Name: **"State in Terms Of ..."**

____ 1. Base your answer to the following question on the information below and on your knowledge of chemistry.

Chemical concepts are applied in candy making. A recipe for making lollipops is shown below.

Hard-Candy Lollipops Recipe

Ingredients:
414 grams of sugar
177 grams of water
158 milliliters of light corn syrup

Step 1: In a saucepan, mix the sugar and water. Heat this mixture, while stirring, until all of the sugar dissolves.
Step 2: Add the corn syrup and heat the mixture until it boils.
Step 3: Continue boiling the mixture until the temperature reaches 143°C at standards pressure.
Step 4: Remove the pan from the heat and allow it to stand until the bubbling stops. Pour the mixture into lollipop molds that have been coated with cooking oil spray.

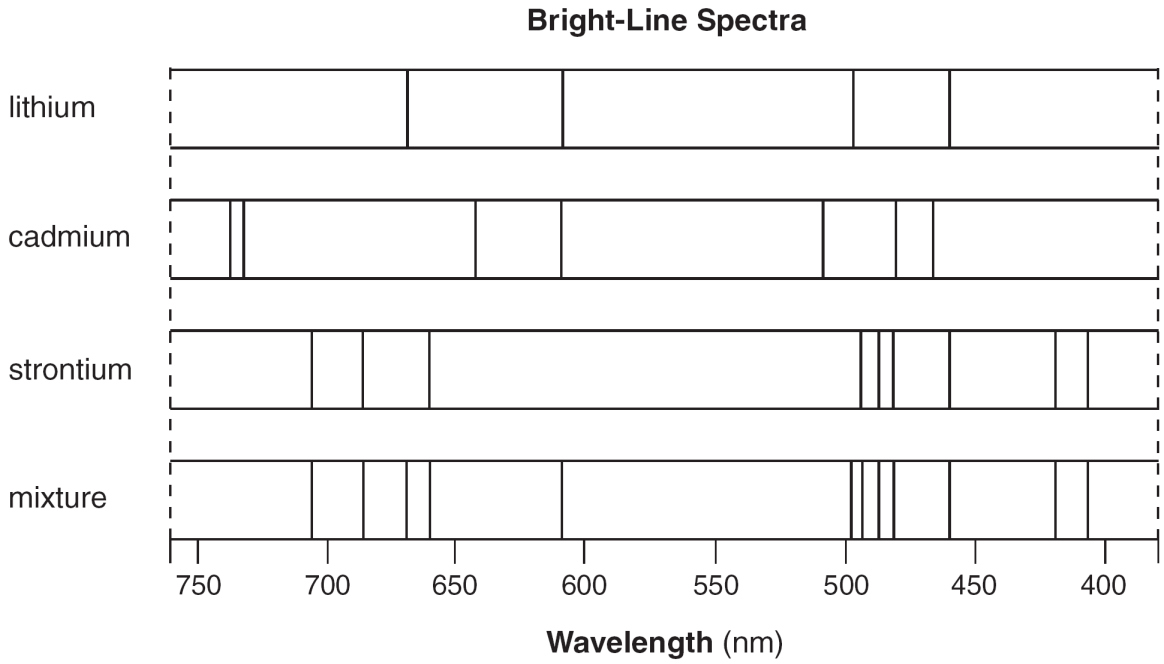
Explain, in terms of the concentration of sugar molecules, why the boiling point of the mixture in step 3 increases as water evaporates from the mixture.

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

The element boron, a trace element in Earth's crust, is found in foods produced from plants. Boron has only two naturally occurring stable isotopes, boron-10 and boron-11.

State, in terms of subatomic particles, *one* difference between the nucleus of a carbon-11 atom and the nucleus of a boron-11 atom.

____ 3. Base your answer to the following question on the information below.
The bright-line spectra for three elements and a mixture of elements are shown below.



Explain, in terms of *both electrons and energy, how the bright-line spectrum of an element is produced.*

____ 4. Explain, in terms of protons and neutrons, why
U-235 and U-238 are different isotopes of uranium.

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

Before atomic numbers were known, Mendeleev developed a classification system for the 63 elements known in 1872, using oxide formulas and atomic masses. He used an R in the oxide formulas to represent any element in each group. The atomic mass was listed in parentheses after the symbol of each element. A modified version of Mendeleev's classification system is shown in the table below.

