1. Which statement describes how an atom in the ground state becomes excited?
   1. The atom absorbs energy, and one or more electrons move to a higher electron shell.
   2. The atom absorbs energy, and one or more electrons move to a lower electron shell.
   3. The atom releases energy, and one or more electrons move to a higher electron shell.
   4. The atom releases energy, and one or more electrons move to a lower electron shell.

2. Which element has both metallic and nonmetallic properties?

3. Which atom has the greatest nuclear charge?

4. An atom is electrically neutral because the
   1. number of protons equals the number of electrons
   2. number of protons equals the number of neutrons
   3. ratio of the number of neutrons to the number of electrons is 1:1
   4. ratio of the number of neutrons to the number of protons is 2:1

5. How do the energy and the most probable location of an electron in the third shell of an atom compare to the energy and the most probable location of an electron in the first shell of the same atom?
   1. In the third shell, an electron has more energy and is closer to the nucleus.
   2. In the third shell, an electron has more energy and is farther from the nucleus.
   3. In the third shell, an electron has less energy and is farther from the nucleus.
   4. In the third shell, an electron has less energy and is closer to the nucleus.

6. Which two particles make up most of the mass of a hydrogen-2 atom?
   1. electron and neutron
   2. proton and neutron
   3. electron and proton
   4. proton and positron

7. An orbital is defined as a region of the most probable location of
   1. an electron
   2. a nucleus
   3. a neutron
   4. a proton

8. What is the electron configuration of a calcium ion (Ca²⁺) in the ground state?
   1. 2-8-8
   2. 2-8-8-8
   3. 2-8-8-1
   4. 2-8-8-2

9. Which statement explains why neon is a Group 18 element?
   1. Neon is a gas at STP.
   2. Neon has a low melting point.
   3. Neon atoms have a stable valence electron configuration.
   4. Neon atoms have two electrons in the first shell.

10. Which substance can be broken down by chemical means?
    1. magnesium
    2. mercury
    3. manganese
    4. methanol
11. What is the molecular formula of a compound with an empirical formula of CH and a molecular mass of 78?

12. Which of the following statements explains why mass is lost when a student heats a sample of BaCl₂·2H₂O crystals?
   1. Water is given off as a gas.
   2. The crystals fuse (melt).
   3. Chlorine is given off as a gas.
   4. The crystals sublime.

13. A substance is classified as either an element or a
   1. compound  2. solution  3. heterogeneous mixture  4. homogeneous mixture

14. Which of the following statements is an identifying characteristic of a mixture?
   1. a mixture must be homogeneous.
   2. a mixture must have a definite composition by weight
   3. a mixture can be separated by physical means.
   4. a mixture can consist of a single element.

15. Compared to a 26-gram sample of NaCl(s) at STP, a 52-gram sample of NaCl(s) at STP has
   1. a different density
   2. a different gram-formula mass
   3. the same chemical properties
   4. the same volume

16. The combustion of propane is best described as an
   1. endothermic physical change
   2. exothermic chemical change
   3. exothermic physical change
   4. endothermic chemical change

17. What occurs as two atoms of fluorine combine to become a molecule of fluorine?
   1. A bond is formed as energy is absorbed.
   2. A bond is formed as energy is released.
   3. A bond is broken as energy is absorbed.
   4. A bond is broken as energy is released.

18. In substances that sublime, the intermolecular forces of attraction are
   1. strong and the vapor pressure is high
   2. weak and the vapor pressure is low
   3. weak and the vapor pressure is high
   4. strong and the vapor pressure is low

19. Which phase change is endothermic?
   1. gas to solid
   2. liquid to solid
   3. liquid to gas
   4. gas to liquid

20. According to the kinetic theory of gases, which assumption is correct?
   1. gas particles travel in curved paths
   2. energy may be transferred between colliding particles.
   3. the volume of gas particles prevents random motion
   4. gas particles strongly attract each other

21. Which element has an atom with the greatest tendency to attract electrons in a chemical bond?
   1. carbon
   2. silicon
   3. chlorine
   4. sulfur

