**NAME:** _____

# Chemistry Final Exam Review

*\*=equations not given on Reference Sheet*

Unit 1: Math & Measurement

*Main Topics:* Conversions, Significant Figures, Density, Percent Error

*Equations:*
- Density
- *Percent Error

*Practice Problems:*
1. How many nanometers are in 10 meters?
2. How many liters are in 345 milliliters?
3. How many grams are in 2.45 kilograms?
4. Round your answer to the correct number of significant figures: 3.45 – 1.434 – 0.4 =
5. Round your answer to the correct number of significant figures: 4.50 x 4.245 =

Unit 2: Matter & Change

*Main Topics:* Classification of Matter, Physical/Chemical Properties & Changes, Periodic Table Basics, Scientific Method

*Equations:* None in this unit

*Practice Problems:*
6. *A student mixes two chemicals in a test tube. The test tube turns hot and bubbles appear. What indicators of chemical reaction is the student observing?*
   a. *Change in color and formation of precipitate.*
   b. *Change in color and formation of a gas.*
   c. *Change in temperature and formation of a precipitate.*
   d. *Change in temperature and formation of gas.*
7. What is the difference between a heterogeneous and homogeneous mixture?
8. What is the difference between a chemical and physical change? Give evidences of both types of changes.

Unit 3: Atoms

*Main Topics:* History of Atomic Theory, Atomic Structure, Average Atomic Mass, Basic Mole Conversions

*Equations:*
- *Atomic Mass (mass number)
- *Atomic Number
- *Average Atomic Mass

*Practice Problems:*
9. *Which atomic symbol represents an isotope of sulfur with 17 neutrons?*
   a. $^{17}_{16}X$      b. $^{33}_{16}X$      c. $^{17}_{32}X$      d. $^{49}_{32}X$
10. How are isotopes different?
11. What are the differences between an atom of nitrogen-15 and sodium-24 (compare neutrons, protons, electrons)?
12. How many moles are in a 35.3 gram sample of $Ca(NO_3)_2$?
13. How many grams are in a 0.453 mole sample of $Zn(OH)_2$?
14. How many molecules are in a 34.5 gram sample of KCl?

Unit 4: Electrons

*Main Topics:* Electromagnetic Spectrum, Light Calculations, Bohr Model, Electron Configurations, Noble Gas Configurations, Orbital Notation, Quantum Numbers

*Equations:*
- *$E = h \cdot v$
- *$c = \lambda \cdot v$

*Practice Problems:*
15. Predict the electron configuration for an element with 36 electrons.

16. Which is the electron configuration of calcium?
    a.  $1s^2 2s^2 2p^6 3s^2 3p^8$
    b.  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
    c.  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2$
    d.  $1s^2 2s^2 2p^6 3s^2 3p^6$
17. Use the Bohr model to explain the release of energy in return of electrons to a ground state.
18. An electron in an atom of hydrogen goes from energy level 6 to energy level 2. What is the wavelength of the electromagnetic radiation emitted?
    a.  410 nm
    b.  434 nm
    c.  486 nm
    d.  656 nm
19. How many electrons are in the outermost energy level of an electrically neutral atom of fluorine?

Unit 5: Periodic Table
*Main Topics:* Properties of Main Group Elements, Periodic Trends
*Equations:* None
*Practice Problems:*
20. Be able to classify elements as metals, nonmetals, or metalloids.
21. Where are the transition metals located?
22. How many periods are on the periodic table and in which direction do periods run?
23. How many groups are on the periodic table and in which direction do groups run?
24. The nucleus of an atom is shown.

8 protons
9 neutrons

Which statement best describes the element?
    a.  It is a nonmetal in group 2.
    b.  It is a nonmetal in group 16.
    c.  It is a metal in group 2.
    d.  It is a nonmetal in group 17.
25. Which atom has the largest radius? Justify your answer.
    a.  Bromine
    b.  Chlorine
    c.  Selenium
    d.  Sulfur
26. Arrange the following elements in order of increasing electronegativity, from lowest to highest: F, K, Si, and S.
    a.  $F < K < S < Si$
    b.  $K < Si < S < F$
    c.  $Si < F < K < S$
    d.  $S < Si < F < K$
27. Does potassium (K) have more similar properties to sodium (Na) or calcium (Ca)? Justify your answer.
28. Which pair of elements is both brittle and not able to conduct heat?
    a.  Bromine and silver
    b.  Iodine and neon
    c.  Iron and bromine
    d.  Silver and iron
29. An atom of which element has the weakest attraction for electrons?
    a.  Ba
    b.  Cs
    c.  O
    d.  F
30. Describe the trends of electronegativity, ionization energy, and atomic radius.

