AP Chemistry-midterm review

Multiple Choice
Identify the choice that best completes the statement or answers the question.

1. Which response lists all of the following properties of sulfur that are physical properties and no other properties?

- It reacts with hydrogen when heated.
- It is a yellow solid at room temperature.
- It is soluble in carbon disulfide.
- Its density is 2.97 g/cm³.
- It melts at 112°C.

a. II, III, IV, and V
b. II, IV, and V
c. I
d. II, III, and IV
e. III, IV, and V

2. Which response includes all the following that are chemical properties of carbon and no physical properties?

- It is a solid at room temperature and atmospheric pressure.
- It undergoes combustion to produce carbon dioxide and water.
- It boils at 4200°C.
- It is not attracted strongly by a magnet.
- Its density is 2.25 g/cm³.

a. I, III, and IV
b. II and IV
c. I and V
d. II
e. III, IV, and V

3. Which of the following is an intensive property of matter?

a. mass
b. density
c. volume
d. weight
e. heat capacity

4. Which of the following is an extensive property of matter?

a. weight
b. melting point
c. specific gravity
d. color
e. density

5. Which response includes all of the following that involve chemical changes, and none that involve physical changes?
I. souring of milk
II. melting of silver
III. digestion of food
IV. burning of coal
V. condensation of steam

a. II and V
b. I, III, and IV
c. I, II, and III
d. IV and V
e. III, IV, and V

6. Which response lists all the physical changes but no chemical changes?

I. evaporation of water
II. fermentation of sugar
III. dissolving sugar in water
IV. melting of gold
V. changing of color of leaves

a. I, II, and III
b. I, III, and IV
c. III, IV, and V
d. I and IV
e. II and V

7. Which of the following is not a mixture?

a. air
b. steel
c. seawater
d. gasoline
e. oxygen

8. Crude oil can be separated into gasoline, diesel, heating oil, etc. by differences in boiling points. The form of matter which would best describe crude oil is:

a. homogeneous mixture
b. heterogeneous mixture
c. compound
d. mineral
e. element

9. Which response includes all the compounds listed below and only the compounds?

I. ethyl alcohol
II. air
III. mercury
IV. steam
V. calcium fluoride

a. I, II, and IV
b. III and V
c. II, IV, and V
10. Which element/symbol pair is incorrect?
   a. Fe/ iron
   b. Ca/ calcium
   c. Ag/ gold
   d. Pb/ lead
   e. O/ oxygen

11. Which of the following volumes is closest to one pint?
   a. 500. mL
   b. 50. dL
   c. 50. cm$^3$
   d. 50. mL
   e. 5000. cm$^3$

12. The sum $2.834 + 5.71520 + 2.12 + 178.1 + 250.2619$ expressed to the proper number of significant figures is:
   a. 439
   b. 439.0
   c. 439.03
   d. 439.031
   e. 439.0311

13. Perform the indicated mathematical operations and express the answer in scientific notation rounded off to the proper number of significant figures:

   \[(8.001 \times 10^2) \times (2.88 \times 10^3 \div 2.4 \times 10^{-3}) = \]
   a. $9.6 \times 10^2$
   b. $9.60 \times 10^8$
   c. $9.601 \times 10^8$
   d. $9.6 \times 10^8$
   e. $9.6 \times 10^{-2}$

14. The answer to the following calculation, rounded to the proper number of significant digits, is:

   \[23.413 \text{ g} \div (2.15 \text{ cm} \times 1.1 \text{ cm} \times 3.73 \text{ cm})\]
   a. 2.654 g/cm$^3$
   b. 2.65 g/cm$^3$
   c. 2.7 g/cm$^3$
   d. 3.0 g/cm$^3$
   e. 2.66 g/cm$^3$

15. Convert 175 milliliters to gallons.
   a. 0.0462 gal
   b. 0.0414 gal
   c. 0.740 gal
   d. 0.164 gal
   e. 0.660 gal
16. Express 21.5 cubic centimeters in quarts.
   a. $2.03 \times 10^{-2}$ qt
   b. $2.26 \times 10^{-4}$ qt
   c. $9.24 \times 10^{-7}$ qt
   d. $2.27 \times 10^{-6}$ qt
   e. $2.02 \times 10^{-4}$ qt

17. The 1970 standard established by the U.S. government for carbon monoxide emission for automobiles limited exhaust to 23.0 grams of CO per vehicle-mile. Assume that in a given metropolitan area there are 82,700 automobiles, driven an average of 13.5 miles per 24-hour period. How many tons/day of CO could legally be discharged into the area’s atmosphere?
   a. 270 tons/day
   b. 0.155 tons/day
   c. 28.3 tons/day
   d. 0.0535 tons/day
   e. 39.0 tons/day

18. What is the specific gravity of nickel if 2.35 cm$^3$ of nickel has the same mass as 20.9 mL of water at room temperature?
   a. 0.112
   b. 2.14
   c. 8.89
   d. 19.7
   e. 49.2

19. The density of octane is 0.702 g/cm$^3$. What is the mass of 65.0 mL of octane?
   a. 110 g
   b. 92.6 g
   c. 22.5 g
   d. 45.6 g
   e. $1.08 \times 10^{-1}$ g

20. What is the volume of a 58.5 gram sample of a liquid with a specific gravity of 1.24?
   a. 47.2 mL
   b. 63.2 mL
   c. 72.8 mL
   d. 20.2 mL
   e. 35.2 mL

21. A saltwater aquarium should have a specific gravity of approximately 1.07. What is the density of seawater?
   a. 1.07 g/mL
   b. 10.7 g/mL
   c. 1.00 g/mL
   d. 0.935 g/mL
   e. 0.00107 g/mL

22. Bromine, a brick red liquid, has a specific gravity of 3.12. What is the volume occupied by 25.0 grams of bromine?
   a. 11.7 mL
   b. 78.0 mL
   c. 32.6 mL
   d. 8.01 mL
e. 2.48 mL

23. Which of the following statements about density is incorrect?
   a. The densities of gases are usually expressed in units of g/L.
   b. The intensive property density can be calculated from the two extensive properties: mass and volume.
   c. The densities of liquids are usually expressed in units of g/mL (or g/cm$^3$).
   d. If oil and water are placed in a container, they form two layers with oil as the top layer because it has the greater density.
   e. Densities of gases change greatly with changes in temperature and pressure.

24. Liquid propane boils at 231 K. What is its boiling point in °C?
   a. 42°C
   b. 315°C
   c. -42°C
   d. 504°C
   e. -231°C

25. Methane, CH$_4$, boils at -162°C. What is the boiling point of methane in °F?
   a. -58°F
   b. -108°F
   c. -260°F
   d. -323°F
   e. -464°F

26. How many kilojoules are equivalent to 565 calories?
   a. 130 kJ
   b. 930 kJ
   c. 0.135 kJ
   d. 2.36 kJ
   e. 2360 kJ

27. What is the specific heat of a 5.75 g piece of metal if the addition of 175 joules of heat causes a 22.3 °C temperature increase?
   a. 1.36 J/g•°C
   b. 4.18 J/g•°C
   c. 1.11 J/g•°C
   d. 0.73 J/g•°C
   e. 1.54 J/g•°C

28. If a 10.0 g ball of iron at 160.0°C is dropped into 50.0 g of water at 20.0°C in an insulated container, what will be the final temperature of the water? The specific heat of iron is 0.444 J/g•°C and that of water is 4.18 J/g•°C.
   a. 23°C
   b. 38°C
   c. 48°C
   d. 82°C
   e. 110°C

29. Which of the following statements is not an idea from Dalton's Atomic Theory?
   a. An element is composed of extremely small indivisible particles called atoms.
b. All atoms of a given element have identical properties which differ from those of all other elements.
c. Atoms can only be transformed into atoms of another element by nuclear reactions.
d. Compounds are formed when atoms of different elements combine with each other in small whole-number ratios.
e. The relative numbers and kind of atoms are constant in a given compound.

30. There are two different common crystalline forms of carbon - diamond and graphite. A less common form called fullerene, C₆₀, also exists. Different forms of the same element in the same physical state are called:
   a. isotopes.
   b. isomers.
   c. alloforms.
   d. allotropes.
   e. structural formulas.

31. Name the molecular compound, H₂SO₄.
   a. hydrogen persulfide
   b. sulfurous acid
   c. sulfur tetroxide
   d. sulfuric acid
   e. hydrogen persulfate

32. Butane, a highly combustible hydrocarbon found in disposable lighters, has the chemical formula:
   a. CO₂
   b. C₄H₈
   c. C₄H₁₀
   d. C₃H₈
   e. CH₃OCH₃

33. A compound contains only calcium and fluorine. A sample of the compound is determined to contain 2.00 g of calcium and 1.90 g of fluorine. According to the Law of Definite Proportions, how much calcium should another sample of this compound contain if it contains 2.85 g of fluorine?
   a. 2.71 g
   b. 4.00 g
   c. 3.00 g
   d. 4.50 g
   e. 6.00 g

34. Each response below lists an ion by name and by chemical symbol or formula. Also each ion is classified as monatomic or polyatomic and as a cation or anion. Which response contains an error?
   a. hydroxide  OH⁻  monatomic  anion
   b. carbonate   CO₃²⁻  polyatomic  anion
   c. ammonium   NH₄⁺  polyatomic  cation
   d. magnesium   Mg²⁺  monatomic  cation
   e. sulfite     SO₃²⁻  polyatomic  anion

35. What is the formula for copper(II) nitrate?
   a. CuNO₃
   b. Cu₂NO₃
   c. CuNO₂
   d. Cu₂NO₂
e. Cu(NO₃)₂

36. From the following ionic compounds, choose the name-formula pair that is not correctly matched.
   a. sodium sulfide                      Na₂S
   b. ammonium nitrate                   NH₄NO₃
   c. zinc hydroxide                     Zn(OH)₂
   d. sodium sulfate                     Na₂SO₃
   e. calcium oxide                      CaO

37. Which element has a mass that is 7.30 times that of carbon-12?
   a. Mg
   b. Sr
   c. Ca
   d. Br
   e. Rb

38. Determine the formula weight of K₃PO₄.
   a. 134 amu
   b. 257 amu
   c. 164 amu
   d. 212 amu
   e. 85 amu

39. How many grams of CaCl₂ equal 3.40 moles of CaCl₂?
   a. 130 g
   b. 159 g
   c. 306 g
   d. 377 g
   e. 239 g

40. How many molecules are contained in 5.00 grams of NH₃?
   a. 5.42 × 10²²
   b. 3.00 × 10²⁴
   c. 3.40 × 10²²
   d. 1.77 × 10²³
   e. 9.45 × 10²²