2.16  1.9  3.2  2.6
22. Which two characteristics are associated with metals?
1. low first ionization energy and low electronegativity
2. low first ionization energy and high electronegativity
3. high first ionization energy and low electronegativity
4. high first ionization energy and high electronegativity

23. Lithium and potassium have similar chemical properties because the atoms of both elements have the same
1. mass number
2. number of electron shells
3. atomic number
4. number of valence electrons

24. The element in Period 2 with the largest atomic radius is
1. an alkali metal
2. an alkaline earth metal
3. a halogen
4. a noble gas

25. Which particle has the largest radius?
1. Cl⁻
2. Ne
3. Ar
4. F⁻

26. Which group 15 elements can lose an electron most readily?
1. P
2. Sb
3. Bi
4. N

27. The color of Na₂CrO₄ is due to the presence of
1. an alkali metal
2. a transition element
3. a halogen
4. a noble gas

28. Which gas is monatomic at STP?
1. helium
2. chlorine
3. oxygen
4. hydrogen

29. Given the balanced equation representing a reaction:
   \[ \text{H}_2(g) + \text{Cl}_2(g) \rightarrow 2\text{HCl}(g) + \text{energy} \]
Which statement describes the energy changes in this reaction?
1. Energy is absorbed as bonds are formed, only.
2. Energy is released as bonds are broken, only.
3. Energy is absorbed as bonds are broken, and energy is released as bonds are formed.
4. Energy is absorbed as bonds are formed, and energy is released as bonds are broken.

30. Which element consists of positive ions immersed in a "sea" of electrons?
1. S
2. Ca
3. N
4. Cl

31. Which of the following liquids has the weakest van der Waals's forces of attraction between its molecules?
1. Xe (l)
2. Kr (l)
3. He (l)
4. Ne (l)

32. Which two substances are covalent compounds?
1. C₆H₁₂O₆(s) and KI(s)
2. KI(s) and NaCl(s)
3. C₆H₁₂O₆(s) and HCl(g)
4. NaCl(s) and HCl(g)

33. Given the balanced equation representing a reaction:
   \[ 2\text{CO}(g) + \text{O}_2(g) \rightarrow 2\text{CO}_2(g) \]
What is the mole ratio of CO(g) to CO₂(g) in this reaction?
1. 1:1
2. 2:1
3. 1:2
4. 3:2

2 + 2 reduces to 1 + 1
34. Which compound has hydrogen bonding between its molecules?
1. CH₄  2. KI  3. CaH₂  4. NH₃

35. Which molecule is nonpolar and contains a nonpolar covalent bond?
1. CCl₄  2. HF  3. F₂  4. HCl

36. Which formula represents lead (II) chromate?
1. PbCrO₄  2. Pb₂CrO₄  3. Pb(CrO₄)₂  4. Pb₂(CrO₄)₃

37. Given the balanced equation representing the reaction between propane and oxygen:
   \[ C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O \]
   According to this equation, which ratio of oxygen to propane is correct?
   \[
   \begin{align*}
   \frac{5 \text{ grams } O_2}{1 \text{ gram } C_3H_8} & \quad \frac{10 \text{ grams } O_2}{11 \text{ grams } C_3H_8} \\
   \frac{5 \text{ moles } O_2}{1 \text{ mole } C_3H_8} & \quad \frac{10 \text{ moles } O_2}{11 \text{ moles } C_3H_8}
   \end{align*}
   \]

38. In the compound KHSO₄, there is an ionic bond between the
   1. K⁺ and SO₄²⁻ ions  2. KHSO₃⁻ and O₂⁻ ions  3. K⁺ and HSO₄⁻ ions

39. Given the balanced equation representing a reaction:
   \[ H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l) \]
   Which type of reaction is represented by this equation?
   1. decomposition  2. neutralization/double replacement  3. single replacement  4. synthesis