Modified Version of Mendeleev's Table

Group →		I	II	III	IV	V	VI	VII
Oxide formulas		R_2O	RO	R_2O_3	RO_2	R_2O_5	RO_3	R_2O_7
Series	1	H(1)						
	2	Li(7)	Be(9.4)	B(11)	C(12)	N(14)	O(16)	F(19)
	3	Na(23)	Mg(24)	Al(27.3)	Si(28)	P(31)	S(32)	Cl(35.5)
	4	K(39)	Ca(40)		Ti(48)	V(51)	Cr(52)	Mn(55)
	5	Cu(63)	Zn(65)			As(75)	Se(78)	Br(80)
	6	Rb(85)	Sr(87)	Yt(88)	Zr(90)	Nb(94)	Mo(96)	
	7	Ag(108)	Cd(112)	In(113)	Sn(118)	Sb(122)	Te(125)	I(127)
	8	Cs(133)	Ba(137)	Di(138)	Ce(140)			

Explain , in terms of chemical reactivity, why the elements in Group 18 on the modern Periodic Table were *not* identified by Mendeleev at that time.

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

When magnesium is ignited in air, the magnesium reacts with oxygen and nitrogen. The reaction between magnesium and nitrogen is represented by the unbalanced equation below:

$Mg(s) + N_2(g) \rightarrow Mg_3N_2(s)$

Explain, in terms of electrons, why an atom of the metal in this reaction forms an ion that has a smaller radius than its atom.

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

The atomic radius and the ionic radius for some Group 1 and some Group 17 elements are given in the tables below.

Atomic and Ionic Radii of Some Elements

Group 1

Particle	Radius (pm)
Li atom	130.
Li^+ ion	78
Na atom	160.
Na^+ ion	98
K atom	200.
K^+ ion	133
Rb atom	215
Rb^+ ion	148

Group 17

Particle	Radius (pm)
F atom	60.
F^- ion	133
Cl atom	100.
Cl^- ion	181
Br atom	117
Br^- ion	?
I atom	136
I^- ion	220.

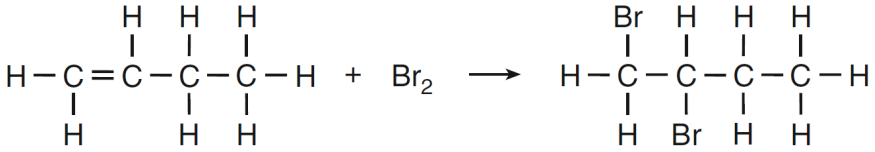
Explain, in terms of electron shells, why the radius of a K^+ ion is greater than the radius of an Na^+ ion.

8. Base your answer to the following question on the elements in Group 2 on the Periodic Table.

Explain, in terms of atomic structure, why the elements in Group 2 have similar chemical properties.

9. 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, $C_4H_8Br_2$.



Explain, in terms of bonding, why the hydrocarbon reactant is an unsaturated hydrocarbon.

Base your answers to questions **10** and **11** 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.

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

11. Explain in terms of electronegativity differences, why a C–O bond is more polar than a C–H bond.

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

Ammonium chloride is dissolved in water to form a 0.10 M $NH_4Cl(aq)$ solution. This dissolving process is represented by the equation below.

$$NH_4Cl(s) + \text{heat} \xrightarrow{H_2O} NH_4{}^+(aq) + Cl^-(aq)$$

Explain, in terms of ions, why a 10.0-milliliter sample of 0.30 M $NH_4Cl(aq)$ is a better conductor of electricity than a 10.0-milliliter sample of the 0.10 M $NH_4Cl(aq)$.

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

Ozone, $O_3(g)$, is produced from oxygen, $O_2(g)$ by electrical discharge during thunderstorms. The unbalanced equation below represents the reaction that forms ozone.

$$O_2(g) \xrightarrow{\text{electricity}} O_3(g)$$

Explain, in terms of electron configuration, why an oxygen molecule is more stable than an oxygen atom.