41. Suppose you have a 100-gram sample of each of the following compounds. Which sample contains the smallest number of moles of compound?
   a. NH₃
   b. MgCl₂
   c. H₃PO₄
   d. CrCl₃
   e. NaCl

42. Calculate the percent composition of K₂CO₃.
   a. % K = 58.2%  % C = 17.9%  % O = 23.9%
   b. % K = 28.2%  % C = 8.8%   % O = 35.9%
   c. % K = 56.6%  % C = 8.7%   % O = 34.7%
   d. % K = 39.4%  % C = 12.0%  % O = 48.4%
   e. % K = 35.1%  % C = 21.6%  % O = 43.2%
43. Analysis of a sample of a covalent compound showed that it contained 14.4% hydrogen and 85.6% carbon by mass. What is the empirical formula for this compound?
   a. CH
   b. CH₂
   c. CH₃
   d. C₂H₃
   e. C₂H₅

44. A compound contains sulfur, oxygen, and chlorine. Analysis shows that it contains by mass 26.95% sulfur and 59.61% chlorine. What is the simplest formula for this compound?
   a. SOCl
   b. SOCl₂
   c. SO₂Cl₂
   d. SO₂Cl
   e. S₂OCl₂

45. A compound contains carbon, oxygen, and hydrogen. Analysis of a sample showed that it contained by mass 53.4% carbon and 11.1% hydrogen. What is the simplest formula for this compound?
   a. CHO
   b. C₂H₅O
   c. C₂H₄O
   d. CH₄O₂
   e. C₂H₅O₂

46. A compound contains, by mass, 87.5% nitrogen and 12.5% hydrogen. Its molecular weight is found to be 32 g/mol. What is its molecular formula?
   a. N₂H₆
   b. N₂H₄
   c. N₂H₃
   d. NH₃
   e. NH₂

47. A compound contains only carbon, hydrogen, and oxygen. Analysis of a sample showed that it contained 54.53% C and 9.15% H. Its molecular weight was determined to be approximately 88 g/mol. What is its molecular formula?
   a. C₂H₄O
   b. C₂H₆O
   c. C₂H₄
   d. C₄H₈O₂
   e. C₄H₁₂O₂

48. Which of the following sets illustrates the Law of Multiple Proportions?
   a. Li₂O, Na₂O, K₂O
   b. KCl, CaCl₂, ScCl₃
   c. H₁₂, H₂, H₃
   d. O, O₂, O₃
   e. BrF, BrF₃, BrF₅

49. What mass of tungsten is present in 10.0 lbs of wolframite, FeWO₄?
   a. 2.21 kg
   b. 2.75 kg
   c. 5.06 lb
d. 0.716 kg  
e. 5.85 lb

50. What mass of fluoristan, SnF₂, would contain the same mass of tin as 306 grams of cassiterite, SnO₂?
   a. 295 g  
b. 318 g  
c. 278 g  
d. 367 g  
e. 335 g

51. Heating MgSO₄•7H₂O at 150°C produces MgSO₄•xH₂O. If heating 24.4 g of pure MgSO₄•7H₂O at 150°C were to give 13.7 g of pure MgSO₄•xH₂O, calculate the value for x.
   a. 5  
b. 4  
c. 3  
d. 2  
e. 1

52. An ore of lead is 45.0% pure lead sulfide, PbS, and 55.0% impurities in which no other lead compounds are present. What mass of lead is contained in 150.0 grams of this ore?
   a. 71.4 g  
b. 67.5 g  
c. 58.5 g  
d. 9.05 g  
e. 18.0 g

53. A dolomite ore contains 40.0% pure MgCO₃•CaCO₃. No other compounds of magnesium or calcium are present in the ore. What mass of magnesium and what mass calcium are contained in 100.0 grams of this ore?
   a. 18.3 g Mg - 21.7 g Ca  
b. 7.91 g Mg - 13.0 g Ca  
c. 8.70 g Mg - 31.3 g Ca  
d. 5.27 g Mg - 8.69 g Ca  
e. 34.5 g Mg - 5.30 g Ca

54. Balancing a chemical equation so that it obeys the law of conservation of matter requires:
   a. Adjusting the coefficients in front of the formulas so there are the same number and type of atom on both sides of the equation.  
b. Making sure the reactants and products are in the same phase.  
c. Keeping the total charge the same on both sides of the equation.  
d. Changing the formulas of the products and reactants.  
e. Keeping the same number of molecules on both sides of the equation.

55. Balance the following equation with the smallest whole number coefficients. What is the coefficient for O₂ in the balanced equation?
   \[ \text{C}_4\text{H}_{10} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]
   a. 9  
b. 5  
c. 15  
d. 6  
e. 13
56. When heated lead nitrate decomposes according to the following equation. What is the coefficient for NO₂ when the this equation is balanced with the **smallest whole number coefficients**?

\[ \text{Pb(NO}_3\text{)}_2 \rightarrow \text{PbO} + \text{O}_2 + \text{NO}_2 \]

a. 1  
b. 2  
c. 3  
d. 4  
e. 5

57. One of the reactions that take place inside a blast furnace to produce iron is the reduction of iron ore by carbon monoxide. Choose the answer that represents the **sum** of all the coefficients when this equation is balanced the **smallest whole number coefficients**.

\[ \text{Fe}_2\text{O}_3 + \text{CO} \rightarrow \text{CO}_2 + \text{Fe} \]

a. 5  
b. 9  
c. 4  
d. 7  
e. 6

58. How many moles of O₂ are required to react with 23.5 moles of methanol?

\[ 2\text{CH}_3\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 4\text{H}_2\text{O} \]

a. 47.0  
b. 35.3  
c. 11.8  
d. 40  
e. 23.5

59. Propane (C₃H₈) burns in oxygen to form CO₂ and H₂O according to the following equation. How many grams of O₂ are required to burn 3.01 × 10²³ propane molecules?

\[ \text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O} \]

a. 80.0 g  
b. 40.0 g  
c. 160 g  
d. 16.0 g  
e. 64.0 g

60. Acrylonitrile, C₃H₅N, is a molecule used to produce a plastic called Orlon. How many grams of acrylonitrile could be produced by reacting 583 g of propene, C₃H₆ with excess ammonia, NH₃ and oxygen?

\[ 2\text{C}_3\text{H}_6 + 2\text{NH}_3 + 3\text{O}_2 \rightarrow 2\text{C}_3\text{H}_3\text{N} + 6\text{H}_2\text{O} \]

a. 368 g  
b. 1470 g
c. 462 g
d. 735 g
e. 583 g

61. What mass of phosphoric acid, $H_3PO_4$, would actually react with 7.17 grams of LiOH?

$$3\text{LiOH} + H_3PO_4 \rightarrow \text{Li}_3\text{PO}_4 + 3\text{H}_2\text{O}$$

a. 3.27 g  
b. 6.53 g  
c. 9.80 g  
d. 19.6 g  
e. 29.4 g

62. What mass of SrF$_2$ can be prepared from the reaction of 10.0 g of Sr(OH)$_2$ with excess HF?

$$\text{Sr(OH)}_2 + 2\text{HF} \rightarrow \text{SrF}_2 + 2\text{H}_2\text{O}$$

a. 9.67 g  
b. 9.82 g  
c. 10.0 g  
d. 11.6 g  
e. 10.3 g

63. A mixture of calcium oxide, CaO, and calcium carbonate, CaCO$_3$, that had a mass of 3.454 g was heated until all the calcium carbonate was decomposed according to the following equation. After heating, the sample had a mass of 3.102 g. Calculate the mass of CaCO$_3$ present in the original sample.

$$\text{CaCO}_3 \text{(solid)} \rightarrow \text{CaO} \text{(solid)} + \text{CO}_2 \text{(gas)}$$

a. 0.400 g  
b. 0.800 g  
c. 1.00 g  
d. 1.60 g  
e. 0.200 g

64. How many moles of carbon dioxide could be produced if 10 moles of octane, $C_8H_{18}$, are combined with 20 moles of oxygen?

$$C_8H_{18} + 25\text{O}_2 \rightarrow 16\text{CO}_2 + 18\text{H}_2\text{O}$$

a. 40 mol  
b. 8.0 mol  
c. 12.8 mol  
d. 62.5 mol  
e. 20 mol

65. How many grams of nitric acid can be prepared from the reaction of 69.0 grams of nitrogen dioxide with 36.0 grams of water?

$$3\text{NO}_2 + \text{H}_2\text{O} \rightarrow 2\text{HNO}_3 + \text{NO}$$
66. The reaction of 5.0 g of fluorine with excess chlorine produced 5.6 g of ClF₃. What percent yield of ClF₃ was obtained?

\[ \text{Cl}_2 + 3\text{F}_2 \rightarrow 2\text{ClF}_3 \]

a. 58%  
b. 69%  
c. 76%  
d. 86%  
e. 92%

67. If a reaction of 5.0 g of hydrogen with 5.0 g of carbon monoxide produced 4.5 g of methanol, what was the percent yield?

\[ 2\text{H}_2 + \text{CO} \rightarrow \text{CH}_3\text{OH} \]

a. 11%  
b. 79%  
c. 96%  
d. 24%  
e. 63%

68. What mass of water is contained in 160. grams of 22.0% KCl solution?

a. 125 g  
b. 86.8 g  
c. 35.2 g  
d. 130 g  
e. 112 g

69. Calculate the molarity of a solution that contains 70.0 g of H₂SO₄ in 280. mL of solution.

a. 2.55 \text{ M}  
b. 6.84 \text{ M}  
c. 8.62 \text{ M}  
d. 9.78 \text{ M}  
e. 11.84 \text{ M}

70. What is the molarity of 175 mL of solution containing 2.18 grams of Na₂SO₄•10H₂O?

a. 3.77 \times 10^{-3} \text{ M}  
b. 6.44 \times 10^{-1} \text{ M}  
c. 8.78 \times 10^{-3} \text{ M}  
d. 1.18 \times 10^{-2} \text{ M}  
e. 3.87 \times 10^{-2} \text{ M}

71. The specific gravity of commercial nitric acid solution is 1.42 and it is 70.0% HNO₃ by mass. Calculate its molarity.

a. 18.0 \text{ M}
72. When a solution is diluted, what is the relationship of the number of moles of solute in the more concentrated initial volume of solution to the number of moles of solute in the less concentrated final volume of solution?
a. The ratio of the numbers is directly proportional to the two volumes.
b. The ratio of the numbers is inversely proportional to the two volumes.
c. The number of moles of solute in the more concentrated initial volume is always greater.
d. The number of moles of solute in the less concentrated final volume is always greater.
e. The number of moles of solute in both solutions is the same.

