1. In the space below, write an electron configuration for a silicon atom in an excited state.

2. Base your answer to the following question on the information below.

   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.
In a laboratory, a glass tube is filled with hydrogen gas at a very low pressure. When a scientist applies a high voltage between metal electrodes in the tube, light is emitted. The scientist analyzes the light with a spectroscope and observes four distinct spectral lines. The table below gives the color, frequency, and energy for each of the four spectral lines. The unit for frequency is hertz, Hz.

<table>
<thead>
<tr>
<th>Color</th>
<th>Frequency ($\times 10^{14}$ Hz)</th>
<th>Energy ($\times 10^{-19}$ J)</th>
</tr>
</thead>
<tbody>
<tr>
<td>red</td>
<td>4.6</td>
<td>3.0</td>
</tr>
<tr>
<td>blue green</td>
<td>6.2</td>
<td>4.1</td>
</tr>
<tr>
<td>blue</td>
<td>6.9</td>
<td>4.6</td>
</tr>
<tr>
<td>violet</td>
<td>7.3</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Explain, in terms of subatomic particles and energy states, why light is emitted by the hydrogen gas.
4. Base your answer to the following question on the information below.
The ionic radii of some Group 2 elements are given in the table below.

<table>
<thead>
<tr>
<th>Ionic Radii of Some Group 2 Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Be</td>
</tr>
<tr>
<td>Mg</td>
</tr>
<tr>
<td>Ca</td>
</tr>
<tr>
<td>Ba</td>
</tr>
</tbody>
</table>

Explain, in terms of electrons, why the ionic radius of a Group 2 element is smaller than its atomic radius.

5. Explain, in terms of atomic structure, why Group 18 elements on the Periodic Table rarely form compounds.

6. Identify the element in Period 3 of the Periodic Table that reacts with oxygen to form an ionic compound represented by the formula X2O.

7. Base your answer to the following question on the article below, the Reference Tables for Physical Setting/Chemistry, and your knowledge of chemistry.

   In the 1920s, paint used to inscribe the numbers on watch dials was composed of a luminescent (glow-in-the-dark) mixture. The powdered-paint base was a mixture of radium salts and zinc sulfide. As the paint was mixed, the powdered base became airborne and drifted throughout the workroom causing the contents of the workroom, including the painters' clothes and bodies, to glow in the dark.

   The paint is luminescent because radiation from the radium salts strikes a scintillator. A scintillator is a material that emits visible light in response to ionizing radiation. In watch dial paint, zinc sulfide acts as the scintillator.

   Radium present in the radium salts decomposes spontaneously, emitting alpha particles. These particles can cause damage to the body when they enter human tissue. Alpha particles are especially harmful to the blood, liver, lungs, and spleen because they can alter genetic information in the cells. Radium can be deposited in the bones because it substitutes for calcium.

   Why does radium substitute for calcium in bones?
8. Base your answer to the following question on the table below.

<table>
<thead>
<tr>
<th>Element</th>
<th>Atomic Number</th>
<th>First Ionization Energy (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>lithium</td>
<td>3</td>
<td>520</td>
</tr>
<tr>
<td>sodium</td>
<td>11</td>
<td>496</td>
</tr>
<tr>
<td>potassium</td>
<td>19</td>
<td>419</td>
</tr>
<tr>
<td>rubidium</td>
<td>37</td>
<td>403</td>
</tr>
<tr>
<td>cesium</td>
<td>55</td>
<td>376</td>
</tr>
</tbody>
</table>

Explain, in terms of atomic structure, why cesium has a lower first ionization energy than rubidium.
9. Base your answer to the following question on the information below.

The atomic number and corresponding atomic radius of the Period 3 elements are shown in the data table below.

