reagent problems

Unit 4

- Classical atomic theory (Dalton, JJ Thompson, Rutherford, and Bohr)
- Quantum theory – Identification of the 4 quantum numbers
- Electron configurations and Orbital Notation
- Periodic properties for elements (size, ionization metal, nonmetals, metalloids, and electronegativity etc.), and interpret their effects on chemical or physical properties of elements

Unit 5

- Use Hess' Law, either by adding chemical reactions or by using ΔH_f data, to determine the enthalpy change for a reaction
- you should be able to identify exothermic and endothermic reactions and give appropriate reaction energy diagrams for each
- given enthalpy and entropy data, you should be able to determine which reactions in a group are likely to be more spontaneous

Unit 6

- Be able to draw Lewis dot structures
- Identify and draw VSEPR molecular models
- Use an electronegativity table and molecular models to determine the net polarity of a molecule
- Predict Van Der Waal forces between molecules

Unit 7

- Use the Classic Gas Laws and other Gas Laws to predict volume/pressure and temperature.

Unit 8

- Use the colloid properties to determine boiling point elevation and freezing point depression.
- you should be able to determine the molar mass of an unknown substance from freezing point depression data

Unit 9

- Chemical kinetics calculations (1st and 2nd order reactions, including half-life)
- Draw an energy diagram indicating the activation energy
- Explain how a catalysts affects a chemical equation

Unit 10

- you should be able to write equilibrium constant expressions for reactions and calculate the equilibrium magnitude (K_c)
- Apply Le Chatelier's Principle in predicting the effect that changes will have on the state of a system at equilibrium,

Unit 11

- Identify the properties of acids and bases
- Calculate pH and pOH as well as $[H^+]$ and $[OH^-]$

- Acid/Base equilibrium calculations. Be able to calculate K_a and K_b in calculations to determine pH and % dissociation of a weak acid or base solution
- Acid/Base nomenclature

**** REVIEW ALL OF THE CHAPTER WORKSHEETS. THESE ARE THE MOST COMPLETE RESOURCE OF TOPICS COVERED THIS YEAR AS WELL AS EXAMPLES OF POSSIBLE QUESTIONS ON THE FINAL****

Some typical multiple choice (note: these questions are from multiple sources: other web sites, old tests, old SAT II books, etc.)

- The percent, by mass, of phosphorus in $\text{Ca}_3(\text{PO}_4)_2$ is
a. 10% b. 20% c. 30% d. 40% e. 50%
- How many neutrons are in an atom of rubidium with a mass number of 87?
a. 37 b. 74 c. 50 d. 87 e. 85
- A deep breath of air has a volume of 1.05L at a pressure of 740mmHg and body temperature, 37°C . Calculate the number of molecules in the breath.
.0402 mol
- Rutherford arrived at a model for the atom different from that of J. J. Thomson. In it
a. electrons are surrounded by a dense mass of protons and neutrons
b. neutrons are positioned between the protons electrons to keep them apart
c. electrons orbit a very dense nucleus containing protons and neutrons
d. the nucleus takes up much of the volume of the atom
- When copper and zinc are placed in contact in a moist environment, which reaction is likely to occur?
a. $\text{Cu}^{2+} + \text{Zn} \rightarrow \text{Cu} + \text{Zn}^{2+}$
b. $\text{Zn} + \text{H}_2\text{O} \rightarrow \text{ZnO} + \text{H}_2$
c. $\text{Cu} + \text{H}_2\text{O} \rightarrow \text{CuO} + \text{H}_2$
d. $\text{Cu} + \text{Zn}^{2+} \rightarrow \text{Cu}^{2+} + \text{Zn}$
- An atom of element X has the electron configuration $1s^2 2s^2 2p^6 3s^2$ and element Y has the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^5$. The formula for a compound of these two elements is:
a. X_2Y b. XY c. XY_3 d. XY_2 e. $\text{X}_{12}\text{Y}_{17}$
- The correct electron dot symbol for Ga is
- As one moves down the periodic table, which of the following properties increases?
a. electron affinity b. ionization energy c. electronegativity d. atomic radius

For the following question, compare the assertion (top) and the reason (bottom) and select the appropriate answer from the options given below:

- a. both are true and reason fits the assertion
- b. both are true but reason does not explain assertion
- c. only the assertion is true
- d. only the reason is a true statement
- e. both are false

9. The first ionization energy of Li is less than that of Na BECAUSE Li is a smaller atom than Na.

10. The hybrid orbitals of the carbon atom in methane, CH₄, are called

- a. sp
- b. sp²
- c. sp³
- d. sp⁴

11. Of the following molecules, all of which have polar bonds, the non-polar molecule is

- a. HCl (linear)
- b. H₂O (bent)
- c. NH₃ (trigonal pyramid)
- d. CCl₄ (tetrahedron)