Unit 6: Chemical Bonding
*Main Topics:* Types of Bonding, Lewis Structures, Polarity, VSEPR Theory, Intermolecular Forces
*Equations:* None
*Practice Problems:*
31. Which statement compares the amount of energy needed to break the bonds in $CaCl_2$ ($E_1$) and $C_{12}H_{22}O_{11}$ ($E_2$)?
    a.  $E_1 > E_2$, as $CaCl_2$ is a covalent bond
    b.  $E_1 < E_2$, as $CaCl_2$ is a covalent bond
    c.  $E_1 > E_2$, as $CaCl_2$ is an ionic bond
    d.  $E_1 < E_2$, as $CaCl_2$ is an ionic bond
32. Given the pairs of atoms below, predict whether the bond formed between the atoms is either ionic or covalent, and if ionic, write the formula for the predicted compound.
    a.  Na and F
    b.  C and O
    c.  K and Br
    d.  Ca and F
    e.  H and N
    f.  Mg and O
33. Which statement describes the compound formed between sodium and oxygen?
    a.  It is $NaO_2$, which is ionic.
    b.  It is $NaO_2$, which is covalent.
    c.  It is $Na_2O$, which is ionic.
    d.  It is $Na_2O$, which is covalent.

34. Compare the physical properties (melting point, boiling point, solubility, electrical conductivity) of ionic, covalent, and metallic compounds.

35. *An unknown substance is tested in the laboratory. The physical test results are listed below:*
- *Nonconductor of electricity*
- *Insoluble in water*
- *Soluble in oil*
- *Low melting point*

*Based on these results, what is the unknown substance?*
a. *Ionic and polar*
b. *Ionic and nonpolar*
c. *Covalent and polar*
d. *Covalent and nonpolar*

36. *Which combination of elements would most likely form a covalent bond?*
a. *Hydrogen and oxygen*
b. *Sodium and fluorine*
c. *Potassium and nickel*
d. *Lithium and hydrogen*

37. What is the difference between bond and molecular polarity?

38. How do you determine if there is a polar bond?

39. How do you determine if there is a polar molecule?

## Unit 7: Chemical Formulas

*Main Topics:* Nomenclature, Oxidation Numbers, Percent Composition, Empirical & Molecular Formulas

*Equations:*
- *Percent Composition

*Practice Problems:*

40. Given the name of the compound below, infer its formula.
a. diphosphorusheptoxide
b. chromium (II) bromide
c. calcium nitrate
d. nickel (II) oxide

41. Given the formula below, write the name.
a. $Be(OH)_2$
b. $Sn(NO_3)_2$
c. $P_2F_3$
d. $Mg_3P_2$

42. *What is the IUPAC name for the compound represented by the formula $Mg(OH)_2$?*
a. *Magnesium hydroxide*
b. *Magnesium dihydroxide*
c. *Magnesium (II) hydroxide*
d. *Magnesium (II) dihydroxide*

43. *A compound consisting of 56.38% phosphorus and 43.62% oxygen has a molecular mass of 220 g/mole. What is the molecular formula of this compound?*
a. *PO*
b. *$PO_2$*
c. *$P_2O_3$*
d. *$P_4O_6$*

44. A 10.10 g sample of barium chloride hydrate is heated in a crucible. After all the water is driven off, 8.50 g of the anhydrous barium chloride remains in the crucible. What is the formula of the hydrate?

45. When zinc and chlorine react, what compound is produced (give chemical formula)?

46. What is the formula for tin (II) phosphate?

47. What is the name for the chemical formula $Fe_2Se_3$?

48. A compound with a molecular mass of 252 g/mol contains the elements carbon, hydrogen, and oxygen in a ratio of 2 carbon: 2 hydrogen: 1 oxygen. What is the empirical formula? What is the molecular formula? What is the percent composition of hydrogen in this compound?

## Unit 8: Chemical Equations

*Main Topics:* Balancing Equations, Types of Reactions, Activity Series of Metals

*Equations:* None

*Practice Problems:*

49. Write a balanced chemical equation for each reaction (include phases). Identify the type of reaction.
a. Sodium metal dropped into a beaker of water.
b. Silver nitrate is added to sodium chloride.