<table>
<thead>
<tr>
<th>Atomic Number</th>
<th>Atomic Radius (pm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>160.</td>
</tr>
<tr>
<td>12</td>
<td>140.</td>
</tr>
<tr>
<td>13</td>
<td>124</td>
</tr>
<tr>
<td>14</td>
<td>114</td>
</tr>
<tr>
<td>15</td>
<td>109</td>
</tr>
<tr>
<td>16</td>
<td>104</td>
</tr>
<tr>
<td>17</td>
<td>100.</td>
</tr>
<tr>
<td>18</td>
<td>101</td>
</tr>
</tbody>
</table>

Explain, in terms of electrons, the change in radius when a sodium atom becomes a sodium ion.

10. One electron is removed from both an Na atom and a K atom, producing two ions. Using principles of atomic structure, explain why the Na ion is much smaller than the K ion. Discuss both ions in your answer.
11. In a laboratory experiment, a student determined the mass of the product, NaNO₃(s), to be 0.105 grams.

   a. Calculate the gram formula mass of NaNO₃(s). Round atomic masses from the Periodic Table to the nearest tenth. [Show all work. Indicate the correct answer in proper significant figures and include an appropriate unit.]

   b. Calculate the number of moles of NaNO₃(s) produced. [Show all work. Indicate the correct answer in proper significant figures.]

12. Base your answer to the following question on the information below and on your knowledge of chemistry.

   One process used to manufacture sulfuric acid is called the contact process. One step in this process, the reaction between sulfur dioxide and oxygen, is represented by the forward reaction in the system at equilibrium shown below.

   \[ 2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g) + 394 \text{kJ} \]

   A mixture of platinum and vanadium(V) oxide may be used as a catalyst for this reaction. The sulfur trioxide produced is then used to make sulfuric acid.

   Write the chemical formula for vanadium(V) oxide.

13. Base your answer to the following question on the information below.

   The equation below represents the reaction between 1-butene and bromine to form the compound 1,2-dibromobutane, C₄H₈Br₂.

   \[ \text{H--C} = \text{C} - \text{C} - \text{C} - \text{H} + \text{Br}_2 \rightarrow \text{H--C} = \text{C} - \text{C} - \text{C} - \text{H} + \text{Br} - \text{C} - \text{C} - \text{H} \]

   Explain, in terms of bonding, why the hydrocarbon reactant is an unsaturated hydrocarbon.
14. Base your answer to the following question on the information below.

John Dalton, an early scientist, sketched the structure of compounds using his own symbols for the elements known at the time. Dalton's symbols for four elements and his drawing of potassium aluminum sulfate are represented by the diagram below.

Today, it is known that the chemical formula for potassium aluminum sulfate is $\text{KAl(SO}_4\text{)}_2 \cdot 12\text{H}_2\text{O}$. It is a hydrated compound because water molecules are included within its crystal structure. There are 12 moles of $\text{H}_2\text{O}$ for every 1 mole of $\text{KAl(SO}_4\text{)}_2$. The compound contains two different positive ions. The gram-formula mass of $\text{KAl(SO}_4\text{)}_2 \cdot 12\text{H}_2\text{O}$ is 474 grams per mole.

Show a numerical setup for calculating the percent composition by mass of water in $\text{KAl(SO}_4\text{)}_2 \cdot 12\text{H}_2\text{O}$.

15. Base your answer to the following question on the information below.

A tablet of one antacid contains citric acid, $\text{H}_3\text{C}_6\text{H}_5\text{O}_7$, and sodium hydrogen carbonate, $\text{NaHCO}_3$. When the tablet dissolves in water, bubbles of $\text{CO}_2$ are produced. This reaction is represented by the incomplete equation below.

$$\text{H}_3\text{C}_6\text{H}_5\text{O}_7(\text{aq}) + 3\text{NaHCO}_3(\text{aq}) \rightarrow \text{Na}_3\text{C}_6\text{H}_5\text{O}_7(\text{aq}) + 3\text{CO}_2(\text{g}) + 3 \ _____ (\text{?})$$

Write the formula of the missing product.