12. For which of the following transformations is hydrogen bonding expected to be the strongest force to overcome?

- a. boiling ICl
- b. melting CH₃OH
- c. subliming CO₂
- d. boiling ClO₂
- e. melting I₂

13. A liquid will boil when

- a. its vapor pressure is less than atmospheric pressure
- b. its critical pressure exceeds atmospheric pressure
- c. its critical temperature equals room temperature
- d. its vapor pressure equals atmospheric pressure
- e. its temperature reaches the triple point

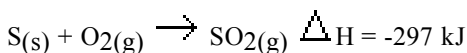
14. A volume of 48 mL of hydrogen gas is collected when the pressure is 600 mm Hg (to the nearest mm). If all other conditions remain constant what volume will this gas occupy when the pressure becomes 800 mm Hg (also to the nearest mm)?

- a. less than 36 mL
- b. 36 mL
- c. 48 mL
- d. 64 mL

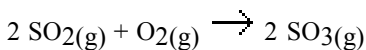
15. The volume occupied by 0.50 mole of propane gas, at a temperature of 27°C and a pressure of 202.6 kPa is best expressed by which of the following?

- a. $(0.50 \times 8.31 \times 27)/202.6$
- b. $(0.50 \times 8.31 \times 300)/202.6$
- c. $(0.50 \times 8.31 \times 273)/300$
- d. $(0.50 \times 8.31 \times 300)/(202.6 \times 760)$
- e. $(0.50 \times 8.31 \times 27)/(202.6 \times 760)$

16. Given these two reaction heats:



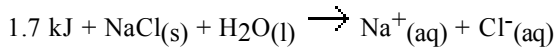
What is the heat of reaction for



under the same conditions?

- a. -282 kJ
- b. -297 kJ
- c. -735 kJ
- d. -890 kJ
- e. -1470 kJ

17. Consider the reaction below:



Which of the following combinations for ΔH and ΔS is correct?

- a. +,- b. -,+ c. -,- d. +,+

18. How many grams of sodium hydroxide pellets are required to prepare 50 mL (to the nearest 1 mL) of a 0.15 M solution?

- a. 0.30 b. 2.0 c. 3.0 d. 20 (to the nearest 1)

19. What is the freezing point of a 0.78 m water solution of non-volatile molecular solute? ($K_f = 1.86$)

- a. -0.400°C b. -0.745°C c. -1.45°C d. -2.26°C
e. insufficient information

20. A solution of a sodium salt that will form a precipitate with 0.1 M $\text{Pb}(\text{NO}_3)_2$ but NOT with 0.1 M $\text{Ba}(\text{NO}_3)_2$ is

- a. NaCl b. Na_2CO_3 c. Na_2SO_4 d. Na_3PO_4 e. Na_2SO_4

21. The $[\text{H}_3\text{O}^+]$ of a solution is 2.3×10^{-4} M. The pH of the solution lies between

- a. 1 and 2 b. 2 and 3 c. 3 and 4 d. 4 and 5

22. Which compound is a weak base?

- a. sodium hydroxide, NaOH
b. potassium hydroxide, KOH
c. aluminum hydroxide, $\text{Al}(\text{OH})_3$
d. lithium hydroxide, LiOH

23. At the "equivalence point" of an acid-base titration, which of the following would always be true?

- a. the volume of acid equals the volume of base
b. the solution is neutral ($\text{pH} = 7$)
c. $[\text{H}^+] = [\text{OH}^-]$
d. moles of H^+ added equals moles of OH^- that were present

24. Which one of the following is not a property you would expect of an acid?

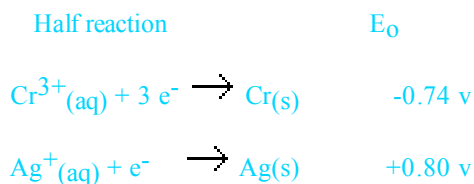
- a. reacts with magnesium to give H_2
b. tastes sour
c. water solution conducts electricity
d. feels slippery

25. When properly balanced with the smallest integer coefficients for acidic solution, the sum of all the coefficients in the half reaction below will be:



- a. 12 b. 14 c. 8 d. 5 e. none of these

26. What is the standard voltage, E_0 , for this electrochemical cell?



- a. -0.06 v b. +0.06 v c. -1.54 v d. +1.54 v

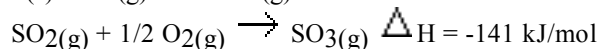
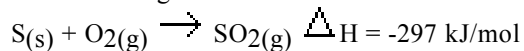
27. The most massive particle among the following is

- a. alpha particle b. beta particle c. positron d. neutron

28. When hydrochloric acid and zinc metal react, the gas produced is collected in an evacuated flask. After the system has returned to room temperature (27.2°C), the pressure inside the flask is 350 mm Hg. The volume of the flask is 255 mL. The energy released during this reaction is 152.4 kJ per mole of Zn.