14. Explain, in terms of valence electrons, why the bonding in magnesium oxide, MgO, is similar to the bonding in barium chloride, $BaCl_2$.

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

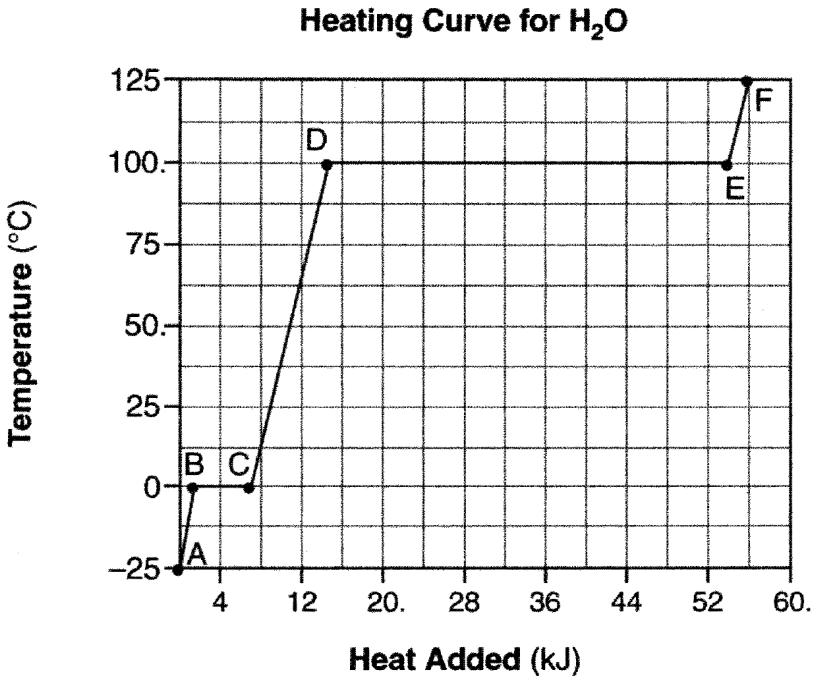
Carbon has three naturally occurring isotopes, C-12, C-13, and C-14. Diamond and graphite are familiar forms of solid carbon. Diamond is one of the hardest substances known, while graphite is a very soft substance. Diamond has a rigid network of bonded atoms. Graphite has atoms bonded in thin layers that are held together by weak forces.

Recent experiments have produced new forms of solid carbon called fullerenes. One fullerene, C_{60}, is a spherical, cagelike molecule of carbon.

State, in terms of the arrangement of atoms, the difference in hardness between diamond and graphite.

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

Starting as a solid at –25°C, a sample of H_2O is heated at a constant rate until the sample is at 125°C. This heating occurs at standard pressure. The graph below represents the relationship between temperature and heat added to the sample.



Explain, in terms of heat of fusion and heat of vaporization, why the heat added during interval *DE* is greater than the heat added during interval *BC* for this sample of water.

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

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.

Atmospheric Concentration of CO_2(g)

Year	Concentration (ppm)
1960	316.9
1980	338.7
2000	369.4

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.*

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

A scientist makes a solution that contains 44.0 grams of hydrogen chloride gas, HCl(g), in 200. grams of water, $H_2O(\ell)$, at 20. ºC. This process is represented by the balanced equation below.

$$HCl(g) \xrightarrow{H_2O} H^+(aq) + Cl^-(aq)$$

Explain, in terms of the distribution of particles, why the solution is a homogeneous mixture.

Base your answers to questions **19** and **20** on the information below.

Some Properties of Three Compounds at Standard Pressure

Compound	Boiling Point (°C)	Solubility in 100. Grams of H_2O at 20.°C (g)
ammonia	–33.2	56
methane	–161.5	0.002
hydrogen chloride	–84.9	72

19. Explain, in terms of intermolecular forces, why ammonia has a higher boiling point than the other compounds in the table.

20. Explain, in terms of molecular polarity, why hydrogen chloride is more soluble than methane in water at 20.ºC and standard pressure.

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

In a laboratory, a student makes a solution by completely dissolving 80.0 grams of $KNO_3(s)$ in 100.0 grams of hot water. The resulting solution has a temperature of 60.°C. The room temperature in the laboratory is 22°C.