73. Calculate the molarity of the resulting solution prepared by diluting 25.0 mL of 18.0% ammonium chloride, \( \text{NH}_4\text{Cl} \), (density = 1.05 g/mL) to a final volume of 80.0 mL.
   a. 0.292 M
   b. 0.059 M
   c. 1.10 M
   d. 0.0536 M
   e. 0.00105 M

74. If 45.0 mL of 0.250 \( M \) \( \text{PbCl}_4 \) solution reacts with 20.0 mL of \( (\text{NH}_4)_2\text{SO}_4 \), what is the molarity of the \( (\text{NH}_4)_2\text{SO}_4 \)?

\[
\text{PbCl}_4 + 2(\text{NH}_4)_2\text{SO}_4 \rightarrow \text{Pb(SO}_4\text{)}_2 + 4\text{NH}_4\text{Cl}
\]
   a. 0.502 M
   b. 1.25 M
   c. 2.25 M
   d. 1.13 M
   e. 0.563 M

75. What volume of 0.130 \( M \) \( \text{HCl} \) solution will just react with 0.424 gram of \( \text{Ba(OH)}_2 \)?

\[
2\text{HCl} + \text{Ba(OH)}_2 \rightarrow \text{BaCl}_2 + 2\text{H}_2\text{O}
\]
   a. 38.1 mL
   b. 32.6 mL
   c. 24.1 mL
   d. 18.6 mL
   e. 96.7 mL

76. What volume of 0.132 \( M \) \( \text{KOH} \) solution would react completely with 25.8 mL of 0.198 \( M \) \( \text{HCl} \) according to the following equation?

\[
\text{HCl} + \text{KOH} \rightarrow \text{KCl} + \text{H}_2\text{O}
\]
   a. 86.4 mL
   b. 25.7 mL
   c. 38.7 mL
   d. 17.2 mL
   e. 3.86 mL
77. Witherite is a mineral that contains barium carbonate. If a 1.68-g sample of witherite were to react completely with 24.6 mL of 0.2558 M HCl, what would be the percent of barium carbonate in the witherite sample? (Barium carbonate is the only compound present that reacts with the hydrochloric acid.)

\[ \text{BaCO}_3 + 2\text{HCl} \rightarrow \text{BaCl}_2 + \text{CO}_2 + \text{H}_2\text{O} \]

(a) 74.2%
(b) 37.0%
(c) 62.1%
(d) 23.4%
(e) 13.5%

78. The chemical behavior of a group of elements is determined by the __________ of the atoms in the group.
(a) mass numbers
(b) atomic numbers
(c) atomic weights
(d) atomic mass units
(e) Avogadro numbers

79. Which of the following is a metalloid?
(a) Cr
(b) K
(c) U
(d) Si
(e) Pb

80. Which element and group are **not** correctly matched?

<table>
<thead>
<tr>
<th>Element</th>
<th>Periodic Group or Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Sb</td>
<td>metalloid</td>
</tr>
<tr>
<td>b. Kr</td>
<td>noble gas</td>
</tr>
<tr>
<td>c. Al</td>
<td>alkali metal</td>
</tr>
<tr>
<td>d. F</td>
<td>halogen</td>
</tr>
<tr>
<td>e. Ca</td>
<td>alkaline earth metal</td>
</tr>
</tbody>
</table>

81. Which of the following is the **BEST** definition of a salt?
(a) A substance that produces ions in solution
(b) A substance that is completely ionized in solution.
(c) A compound composed of metals and nonmetals.
(d) A compound that contains a cation other than H\(^+\) and an anion other than OH\(^-\) or O\(^2-\)
(e) A substance that does not produce ions in solution.

82. Which statement regarding nitric acid is **false**?
(a) It only slightly ionizes in aqueous solution.
(b) Its solutions conduct electricity.
(c) It is soluble in water.
(d) It is a strong electrolyte.
(e) It produces H\(^+\) and NO\(_3^-\) in aqueous solution.

83. Which one of the statements below is **false** concerning the following reaction:
\[
\text{NH}_3(g) + \text{H}_2\text{O}(l) \rightleftharpoons \text{NH}_4^+(aq) + \text{OH}^-(aq)
\]

a. The double arrows indicate that ammonia, \(\text{NH}_3\), is only very slightly soluble in water.
b. The reaction is reversible.
c. When \(\text{NH}_3\) is added to \(\text{H}_2\text{O}\), \(\text{NH}_4^+\) and \(\text{OH}^-\) ions are produced in a 1:1 ratio.
d. When solutions of \(\text{NH}_4\text{Cl}\) and \(\text{NaOH}\) are mixed, some ammonia is produced.
e. Ammonia is considered a weak base.

84. Which one of the following salts is **insoluble** in water?
   a. \(\text{NaF}\)
   b. \(\text{NH}_4\text{ClO}_3\)
   c. \(\text{CuCl}_2\)
   d. \(\text{CaSO}_4\)
   e. \(\text{Ba}_3(\text{AsO}_4)_2\)

85. Which response includes only soluble salts and no others?
   I. \(\text{BaCl}_2\)
   II. \(\text{PbSO}_4\)
   III. \(\text{Fe}_2\text{S}_3\)
   IV. \(\text{Ca}_3(\text{PO}_4)_2\)
   V. \(\text{Sn}(\text{NO}_3)_4\)
   a. II, III, IV
   b. I, IV, V
   c. I, V
   d. I, III
   e. II, IV, V

86. Which one of the following salts is **insoluble** in water?
   a. \(\text{FeCl}_2\)
   b. \(\text{KCH}_3\text{COO}\)
   c. \(\text{Pb(NO}_3)_2\)
   d. \(\text{PbS}\)
   e. \(\text{NH}_4\text{Cl}\)

87. Which one of the following is a weak electrolyte?
   a. \(\text{H}_2\text{CO}_3\)
   b. \(\text{HCl}\)
   c. \(\text{NaCl}\)
   d. \((\text{NH}_4)_2\text{S}\)
   e. \(\text{LiOH}\)

88. Which response includes all of the following substances that are strong electrolytes, and no others?
   I. \(\text{LiOH}\)
   II. \(\text{Ca}(\text{CH}_3\text{COO})_2\)
   III. \(\text{HClO}_4\)
   IV. \(\text{H}_3\text{PO}_4\)
   a. I
   b. II and III
c. II, III, and IV  
d. I and III  
e. I, II, and III

89. What is the total ionic equation for the following formula unit equation?

\[ \text{BaCl}_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq}) \rightarrow \text{BaSO}_4(\text{s}) + 2\text{NaCl}(\text{aq}) \]

a. \([\text{Ba}^{2+}(\text{aq})+\text{Cl}^-\text{(aq)}] + [\text{Na}^+(\text{aq})+\text{SO}_4^{2-}\text{(aq)}] \rightarrow \text{BaSO}_4(\text{s}) + [\text{Na}^+(\text{aq})+\text{Cl}^-\text{(aq)}] \]

b. \([\text{Ba}^{2+}(\text{aq})+2\text{Cl}^-\text{(aq)}] + [2\text{Na}^+(\text{aq})+\text{SO}_4^{2-}\text{(aq)}] \rightarrow \text{BaSO}_4(\text{s}) + 2[\text{Na}^+(\text{aq})+\text{Cl}^-\text{(aq)}] \]

c. \([\text{Ba}^{2+}(\text{aq})+2\text{Cl}^-\text{(aq)}] + 2[\text{Na}^+(\text{aq})+\text{SO}_4^{2-}\text{(aq)}] \rightarrow \text{BaSO}_4(\text{s}) + 2[\text{Na}^+(\text{aq})+\text{Cl}^-\text{(aq)}] \]

d. \([\text{Ba}^{2+}(\text{aq})+2\text{Cl}^-\text{(aq)}] + [\text{Na}^+(\text{aq})+\text{SO}_4^{2-}\text{(aq)}] \rightarrow \text{BaSO}_4(\text{s}) + [\text{Na}^+(\text{aq})+\text{Cl}^-\text{(aq)}] \]

e. \text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}\text{(aq)} \rightarrow \text{BaSO}_4(\text{s})

90. Which of the following equations could not be a formula unit equation for the net ionic equation: \(\text{H}^+(\text{aq}) + \text{OH}^-\text{(aq)} \rightarrow \text{H}_2\text{O}(\text{l})\)?

a. \(\text{HCN}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaCN}(\text{aq}) + \text{H}_2\text{O}(\text{l})\)

b. \(\text{HNO}_3(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaNO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})\)

c. \(\text{HCl}(\text{aq}) + \text{KOH}(\text{aq}) \rightarrow \text{KCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})\)

d. \(\text{HClO}_4(\text{aq}) + \text{LiOH}(\text{aq}) \rightarrow \text{LiClO}_4(\text{aq}) + \text{H}_2\text{O}(\text{l})\)

e. \(\text{Ba(OH)}_2(\text{aq}) + 2\text{HCl}(\text{aq}) \rightarrow \text{BaCl}_2(\text{aq}) + \text{2H}_2\text{O}(\text{l})\)

91. Determine the oxidation number of the underlined element in \(\text{NaNO}_3\).  

a. +1  
b. +2  
c. +3  
d. +4  
e. +5

92. Determine the oxidation number of the underlined element in \(\text{P}_2\text{O}_{10}\).  

a. +3  
b. -2  
c. +4  
d. -1  
e. +5

93. Determine the oxidation number of the underlined element in \(\frac{3}{2}\text{H}_3^+\).  

a. +1  
b. +2  
c. +3  
d. -1  
e. -2

94. What are the oxidation numbers (oxidation states) of the elements in \(\text{HCO}_3^-\)?  

a. \(\text{H} = +1, \text{C} = +5, \text{O} = -2\)  
b. \(\text{H} = +1, \text{C} = +3, \text{O} = -2\)  
c. \(\text{H} = +1, \text{C} = +2, \text{O} = -2\)  
d. \(\text{H} = +2, \text{C} = +2, \text{O} = -2\)  
e. \(\text{H} = +1, \text{C} = +4, \text{O} = -2\)
95. Which of the following matched pairs of name and formula has an error?