- a. How many moles of gas have been collected?
- b. Write the chemical reaction, including the correct numerical energy term on the appropriate side
- c. Assuming that the zinc has been completely consumed, how many grams of zinc were used in this reaction?
- d. If the resulting solution was evaporated, what is the name of the solid compound that would remain?
- e. How many kJ of heat energy are released by the amounts used in this problem?

29. Given the following reactions:



- a. calculate ΔH for the reaction: $\text{S(s)} + 3/2 \text{O}_2(\text{g}) \rightarrow \text{SO}_3(\text{g})$
- b. sketch a reaction energy diagram for the reaction.

30. The reaction

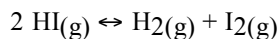


has been studied to determine the effect of varying the concentrations of nitrogen dioxide and carbon monoxide upon the rate of the reaction. The rate was determined by noting changes in absorbance in the system (NO_2 is colored, all other gases are colorless).

Initial Concentrations [NO ₂]	Rate of Absorbance decrease	
	[CO]	(Abs/s)
1×10^{-3}	6×10^{-3}	0.020
2×10^{-3}	6×10^{-3}	0.080
6×10^{-3}	1×10^{-3}	0.72
6×10^{-3}	2×10^{-3}	0.72

- write a consistent rate law expression for this reaction
- determine the value of the rate constant, k , including its units.
- what will the initial rate of the reaction be if each initial concentration is $2.0 \times 10^{-3} \text{ M}$?

31. Write the equilibrium constant expression for the following reaction:



- If $K_c = 0.016$ at 520°C , calculate the concentrations of all species at equilibrium when 0.50 mol of HI

32. What is the molar mass of glucose if 22.5 g gives a freezing point of -0.930°C when dissolved in 250g (to the nearest 1 g) of water? (K_f for water is 1.86)

33. The solubility product constant, K_{sp} , for silver bromide, AgBr, is 4.8×10^{-13} . When equal volumes of $2.0 \times 10^{-3} \text{ M AgNO}_3$ and $2.0 \times 10^{-3} \text{ M NaBr}$ are mixed will a precipitate form?

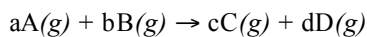
34. Formic acid, HCHO_2 , has a K_a of 1.78×10^{-4} . For a 0.45 M solution of formic acid calculate $[\text{H}^+]$, and the pH.

35. A 10.0 mL sample of vinegar, an aqueous solution of acetic acid (CH_3COOH), is titrated with 0.5062 M NaOH, and 16.58 mL is required to reach the end point.

- What is the Molarity of the acetic acid?

36. Calculate the molality of a solution which is 40.0 % HNO_3 .

37. The following initial rate data was collected for the reaction;



Experiment	[A] (M)	[B] (M)	Initial Rate (M/sec)
1	0.422	1.52×10^{-2}	2.71×10^{-5}
2	0.638	1.21×10^{-2}	4.93×10^{-5}
3	0.921	1.52×10^{-2}	1.29×10^{-4}

- Determine the reaction order for A and B.
- Write the specific rate law for the reaction?
- Determine the rate constant for the reaction (include units).

38. What is the maximum number of electrons in a

- 2s orbital
- 3d orbital
- $n = 3$

39. Thionyl chloride, SOCl_2 , decomposes according to the equation,



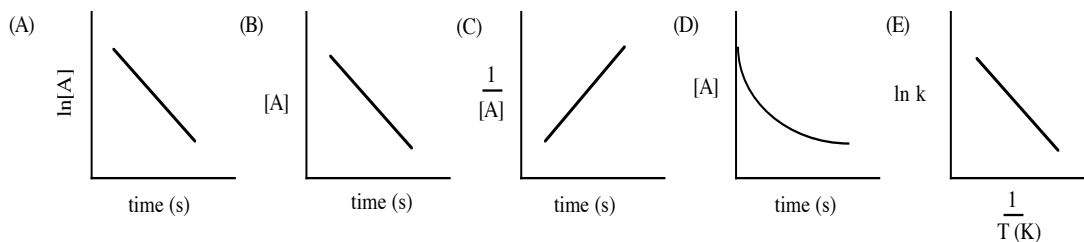
The decomposition is first order with a half-life of 3.2×10^4 seconds at 320°C .

- Calculate the rate constant for this reaction.
- How long would it take 30.0 % of a sample of SOCl_2 to decompose?

40. Which of the following set of quantum numbers describes an electron in an excited state in a hydrogen atom? Which describes a ground state? Which are not allowed?