40. Which salt is produced when sulfuric acid and calcium hydroxide react completely?

41. Which 0.2 M solution has the greatest concentration of the hydronium ion?
   1. CH₃COOH  2. LiH  3. NaCl  4. LiOH

42. Which compounds are electrolytes?
   \[ \text{ALL ACIDS, BASES, SALT} \]
   1. H₂SO₄ and H₂SO₄  2. H₂SO₄ and CH₄  3. KOH and H₂SO₄  4. KOH and CH₃OH

43. For which compound is the process of dissolving in water exothermic?
   \[ \text{USE Table I} \]
   1. NaCl  2. NH₄Cl  3. NaOH  4. NH₄NO₃

44. What is the oxidation number of iodine in KIO₃?
   \[ +1 \quad 2. +7 \quad 3. -1 \quad 4. -7 \]

45. Which hydrocarbon is a member of the series with the general formula CₙH₂ₙ₊₂?
   1. ethyne  2. butane  3. ethene  4. benzene

46. In which type of reaction do two lighter nuclei combine to form one heavier nucleus?
   1. combustion  2. nuclear fission  3. reduction  4. nuclear fusion

Memorize
47. Butanal and butanone have different chemical and physical properties primarily because of differences in their functional groups, molecular formulas, molecular masses, and number of carbon atoms per molecule.

48. The diagram below represents an operating electrochemical cell and the balanced ionic equation for the reaction occurring in the cell.

\[ \text{Zn(s)} + \text{Ni}^{2+}(aq) \rightarrow \text{Zn}^{2+}(aq) + \text{Ni(s)} \]

Which statement identifies the part of the cell that conducts electrons and describes the direction of electron flow as the cell operates?
1. Electrons flow through the salt bridge from the Ni(s) to the Zn(s).
2. Electrons flow through the salt bridge from the Zn(s) to the Ni(s).
3. Electrons flow through the wire from the Ni(s) to the Zn(s).
4. Electrons flow through the wire from the Zn(s) to the Ni(s).

49. Which compounds are isomers?
1. ethane & ethanol
2. methanoic acid and ethanoic acid
3. 1-propanol & 2-propanol
4. methanol & methanal

50. Which radioisotope has an atom that emits a particle with a mass number of 0 and a charge of +1?
1. $\text{{}^3\text{H}}^-$
2. $\text{{}^{19}\text{Ne}}^+$
3. $\text{{}^{16}\text{N}}\beta^-$
4. $\text{{}^{239}\text{Pu}}\alpha$

51. Which particle diagram represents the arrangement of F₂ molecules in a sample of fluorine at 95 K and standard pressure?

Table: S
- melt: 53 K
- boil: 85 K

52. During which intervals is potential energy decreasing and average kinetic energy remaining constant?
1. AB and BC
2. DE and BC
3. AB and CD
4. DE and EF
53. What is the total amount of heat required to vaporize 1.00 gram of H₂O(1) at 100.0°C and 1 atmosphere?

\[ q = m \cdot \Delta H \]

\[ q = 1 \, \text{g} \cdot 2.373 \, \text{J} \]

\[ q = 4.226 \, \text{J} \]

54. What is the average atomic mass of element X if a sample is composed of 85% \(^{127}\text{X}\), 12% \(^{130}\text{X}\), and 3% \(^{128}\text{X}\)?

AVG atomic mass = \( \frac{(0.85 \times 127) + (0.12 \times 130) + (0.03 \times 128)}{100} \)

55. In a laboratory experiment, a student determined the mass of the product, KCl(s), to be 2.65 grams. Calculate the number of moles of KCl(s) produced.

\[ \text{mol} = \frac{q_{\text{prod}}}{q_{\text{f,m}}} = \frac{2.65}{74.6} = 0.0355 \, \text{mol} \]

56. The potential energy diagram and balanced equation shown below represent a reaction between solid carbon and hydrogen gas to produce 1 mole of C₂H₆(g) at 101.3 kPa and 298 K.

\[ \text{C}(s) + 2 \text{H}_2(g) \rightarrow \text{C}_2\text{H}_6(g) \]

\[ \Delta H \text{ or heat of reaction} \]

a. State what interval 3 represents.

b. Determine the net amount of energy absorbed when 2.00 moles of C₂H₆(g) are produced.

\[ 2 \times 52.4 = 104.8 \, \text{kJ} \]

c. Identify one change in the reaction conditions, other than adding a catalyst, that can increase the rate of this reaction.

increase Temp. or increase pressure

57. Based on Table 5, determine the total mass of NH₃ that must be dissolved in 200. grams of water to produce a saturated solution at 20.0°C.
59. Determine the total charge of the boron nucleus.