<table>
<thead>
<tr>
<th>Formula</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mn₂O₃</td>
<td>manganese(II) oxide</td>
</tr>
<tr>
<td>FeCl₃</td>
<td>ferric chloride</td>
</tr>
<tr>
<td>SnBr₂</td>
<td>stannous bromide</td>
</tr>
<tr>
<td>CuS</td>
<td>copper(II) sulfide</td>
</tr>
<tr>
<td>CrO</td>
<td>chromium(II) oxide</td>
</tr>
</tbody>
</table>

96. What is the correct name for NaClO?

a. sodium hypochlorite
b. sodium chlorite
c. sodium chloride
d. natrium chlorite
e. sodium perchlorite

97. Which of the following matched pairs of name and formula has an error?

<table>
<thead>
<tr>
<th>Formula</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂SO₃</td>
<td>sulfurous acid</td>
</tr>
<tr>
<td>HClO₃</td>
<td>chloric acid</td>
</tr>
<tr>
<td>H₂CO₃</td>
<td>carbonic acid</td>
</tr>
<tr>
<td>HBrO₄</td>
<td>perbromic acid</td>
</tr>
<tr>
<td>HIO₂</td>
<td>hypoiodous acid</td>
</tr>
</tbody>
</table>

98. Which of the following matched pairs of name and formula has an error?

<table>
<thead>
<tr>
<th>Formula</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al(NO₂)₃</td>
<td>aluminum nitrate</td>
</tr>
<tr>
<td>BaSO₃</td>
<td>barium sulfite</td>
</tr>
<tr>
<td>Cr(SCN)₃</td>
<td>chromium(III) thiocyanate</td>
</tr>
<tr>
<td>N₂O₃</td>
<td>dinitrogen trioxide</td>
</tr>
<tr>
<td>Sb₂O₆</td>
<td>tetraantimony hexoxide</td>
</tr>
</tbody>
</table>

99. Which response includes all the following that are oxidation-reduction reactions, and no others?

I. BaSO₃(s) → BaO(s) + SO₂(g)
II. 2K(s) + Br₂(l) → 2KBr(s)
III. H₂CO₃(aq) + Ca(OH)₂(aq) → CaCO₃(s) + 2H₂O(l)
IV. SnS₂(s) + 6HCl(aq) → H₂SnCl₆(s) + 2H₂S(aq)
V. 3Cl₂(g) + 6KOH(aq) → 5KCl(aq) + KClO₃(aq) + 3H₂O(l)

a. II, III, and IV
b. I and III
c. II and V
d. I and IV
e. another one or another combination

100. In the following reaction oxygen is __________.
\[2C_3H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10 \text{H}_2\text{O(l)}\]

a. the oxidizing agent and is oxidized.
b. the oxidizing agent and is reduced.
c. the reducing agent and is oxidized.
d. the reducing agent and is reduced.
e. neither an oxidizing agent nor a reducing agent.

**101.** Which of the following reactions is **not** a decomposition reaction?

a. \(2\text{HgO(s)} \rightarrow 2\text{Hg(l)} + \text{O}_2(g)\)
b. \(\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl(g)}\)
c. \(\text{NH}_4\text{NO}_3(\text{s}) \rightarrow \text{N}_2\text{O(g)} + 2\text{H}_2\text{O(g)}\)
d. \(\text{Mg(OH)}_2(\text{s}) \rightarrow \text{MgO(s)} + \text{H}_2\text{O(g)}\)
e. \(2\text{H}_2\text{O}_2(\text{aq}) \rightarrow 2\text{H}_2\text{O(l)} + \text{O}_2(\text{g})\)

**102.** Which response includes all of the following that are displacement reactions, and no other reactions?

I. \(\text{BaO(s)} + \text{SO}_2(\text{g}) \rightarrow \text{BaSO}_3(\text{s})\)
II. \(2\text{Rb(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{RbOH(aq)} + \text{H}_2(\text{g})\)
III. \(2\text{HI(aq)} + \text{Ca(OH)}_2(\text{aq}) \rightarrow \text{CaI}_2(\text{aq}) + 2\text{H}_2\text{O(l)}\)
IV. \(2\text{HgO(s)} \rightarrow_{\text{heat}} 2\text{Hg(l)} + \text{O}_2(\text{g})\)

a. I and IV
b. II
c. II, III, and IV
d. II and IV
e. I, II, and IV

**103.** Which of the following represents the net ionic reaction for all strong acid / strong base reactions that produce a soluble salt?

a. \(2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})\)
b. \(2\text{H}^+(\text{aq}) + 2\text{H}_2\text{O(l)} \rightarrow 4\text{OH(aq)}\)
c. \(\text{H}^+(\text{aq}) + \text{OH(aq)} \rightarrow \text{H}_2\text{O(l)}\)
d. \(\text{H}_2\text{O(l)} + \text{OH(aq)} \rightarrow \text{O}_2(\text{g}) + 3/2\text{H}_2(\text{g})\)
e. \(2\text{H}^+(\text{aq}) + \text{O}_2^-(\text{aq}) \rightarrow 2\text{H}_2\text{O(l)}\)

**104.** Write the balanced **formula unit** equation for the complete neutralization of dilute H₃PO₄ with Ca(OH)₂ in aqueous solution. What is the sum of the coefficients? (Do not forget coefficients of one.)

a. 10
b. 12
c. 14
d. 16
e. 18

**105.** Write the balanced **total ionic** equation for the reaction of nitric acid with aqueous ammonia. What is the coefficient preceding NH₃?

a. 1
b. 2
c. 3
d. 4
106. Write the balanced net ionic equation for the reaction of HClO₃ with aqueous NH₃. Use H⁺ rather than H₂O⁺. What is the sum of the coefficients? (Do not forget coefficients of one.)

a. 7
b. 8
c. 3
d. 4
e. 5

107. Will a precipitate form when 0.1 M aqueous solutions of HBr and Pb(CH₃COO)₂ are mixed? If a precipitate does form, identify the precipitate and give the net ionic equation for the reaction.

a. PbBr₂ precipitates. 2[H⁺(aq)+Br⁻(aq)] + [Pb²⁺(aq)+2CH₃COO⁻(aq)] → PbBr₂(s) + 2CH₃COO⁻(aq)
b. CH₃COOH precipitates. H⁺(aq) + CH₃COO⁻(aq) → CH₃COOH(s)
c. PbBr₂ precipitates. Pb²⁺(aq) + 2Br⁻(aq) → PbBr₂(s)
d. PbBr₂ precipitates. Pb(CH₃COO)₂(aq) + 2Br⁻(aq) → PbBr₂(s) + 2CH₃COO⁻(aq)
e. No precipitate forms.

108. Will a precipitate form when 0.1 M aqueous solutions of NH₄NO₃ and NaBr are mixed? If it does form, identify the precipitate and give the net ionic equation for the reaction.

a. No precipitate forms.
b. NaNO₃ precipitates. Na⁺(aq) + NO₃⁻(aq) → NaNO₃(s)
c. NH₄BrO₃ precipitates. NH₄⁺(aq) + NO₃⁻(aq) + Br⁻(aq) → NH₄BrO₃(s) + N₂
d. NH₄N precipitates. 2NH₄⁺(aq) + 2NO₃⁻(aq) → 2NH₄N(s) + 3O₂(g)
e. NH₄Br precipitates. NH₄⁺(aq) + Br⁻(aq) → NH₄Br(s)

109. Which of the following is not a metathesis reaction?

a. CH₄(g) + 2O₂(g) → CO₂(g) + 2H₂O(l)
b. FeS(s) + 2HCl(aq) → FeCl₂(aq) + H₂S(g)
c. CaCl₂(aq) + K₂CO₃(aq) → CaCO₃(s) + 2KCl(aq)
d. 2HCl(aq) + Ba(OH)₂(aq) → BaCl₂(aq) + 2H₂O(l)
e. AgNO₃(aq) + NaBr(aq) → AgBr(s) + NaNO₃(aq)

110. Which of the following reactions is (are) not metathesis reactions?

I. Cl₂(g) + 2KBr(aq) → Br₂(l) + 2KCl(aq)
II. BaCl₂(aq) + H₂SO₄(aq) → BaSO₄(s) + 2HCl(aq)
III. CH₄(g) + 2O₂(g) → CO₂(g) + 2H₂O(g)

a. only I
b. only II
c. only III
d. only I and II
e. only I and III

111. Classify the following reaction by giving the reaction type that applies.

2HI(aq) + Ba(OH)₂(aq) → 2H₂O(l) + BaI₂(aq)
112. Classify the following reaction by giving all of these reaction type(s) that apply.

\[ \text{CaCO}_3(s) \xrightarrow{\text{heat}} \text{CaO}(s) + \text{CO}_2(g) \]

a. only I  
b. only II  
c. only III  
d. only IV  
e. I and V

113. Classify the following reaction by giving all of these reaction type(s) that apply.

\[ \text{P}_4(s) + 10\text{Cl}_2(g) \rightarrow 4\text{PCl}_5(g) \]

a. I and V  
b. only II  
c. only III  
d. I and II  
e. only V

114. Classify the following reaction by giving all of these reaction type(s) that apply.

\[ \text{Zn}(s) + 2\text{HCl}(aq) \rightarrow \text{ZnCl}_2(aq) + \text{H}_2(g) \]

a. only I  
b. only II  
c. only III
115. Which of the following has a negative charge?
   a. nucleus
   b. neutron
   c. proton
   d. electron
   e. alpha particle

116. Ernest Rutherford's model of the atom did not specifically include the ________.
   a. neutron
   b. nucleus
   c. proton
   d. electron
   e. electron or the proton

117. The number of electrons in a neutral atom of an element is always equal to the ________ of the element.
   a. mass number
   b. atomic number
   c. atomic mass unit
   d. isotope number
   e. Avogadro's number

118. The atomic number of an element gives the number of ________ and ________ in the atom while the
     mass number gives the total number of ________ and ________.
   a. neutrons, protons; neutrons, electrons
   b. neutrons, electrons; protons, electrons
   c. neutrons, electrons; neutrons, protons
   d. protons, electrons; neutrons, electrons
   e. protons, electrons; neutrons, protons

119. The difference between the mass number of an atom and the atomic number of the atom is always equal to
     ________.
   a. $6.02 \times 10^{23}$
   b. the atomic number of the element
   c. the atomic mass unit
   d. the number of protons in the nucleus
   e. the number of neutrons in the nucleus

120. Give the number of protons, neutrons, and electrons in an atom of the $^{41}$K isotope.
   a. 19 p, 22 n, 22 e
   b. 41 p, 19 n, 41 e
   c. 19 p, 22 n, 19 e
   d. 19 p, 16 n, 19 e
   e. 15 p, 26 n, 15 e

121. What is the symbol for a species composed of 38 protons, 52 neutrons, and 36 electrons?
   a. $^{80}$Kr$^{2+}$
   b. $^{90}$Sr$^{2+}$
   c. $^{90}$Sr
   d. $^{52}$Kr
   e. $^{38}$Th$^{2+}$
122. These three species $^{80}$Se, $^{81}$Br and $^{82}$Kr have
a. the same atomic mass.
b. the same number of protons.
c. the same number of neutrons.
d. the same mass number.
e. the same number of electrons.