16. During a laboratory activity, a student reacted a piece of zinc with 0.1 M $\text{HCl(}\text{aq})$.

Complete the equation below by writing the formula of the missing product.

$$\text{Zn(s)} + 2\text{HCl(}\text{aq}) \rightarrow \ _____ (\text{aq}) + \text{H}_2(\text{g})$$

17. What is the mass of 4.76 moles of $\text{Na}_3\text{PO}_4$ (gram-formula mass = 164 grams/mole)?
18. In a laboratory experiment, a student determined the mass of the product, CaSO₄(s), to be 31.9 grams.

a  Calculate the gram formula mass of CaSO₄(s). Round atomic masses from the Periodic Table to the nearest tenth. [Show all work. Indicate the correct answer in proper significant figures and include an appropriate unit.]

b  Calculate the number of moles of CaSO₄(s) produced. [Show all work. Indicate the correct answer in proper significant figures.]

19. Base your answer to the following question on the information below.

   At STP, iodine, I₂, is a crystal, and fluorine, F₂, is a gas. Iodine is soluble in ethanol, forming a tincture of iodine. A typical tincture of iodine is 2% iodine by mass.

   Draw a Lewis electron-dot diagram for a molecule of I₂.

20. Base your answer to the following question on the information below and on your knowledge of chemistry.

   Rubbing alcohol is a product available at most pharmacies and supermarkets. One rubbing alcohol solution contains 2-propanol and water. The boiling point of 2-propanol is 82.3°C at standard pressure.

   Explain, in term of charge distribution, why a molecule of the 2-propanol is a polar molecule.

21. Base your answer to the following question on the table below.

<table>
<thead>
<tr>
<th>Physical Properties of Four Gasses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of Gas</td>
</tr>
<tr>
<td>Molecular Structure</td>
</tr>
<tr>
<td>Boiling Point (K) at 1 Atm</td>
</tr>
<tr>
<td>Density (g/L) at STP</td>
</tr>
</tbody>
</table>

   Explain, in terms of intermolecular forces, why hydrogen has a lower boiling point than hydrogen bromide.
22. Explain, in terms of electronegativity, why the H-F bond is expected to be more polar than the H-I bond.

23. a. Mark an appropriate scale on the axis labeled "Electronegativity." An appropriate scale is one that allows a trend to be seen.

b. On the same grid, plot the electronegativity and atomic number data from Reference Table S. Circle and connect the points.

24. Base your answer to the following question on the information below.

Ammonium chloride is dissolved in water to form a 0.10 M NH₄Cl(aq) solution. This dissolving process is represented by the equation below.

\[ \text{NH}_4\text{Cl}(s) + \text{heat} \xrightarrow{H_2O} \text{NH}_4^+(aq) + \text{Cl}^-(aq) \]

Determine the number of moles of NH₄Cl(s) used to produce 2.0 liters of this solution.

25. Base your answer to the following question on the following paragraph.

The boiling point of a liquid is the temperature at which the vapor pressure of the liquid is equal to the pressure on the surface of the liquid. The heat of vaporization of ethanol is 838 joules per gram. A sample of ethanol has a mass of 65.0 grams and is boiling at 1.00 atmosphere.

Calculate the minimum amount of heat required to completely vaporize this sample of ethanol. Your response must include both a correct numerical setup and the calculated result.
26. Base your answer to the following question on the data table below, which shows the solubility of a solid solute.

According to Reference Table $G$, how many grams of KClO$_3$ must be dissolved in 100 grams of H$_2$O at 10°C to produce a saturated solution?
27. In this investigation, the change in heat of the copper is greater than the change in heat of the water. What error could account for this apparent violation of the Law of Conservation of Energy? Do not use human error as part of the answer.

A Styrofoam cup with a lid is used as a calorimeter. The cup contains 100.0 grams of distilled water at 23.2°C.

A thermometer is inserted through the lid. The copper and water are gently stirred in the cup. The temperature is checked periodically. The highest temperature noted is 26.3°C.

