Complete combustion of a sample of a hydrocarbon in excess oxygen produces equimolar quantities of carbon dioxide and water. Which of the following could be the molecular formula of the compound?

1. A) C₂H₂  
   B) C₂H₆  
   C) C₄H₈  
   D) C₆H₆

Based on the data below, which of the following correctly predicts the relative strength of the attraction of Zn²⁺, Ca²⁺, and Ba²⁺ ions to water molecules in a solution from strongest to weakest, and provides the correct reason? ION IONIC RADIUS (pm) Zn²⁺ 74 Ca²⁺ 100 Ba²⁺ 135

2. A) Zn²⁺ > Ca²⁺ > Ba²⁺ because the smaller ions have a stronger coloumbic attraction to water  
   B) Zn²⁺ > Ca²⁺ > Ba²⁺ because smaller ions are more electronegative  
   C) Ba²⁺ > Ca²⁺ > Zn²⁺ because the larger ions are more polarizable  
   D) Ba²⁺ > Ca²⁺ > Zn²⁺ because the larger ions are less electronegative

The elements Te and I have similar average atomic masses. A sample that was believed to be a mixture of I and Te was run through a mass spectrometer, resulting in the data above. All of the following statements are true. Which one would be the best basis for concluding that the sample was pure Te?

3. A) Te forms ions with a -2 charge, whereas I forms ions with a -1 charge.  
   B) Te is more abundant than I in the universe.  
   C) I consists of only one naturally occurring isotope with 74 neutrons, whereas Te has more than one isotope.  
   D) I has a higher first ionization energy than Te does.

Which of the following particulate diagrams best shows the formation of water vapor from hydrogen gas and oxygen gas in a rigid container at 125°C?

4. A) Picture A  
   B) Picture B  
   C) Picture C  
   D) Picture D

The mass percent of carbon in pure glucose, C₆H₁₂O₆, is 40%. A chemist analyzes an impure sample of glucose and determines that the mass percent of carbon is 38.2%. Which of the following impurities could account for the low mass percent of carbon in the sample?

5. A) Water, H₂O  
   B) Ribose, C₅H₁₀O₅  
   C) Fructose, C₆H₁₂O₆, an isomer of glucose.  
   D) Sucrose, C₁₂H₂₂O₁₁
6. Lewis dot diagrams for CO\textsubscript{2} and SO\textsubscript{2} are given. The molecular geometry and polarity of the two substances are

A) the same because the molecular formulas are the same.
B) the same because C and S have similar electronegativity values.
C) different because the lone pair of electrons on the S atom make it the negative end of the dipole.
D) different because S has a greater number of electron domains (region of electron density) surrounding it than C has.

7. What remains in the reaction vessel after equal masses of K\textsubscript{(s)} and Cl\textsubscript{2(g)} have reacted until either one or both of the reactants have been completely consumed? K\textsubscript{(s)} + \frac{1}{2} Cl\textsubscript{2(g)} --&gt; KCl\textsubscript{(s)} + 437 kJ

A) KCl only
B) KCl and K only
C) KCl and Cl\textsubscript{2} only
D) KCl, K, and Cl\textsubscript{2}

8. N\textsubscript{2} molecules absorb UV light but not visible light. I\textsubscript{2} molecules absorb both UV and visible light. Which of the following statements explains the observations.

A) More energy is required to make N\textsubscript{2} molecules vibrate than is required to make I\textsubscript{2} molecules vibrate.
B) More energy is required to remove an electron from an I\textsubscript{2} molecule than is required to remove an electron from an N\textsubscript{2} molecule.
C) Visible light does not produce transitions between electronic energy levels in the N\textsubscript{2} molecule but does produce transitions in the I\textsubscript{2} molecule.
D) The molecular mass of I\textsubscript{2} is greater than the molecular mass of N\textsubscript{2}.

9. The photoelectron spectra above show the energy required to remove a 1s electron from a nitrogen atom and an oxygen atom. Which of the following statements best accounts for the peak in the upper spectrum being to the right of the peak in the lower spectrum?

