8. Shown below are the postulates of the kinetic molecular theory:

I. Gases are mostly empty space; the volume of the gas particles is negligible.
II. Gas particles are in constant random motion.
III. Gas particles neither attract nor repel each other.
IV. Pressure is due to collisions of gas particles with the walls of the container.
V. The average kinetic energy of a gas sample is proportional to the Kelvin temperature.

Which of the above postulates do not always hold true for real gases?

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

Consider the following gases for the next two questions:

Ne  Ar  N₂  H₂

11. Which gas has the largest average kinetic energy at 300 K?

a. Ne  b. Ar  c. N₂  d. H₂
e. All of the gases have the same average kinetic energy at 300 K.

12. Which of the gases has the fastest average velocity at 300 K?

a. Ne  b. Ar  c. N₂  d. H₂
e. All of the gases have the same average velocity at 300 K.

31. An unknown gas has an average velocity which is \( \frac{1}{2} \) (one-half) that of the He average velocity at some temperature. Which of the following is the best choice for the unknown gas?

a. CH₄  b. Ne  c. H  d. O₂  e. H₂
2. How many significant figures should the answer to the following problem have?

\[
\left(\frac{(0.0023 + 101.23)(3.24 + 2.221)}{6.24 - 3.04}\right)
\]

a. one  b. two  c. three  d. four  e. five

3. A 50.00 g sample of a solid is placed into a graduated cylinder and then the cylinder is filled to the 100.00 mL mark with Code Red Mountain Dew (density = 1.04 g/mL). The mass of Code Red and solid together is 146.40 g. Assuming the solid is insoluble in the Code Red, calculate the density of the solid.

a. 0.519 g/mL  b. 1.46 g/mL  c. 6.84 g/mL
d. 6.94 g/mL  e. 7.31 g/mL

6. A compound containing only C, H, and N is 55.77% C and 32.53% N by mass. The molar mass of the compound is between 50.00 and 100.00 g/mol. What is the molecular formula of the compound?

d. C₄H₁₀N₂  e. C₃H₃N₃

7. A certain protein contains 4 atoms of iron per molecule. If analysis of 500.0 g of protein yields 6.6 grams of iron, what is the molar mass of the protein?

a. 4,300 g/mol  b. 17,000 g/mol  c. 24,000 g/mol
d. 30,000 g/mol  e. 68,000 g/mol

8. Consider 2 reactants, A and B. The molar mass of A is greater than the molar mass of B. You add equal masses of A and B together and let them react. Which of the following (a-d) statements **must** be true?

a. Reactant A **must** be limiting.
b. Reactant B **must** be limiting.
c. If the coefficient for B is greater than the coefficient of A in the balanced equation, then reactant B **must** be limiting.
d. If the coefficient for A is greater than the coefficient of B in the balanced equation, then reactant A **must** be limiting.
e. None of the above choices **must** be true.
9. How much water must you add to 50.0 mL of 0.750 M MgCl₂ in order to form a solution having a Cl⁻ concentration of 0.100 M?

a. 700. mL       b. 375 mL       c. 325 mL
    d. 750. mL       e. 425 mL

10. The reaction of element X (shaded squares) with element Y (open circles) is represented in the following diagrams. Which of the equations best describes this reaction?

    a. 3X + 8Y → X₃Y₈       b. 3X + 6Y → X₃Y₆       c. X + 2Y → XY₂
    d. 4X + 6Y → 3XY₂ + 2X   e. X + 4Y → XY₂

11. Which of the following samples contains the largest number of Cl atoms or Cl ions? W is element #74.

a. 2.0 g HCl       b. 2.0 g KCl       c. 2.0 g SrCl₂
    d. 2.0 g HClO₄    e. 2.0 g WCl₃

12. Glucose is metabolized in the body according to the following balanced reaction:

C₆H₁₂O₆(s) + 6O₂(g) → 6CO₂(g) + 6H₂O(l)

What mass of carbon dioxide (MM = 44.01 g/mol) is produced if 45.0 grams of water (MM = 18.02 g/mol) are produced?

a. 2.50 g       b. 18.3 g       c. 45.0 g
    d. 110. g      e. 270. g

14. A sample of ascorbic acid (vitamin C) is synthesized in the laboratory. It contains 1.50 g of carbon and 2.00 g of oxygen, along with other elements. Another sample of ascorbic acid isolated from nature contains 6.35 g of carbon. How many grams of oxygen does the second sample contain?

a. 8.47 g O       b. 16.9 g O       c. 4.23 g O
    d. 9.07 g O      e. none of these
15. Consider the following \textit{unbalanced} reaction:

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

If the reaction has a 68.4\% yield how many grams of zinc (MM = 65.38 g/mol) are needed to obtain an actual yield of 1.00 g of zinc chloride (MM = 136.28 g/mol)?

a. 7.01 g  
b. 0.701 g  
c. 1.40 g  
d. 0.480 g  
e. 0.960 g

16. You are holding two balloons, one orange and one blue. The blue balloon contains He and is 4 times the volume of the orange balloon. The orange balloon contains Ne. Which of following best represents the mass ratio of He:Ne in the balloons?

a. 5:4  
b. 4:5  
c. 4:1  
d. 1:4  
e. 20:1

17. How many grams of precipitate can form when 23.7 mL of 0.204 M sodium sulfate are mixed with 30.6 mL of 0.130 M calcium nitrate? Assume the reaction goes to completion.

a. 0.271 g  
b. 0.329 g  
c. 0.542 g  
d. 0.658 g  
e. 1.22 g

18. What ions remain in the solution after 23.7 mL of 0.204 M sodium sulfate are mixed with 30.6 mL of 0.130 M calcium nitrate (this is the same reaction as in the previous question)? Assume the reaction goes to completion.