Classify, in terms of saturation, the type of solution made by the student.

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

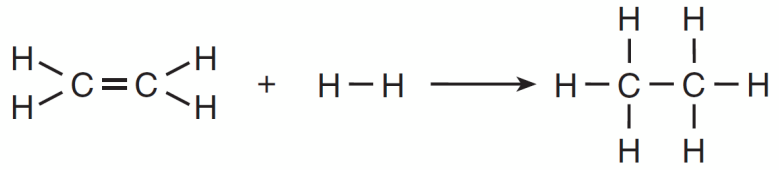
Molar Mass and Boiling Point of Four Substances

Substance	Molar Mass (g/mol)	Boiling Point at 1 atm (K)
methane	16	112
ethane	30.	185
propane	44	231
butane	58	273

State, in terms of intermolecular forces, why the boiling point of propane at 1 atmosphere is *lower* than the boiling point of butane at 1 atmosphere.

____ 23. Base your answer to the following question on the information below and on your knowledge of chemistry.

Ethene and hydrogen can react at a faster rate in the presence of the catalyst platinum. The equation below represents a reaction between ethene and hydrogen.



Explain, in terms of activation energy, why the catalyzed reaction occurs at a faster rate.

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

At standard pressure, hydrogen peroxide, H_2O_2, melts at –0.4°C, boils at 151°C, and is very soluble in water. A bottle of aqueous hydrogen peroxide, $H_2O_2(aq)$, purchased from a pharmacy has a pressure-releasing cap. Aqueous hydrogen peroxide decomposes at room temperature, as represented by the balanced equation below.

$$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g) + 196.0\ kJ$$

State, in terms of *both* melting point and boiling point, why H_2O_2 is a liquid at room temperature.

Base your answers to questions **25** and **26** on the information below.

Several steps are involved in the industrial production of sulfuric acid. One step involves the oxidation of sulfur dioxide gas to form sulfur trioxide gas. A catalyst is used to increase the rate of production of sulfur trioxide gas. In a rigid cylinder with a movable piston, this reaction reaches equilibrium, as represented by the equation below.

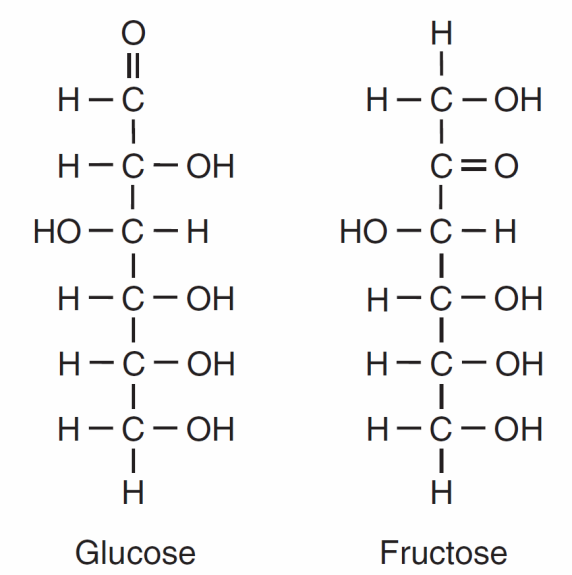
$$2SO_2(g) + O_2(g) \leftrightarrow 2SO_3(g) + 392\ kJ$$

____ 25. State, in terms of the concentration of $SO_3(g)$, what occurs when more $O_2(g)$ is added to the reaction at equilibrium.

____ 26. Explain, in terms of collision theory, why increasing the pressure of the gases in the cylinder increases the rate of the forward reaction.

____ 27. Base your answer to the following question on the information below and on your knowledge of chemistry.

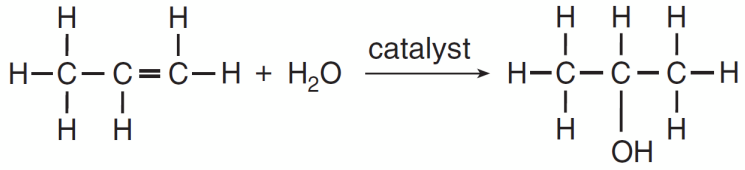
Table sugar, sucrose, is a combination of two simple sugars, glucose and fructose. The formulas below represent these simple sugars.