123. What is the atomic weight of a hypothetical element consisting of two isotopes, one with mass = 64.23 amu (26.00%), and one with mass = 65.32 amu?
a. 65.16 amu
b. 64.37 amu
c. 64.96 amu
d. 65.04 amu
e. 64.80 amu

124. Gallium has two naturally occurring isotopes. $^{69}$Ga (68.9257 amu) is the more abundant isotope, at 60.4%. If the atomic mass of gallium is 69.723 amu, what is the mass of the other isotope, $^{71}$Ga?
a. 71 amu
b. 71.512 amu
c. 39.60 amu
d. 69.985 amu
e. 70.925 amu

125. The atomic weight of rubidium is 85.4678 amu. Rubidium consists of two isotopes, $^{85}$Rb 72.15%) and $^{87}$Rb (27.85%). The mass of an atom of $^{85}$Rb is 84.9117 amu. What is the mass of an atom of $^{87}$Rb?
a. 86.7271 amu
b. 86.8013 amu
c. 86.8220 amu
d. 86.8621 amu
e. 86.9085 amu

Ch. 5 Values
Some of the following values may be useful for solving some of the following problems.

speed of light = $3.00 \times 10^8$ m/s
joule = 1 kg•m$^2$/s$^2$
Planck's constant = $6.63 \times 10^{-34}$ J•s
Ångstrom = $1 \times 10^{-10}$ m

126. Refer to Ch. 5 Values. What is the frequency of light having a wavelength of $4.50 \times 10^{-6}$ cm?
a. $2.84 \times 10^{12}$ s$^{-1}$
b. $2.1 \times 10^{14}$ s$^{-1}$
c. $4.29 \times 10^{14}$ s$^{-1}$
d. $1.06 \times 10^{13}$ s$^{-1}$
e. $6.67 \times 10^{13}$ s$^{-1}$

127. Refer to Ch. 5 Values. What is the wavelength of green light having a frequency of $6.10 \times 10^{14}$ Hz?
a. $1.67 \times 10$ Å
b. $1.07 \times 10^{17}$ Å
c. $4.92 \times 10^3$ Å
d. $2.38 \times 10^{13}$ Å
e. $6.61 \times 10^8$ Å
128. Refer to Ch. 5 Values. The energy of a photon of light is $1.5 \times 10^{-20}$ J. What is its wavelength?
   a. $4.67 \times 10^4$ Å  
   b. $1.33 \times 10^3$ Å  
   c. $5.12 \times 10^4$ Å  
   d. $6.25 \times 10^4$ Å  
   e. $7.60 \times 10^3$ Å  

129. Refer to Ch. 5 Values. The emission spectrum of mercury shows a line of wavelength 579 nm. How much energy is emitted as the excited electron falls to a lower energy level?
   a. $3.43 \times 10^{-19}$ J/atom  
   b. $1.07 \times 10^{-20}$ J/atom  
   c. $6.05 \times 10^{-19}$ J/atom  
   d. $3.60 \times 10^{-20}$ J/atom  
   e. $5.16 \times 10^{-20}$ J/atom  

130. What is the de Broglie wavelength of a 16.0 lb shotput moving at a velocity of 7.26 m/s?
   a. $1.30 \times 10^{-38}$ m  
   b. $1.85 \times 10^{-30}$ m  
   c. $1.26 \times 10^{-35}$ m  
   d. $2.60 \times 10^{-36}$ m  
   e. $6.63 \times 10^{-31}$ m  

131. Which response includes all the following statements that are true, and no others?
   I. When an electron falls to a lower energy level in an atom, it emits electromagnetic radiation.
   II. The energy of electromagnetic radiation is directly proportional to its frequency.
   III. The product of wavelength and the speed of light is frequency.
   IV. Atoms can exist only in certain energy states.
   a. I  
   b. I and III  
   c. II  
   d. II and III  
   e. I, II, and IV  

132. Which response lists all the true statements about the four quantum numbers?
   I. $n =$ principal quantum number, $n = 1, 2, 3, \ldots$  
   II. $l =$ angular momentum quantum number, $l = 0, 1, 2, 3, \ldots, (n-1)$  
   III. $m_l =$ magnetic quantum number, $m_l = 0, 1, \ldots, l$  
   IV. $m_s =$ spin quantum number, $m_s = \pm \frac{1}{2}$  
   a. I, II, and IV  
   b. I, II, and III  
   c. I and III  
   d. II and III  
   e. II, III, and IV  

133. The orientation in space of an orbital is designated by which quantum number?
134. Which of the following statements is false?
   a. A set of p orbitals in a given energy level are equal in energy.
   b. The 5d and 4f orbitals are very close in energy.
   c. The 4s orbitals are lower in energy the 3d orbitals.
   d. An f set of orbitals is filled with 10 electrons.
   e. The third energy level has 5d orbitals.

135. Which response includes all the following statements that are true, and no false statements?
   I. Each set of d orbitals contains 7 orbitals.
   II. Each set of d orbitals can hold a maximum of 14 electrons.
   III. The first energy level contains only s and p orbitals.
   IV. The s orbital in any shell is always spherically symmetrical.
   a. I and II
   b. I, III, and IV
   c. IV
   d. II and IV
   e. III

136. No two electrons in the same atom can have the same set of four quantum numbers is a statement of
   _________.
   a. the Aufbau Principle
   b. the Pauli Exclusion Principle
   c. Dalton's Theory
   d. Hund's Rule
   e. the Heisenberg Uncertainty Principle

137. The electron configuration 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6 represents the element _________.
   a. Mn
   b. Se
   c. Fe
   d. Co
   e. Kr

138. What is the electron configuration of tin, Sn?
   a. [Kr]5s^2 3d^{10} 4p^4
   b. [Kr]5s^2 3d^{10} 4d^5 p^4
   c. [Kr]5s^2 3d^{10} 4f^4 5p^2
   d. [Kr]5s^2 4d^{10} 5p^2
   e. [Xe]5s^2 4d^{10} 5p^2

139. The electron configuration

```
1s    2s    2p    3s    3p    4s
  ↑↓   ↑↓   ↑↓↑↓↑↓   ↑↓   ↑↓↑↓↑↓   ↑↓
```
represents the element __________.
   a. Rb
   b. Ca
   c. Ge
   d. Ti
   e. Sr

140. Which of the following sets of quantum numbers could represent the highest energy electron in \( V^{2+} \)?

   \[
   \begin{array}{cccc}
   n & l & m_l & m_s \\
   \hline
   a. 4 & 0 & 0 & \frac{1}{2} \\
   b. 4 & 1 & 1 & \frac{1}{2} \\
   c. 3 & 2 & 1 & \frac{1}{2} \\
   d. 3 & 1 & 0 & \frac{1}{2} \\
   e. 4 & 2 & 1 & \frac{1}{2} \\
   \end{array}
   \]

141. Which of the following atoms has one unpaired electron in its ground state?
   a. Fe
   b. Al
   c. Mg
   d. As
   e. C

142. The number of electrons in \( p \) orbitals in the highest energy levels of the Group IVA elements is __________.
   a. one
   b. two
   c. three
   d. four
   e. six

143. The group of elements with outermost electron configuration \((n-1)d^{10}ns^2\) is?
   a. IIA
   b. IIIB
   c. IB
   d. IIB
   e. IIIA

144. The number of electrons present in the \( p \) orbitals in the outermost electron shell (major energy level, \( n \)) of the halogen atoms is __________.
   a. one
   b. two
   c. six
   d. seven
   e. five

145. Which periodic group or series of elements is not correctly matched with its common family name?
   a. alkaline earth metals       IIA
b. alkali metals IIIA

c. lanthanides $^{58}$Ce - $^{71}$Lu

d. halogens VIIA

e. noble gases VIIIA

146. __________ is an actinide.
    a. $^{22}$Ti
    b. $^{42}$Mo
    c. $^{81}$Tl
    d. $^{36}$Kr
    e. $^{92}$U

147. What would be the outer electron configuration of group IIIB (Sc, Y, La . . .)?
    a. $ns^2nd^1np^0$
    b. $nd^1ns^2$
    c. $ns^2(n-1)d^1$
    d. $ns^2np^3$
    e. $(n-1)d^1ns^2$

148. Which element has the largest atomic radius?
    a. Al
    b. Si
    c. P
    d. S
    e. Cl

149. Which element has the largest atomic radius?
    a. $^9$F
    b. $^{16}$S
    c. $^{11}$Na
    d. $^{28}$Ni
    e. $^{37}$Rb

150. Arrange the following elements in order of increasing atomic radii.
    K, Na, Mg, Cs, Cl
    a. Na < Mg < Cl < K < Cs
    b. Cl < Mg < Na < K < Cs
    c. Cs < K < Cl < Mg < Na
    d. Cl < Mg < Cs < K < Na
    e. Cl < Mg < Na < Cs < K

151. Which element has the lowest first ionization energy?
    a. Be
    b. B
    c. C
    d. N
    e. O

152. Arrange the following elements in order of decreasing first ionization energy.
    Be, Ca, Cs, Mg, K
a. Mg > Be > Ca > K > Cs
b. Be > Mg > Ca > K > Cs
c. Cs > K > Ca > Be > Mg
d. Ca > Mg > Be > Cs > K
e. Ca > Mg > Be > K > Cs

153. Arrange the following elements in order of **increasing** values of electron affinity, i.e., from most negative to least negative. (Note: None of these elements is an exception to the general trends of electron affinities.)