60. What Kelvin temperature is equal to 15°C?
\[ K = ^\circ C + 273 \]
\[ 15 + 273 = 288 \, K \]

61. When a chemical cold pack is activated, a chemical reaction occurs that causes the pack to feel cold.
   a. Is the reaction that takes place inside the pack exothermic or endothermic?
   b. Describe the transfer of energy between a cold pack and the air around it.

   **Energy flows from air to the cold pack**

62. A glass tube is filled with hydrogen gas at low pressure. An electric current is passed through the gas, causing it to emit light. This light is passed through a prism to separate the light into the bright, colored lines of hydrogen’s visible spectrum. Each colored line corresponds to a particular wavelength of light. One of hydrogen’s spectral lines is red light with a wavelength of 656 nanometers. Tubes filled with other gases produce different bright-line spectra that are characteristic of each kind of gas. These spectra have been observed and recorded. Explain, in terms of electron energy states and energy changes, how hydrogen’s bright-line spectrum is produced.

   **Energy is emitted when electrons fall from high energy states to low energy states.**

   Explain how the elements present on the surface of a star can be identified using bright-line spectra.

   **The wavelength of the light emitted by the star will correspond to a specific element.**

   A student measured the wavelength of hydrogen’s visible red spectral line to be 647 nanometers. Show a correct numerical setup for calculating the student’s percent error.
   \[ \frac{|656 - 647| \times 100}{656} = 1.37\% \]
   Error

63. Given the incomplete equation representing a reaction:
   \[ 2\text{Na}(s) + 2\text{H}_2\text{O}(l) \rightarrow 2\text{Na}^+(aq) + 2 \_\_\_\_\_\_\_\_ (aq) + \text{H}_2(g) \]
   What is the formula of the missing product?

64. Given the balanced equation: \[ \text{H}_2\text{SO}_4(aq) + \text{BaCl}_2(aq) \rightarrow 2\text{HCl}(aq) + X \]
   What is the correct formula for the product represented by the letter X?

   **BaSO_4**
65. Because tap water is slightly acidic, water pipes made of iron corrode over time, as shown by the balanced ionic equation below:

\[ 2\text{Fe} + 6\text{H}^+ \rightarrow 2\text{Fe}^{2+} + 3\text{H}_2 \]

Explain, in terms of chemical reactivity, why copper pipes are less likely to corrode than iron pipes.

Iron is a more reactive metal than copper.

66. Some radioisotopes used as tracers make it possible for doctors to see the images of internal body parts and observe their functions. The table below lists information about three isotopes and the body part each radioisotope is used to study.

<table>
<thead>
<tr>
<th>Radioisotope</th>
<th>Half-life</th>
<th>Decay Mode</th>
<th>Body Part</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{24}\text{Na}$</td>
<td>15 hours</td>
<td>Beta</td>
<td>Circulatory system</td>
</tr>
<tr>
<td>$^{59}\text{Fe}$</td>
<td>44.5 days</td>
<td>Beta</td>
<td>Red blood cells</td>
</tr>
<tr>
<td>$^{131}\text{I}$</td>
<td>8.1 days</td>
<td>Beta</td>
<td>Thyroid</td>
</tr>
</tbody>
</table>

a. Write the nuclear decay of the radioisotope used to study red blood cells.

\[ \text{59Fe}^{26} \rightarrow 0^\circ + \text{59Co}^{27} \]

b. It can take up to 60 hours for a radioisotope to be delivered to the hospital from the laboratory where it is produced. What fraction of an original sample of $^{24}\text{Na}$ remains unchanged after 60 hours?

\[ \frac{1}{16} \]

67. A metal, $M$, was obtained from a compound in a rock sample. Experiments have determined that the element is a member of Group 2 on the Periodic Table of the Elements.

a. What is the phase of element $M$ as a good conductor of electricity?