Explain, in terms of atoms and molecular structure, why glucose and fructose are isomers of each other.

____ 28. Base your answer to the following question on the information below.

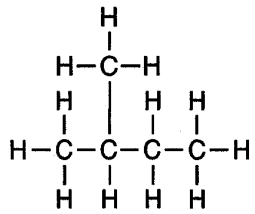
In one industrial organic reaction, C_3H_6 reacts with water in the presence of a catalyst. This reaction is represented by the balanced equation below.



Explain, in terms of bonding, why C_3H_6 is classified as an unsaturated hydrocarbon.

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

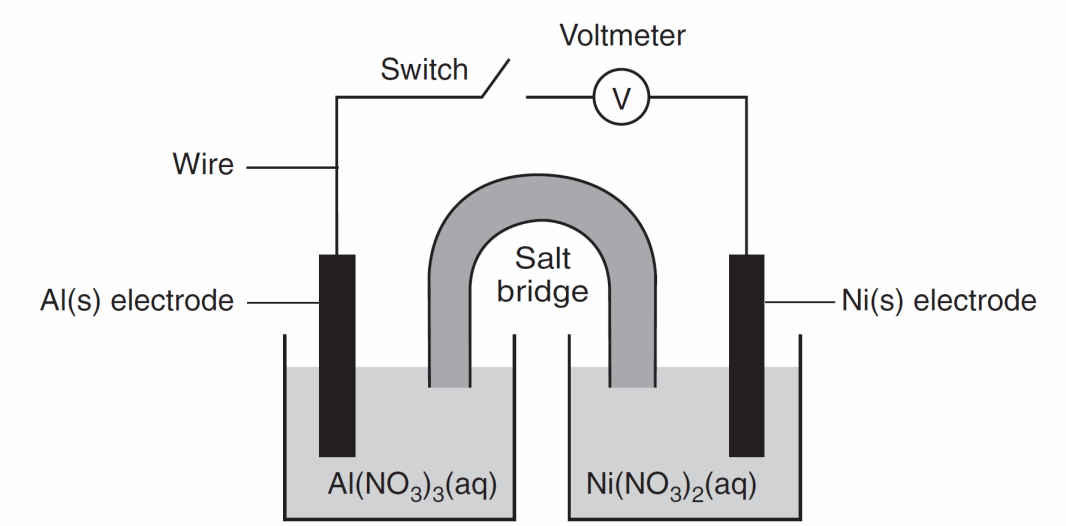
The formula below represents a hydrocarbon.



Explain, in terms of carbon-carbon bonds, why this hydrocarbon is saturated.

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

A student constructs an electrochemical cell during a laboratory investigation. When the switch is closed, electrons flow through the external circuit. The diagram and equation below represent this cell and the reaction that occurs.

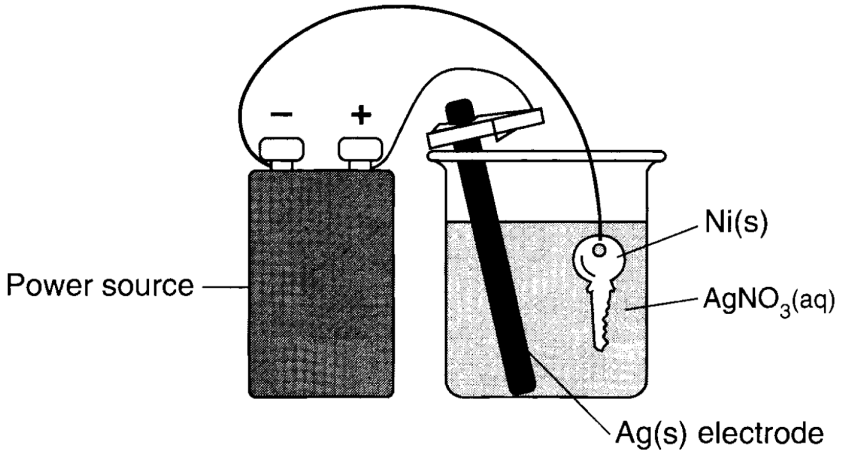


$$2Al(s) + 3Ni^{2+}(aq) \rightarrow 2Al^{3+}(aq) + 3Ni(s)$$

State, in terms of energy, why this cell is a voltaic cell.