<table>
<thead>
<tr>
<th>Quantity Measured</th>
<th>Data (units are given)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of copper</td>
<td>g</td>
</tr>
<tr>
<td>Temperature of hot copper</td>
<td>°C</td>
</tr>
<tr>
<td>Mass of H₂O in calorimeter</td>
<td>g</td>
</tr>
<tr>
<td>Initial temperature of H₂O in calorimeter</td>
<td>°C</td>
</tr>
<tr>
<td>Final temperature of H₂O and copper</td>
<td>°C</td>
</tr>
</tbody>
</table>

In this investigation, the change in heat of the copper is greater than the change in heat of the water. What error could account for this apparent violation of the Law of Conservation of Energy? Do not use human error as part of the answer.
28. Base your answer to the following question on the information below.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Boiling Point (°C)</th>
<th>Solubility in 100 Grams of H₂O at 20.0°C (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ammonia</td>
<td>-33.2</td>
<td>56</td>
</tr>
<tr>
<td>methane</td>
<td>-161.5</td>
<td>0.002</td>
</tr>
<tr>
<td>hydrogen chloride</td>
<td>-84.9</td>
<td>72</td>
</tr>
</tbody>
</table>

Explain, in terms of molecular polarity, why hydrogen chloride is more soluble than methane in water at 20.0°C and standard pressure.

29. Base your answer to the following question on the information below.

A solution is made by completely dissolving 90. grams of KNO₃(s) in 100. grams of water in a beaker. The temperature of this solution is 65°C.

Describe the effect on the solubility of KNO₃(s) in this solution when the pressure on the solution increases.

30. Base your answer to the following question on the information below.

A student wishes to investigate how the reaction rate changes with a change in concentration of HCl(aq).

Given the reaction:

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

Identify one other variable that might affect the rate and should be held constant during this investigation.

31. Base your answer to the following question on the information below.

Given the equilibrium equation at 298 K:

\[
\text{KNO}_3\text{(s) + 34.89 kJ \rightleftharpoons K}^+\text{(aq) + NO}_3^-\text{(aq)}
\]

The equation indicates that KNO₃ has formed a saturated solution. Explain, in terms of equilibrium, why the solution is saturated.
32. Base your answer to the following question on the information below and on your knowledge of chemistry.

Baking soda, NaHCO₃, can be commercially produced during a series of chemical reactions called the Solvay process. In this process, NH₃(aq), NaCl(aq), and other chemicals are used to produce NaHCO₃(s) and NH₄Cl(aq).

To reduce production costs, NH₃(aq) is recovered from NH₄Cl(aq) through a different series of reactions. This series of reactions can be summarized by the overall reaction represented by the unbalanced equation below.

\[
\text{NH}_4\text{Cl}(aq) + \text{CaO}(s) \rightarrow \text{NH}_3(aq) + \text{H}_2\text{O}(\ell) + \text{CaCl}_2(aq)
\]

Write a chemical name for baking soda.

33. Base your answer to the following question on the potential energy diagram below.

![Potential Energy Diagram](image)

What is the activation energy for the forward reaction with the catalyst?

34. Base your answer to the following question on the following information.

The equation below represents the reaction between butanoic acid and an unidentified reactant, X.

![Chemical Equation](image)

Write the molecular formula of the organic product in the equation.
Gasoline is a mixture composed primarily of hydrocarbons such as isoctane, which is also known as 2,2,4-trimethylpentane. Gasoline is assigned a number called an octane rating. Gasoline with an octane rating of 87 performs the same as a mixture that consists of 87% isoctane and 13% heptane.

An alternative fuel, E-85, can be used in some automobiles. This fuel is a mixture of 85% ethanol and 15% gasoline.

State the octane rating of a gasoline sample that performs the same as a mixture consisting of 92% isoctane and 8% heptane.
36. Base your answer to the following question on the information and diagram below and on your knowledge of chemistry.