50. *Consider the combustion reaction equation: $C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$*
*When the equation is balanced, what will be the coefficient of $O_2$?*
a. *1*
b. *7*
c. *10*
d. *13*

51. 10.3 grams of sodium hydrogen carbonate reacts with an excess of hydrochloric acid. A white crystalline substance is produced and the mass of the product is 7.59 g.
    a. What type of reaction occurred?
    b. Write the balanced chemical equation for this reaction.
    c. What is the identity of the white crystalline product?
    d. Based on the data from the reaction, determine the molar ratio between the given reactant and product.
52. Balance the following equation: ___ $H_2SO_4$ + ___ $B(OH)_3$ → __ $B_2(SO_4)_3$ + ___ $H_2O$
53. When CuBr is mixed with $BaCl_2$, which type of reaction will occur?

Unit 9: Stoichiometry
*Main Topics:* Mole-Mole Stoichiometry, Mole-Mass Stoichiometry, Mass-Mass Stoichiometry, Percent Yield, Limiting Reactant
*Equations:*
  ▪ *Percent Yield

*Practice Problems:*
54. *Given the balanced chemical equation the reaction, $P_4 + 5O_2 \rightarrow P_4O_{10}$*
    *What mass of oxygen is needed to completely react with 7.75 g $P_4$?*
    *a. 2.00 grams*                     *c. 10.00 grams*
    *b. 5.00 grams*                     *d. 40.00 grams*
55. A sample of limestone consists of a large percentage of calcium carbonate. The sample reacts with an excess of hydrochloric acid and 14.0 L of carbon dioxide is generated at STP. Balance the equation. How many grams of calcium carbonate in the limestone?
$$CaCO_3 + HCl \rightarrow CaCl_2 + H_2O + CO_2$$
56. Given the balanced chemical equation the reaction, $P_4 + 5O_2 \rightarrow P_4O_{10}$
    How many moles of $P_4O_{10}$ is produced with 45.1 g $O_2$?
57. Given the balanced chemical equation the reaction, $P_4 + 5O_2 \rightarrow P_4O_{10}$
    How many moles of $P_4O_{10}$ is produced when 2.3 moles of $P_4$ react with $O_2$?

Unit 10: Gases
*Main Topics:* Kinetic Molecular Theory (KMT), Ideal Gas Equation, Gas Laws, Standard Molar Volume
*Equations:*
  ▪ Ideal Gas Equation
  ▪ Combined Gas Law
  ▪ *$MM = \dfrac{gRT}{PV}$
  ▪ *$D = \dfrac{MM\ P}{RT}$
  ▪ Dalton's Law of Partial Pressure
  ▪ *Graham's Law of Effusion

*Practice Problems:*
58. *What causes an inflated balloon to shrink when it is cooled?*
    a. *Because cooling the balloon causes gas to escape from the ball*
    b. *Because cooling the balloon causes the gas molecules to collide more frequently*
    c. *Because cooling the balloon causes gas molecules to become smaller*
    d. *Because cooling the balloon causes the average kinetic energy of the gas molecule to decrease*
59. The Kelvin temperature and the pressure of a sample of gas are doubled. What will be the effect on the density of gas?
60. How many  moles of oxygen gas are in 45 mL of oxygen gas at STP?
61. A mixture of gases ($O_2$, $CO_2$, $N_2$) is collected in a bottle. The partial pressure of $O_2$ is 795 torr, and the partial pressure of $CO_2$ is 845 torr. If the total pressure of the gases is 2540 torr, what is the partial pressure of $N_2$ (in atm)?
62. How does decreasing temperature affect the collisions that occur among gas particles?

Unit 11: Solids, Liquids, Phase Changes

*Main Topics:* Phase Diagrams, Heat/Cooling Curves, Properties of Liquids & Solids, Specific Heat Calculations
*Equations:*
- Heat Energy Equations

*Practice Problems:*

63. What causes the process of perspiration to be cooling for human skin? (applies to Unit 15 as well)
    a. It involves condensation and is exothermic.
    b. It involves evaporation and is endothermic.
    c. It involves evaporation and is exothermic.
    d. It involves condensation and is endothermic.