Solid

b. Explain in terms of electrons, why $M$ is a good conductor of electricity?

$M$ is a good conductor because it loses 2 $e^-$ to form a "sea of mobile $e^-$".

c. Explain why the radius of a positive ion of element $M$ is smaller than the radius of an atom of element $M$.

Metals lose their valence $e^-$ and their ions are smaller.

d. Using the symbol $M$ for the element, write the chemical formula for the compound that forms when element $M$ reacts with iodine.

\[ M^2 + I^{-1} \rightarrow M\text{I}_2 \]
The graph below shows a compound being cooled at a constant rate starting in the liquid phase at 75°C and ending at 15°C.

68. What is the freezing point of the compound, in degrees Celsius?

50 °C

69. Base your answers on the graph below. The graph shows the relationship between pH value and hydronium ion concentration for common aqueous solutions and mixtures.

a. What is the hydronium ion concentration of tomato juice?

10^-4 M

b. What color is thymol blue when added to milk?

Yellow

c. According to this graph, which mixture is approximately 100 times less acidic than milk of magnesia?

pH12 → Bleach

70. A student is instructed to make 0.250 liter of a 0.200 M aqueous solution of Ca(NO₃)₂.

What is the gram-formula mass of Ca(NO₃)₂?

\[ Ca \times 40 = 40 \]
\[ N \times 2 \times 14 = 28 \]
\[ O \times 6 \times 16 = 96 \]

\[ 164 \text{ g/mol} \]

Show a correct numerical setup for calculating the total number of moles of Ca(NO₃)₂ needed to make 0.250 liter of the 0.200 M calcium nitrate solution.

\[ M = \frac{\text{mol}}{L} \]
\[ 0.200 = \frac{\text{mol}}{0.25} \]

mol/L = 0.05 mol/L
71. Air bags are an important safety feature in modern automobiles. An air bag is inflated in milliseconds by the explosive decomposition of NaN₃(s). The decomposition reaction produces N₂(g), as well as Na(s), according to the unbalanced equation below.

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

Balance the equation for the decomposition of NaN₃, using the smallest whole-number coefficients.

When the air bag inflates, the nitrogen gas is at a pressure of 1.30 atmospheres, a temperature of 301 K, and has a volume of 40.0 liters. Calculate the volume of the nitrogen gas at STP. Your response must include both a correct numerical setup and the calculated volume.

\[ \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \]

\[ \frac{(1.3)(40.0)}{(301)} = \frac{(1)V_2}{273} \]

\[ V_2 = 47.2 \text{L} \]

72. A thiol is very similar to an alcohol, but a thiol has a sulfur atom instead of an oxygen atom in the functional group. One of the compounds in a skunk's spray is 2-butene-1-thiol. The formula of this compound is shown below.

\[ \text{H} \quad \text{H} \quad \text{H} \]

\[ \text{H}-\text{C}-\text{C}=-\text{C}-\text{H} \]

\[ \text{SH} \quad \text{H} \quad \text{H} \]

Explain, in terms of composition, why this compound is a thiol.

This is a thiol because it contains the \( -\text{SH} \) group.

Explain, in terms of electron configuration, why oxygen atoms and sulfur atoms form compounds with similar molecular structures.

Oxygen and Sulfur are in the same group and have the same number of valence electrons.

73. Given the reaction between 1-butene and chlorine gas:

\[ \text{C}_4\text{H}_8 + \text{Cl}_2 \rightarrow \text{C}_4\text{H}_8\text{Cl}_2 \]

a. Which type of chemical reaction is represented by this equation?