Crude oil is a mixture of many hydrocarbons that have different numbers of carbon atoms. The use of a fractionating tower allows the separation of this mixture based on the boiling points of the hydrocarbons.

To begin the separation process, the crude oil is heated to about 400°C in a furnace, causing many of the hydrocarbons of the crude oil to vaporize. The vaporized mixture is pumped into a fractionating tower that is usually more than 30 meters tall. The temperature of the tower is highest at the bottom. As vaporized samples of hydrocarbons travel up the tower, they cool and condense. The liquid hydrocarbons are collected on trays and removed from the tower. The diagram below illustrates the fractional distillation of the crude oil and the temperature ranges in which the different hydrocarbons condense.

![Fractionating Tower Diagram]

Write an IUPAC name of one saturated hydrocarbon that leaves the fractionating tower at less than 40°C.
37. Base your answer to the following question on the information below.

A voltaic cell with magnesium and copper electrodes is shown in the diagram below. The copper electrode has a mass of 15.0 grams.

![Voltaic Cell Diagram]

When the switch is closed, the reaction in the cell begins. The balanced ionic equation for the reaction in the cell is shown below the cell diagram. After several hours, the copper electrode is removed, rinsed with water, and dried. At this time, the mass of the copper electrode is greater than 15.0 grams.

State the directions of electron flow through the wire between the electrodes when the switch is closed.

38. Base your answer to the following question on the information below.

The outer structure of the Statue of Liberty is made of copper metal. The framework is made of iron. Over time, a thin green layer (patina) forms on the copper surface.

When copper oxidized to form this patina layer, the copper atoms became copper(II) ions (Cu\(^{2+}\)). Write a balanced half-reaction for this oxidation of copper.

39. Base your answer to the following question on the information below.

The unbalanced equation below represents the decomposition of potassium chlorate.

\[
\text{KClO}_3(s) \rightarrow \text{KCl}(s) + \text{O}_2(g)
\]

Balance the equation below, using the smallest whole-number coefficients.

\[
\underline{\quad \text{KClO}_3(s)} \rightarrow \underline{\quad \text{KCl}(s)} + \underline{\quad \text{O}_2(g)}
\]
40. Base your answer to the following question on the diagram below, which represents a voltaic cell at 298 K and 1 atm.

Describe the direction of electron flow between the electrodes when switch $S$ is closed.

41. Base your answer to the following question on the information below

Sulfur dioxide, $\text{SO}_2$, is one gas produced when fossil fuels are burned. When this gas reacts with water in the atmosphere, an acid is produced forming acid rain. The pH of the water in a lake changes when acid rain collects in the lake.

Two samples of the same rainwater are tested using two indicators. Methyl orange is yellow in one sample of this rainwater. Litmus is red in the other sample of this rainwater.

Identify a possible pH value for the rainwater that was tested.

42. Base your answer to the following question on the information below.

In liquid water, an equilibrium exists between $\text{H}_2\text{O}(l)$ molecules, $\text{H}^+(aq)$ ions, and $\text{OH}^-(aq)$ ions.

A person experiencing acid indigestion after drinking tomato juice can ingest milk of magnesia to reduce the acidity of the stomach contents. Tomato juice has a pH value of 4. Milk of magnesia, a mixture of magnesium hydroxide and water, has a pH value of 10.

Complete the equation below for the equilibrium that exists in liquid water.

$$\text{_______} (l) \leftrightarrow \text{_______} (aq) + \text{_______} (aq)$$

43. A student is given two beakers, each containing an equal amount of clear, odorless liquid. One solution is acidic and the other is basic.

1. State two safe methods of distinguishing the acid solution from the base solution.
2. For each method, state the results of both the testing of the acid solution and the testing of the base solution.
44. A substance known as heavy water can be obtained from ordinary water and could be a significant source of energy in the future. Heavy water contains deuterium, H-2. Instead of the two hydrogen atoms in a typical water molecule, a heavy water molecule has two deuterium atoms. In 3.78 kilograms of ordinary water, the percent composition by mass of heavy water is approximately 0.0156%.