64. When is a liquid considered to be boiling? Explain your reasoning.

65. Given the heating curve below, what is occurring between minutes 6 and 12?
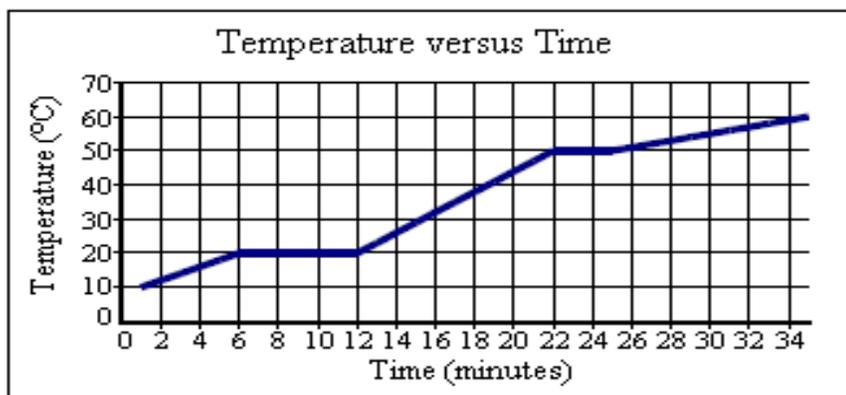


a. There is an increase in kinetic energy and vaporization is occurring.
b. There is an increase in kinetic energy and condensation is occurring.
c. There is an increase in potential energy and melting is occurring.
d. There is an increase in potential energy and freezing is occurring.

66. Compare the phase diagrams. What can be said about the relationship between the processes of melting for the two substances above? What can you determine about the densities of the solids compared to the liquids of each substance? Explain your reasoning.
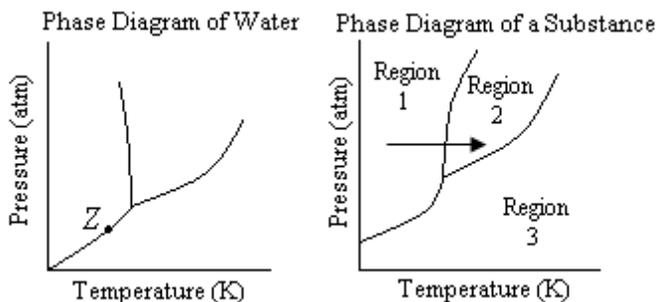
67. Be able to interpret and label (solid, liquid, gas, freezing/melting point, evaporation/condensation point) heating and cooling curves.

68. According to the phase diagram below, what is the boiling point of this substance at a pressure of 1.25 atmospheres?
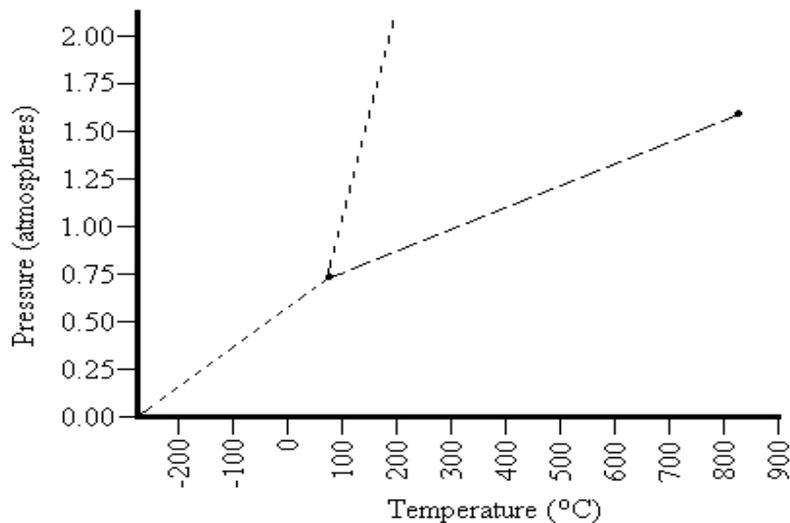