Addition or Halogenation

b. Draw the structural formula of the product 1,2-dichlorobutane.

\[ \begin{array}{c}
\text{Cl} \\
\text{C} \\
\text{Cl}
\end{array} \quad \begin{array}{c}
\text{Cl} \\
\text{C} \\
\text{Cl}
\end{array} \]

\[ \begin{array}{c}
\text{C} \\
\text{C} \\
\text{C} \\
\text{C}
\end{array} \]
Base your answers to questions 74 through 75 on the information below. Hydrocarbons and fissionable nuclei are among the sources used for the production of energy in the United States. A chemical reaction produces much less energy than a nuclear reaction per mole of reactant.

The balanced chemical equation below represents the reaction of one molecule of a hydrocarbon with two molecules of oxygen.

Chemical equation:
\[\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} + 1.48 \times 10^{18} \text{ J}\]

The nuclear equation below represents one of the many possible reactions for one fissionable nucleus. In this equation, \(X\) represents a missing product.

Nuclear equation:
\[{}^{235}\text{U} + {}^{2}{}^{0}\text{He} \rightarrow {}^{56}\text{Kr} + X + 3^{0}\text{He} + 3.36 \times 10^{-11} \text{ J}\]

74. Identify the type of organic reaction represented by the chemical equation. 

**complete combustion**

75. Write an isotopic notation for the missing product represented by \(X\) in the nuclear equation.

\[
\begin{array}{c}
144 \\
56
\end{array}
\]

76. Metallic elements are obtained from their ores by reduction. Some metals, such as zinc, lead, iron, and copper, can be obtained by heating their oxides with carbon.

More active metals, such as aluminum, magnesium, and sodium, can not be reduced by carbon. These metals can be obtained by the electrolysis of their molten (melted) ores. The diagram below represents an incomplete cell for the electrolysis of molten NaCl. The equation below represents the reaction that occurs when the completed cell operates.

![Electrolysis Diagram](image)

2NaCl(l) \(\rightarrow\) 2Na(l) + Cl₂(g)

Identify the component required for the electrolysis of molten NaCl that is missing from the cell diagram. 

a battery

Identify one metal from the passage that is more active than carbon and one metal from the passage that is less active than carbon. more active: Al, Mg, Na

less active: Zn, Pb, Fe, Cu

Write a balanced half-reaction equation for the reduction of the iron ions in iron(III) oxide to iron atoms.

\[\text{Fe}^{3+} + 3\text{e}^- \rightarrow \text{Fe}\]
Base your answers to questions 77 and 79 on the information below.

**Uranium Disintegration Series**

77. Based on this graph, what particle is emitted during the nuclear decay of a Po-218 atom?
   
   ![Graph showing nuclear decay of Po-218](image)

   
   *alpha* \( \rightarrow \)

78. Explain why the U-238 disintegration series ends with the nuclide Pb-206.

   \( \text{Pb-206 is stable} \)

79. Determine the total time that must elapse until only \( \frac{1}{4} \) of an original sample of the radioisotope Rn-222 remains unchanged.

   \[
   1 \quad \frac{1}{2} \quad 2 \quad \frac{1}{4}
   \]

   \[
   2 \times 3,82 = 7,64 \text{ days}
   \]

80. Ethene (common name ethylene) is a commercially important organic compound.

   Millions of tons of ethene are produced by the chemical industry each year. Ethene is used in the manufacture of synthetic fibers for carpeting and clothing, and it is widely used in making polyethylene. Low-density polyethylene can be stretched into a clear, thin film that is used for wrapping food products and consumer goods. High-density polyethylene is molded into bottles for milk and other liquids. Ethene can also be oxidized to produce ethylene glycol, which is used in antifreeze for automobiles. The structural formula for ethylene glycol is:

   \[
   \begin{array}{c}
   H \\
   \left\langle \begin{array}{c}
   \text{H} \\
   \text{H}
   \end{array} \right\rangle \\
   \text{O} \\
   \text{H}
   \end{array}
   \]

   At standard atmospheric pressure, the boiling point of ethylene glycol is 198°C, compared to ethene that boils at -104°C.

   a. Identify the type of organic reaction by which ethene (ethylene) is made into polyethylene.

   \[
   \text{polymerization}
   \]

   b. Explain, in terms of bonding, why ethene is an unsaturated hydrocarbon.

   \[
   \text{ethene contains a double bond}
   \]
Using burets, a student titrated a sodium hydroxide solution of unknown concentration with a standard solution of 0.10 M hydrochloric acid. The data are recorded in the table below.