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

The diagram below represents an operating electrolytic cell used to plate silver onto a nickel key. As the cell operates, oxidation occurs at the silver electrode and the mass of the silver electrode decreases.



Explain, in terms of Ag atoms and $Ag^+(aq)$ ions, why the mass of the silver electrode *decreases* as the cell operates.

____ 32. Base your answer to the following question on on the information below.

A laboratory worker filled a bottle with a hydrochloric acid solution. Another bottle was filled with methanol, while a third bottle was filled with a sodium hydroxide solution. However, the worker neglected to label each bottle. After a few days, the worker could not remember which liquid was in each bottle.

The worker needed to identify the liquid in each bottle. The bottles were labeled *A*, *B*, and *C*. Using materials found in the lab (indicators, conductivity apparatus, and pieces of Mg metal), the worker tested samples of liquid from each bottle. The test results are shown in the table below.

Table of Tests and Results

Test	Test Results		
	Bottle A	Bottle B	Bottle C
methyl orange indicator	yellow	yellow	yellow
bromthymol blue indicator	blue	green	yellow
electrical conductivity	conductor	nonconductor	conductor
reactivity with Mg metal	no reaction	no reaction	reaction

Explain, in terms of pH, why the methyl orange indicator test results were the same for each of the three liquids.

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

Iodine has many isotopes, but only iodine-127 is stable and is found in nature. One radioactive iodine isotope, I-108, decays by alpha particle emission. Iodine-131 is also radioactive and has many important medical uses.

Explain, in terms of protons and neutrons, why I-127 and I-131 are different isotopes of iodine.

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

The radioisotope uranium-238 occurs naturally in Earth's crust. The disintegration of this radioisotope is the first in a series of spontaneous decays.

The sixth decay in this series produces the radioisotope radon-222. The decay of radon-222 produces the radioisotope polonium-218 that has a half life of 3.04 minutes. Eventually, the stable isotope lead-206 is produced by the alpha decay of an unstable nuclide.

Explain, in terms of electron configuration, why atoms of the radioisotope produced by the sixth decay in the U-238 disintegration series do not readily react to form compounds.

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

Scientists are investigating the production of energy using hydrogen-2 nuclei (deuterons) and hydrogen-3 nuclei (tritons). The balanced equation below represents one nuclear reaction between two deuterons.

$$^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + {}^{1}_{0}n + 5.23 \times 10^{-13}\,J$$

State, in terms of subatomic particles, how a deuteron differs from a triton.

Answer Key

"State in Terms Of ..."

1. –The boiling point of the mixture increases as water evaporates because the concentration of dissolved molecules increases. –An increase in the concentration of sugar particles increases the boiling point.
2. –The carbon-11 nucleus has one more proton than the nucleus of boron-11. –A B-11 atom has a different number of neutrons than a C-11 atom.
3. – When electrons in an excited state return to a lower energy state, specific amounts of energy are emitted. These energies are associated with specific wavelengths of light that are characteristic of the bright-line spectrum of an element. – Energy is emitted when excited electrons fall back to lower shells.
4. – A U-235 atom has 92 protons and 143 neutrons, and a U-238 atom has 92 protons and 146 neutrons. – A U-235 atom and a U-238 atom have the same number of protons but a different number of neutrons.
5. –Since the Group 18 elements tend not to react with other elements, there were no oxide compounds for Mendeleev to study. –Group 18 elements are generally unreactive.
6. – An atom of magnesium loses its outer shell electrons to form the Mg^{2+} ion. – The electron configuration of a magnesium atom is 2-8-2, and the electron configuration of the magnesium ion is 2-8. – An atom of the metal loses electrons to form the ion.
7. —A K^+ ion has three electron shells and an Na^+ ion has only two. —A sodium ion has fewer electron shells than a potassium ion.
8. –In the ground state, an atom of each element has two valence electrons. –The number of electrons in the outermost shell of each atom is the same.
9. –Each reactant hydrocarbon molecule has a double carbon-carbon bond. –There is a multiple carbon-carbon bond in each molecule. –More hydrogen atoms can be bonded with this hydrocarbon.
10. – A 2-proponal 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
11. – There is a greater electronegativity difference in a CO bond than in a CH bond. – The CO bond is more polar because the electronegativity difference for a CO bond is 0.8, and the electronegativity difference for a CH bond is 0.4. – The CH bond has a smaller difference. – The CO is .8 and the CH is .4
12. –The 0.30 M NH_4 Cl(aq) sample has more mobile ions in solution. –The 0.10 M NH_4Cl solution has a lower concentration of ions.
13. – Both atoms in an O2 molecule have achieved a noble gas electron configuration. – An oxygen atom does not have a stable octet of valence electrons.
14. –The bonding in each compound involves a transfer of valence electrons from the metal to the nonmetal. –Both metals lose all of their valence electrons.
15. Diamond has atoms bonded strongly in a three-dimensional network. Graphite has atoms that are held weakly between layers.
16. –The heat of vaporization of water is 2260 J/g and the heat of fusion for water is only 334 J/g. –The heat of fusion of water is much less than its heat of vaporization.