Cl, Se, S, Cs, Rb, Te

a. Cl < S < Se < Rb < Te < Cs
b. Cl > Te > Se > S > Rb > Cs
c. Cl > Se > S > Te > Rb > Cs
d. Cl < S < Se < Te < Cs < Rb
e. Cl < S < Se < Te < Rb < Cs

154. Which ion has the **smallest** radius?

a. As\(^{3-}\)
b. Se\(^{2-}\)
c. Br\(^-\)
d. Rb\(^+\)
e. Sr\(^{2+}\)

155. Which element has the **lowest** electronegativity?

a. Mg
b. Na
c. Rb
d. Y
e. Sc

156. Which comparison of electronegativities is **not** correct?

a. Br > Se
b. K > Mg
c. O > S
d. N > Be
e. I > Ba

157. Which of the following responses lists only the **ionic** hydrides?

I. LiH
II. B\(_3\)H\(_6\)
III. GeH\(_4\)
IV. HCl
V. BaH\(_2\)

a. I
b. I, V
c. II, III
d. II, III, IV
e. I, II, V
158. Which response includes all the elements below whose compounds with hydrogen would be expected to be molecular hydrides, and no others?

Br, K, P, B

  a. K, B
  b. Br, P
  c. K, Br
  d. Br, P, B
  e. Br

159. Which one of the following hydrides is basic?

  a. H₂Te
  b. B₂H₆
  c. CaH₂
  d. HI
  e. CH₄

160. What would be the general balanced equation for the reaction of the ionic hydride MH₂ with excess water?

  a. MH₂(s) + H₂O(l) → MOH(aq) + H₂(g)
  b. MH₂(s) + H₂O(l) → MO(s) + 2H₂(g)
  c. MH₂(s) + H₂O(l) → MH₂(s) + H₂O(g)
  d. MH₂(s) + 2H₂O(l) → M(OH)₂(aq) + 2H₂(g)
  e. MH₂(s) + 3H₂O(l) → MO(s) + 4H₂(g) + O₂(g)

161. Write the balanced formula unit equation for the reaction of magnesium with hydrochloric acid. What is the sum of the coefficients? Don't forget coefficients of one. Use the smallest whole number coefficients.

  a. 5
  b. 6
  c. 3
  d. 4
  e. none of these

162. Which of the following statements about oxygen is false?

  a. The most common form of oxygen is a diatomic molecule.
  b. Ozone is an allotrope of oxygen.
  c. Both ozone and oxygen are oxidizing agents.
  d. Oxygen forms binary compounds with nonmetals called acid anhydrides.
  e. Oxygen forms basic nonmetal oxides.

163. Which one of the following compounds is a superoxide?

  a. Na₂O₂
  b. SrO
  c. KO₂
  d. Li₂O
  e. Cl₂O₇

164. Which of the following statements about binary oxides is false?

  a. Basic oxides are molecular.
  b. Some oxides like BeO are amphoteric.
  c. Nonmetal oxides are usually acidic.
d. Metal oxides are usually basic.
e. Acid anhydrides are molecular.

165. Which response includes all of the following oxides that are basic anhydrides and no others?
I. N₂O
II. P₄O₆
III. CaO
IV. OF₂

a. I and II
b. II
c. III
d. IV
e. III and IV

166. Which of the following oxides does not give an acidic solution when dissolved in water?

a. SO₃
b. CO₂
c. N₂O₅
d. P₄O₁₀
e. Na₂O

167. One of the following oxides is insoluble in water. Which one?

a. CO₂
b. N₂O₅
c. SO₂
d. SiO₂
e. SO₃

168. Arrange the following in order of increasing acidic character (most acidic at the right).

Al₂O₃, Na₂O, N₂O₅

a. Al₂O₃ < Na₂O < N₂O₅
b. N₂O₅ < Al₂O₃ < Na₂O
c. Al₂O₃ < N₂O₅ < Na₂O
d. Na₂O < Al₂O₃ < N₂O₅
e. Na₂O < N₂O₅ < Al₂O₃

169. Write the balanced formula unit equation for the reaction of rubidium, Rb, with oxygen use the major product. What is the sum of the coefficients?

a. 3
b. 7
c. 8
d. 4
e. 5

170. Which of the following metal oxides would not be expected to form under conditions of limited oxygen?

a. FeO
b. PbO
c. Cu₂O
d. \( \text{CrO}_3 \)
e. \( \text{SnO} \)

171. Write the balanced formula unit equation for the reaction of the complete combustion of pentane, \( \text{C}_5\text{H}_{12} \). What is the sum of the coefficients?

a. 16  
b. 19  
c. 20  
d. 21  
e. 22

172. Combustion of fossil fuels and the roasting of metal ores often both produce oxides of

a. \( \text{P} \)  
b. \( \text{N} \)  
c. \( \text{S} \)  
d. \( \text{Si} \)  
e. \( \text{C} \)

173. The brownish color of photochemical smog is due to _________.

a. \( \text{CO} \)  
b. \( \text{NO}_2 \)  
c. \( \text{NO} \)  
d. \( \text{SO}_2 \)  
e. \( \text{SO}_3 \)

174. Combustion of fossil fuels contaminated with sulfur leads to what phenomena?

a. greenhouse effect  
b. global warming  
c. ozone destruction  
d. photochemical smog  
e. acid rain

175. The two acids that are major contributors to "acid rain" are _________.

a. \( \text{H}_2\text{CO}_3 \) and \( \text{HNO}_3 \)  
b. \( \text{H}_2\text{SO}_4 \) and \( \text{H}_3\text{PO}_4 \)  
c. \( \text{H}_2\text{CO}_3 \) and \( \text{H}_2\text{SO}_4 \)  
d. \( \text{H}_2\text{SO}_4 \) and \( \text{HNO}_3 \)  
e. \( \text{H}_3\text{PO}_4 \) and \( \text{HNO}_3 \)

176. Which of the following statements about ionic and covalent compounds is false?

a. Electrons are shared in covalent compounds.  
b. Covalent compounds are usually poor conductors of electricity.  
c. Many ionic compounds are soluble in water.  
d. Covalent compounds commonly exist as gases, liquids or solids.  
e. Ionic compounds have low melting points.

177. Which Lewis Dot Formula below is incorrect?

a. \( \text{Ca}^+ \)  
b. \( \cdot\text{I}^+\cdot \)  
c. \( \cdot\text{C}^-\cdot \)  
d. \( \cdot\text{N}^-\cdot \)
178. How many valence electrons does a phosphorus atom have?
   a. 2  
   b. 6  
   c. 3  
   d. 5  
   e. 4

179. An element has the following electronic configuration in its outermost shell. In simple ionic compounds the oxidation number of this element would be ________.

\[ \begin{array}{c}
\uparrow \downarrow \\
\text{ns} \\
\quad \\
\text{np}
\end{array} \]

   a. -1  
   b. -2  
   c. -3  
   d. +2  
   e. +1

180. Consider the following electron transfer diagram representing the formation of a binary ionic compound from atoms of its constituent elements. Which response correctly identifies the elements?

\[ \begin{array}{c}
2(M \text{ [Noble Gas]} \uparrow \downarrow \downarrow \downarrow 3s \quad \downarrow \downarrow \downarrow \downarrow 3p) \rightarrow 2(M^+ \text{ [Noble Gas]} \uparrow \downarrow \downarrow \downarrow \downarrow \downarrow 4s \quad \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow 4p) \\
X \text{ [Noble Gas]} \uparrow \downarrow \uparrow \uparrow \uparrow 3p \\
X^{2-} \text{ [Noble Gas]} \uparrow \downarrow \uparrow \uparrow \uparrow \uparrow 3s \end{array} \]

   a. M = Na, X = O  
   b. M = Ca, X = Cl  
   c. M = K, X = S  
   d. M = Na, X = S  
   e. M = Rb, X = O

181. Which Lewis dot notation for atoms and ions is correct for the reaction for the formation of aluminum oxide?

   a. \[ 3\overline{\text{Al}}^+ + 2 \cdot \text{O}^- \rightarrow 3\text{Al}^{3+}, 2\left[\text{O}^2-\right] \]
   b. \[ \text{Al}^+ + 3 \cdot \text{O}^- \rightarrow \text{Al}^{3+}, 3\left[\text{O}^2-\right] \]
   c. \[ 2\text{Al}^+ + 3 \cdot \text{O}^- \rightarrow 2\text{Al}^{3+}, 3\left[\text{O}^2-\right] \]
   d. \[ 2\overline{\text{Al}}^+ + 3 \cdot \text{O}^- \rightarrow 2\text{Al}^{3+}, 3\left[\text{O}^2-\right] \]
   e. \[ \overline{\text{Al}} + \cdot \text{O}^- \rightarrow \text{Al}^{2+}, \left[\text{O}^2-\right] \]

182. Which of the following pairs of species are isoelectronic?
   a. Ne, K⁺  
   b. Rb⁺, Cs⁺  
   c. Cl⁻, S²⁻
d. Na, Al$^{3+}$
e. S$^2-$, Se$^2-$

183. Consider the formation of one formula unit of AlF$_3$ from neutral atoms. In the process, each aluminum atom __________ electron(s) and each fluorine atom __________ electron(s).
   a. gains three; loses one
   b. loses three; gains one
   c. loses three; gains three
   d. loses one; gains three
   e. gains one; loses three

184. The formula for the simple ionic compound of calcium and nitrogen is __________.
   a. CaN
   b. Ca$_2$N
   c. Ca$_3$N$_3$
   d. CaN$_2$
   e. Ca$_3$N$_2$

185. Which of the following formulas is incorrect?
   a. Li$_2$N
   b. Mg$_2$O
   c. KI
   d. NaBr
   e. SrS

186. Which of the following is the correct Lewis dot formula for H$_2$S?
   a. H: S
   b. H: S:
   c. H: S:
   d. H: H: S:
   e. H$: [H: S:]$

187. The Lewis structure for the carbonate ion, CO$_3^{2-}$, shows __________ doubles bond(s), __________ single bond(s) and __________ lone pair(s) on the central atom.
   a. 3, 1, 2
   b. 1, 2, 0
   c. 2, 2, 1
   d. 2, 1, 1
   e. 2, 1, 2

188. When writing the relationship among N, A, and S for H$_2$CO$_3$, N = __________, A = __________, and S = __________.