a. 500°C
    b.      300°C
    c. 150°C
    d.      100°C

69.      1000 J of heat is added to 2 g of the following substances. Which one will experience the biggest change in temperature? (need to look up the specific heat for these metals)
    a.      Iron
    b.      lead
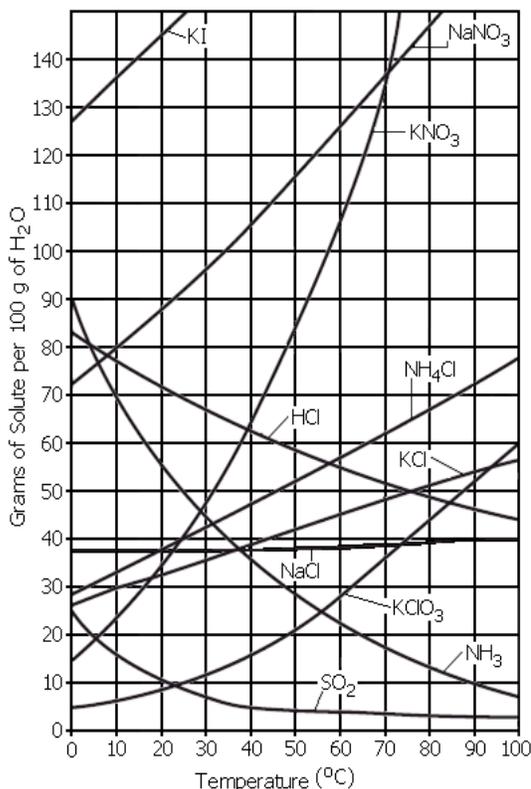    c. Copper
    d.      Aluminum

Unit 12: Solutions

*Main Topics:* Solubility Curve, Concentration, Types of Solutions, Net Ionic Equations

*Equations:*
- Molarity
- *Molality
- Dilutions
- *Boiling Point Elevation and Freezing Point Depression



*Practice Problems:*

70.       Heat is added to a solution to
a. Increase the solubility of a gas solute
b. Increase the solubility of a solid solute
c. Increase the miscibility of the solution
d. Increase the degree of saturation of the solution

71.       How many grams of KCl are required to make a saturated solution in 50.0 g of water at 80°C?
a. 150.0 g
b. 100.0 g
c. 50.0 g
d. 25.0 g

72.       Why does the solubility of $NH_3$ decrease as the temperature increases?

73.       At what temperature will 30 g of HCl produce a saturated solution when dissolved in 100 g of water?

74.       Which salt solution should contain approximately 80 g of solute per 100 g of $H_2O$ at 10°C?

Unit 13: Equilibrium

*Main Topics:* Equilibrium, LeChatelier's Principle, Equilibrium Constant Expressions

*Equations:*
- *Equilibrium Constant Expression ($K_{eq}$)

*Practice Problems:*

75. What determines if a system is at equilibrium?

76. *A scientist observes a chemical reaction as it takes place. What can the scientist do in order to tell if the reaction has achieved equilibrium?*
    a. *Monitor the temperature of the reaction over time.*
    b. *Measure concentration of products and reactants over time.*
    c. *Measure the pH of the solution over time.*
    d. *Wait for the formation of a precipitate.*

77. Given different equilibrium equations, determine the shift in equilibrium and the effects for a variety of changes (concentration of reactant or product, change in temperature, change in pressure, adding a catalyst).

78. Write the equilibrium expression for the following reaction: $2SO_2$ (g) + $O_2$ (g)<==> $2SO_3$ (g)

79. *For the reaction $2SO_2$ (g) + $O_2$ (g)<==> $2SO_3$ (g) + heat*
    *Which action will increase the concentration of $SO_3$?*
    a. *Removing $SO_2$*
    b. *Increasing the pressure*
    c. *Increasing the temperature*
    d. *Adding a catalyst*

Unit 14: Acids & Bases

*Main Topics:* Properties of Acids & Bases, Bronsted-Lowry Theory, Arrhenius Theory, pH calculations, Titrations

*Equations:*
- pH & pOH
- $[H^+]$ & $[OH^-]$
- *Titrations

*Practice Problems:*

80. *Based on the hydroxide ion concentration, which unknown substance would be an acid?*
   a. *Substance A, $[OH^-] = 1.0 \times 10^{-2}$ M*
   b. *Substance B, $[OH^-] = 1.0 \times 10^{-4}$ M*
   c. *Substance C, $[OH^-] = 1.0 \times 10^{-6}$ M*
   d. *Substance D, $[OH^-] = 1.0 \times 10^{-8}$ M*

81. Given a list of substances and their hydronium ion concentrations, classify them as acidic, basic, or neutral.

82. *Give the data table below, which substance is an acid?*

|  | Substance | | | |
|---|---|---|---|---|
|  | **W** | **X** | **Y** | **Z** |
| **Tastes bitter** | ? | Yes | Yes | No |
| **Tastes sour** | No | No | ? | Yes |
| **Feels slippery** | No | Yes | Yes | ? |
| **Turns litmus blue** | Yes | Yes | Yes | ? |
| **Turns litmus red** | ? | No | No | Yes |

   a. *Substance W*
   b. *Substance X*
   c. *Substance Y*
   d. *Substance Z*

83. List properties, interactions, concentration ranges, pH's, etc. for acids, bases, and neutral substances.

84. *What volume of 0.200M HCl will neutralize 10.0mL of 0.400M KOH?*
   a. *5.00mL*
   b. *8.00mL*
   c. *20.0mL*
   d. *40.0mL*

85. 25.0mL of 6.0M $H_2SO_4$ is diluted to a total volume of 1.00L. What is the concentration of the newly diluted solution? Justify your answer.