<table>
<thead>
<tr>
<th>Titration Data</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution</td>
<td>HCl(aq)</td>
<td>NaOH(aq)</td>
</tr>
<tr>
<td>Initial Buret Reading</td>
<td>15.50</td>
<td>5.00</td>
</tr>
<tr>
<td>Final Buret Reading</td>
<td>25.00</td>
<td>8.80</td>
</tr>
</tbody>
</table>

81. Determine both the total volume of HCl(aq) and the total volume of NaOH(aq) used in the titration.

\[ 9.5 \text{ mL HCl} \quad 3.8 \text{ mL NaOH} \]

82. Show a correct numerical setup for calculating the molarity of the sodium hydroxide solution.

\[ M_A \cdot V_A = M_B \cdot V_B \]

\[ (0.10)(9.5) = M_B (3.8) \]

\[ M_B = \frac{25}{M} \]

83. Nitrogen gas and oxygen gas make up about 99% of Earth’s atmosphere. Other atmospheric gases include argon, carbon dioxide, methane, ozone, hydrogen, etc. The amount of carbon dioxide in the atmosphere can vary. Data for the concentration of CO₂(g) from 1960 to 2000 are shown in the table below.

<table>
<thead>
<tr>
<th>Atmospheric Concentration of CO₂(g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1960</td>
</tr>
<tr>
<td>1980</td>
</tr>
<tr>
<td>2000</td>
</tr>
</tbody>
</table>

a. Identify one diatomic element found in the atmosphere. \( N_2 \quad O_2 \quad H_2 \)

b. Explain, in terms of types of matter, why methane can be broken down by chemical means, but argon can not be broken down by chemical means. Your response must include both methane and argon.

methane is a compound and argon is an element.

c. Show a numerical setup for calculating the mass of carbon dioxide in a 100.0-gram sample of air taken in 1980.

\[ \text{ppm} = \frac{338.7 \times 1,000,000}{100} \]

ppm = 338,700

d. Explain why the atmosphere is classified as a mixture.

The atmosphere can vary in composition.
84. Indigestion may be caused by excess stomach acid (hydrochloric acid). Some products used to treat indigestion contain magnesium hydroxide. The magnesium hydroxide neutralizes some of the stomach acid. The amount of acid that can be neutralized by three different brands of antacids is shown in the data table below.

<table>
<thead>
<tr>
<th>Antacid Brand</th>
<th>Mass of Antacid Tablet (g)</th>
<th>Volume of HCl(aq) Neutralized (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>2.00</td>
<td>25.20</td>
</tr>
<tr>
<td>Y</td>
<td>1.20</td>
<td>18.65</td>
</tr>
<tr>
<td>Z</td>
<td>1.76</td>
<td>22.50</td>
</tr>
</tbody>
</table>

a. Based on Reference Table F, describe the solubility of magnesium hydroxide in water. *Magnesium hydroxide is insoluble*

b. Write the neutralization reaction between the common antacid and stomach acid.

\[ \text{HCl} + \text{Mg(OH)}_2 \rightarrow \text{H}_2\text{O} + \text{MgCl}_2 \]

Base your answers to questions 85 and 86 on the information below.
Many esters have distinctive odors, which lead to their widespread use as artificial flavorings and fragrances. For example, methyl butanoate has an odor like pineapple and ethyl methanoate has an odor like raspberry.

85. In the space below, draw a structural formula for the ester that has an odor like pineapple.

![Structural formula for pineapple ester]

86. What is a chemical name for the alcohol that reacts with methanoic acid to produce the ester that has an odor like raspberry?

*Ethyl methanoate*

![Structural formula for ethyl methanoate]