Deuterium atoms completely ionize at approximately $10^8$ K. The result is an ionized gas consisting of electrons and deuterons (the nuclei of deuterium). A triton is the nucleus of a tritium atom, H-3. These particles react according to the equations below. In the second equation, $X$ represents an unidentified product.

\[ ^2\text{H} + ^2\text{H} \rightarrow ^3\text{H} + ^1\text{H} + \text{energy} \]
\[ ^2\text{H} + ^3\text{H} \rightarrow ^4\text{He} + X + \text{energy} \]

Calculate the mass of heavy water in a 3.78-kilogram sample of ordinary water. Your response must include both a correct numerical setup and the calculated result.

45. a State one possible advantage of using nuclear power instead of burning fossil fuels.

b State one possible risk of using nuclear power.

c If animals feed on plants that have taken up Sr-90, the Sr-90 can find its way into their bone structure. Explain one danger to the animals.

46. Polonium-210 occurs naturally, but is scarce. Polonium-210 is primarily used in devices designed to eliminate static electricity in machinery. It is also used in brushes to remove dust from camera lenses. Polonium-210 can be created in the laboratory by bombarding bismuth-209 with neutrons to create bismuth-210. The bismuth-210 undergoes beta decay to produce polonium-210. Polonium-210 has a half-life of 138 days and undergoes alpha decay.

Complete the nuclear equation for the decay of Po-210, by writing a notation for the missing product.

\[ ^{210}_{84}\text{Po} \rightarrow ^4_2\text{He} + \text{______________} \]
1. 2-7-5 1-8-5 2-8-3-1
2. Examples: – The electron of hydrogen absorbs energy and jumps to a higher energy state. The excited electron returns to a lower energy state, releasing light energy. The electron of hydrogen absorbs energy and jumps to a higher energy state. The excited electron returns to a lower energy state, releasing light energy.

3. Examples: – When the electron in a hydrogen atom moves from a higher energy state to a lower energy state, a specific amount of energy is emitted. Light is emitted when electrons drop from higher electron shells to lower electron shells.

4. – The valence electron shell of a Group 2 atom is lost when it becomes an ion. – A Group 2 ion has two fewer electrons than the atom from which it was formed.

5. Group 18 elements rarely form compounds because their atoms have stable electron configurations. – Their valence shells are completely filled. – All the elements have maximum numbers of valence electrons. – Atoms of Group 18 have a stable octet except He, which is stable with two electrons.

6. Examples: -Na -sodium -element 11

7. Examples: –both Group 2 metals – Radium is a more active metal. – similar chemical properties – They are both alkaline earth metals. – It also has two valence electrons.

8. Acceptable responses include, but are not limited to:

9. The radius of a sodium ion is smaller because the sodium atom lost one electron. – An Na⁺ ion is smaller because it has one fewer electron shell.

10. Examples:

- K⁺ has three energy levels, while Na⁺ has only two energy levels.
- Na⁺ has its valence electrons drawn closer to the nucleus than K⁺ because the effect of the nucleus is greater for Na⁺.

11. a) 23.0 + 14.0 + 3(16.0) = 85.0 g  b) 0.105g x 1.00 mole/85.0g = 0.00124 mole

12. V₂O₅ – O₅V₂

13. – Each reactant hydrocarbon molecule has a double carbon-carbon bond. – There is a multiple carbon-carbon bond in each molecule.

14. The force of attraction between the nucleus and the valence electrons decreases down the group. Cesium has more shells, easier to remove electrons

15. H₂O.

16. ZnCl₂

17. 781 g

18. a) 40.1 + 32.1 + 4(16.0) = 136.2 g  b) 31.9g x 1.00 mole/136.2g = 0.234 mole

19. – A 2-propanal molecule is polar because it has an asymmetrical distribution of charge. – The charge distribution is uneven. – The center of positive charge and the center of negative charge do not coincide.