I. sodium ion  
II. nitrate ion  
III. calcium ion  
IV. sulfate ion

a. I, II  
b. I, III, IV  
c. I, II, IV  
d. II, III, IV  
e. I, II, III
19. How many of the following five statements are true concerning ideal gases?

I. At constant P and T, a 2.0 L sample of \( \text{N}_2 \) (g) contains the same number of molecules as a 1.0 L sample of \( \text{O}_2 \) (g).
II. At constant n and T, as the volume of a gas sample increases, the pressure of the gas increases.
III. For a mixture of gases, the total pressure is the sum of the partial pressures of all the gases present.
IV. At constant V and T, the moles of gas present is directly related to the pressure of the gas sample.
V. At constant P and n, a plot of volume (L) vs. temperature (K) is linear.

a. zero  
   b. one  
   c. two  
   d. three  
   e. four (4 statements are true)

20. Automobile airbags inflate when solid sodium azide, \( \text{NaN}_3 \), decomposes explosively to form the elements, \( \text{Na} \) (s) and \( \text{N}_2 \) (g) according to the following \textit{balanced} reaction.

\[
2 \text{NaN}_3 (s) \rightarrow 2 \text{Na} (s) + 3 \text{N}_2 (g)
\]

How many grams of \( \text{NaN}_3 \) are needed to produce enough nitrogen gas to fill an airbag with a volume of 10.0 L at 25°C and 1.50 atm?

a. 0.613 g \( \text{NaN}_3 \)  
   b. 39.9 g \( \text{NaN}_3 \)  
   c. 475 g \( \text{NaN}_3 \)  
   d. 59.8 g \( \text{NaN}_3 \)  
   e. 26.6 g \( \text{NaN}_3 \)

21. Four identical 25 L flasks (each at standard temperature and pressure) contain the gases \( \text{Ar} \), \( \text{CO}_2 \), \( \text{O}_2 \), and \( \text{He} \). Which gas has the smallest density?

a. \( \text{He} \)  
   b. \( \text{O}_2 \)  
   c. \( \text{Ar} \)  
   d. \( \text{CO}_2 \)  
   e. All have the same density.

22. \( \text{O}_2 \) gas is collected over water into a 2.00 L container at 30. °C and a total pressure of 783 torr. The vapor pressure of \( \text{H}_2\text{O} \) at 30. °C is 31.8 torr. What is the pressure of the dried gas at 25 °C in the same 2.00 L container?

a. 752 torr  
   b. 783 torr  
   c. 739 torr  
   d. 764 torr  
   e. 770. torr
23. A 100. mL flask containing O₂ (g) at 3.00 atm and a 300. mL flask containing He (g) at 3000. torr are connected by a stopcock (see picture below).

After the stopcock valve between the two flasks is opened and the gases have time to mix completely, what is the total pressure inside the entire system? Assume the temperature is constant.

a. 6.94 atm   b. 7.00 atm   c. 7.06 atm
   d. 3.00 atm   e. 3.71 atm

24. A 0.25 M Ca(OH)₂ solution is used to titrate HCl. It takes 20.7 mL of base to react completely with 30.0 mL of HCl. Calculate the molarity of the HCl solution.

a. 0.50 M   b. 0.17 M   c. 8.6 x 10⁻² M
   d. 3.1 x 10⁻⁴ M   e. 0.35 M

25. How many of the following five compounds are not strong electrolytes?

PCl₅  H₂CO₃  HNO₃  H₂O  C₁₂H₂₂O₁₁

a. zero (all are strong electrolytes)   b. one   c. two   d. three   e. four (4 are not strong electrolytes)

26. How many of the following four reactions are correctly classified?

I. Na₂CO₃ (aq) + ZnCl₂ (aq) → 2 NaCl (aq) + ZnCO₃ (s) precipitation reaction
II. H₃PO₄ (aq) + 3 KOH (aq) → 3 H₂O (l) + K₃PO₄ (aq) acid-base reaction
III. Mg (s) + 2 HCl (aq) → MgCl₂ (aq) + H₂ (g) single displacement reaction
IV. KClO₃ (s) → 2 KCl (s) + 3 O₂ (g) synthesis reaction

a. zero   b. one   c. two   d. three   e. four (all are correctly classified)
27. At STP, 6.50 L of F₂ reacts completely with 3.25 L of Xe to form 3.25 L of product gas. What is the formula of the product?

a. XeF  
   b. Xe₂F₃  
   c. XeF₂  
   d. Xe₄F₂  
   e. XeF₄

28. If 6.00 g of CH₄ is combusted with excess oxygen, what volume of water is produced? Assume the density of water is 0.997 g/mL.

a. 0.166 mL  
   b. 6.02 mL  
   c. 6.76 mL  
   d. 13.5 mL  
   e. 27.0 mL

30. Consider the following balanced reaction:

\[2 \text{C}_3\text{H}_6(g) + 9 \text{O}_2(g) \rightarrow 6 \text{CO}_2(g) + 6 \text{H}_2\text{O}(l)\quad \Delta H=?\]

When 4.00 mol of C₃H₆ are reacted completely with excess O₂, 8880 kJ of heat are released (produced). Determine \(\Delta H\) for this reaction as it is written above.

a. 8880 kJ  
   b. -2220 kJ  
   c. 2220 kJ  
   d. 4440 kJ  
   e. -4440 kJ

31. At 227 °C and 26.4 torr, a certain gas has a density of \(1.71 \times 10^{-2}\) g/L. The gas is:

a. He  
   b. Ne  
   c. Ar  
   d. Xe  
   e. Zr