Answer Key

"State in Terms Of ..."

17. –Methane is a compound consisting of two elements, so it can be broken down by chemical means, but argon is an element, which cannot be broken down. –Methane is a compound and argon is an element.

18. —The H^+ ions and the Cl^- ions are distributed uniformly throughout the solution. — There is an even distribution of $H^+(aq)$ and $Cl^-(aq)$.

19. –Ammonia has stronger intermolecular forces than either methane or hydrogen chloride. –Ammonia has hydrogen bonding

20. –Molecules of CH_4 are nonpolar, but molecules of HCl and H_2O are both polar. –Hydrogen chloride and water are both polar.

21. The solution made by the student is unsaturated.

22. The boiling point of propane at 1 atm is lower than the boiling point of butane at 1 atm because propane has weaker intermolecular forces than butane; Butane has stronger intermolecular forces.

23. – The catalyzed reaction pathway has a lower activation energy than the original reaction. – Less energy is needed.

24. —Room temperature is above the melting point and below the boiling point of H_2O_2 . —Room temperature is between –0.4°C and 151°C. — –0.4°C < room temperature < 151°C

25. The concentration of $SO_3(g)$ increases.

26. When the pressure in the cylinder is increased, the $SO_2(g)$ molecules and $O_2(g)$ molecules collide more frequently, producing more $SO_3(g)$.

27. – The number of each kind of atom is the same in both, but their structures are not he same. – Their molecular formulas are the same, but their structural arrangement of atoms is different. – same molecular formula but different structural formulas – The only different is the arrangement of the atoms.

28. Acceptable responses include, but are not limited to: The C_3H_6 is unsaturated because each molecule has a double covalent bond between two of its carbon atoms. There is a carbon-carbon double bond in each molecule

29. • All of the carbon-carbon bonds are single covalent bonds. • There are only single bonds between the carbon atoms.

30. —A spontaneous reaction converts chemical energy to electrical energy. —A battery is not required to provide energy for the cell to operate.

31. —Silver atoms lose electrons and become silver ions in the solution. — Some of the Ag atoms become Ag^+ ions. —Silver atoms are oxidized to silver ions.

32. *Examples*: -All three solutions have a pH greater than 4.4. -Methyl orange changes to yellow at a pH of 4.4, which is still in the acid range. -A solution with a pH greater than 4.4 could be acidic, basic, or neutral.

33. – I-127 atoms and I-131 atoms have the same number of protons, but different numbers of neutrons. – Both have 53 p, but I-127 has 74 n while I-131 has 78 n. – They have the same atomic number but different mass numbers. – same atomic number but different numbers of neutrons – The only difference is the number of neutrons.

34. –Radon-222 atoms have a complete outer shell of electrons and tend not to bond. –There are eight valence electrons in a radon atom. –Octet in valence shell.

35. Examples: A deuteron has one neutron and a triton has two neutrons.; A deuteron has one fewer neutron than a triton.