- $n = 3; l = 3; m_l = 0$
- $n = 2; l = 1; m_l = -1$
- $n = 1; l = 0; m_l = 0$
- $n = 2; l = 0; m_l = +1$
- $n = 5; l = 2; m_l = +2$

41. Five plots, labeled A) - E) are shown below. Choose any three and briefly explain what information can be obtained from the plot.



42. Sketch a plot of energy versus reaction path for an exothermic chemical reaction have an activation energy approximately equal to its enthalpy of reaction.

- Identify the reactant area, products, reactants, $\Delta H^\circ_{\text{rxn}}$, and Activation Energy.
- Using a dashed line (-----) sketch in the plot of energy versus reaction path when a catalyst has been added to the reaction mixture.
- Explain in a few sentences, referring to your sketch, how a catalyst effects the rate of the chemical reaction.

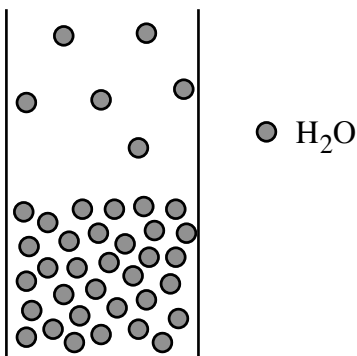
43. Which of the following solute:solvent pairs will form a solution?

- $\text{CBr}_4(l) : \text{H}_2\text{O}(l)$
- $\text{Br}_2(l) : \text{C}_6\text{H}_{14}(l)$
- $\text{AgCl}(s) : \text{H}_2\text{O}(l)$
- $\text{I}_2(s) : \text{H}_2\text{O}(l)$

44. A solution is prepared by dissolving 12.0 g of sodium bicarbonate, NaHCO_3 , in 1.00 kg of distilled water. The freezing point of the solution is determined to be -0.528°C . Which of the following equation **best** describes how sodium bicarbonate ionizes in water.

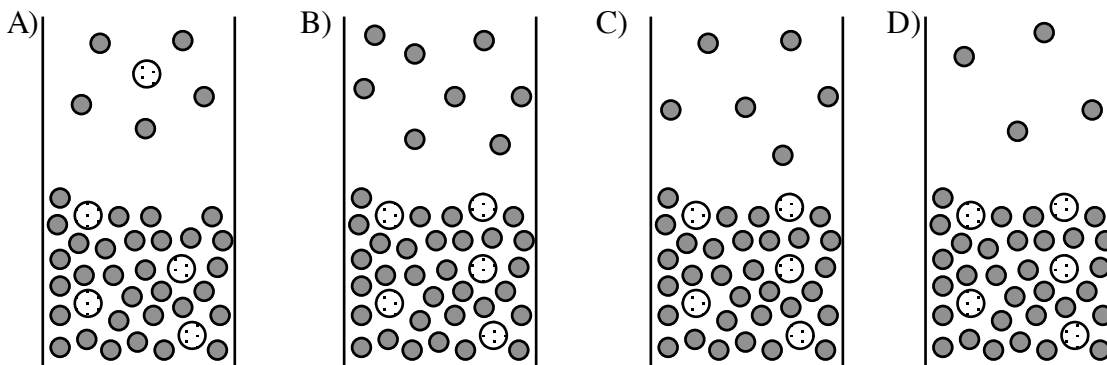
- $\text{NaHCO}_3(s) - \text{H}_2\text{O} \rightarrow$ will not dissolve
- $\text{NaHCO}_3(s) - \text{H}_2\text{O} \rightarrow \text{NaHCO}_3(aq)$
- $\text{NaHCO}_3(s) - \text{H}_2\text{O} \rightarrow \text{Na}^+(aq) + \text{HCO}_3^-(aq)$
- $\text{NaHCO}_3(s) - \text{H}_2\text{O} \rightarrow \text{Na}^+(aq) + \text{H}^+(aq) + \text{CO}_3^{2-}(aq)$

45. The diagram below represents a 2-dimensional model of a sample of water at a particular temperature.



46. Which of the following diagrams best represents the same system following the addition of a sample of sucrose ($C_{12}H_{22}O_{11}$)?

where $C_{12}H_{22}O_{11}$

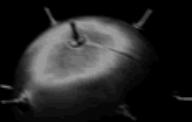


46. Which of the following statements is true for simple reactions which follow first order kinetics?

- A) The units for the rate constant are $M^{-1}s^{-1}$
- B) The time required for 75 % of a sample to react is independent of the initial concentration of reacting species.
- C) A plot of concentration versus time is always linear.
- D) If the concentration of reacting species is doubled, the rate of the reaction increases by a factor of four.
- E) The rate constant remains unchanged when the temperature changes.

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