86. Why is NaOH considered an Arrhenius base?

87. What is the difference between a strong and weak acid/base?
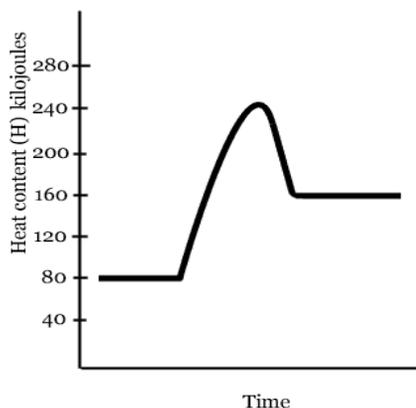
## Unit 15: Reaction Energy

*Main Topics:* Enthalpy, Entropy, Free Energy, Reaction Pathway Diagrams

*Equations:*
- *Enthalpy
- *Entropy
- *Gibbs Free Energy

*Practice Problems:*

88. *Given the energy diagram below, which statement describes the forward reaction?*

   a. *It is an exothermic reaction with an energy change of 80 kJ.*
   b. *It is an exothermic reaction with an energy change of 160 kJ.*
   c. It is an endothermic reaction with an energy change of 80 kJ.
   d. It is an endothermic reaction with an energy change of 160 kJ.

89. What type of reaction is represented by the diagram below?
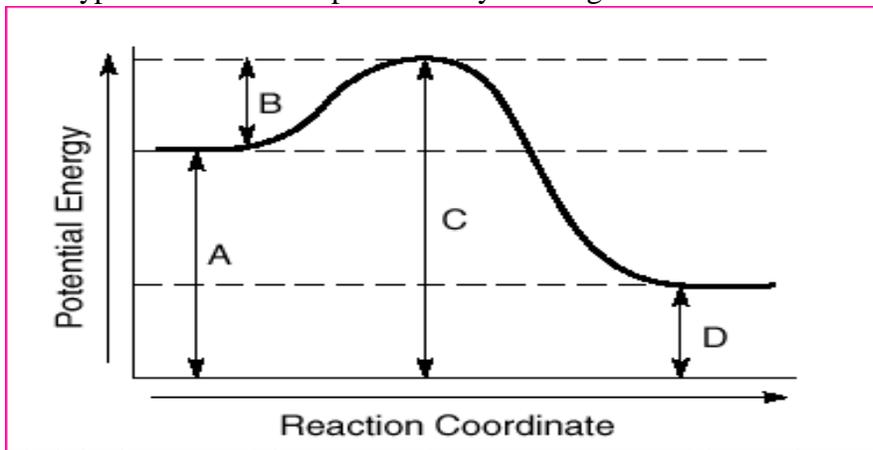


Label the location of the energy of reactants, energy of the products, activation energy, and enthalpy (heat of reaction). If a catalyst were added to this reaction, what quantities would change? Justify your reasoning.

90. Explain how temperature, concentration, particle size and a catalyst affect the rate of a chemical reaction. Give examples of each.

91. *When a set amount of marble chips (CaCO₃) is added to a small amount of dilute hydrochloric acid, a reaction occurs. What should be done to decrease the rate of reaction the next time the experiment is performed?*
    *a.   Use larger marble chips*                          *c.   Stir*
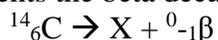    *b.   Use more acid*                                    *d.   Add heat*

Unit 16: Nuclear Chemistry

*Main Topics:* Nuclear Decay, Balancing Nuclear Reactions, Half Life

*Equations:* None

*Practice Problems:*

92. *The half-life of a radioactive isotope is 20 minutes. What is the total amount of 1.00 g of sample of this isotope remaining after 1 hour?*
    *a.   0.125 g*            *b.   0.250 g*            *c.   0.333 g*            *d.   0.500 g*

93. The nuclear reaction below represents the beta decay of $^{14}_{6}C$:
$$^{14}_{6}C \rightarrow X + ^{0}_{-1}\beta$$
What is the mass number of the element represented by X?
Link to the answers to this review