<table>
<thead>
<tr>
<th>N</th>
<th>A</th>
<th>S</th>
</tr>
</thead>
</table>
   a. 36 | 24 | 12 |
   b. 36 | 26 | 10 |
   c. 34 | 22 | 12 |
   d. 40 | 16 | 14 |
Which one of the following Lewis dot formulas is incorrect?

a. \( \text{C}_2\text{H}_4, \quad \text{H}:\text{C}=\text{C}:\text{H} \)

b. \( \text{ClO}_3^-, \quad \left[ \begin{array}{c} \text{O} \quad \text{O} \\ \text{O} \end{array} \right] \)

c. \( \text{AsCl}_3, \quad \text{As}:\text{Cl}:\text{Cl}:\text{Cl} \)

d. \( \text{PH}_4^+, \quad \left[ \begin{array}{c} \text{H} \\ \text{H} \end{array} \right] \)

e. \( \text{N}_2, \quad \text{N}:\text{N} \)

Which Lewis dot formula is incorrect?

a. \( \text{NH}_4^+, \quad \left[ \begin{array}{c} \text{H} \\ \text{H} \end{array} \right] \)

b. \( \text{ClO}_4^-, \quad \left[ \begin{array}{c} \text{O} \\ \text{O} \\ \text{O} \\ \text{O} \\ \text{O} \end{array} \right] \)

c. \( \text{ClO}^-, \quad \left[ \begin{array}{c} \text{Cl} \\ \text{O} \\ \text{O} \end{array} \right] \)

d. \( \text{SO}_3^{2-}, \quad \left[ \begin{array}{c} \text{O} \\ \text{O} \\ \text{O} \end{array} \right]^{2-} \)

e. \( \text{SO}_4^{2-}, \quad \left[ \begin{array}{c} \text{O} \\ \text{O} \\ \text{O} \\ \text{O} \end{array} \right]^{2-} \)

Draw the dot formula for ethylene, \( \text{C}_2\text{H}_4 \). Each carbon-hydrogen bond is a ______ bond and each carbon-carbon bond is a ______ bond.

a. single, single
b. single, double
c. single, triple
d. double, single
e. double, double

The Lewis dot formula for \( \text{N}_2 \) shows

a. a single covalent bond.
b. a double covalent bond.
c. a triple covalent bond.
d. a single ionic bond.
e. a total of $8 \times 2 = 16$ electrons.

193. How many resonance structures does $O_3$ have?
   a. 1
   b. 2
   c. 3
   d. 4
   e. 0

194. Assign a formal charge to each atom of $\left[ \begin{array}{c} \ddot{O} \\ :Cl:O: \\ :O: \end{array} \right]^{-}$.
   a. Cl = 1-, O = 0
   b. Cl = 0, O = 0
   c. Cl = 0, O = 1-
   d. Cl = 2+, O = 1-
   e. Cl = 2-, O = 1-

195. Which one of the following dot formulas is incorrect?
   a. \[ H \quad H \quad C_2H_4 \quad \ddot{C}::\ddot{C} \quad H \quad H \]
   b. \[ SiF_4 \quad \dddot{F}::\dddot{F}::\dddot{F}::\dddot{F}:: \]
   c. \[ PH_3 \quad H::\dddot{P}::H \quad H \]
   d. \[ BCl_3 \quad \dddot{Cl}::\dddot{Cl}::\dddot{Cl}:: \]
   e. \[ SO_3^{2-} \quad \left[ \begin{array}{c} \dddot{O}::\dddot{S}::\dddot{O} \\ :O: \end{array} \right]^{-} \]

196. Which response lists all of the correct Lewis dot formulas and no incorrect ones?

I. \[ H-O-O-P-O-H \]
   \[ H \quad H \quad H_3PO_4 \]

II. \[ \dddot{F}::\dddot{F}::\dddot{F}:: \]
   \[ AsF_5 \]
III. \( \text{BeI}_2 \) 

IV. \( \text{CF}_4 \)

a. I and II 
b. II, III, and IV 
c. III and IV 
d. II and III 
e. I, II, and III 

197. Which of the following molecules can NOT exist? 
   a. \( \text{PI}_6 \) 
   b. \( \text{BeF}_2 \) 
   c. \( \text{SF}_2 \) 
   d. \( \text{CF}_3 \) 
   e. \( \text{N}_2\text{O} \) 

198. Which of the responses lists only the molecules below that have polar covalent bonds? 
   HI, \( \text{I}_2 \), \( \text{S}_8 \), KCl 
   a. HI and KCl 
   b. \( \text{I}_2 \) 
   c. \( \text{S}_8 \) 
   d. \( \text{I}_2 \) and KCl 
   e. HI 

199. Which molecule has the most polar covalent bond? 
   a. \( \text{IBr} \) 
   b. \( \text{HCl} \) 
   c. \( \text{N}_2 \) 
   d. \( \text{H}_2 \) 
   e. \( \text{PH}_3 \) 

200. Which one of the following molecules contains bonds that are the most polar? 
   Electronegativities: \( \text{H} = 2.1 \), \( \text{Be} = 1.5 \), \( \text{B} = 2.0 \), \( \text{N} = 3.0 \), \( \text{F} = 4.0 \), \( \text{S} = 2.5 \), \( \text{Br} = 2.8 \), \( \text{I} = 2.5 \) 
   a. \( \text{SF}_6 \) 
   b. \( \text{BI}_3 \) 
   c. \( \text{BeBr}_2 \) 
   d. \( \text{NH}_3 \) 
   e. \( \text{NF}_3 \) 

201. Which one of the following molecules does not have a dipole moment? 
   a. \( \text{IBr} \) 
   b. \( \text{NO} \)
202. Which one of the following compounds contains both ionic and covalent bonding?
   a. LiF
   b. KNO₃
   c. MgO
   d. CaCl₂
   e. Rb₃N

203. Which of the following compounds does not contain both ionic and covalent bonding?
   a. NaNO₃
   b. BaSO₄
   c. CBr₄
   d. NaClO₃
   e. NH₄Br

204. What is the electronic geometry for 5 regions of high electron density on a central atom?
   a. octahedral
   b. square planar
   c. tetrahedral
   d. trigonal bipyramidal
   e. trigonal planar

205. What is the electronic geometry for 6 regions of high electron density on a central atom?
   a. octahedral
   b. square planar
   c. trigonal bipyramidal
   d. tetrahedral
   e. trigonal planar

206. Which one of the following molecules is polar?
   a. N₂
   b. P₄
   c. Cl₂
   d. CO₂
   e. H₂O

207. Which one of the following statements about compounds or polyatomic ions of the A group elements is false?
   a. All compounds in which the central atom is sp³d² hybridized violate the octet rule.
   b. Sulfur hexafluoride is an example of a compound with a central atom that has sp³d² hybridization.
   c. All molecules in which the central element is sp³d² hybridized have octahedral electronic geometry.
   d. All molecules in which the central element is sp³d² hybridized have octahedral molecular geometry.
   e. All ions in which the central atom is sp³d² hybridized have octahedral electronic geometry.

208. The hybridization associated with the central atom of a molecule in which all the bond angles are 109.5° is
   a. sp
   b. sp²
209. The central atom in a molecule is sharing a total of 12 electrons. What type of hybrid orbitals are formed by the central atom?
   a. \( sp^3 \)
   b. \( sp^2 \)
   c. \( sp^3 \)
   d. \( sp'd \)
   e. \( sp'd^2 \)

210. What kind of hybrid orbitals are utilized by the boron atom in BF\(_3\) molecules?
   a. \( sp \)
   b. \( sp^2 \)
   c. \( sp^3 \)
   d. \( sp'd \)
   e. \( sp'd^2 \)

211. Which of the following is a false statement about BF\(_3\)?
   a. BF\(_3\) has trigonal planar molecular geometry.
   b. BF\(_3\) has trigonal pyramidal electronic geometry.
   c. All three bond angles in BF\(_3\) are 120\( ^\circ \).
   d. The B atom does not satisfy the octet rule.
   e. Although the electronegativity difference between B and F is large (2.0 units), BF\(_3\) is a covalent compound.

212. Which of the following statements about chloroform, CHCl\(_3\), is false?
   a. The hybridization of C is \( sp^3 \).
   b. The hybridization of Cl is \( sp^3 \).
   c. The bond angles are 109.5\( ^\circ \).
   d. The molecule is polar.
   e. The molecule has tetrahedral electronic geometry.

213. For AsF\(_3\), the electronic geometry is ________ and the molecular geometry is ________.
   a. tetrahedral, trigonal planar
   b. trigonal planar, tetrahedral
   c. tetrahedral, tetrahedral
   d. trigonal planar, trigonal planar
   e. trigonal planar, linear

214. Which of the following statements regarding a carbon atom involved in 2 double bonds is false?
   a. The geometry is linear.
   b. The hybridization is \( sp \).
   c. There are 2 sigma and two pi bonds.
   d. The C atom has two unhybridized \( p \) atomic orbitals.
   e. The C atom can make one more bond to complete its octet.