20. Examples: – Hydrogen has weaker intermolecular forces than HBr. – Hydrogen – weaker forces.

The difference in electronegativity for the H–F bond is 1.9 and the electronegativity difference for the H–I bond is 0.6. The difference for H–F is greater and therefore H–F is more polar or H–F is more polar because F is more electronegative than I.

21. Examples:

22. The difference in electronegativity for the H–F bond is 1.9 and the electronegativity difference for the H–I bond is 0.6. The difference for H–F is greater and therefore H–F is more polar or H–F is more polar because F is more electronegative than I.

23. 0.20 mol

24. Examples:

25. – (65)(838) – 5.45 x 10⁴ J – 54 500 J
26. 7; ±1

27. Responses include, but are not limited to, these examples: heat lost to surroundings; heat absorbed by the thermometer; heat absorbed by the calorimeter

28. –Molecules of CH₄ are nonpolar, but molecules of HCl and H₂O are both polar. –Hydrogen chloride and water are both polar.

29. The solubility of KNO₃(s) is not affected by an increase in pressure.

30. Examples: –temperature; –surface area of Zn; –amount of Zn; –Zn; –concentration of Zn; –[Zn]

31. The rate of dissolving KNO₃ is equal to the rate of recrystallizing KNO₃ or The KNO₃ is going into the solution at the same rate it precipitates out of the solution

32. –sodium hydrogen carbonate –sodium bicarbonate –sodium acid carbonate –monosodium carbonate–bicarbonate of soda

33. +100 kJ or 100 kJ.

34. C₆H₁₂O₂

35. 92

36. methane; ethane; propane; methyl propane; butane

37. The electrons flow from the Mg electrode to the Cu electrode; From anode to cathode.

38. Responses include, but are not limited to, these examples: Cu → Cu²⁺ + 2e⁻ • Cu – 2e⁻ → Cu²⁺

39. 2KClO₃(s) → 2KCl(s) + 3O₂(g)

40. from anode to cathode or Zn electrode to Pb electrode or to the left or from half-cell 2 to half-cell 1 or – to +

41. pH value that is greater than or equal to 4.4, but is less than or equal to 5.5

42. –H₂O(ℓ) ↔ H⁺(aq) + OH⁻(aq) –2H₂O(ℓ) ↔ OH⁻(aq) + H₃O⁺ (aq) –water(ℓ) ↔ hydrogen ion(aq) + hydroxide ion(aq)

43. a. Examples: -Test with an indicator. -Use pH paper. -Check for creativity.
   b. Examples: -The base will turn phenolphthalein pink; the acid will not.
   -The acid will turn blue litmus paper red, and the base will turn red litmus paper blue.
   -Bromthymol blue will turn yellow in the acid and blue in the base.

44. a Examples: –less air pollution –low cost –conservation of fossil fuels –more energy produced

   b Examples: –nuclear meltdown –biological risks (cancer, mutations)
   –contamination of the environment
   –radiation exposure
   –lack of storage facilities for spent fuel rods –radiation emitted

   c Examples: –Sr-90 is radioactive and might cause tissue damage to the animal. –Sr-90 emits beta particles. –Bones become radioactive.

45. a Examples: –less air pollution –low cost –conservation of fossil fuels –more energy produced

   b Examples: –nuclear meltdown –biological risks (cancer, mutations)
   –contamination of the environment
   –radiation exposure
   –lack of storage facilities for spent fuel rods –radiation emitted

   c Examples: –Sr-90 is radioactive and might cause tissue damage to the animal. –Sr-90 emits beta particles. –Bones become radioactive.

46. –¹⁰⁶⁺²⁰⁶Pb — lead — 206

\[
\frac{0.0156}{100} \times 3.78
\]

\[
5.90 \times 10^{-4} \text{ kg or } 0.000590 \text{ kg}
\]