215. Choose the species that is incorrectly matched with the electronic geometry about the central atom.

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Electronic Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiH(_4)</td>
<td>tetrahedral</td>
</tr>
</tbody>
</table>
b. SO₂ \text{ trigonal planar}

c. NH₂⁻ \text{ tetrahedral}

d. NH₃ \text{ tetrahedral}

e. BH₄⁻ \text{ trigonal planar}

216. Which one of the following molecules has a central atom that is \textbf{not} \text{sp}³ hybridized?

a. H₂O
b. NH₃
c. CH₄
d. CHCl₃
e. SF₄

217. Which species is \textbf{incorrectly} matched with \textbf{bond angles}?

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Bond Angles</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Cl₄</td>
<td>109.5°</td>
</tr>
<tr>
<td>b. BeF₂</td>
<td>180°</td>
</tr>
<tr>
<td>c. HI</td>
<td>90°</td>
</tr>
<tr>
<td>d. I₃⁻</td>
<td>180°</td>
</tr>
<tr>
<td>e. Bi₃</td>
<td>120°</td>
</tr>
</tbody>
</table>

218. Which response contains all the covalent molecules below that are polar, and no others?

I. CCl₄
II. HBr
III. N₂
IV. C₂H₆
V. H₂S

a. II, III, and IV
b. I and II
c. III, IV, and V
d. II and V
e. I, III, and V

219. Which one of the following is the \textbf{most polar molecule}?

Electronegativities: H = 2.1, Be = 1.5, B = 2.0, F = 4.0, S = 2.5, Cl = 3.0, Te = 2.1, P = 2.1)

a. BF₃
b. H₂S
c. BeCl₂
d. H₂Te
e. PF₅

220. Which one of the following statements about nuclear reactions does \textbf{not} correctly distinguish nuclear reactions from ordinary chemical reactions?

a. Particles within the nucleus are involved.
b. No new elements can be produced.
c. Rate of reaction is independent of the presence of a catalyst.
d. Rate of reaction is independent of temperature.
e. They are often accompanied by the release of enormous amounts of energy.

221. Which statement concerning stable nuclides and/or the "magic numbers" (such as 2, 8, 20, 28, 50, 82 or 128) is false?

a. Nuclides with their number of protons equal to a "magic number" are especially stable.
b. Nuclides with their number of neutrons equal to a "magic number" are especially stable.
c. Nuclides with the sum of the numbers of their protons and neutrons equal to a "magic number" are especially stable.
d. Above atomic number 20, the most stable nuclides have more protons than neutrons.
e. The existence of "magic numbers" suggests an energy level (shell) model for the nucleus.

Particles
Masses of subatomic particles that may be useful for the following questions.

electron 0.00055 amu
proton 1.0073 amu
neutron 1.0087 amu

222. Refer to Particles. The mass of one atom of $^{30}_{14}$ silicon is 29.9738 amu. What is its mass deficiency?

a. 1.742 amu
b. 1.757 amu
c. 0.275 amu
d. 0.413 amu
e. 0.272 amu

Values 26
Values that may be useful for the following questions.

speed of light $= 3.00 \times 10^8$ m/s
1 J = 1 kg•m$^2$/s$^2$
1 cal = 4.18 J

223. Refer to Values 26. The mass deficiency for an isotope was found to be 0.410 amu/atom. Calculate the binding energy in J/mol of atoms.

a. $3.69 \times 10^{13}$ J/mol
b. $1.23 \times 10^{20}$ J/mol
c. $3.69 \times 10^9$ J/mol
d. $1.23 \times 10^3$ J/mol
e. $1.23 \times 10^{13}$ J/mol

224. Refer to Values 26. Calculate the nuclear binding energy in kJ/g of an isotope that has a mass deficiency of 0.6050 amu/atom. The isotope has a mass of 63.9280 amu.

a. $5.44 \times 10^{10}$ kJ/g
b. $1.89 \times 10^{10}$ kJ/g
c. $2.97 \times 10^8$ kJ/g
d. $3.48 \times 10^{12}$ kJ/g
e. $8.52 \times 10^8$ kJ/g

225. Which isotope below has the smallest nuclear binding energy per gram? (No calculations are necessary.)

a. $^4_2$ He
--- 226. A positron has a mass number of __________, a charge of __________, and a mass equal to that of a(an) __________.
   a. 0, 1+, proton
   b. 1, 2+, proton
   c. 0, 1+, electron
   d. 1, 2+, electron
   e. 0, 0, proton

--- 227. Complete and balance the following equation. The missing term is __________.

\[ ^{85}_{36} \text{Kr} \rightarrow _____ + ^0_\beta \]
   a. \(^{85}_{36} \text{Kr}\)
   b. \(^{85}_{37} \text{Rb}\)
   c. \(^{84}_{36} \text{Kr}\)
   d. \(^{85}_{35} \text{Br}\)
   e. \(^{85}_{35} \text{Rb}\)

--- 228. Complete and balance the following equation. The missing term is __________.

\[ ^{92}_{37} \text{Rb} \rightarrow _____ + ^0_\beta \]
   a. \(^{92}_{38} \text{U}\)
   b. \(^{92}_{36} \text{Kr}\)
   c. \(^{92}_{38} \text{Sr}\)
   d. \(^{92}_{37} \text{Rb}\)
   e. \(^{91}_{36} \text{K}\)

--- 229. Complete and balance the following equation. The missing term is __________.

\[ ^{14}_{7} \text{N} + ^{1}_{1} \text{H} \rightarrow ^{15}_{8} \text{O} + _____ \]
   a. \(^{0}_{-1} \beta\)
   b. \(^{0}_{+1} \beta\)
   c. \(^{4}_{2} \text{He}\)
   d. \(^{0}_{0} \gamma\)
230. A radioisotope of argon, $^{37}_{18}$Ar, lies below the "band of stability." One would predict that it decays via

a. neutron emission
b. beta emission
c. electron capture
d. alpha emission
e. fission

231. The half-life of Tc-99 is $2.13 \times 10^5$ years. What is the value of the specific rate constant, $k$?

a. $3.25 \times 10^{-6}$ y$^{-1}$
b. $1.41 \times 10^{-6}$ y$^{-1}$
c. $4.69 \times 10^{-6}$ y$^{-1}$
d. $0.693$ y$^{-1}$
e. $1.48 \times 10^5$ y$^{-1}$

232. The specific rate constant for the decay of Tc-95 is $0.0346$ h$^{-1}$. What is its half-life?

a. 10.6 h
b. 8.70 h
c. 28.9 h
d. 0.0499 h
e. 20.0 h

233. The half-life of Sr-83 is 32.4 hours. How much of a 20.0-mg sample of $^{83}_{38}$Sr will be left after 75.0 hours?

a. 3.68 mg
b. 0.249 mg
c. 4.02 mg
d. 0.497 mg
e. 4.62 mg

234. Which one of the following reactions represents fission?

a. $^{238}_{92}$U + $^{12}_{6}$C $\rightarrow$ $^{246}_{98}$Cf + $^{4}_{0}$n
b. $^{15}_{5}$B + $^{4}_{2}$He $\rightarrow$ $^{12}_{6}$C + $^{3}_{1}$H
c. $^{233}_{90}$Th $\rightarrow$ $^{203}_{92}$Tb + $^{0}_{1}$e
d. $^{235}_{92}$U + $^{1}_{0}$n $\rightarrow$ $^{146}_{55}$La + $^{87}_{35}$Ba + $^{3}_{0}$n
e. $^{3}_{1}$H + $^{2}_{1}$H $\rightarrow$ $^{4}_{2}$He + $^{1}_{0}$n

235. Which one of the components of a light water reactor listed below is described by an incorrect function?

<table>
<thead>
<tr>
<th>Component</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. moderator</td>
<td>slows neutrons</td>
</tr>
<tr>
<td>b. fuel</td>
<td>supplies neutrons plus heat</td>
</tr>
<tr>
<td>c. cooling system</td>
<td>coolant for the reactor</td>
</tr>
<tr>
<td>d. control rods</td>
<td>absorb some neutrons to control rate of fission</td>
</tr>
<tr>
<td>e. shielding</td>
<td>prevents the absorption of beta gamma rays by the fuel and cooling system</td>
</tr>
</tbody>
</table>
236. The major problem associated with the development of fusion for controlled energy generation is
__________.
   a. containment of radioactive products of fusion
   b. relatively low energy yield per gram of fuel
   c. containment of extremely high temperature plasmas
   d. depletion of water reserves which serve as a source of fuel
   e. the resulting air pollution

237. Four of the following factors can affect the forward rate of a chemical reaction. Which one cannot affect this rate? (Note: the question refers to reaction rate, not equilibrium.)
   a. temperature
   b. concentration of reactants of the forward reaction
   c. presence of a catalyst
   d. removal of some of the products of the forward reaction
   e. physical state or state of subdivision of solid reactants

238. A hypothetical reaction $X + 2Y \rightarrow$ Products is found to be first order in X and second order in Y. What are the units of $k$, the specific rate constant, if reaction rate is expressed in units of moles per liter per second?
   a. $M\cdot s^{-1}$
   b. $M^{2}\cdot s^{-1}$
   c. $M^{3}\cdot s$
   d. $M^{2}\cdot s^{-1}$
   e. $M\cdot s$

239. The half-life for the reactant A in the first order reaction $A \rightarrow B$ is 36.2 seconds. What is the rate constant for this reaction at the same temperature?
   a. 52.2 s^{-1}
   b. 0.0276 s^{-1}
   c. 0.0191 s^{-1}
   d. 18.1 s^{-1}
   e. 0.00832 s^{-1}

240. The rate constant for the first order reaction $A \rightarrow B + C$ is $k = 3.3 \times 10^{-2} \text{ min}^{-1}$ at 57 K. What is the half-life for this reaction at 57 K?
   a. 21 min
   b. 30 min
   c. 61 min
   d. 9.1 min
   e. 1200 min

241. The rate constant for the second order reaction $2NO_2 \rightarrow N_2O_4$ is 2.79 L/mol•min at 48 °C. If the initial concentration of NO_2 is 1.05 $M$, what is the half-life?
   a. 20.5 s
   b. 10.3 s
   c. 0.341 min
   d. 176 s
   e. 14.9 s

242. The half-life of the zero order reaction $A \rightarrow B$ is 0.56 minutes. If the initial concentration of A is 3.4 $M$, what is the rate constant?
   a. 6.07 mol/L •min
b. 1.24 mol/L • min
c. 3.04 mol/L • min
d. 0.619 mol/L • min
e. 1.79 mol/L • min

Essay

243. Explain why the 1st ionization energy of N is larger than that of O.

244. The 2nd ionization energy is the energy to remove a second electron. Why is the 2nd IE of potassium much larger than the 1st IE? Comment on the relative values of the 1st IE of Ne and the 2nd IE of Na.

245. Burning fossil fuels produces SO₂, a pollutant responsible for acid rain. SO₂ is formed when sulfur in the fossil fuels combines with oxygen during combustion. Give several ways to reduce the amount of acid rain produced by SO₂.
### AP Chemistry-midterm review

**Answer Section**

#### MULTIPLE CHOICE

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228. ANS: C  
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PTS: 1

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ESSAY

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