A) Nitrogen atoms have a half-filled p subshell.
B) There are more electron-electron repulsions in oxygen atoms than in nitrogen atoms.
C) Electrons in the p subshell of oxygen atoms provide more shielding than electrons in the p subshell of nitrogen atoms.
D) Nitrogen atoms have a smaller nuclear charge than oxygen atoms.

10. This diagram best represents the PES of

A) Si
B) S
C) Ar
D) Ne

11. The first ionization element of this element, in megajoules per mole, is closest to (note the x axis is measured in units of megajoules/mole)
12. The PES of the element having an atomic number one greater than that of element X is plotted on the same axes. The spectrum would contain

A. The same number of peaks, all placed to the left of the peaks produced by X
B. The same number of peaks, all placed to the right of the peaks produced by X
C. One additional peak, located to the right of the 1 megajoule mark
D. One additional peak, located to the left of the 1 megajoule mark

13. The lower first ionization energy of oxygen, compared with that of nitrogen is best explained by

A. a greater effective nuclear charge acting on the valence electrons in oxygen.
B. repulsions between the electrons in the filled "p" orbital of an oxygen atom.
C. repulsions between 2s and 2p electrons that are greater in oxygen than in nitrogen.
D. a greater effective nuclear charge acting on the valence electrons in nitrogen.

14. Compared with the data for these two elements, we would expect the ionization energy, atomic radius, and electronegativity values for fluorine, to be, respectively

A. larger, smaller, larger
B. larger, larger, larger
C. smaller, larger, smaller
D. smaller, smaller, larger

15. Which ions contains 7 electrons in its 3d sublevel?

A. Cu$^{+2}$
B. Co$^{+2}$
C. Ni$^+$
D. Ni$^{+2}$

16. In one of the earliest atomic theories, John Dalton stated that all atoms of the same element are identical. This statement can be most directly disproved using

A. photonelectron spectroscopy
B. mass spectroscopy
C. IR spectroscopy
D. UV spectroscopy
A student performed an experiment to determine the formula hydrated copper (II) sulfate. A sample of the hydrate was heated to drive off the water, and was weighed before and after the heating. The student obtained the formula CuSO\(_4\)\(6\)H\(_2\)O, but the actual formula is CuSO\(_4\)5H\(_2\)O.

17. Which error best accounts for the difference in results?
   A. The hydrated sample was not reheated to a constant mass
   B. Some of the solid hydrate was lost during heating
   C. The initial sample of hydrate was contaminated with some anhydrous CuSO\(_4\)
   D. The balance gave masses that were consistently 0.20 g too high

18. The sublevel that is filled between elements 39 and 48 is the
   A. 3d
   B. 4d
   C. 5d
   D. 5p

19. The three groups on the periodic table on which NONE of the elements have any unpaired electrons in the ground state are groups
   A. 2, 8, and 12
   B. 2, 16, and 18
   C. 2, 12, and 18
   D. 12, 16, and 18

20. Atoms of which element have the highest electronegativity?
   A. Li, since they are the most likely to gain electrons.
   B. Li, since they are the most likely to lose electrons.
   C. K, since they are most likely to gain electrons.
   D. Na, since it is the most reactive.

21. Atoms of which element have the largest atomic radius?
   A. Li, since it has the fewest number of protons.
   B. K, since it has the greatest number of occupied principal shells.
   C. K, since it has the greatest number of protons.
   D. It is not possible to tell without further information.

22. From atoms of which element is it easiest to remove an electron?
   A. Li, since the first ionization is the highest.
   B. K, since Coulomb's law predicts the force of attraction between the nucleus and the valence electrons to be the lowest.
   C. Li, since it has the fewest protons.
   D. K, since potassium wants to become "happy" and achieve a noble gas electronic configuration.

23. Atoms of which element have the highest second ionization energy?
24. The most common ion of which element will be smaller than the corresponding parent atom?

A. Li  
B. Na  
C. K  
D. all three elements

25. Which element has the strongest metallic bonding?

A. Li since it has the most valence electrons.  
B. Li since the melting point suggest the strongest attraction between valence electrons and nuclei.  
C. K since it has the most electrons.  
D. Li since the melting point suggest the weakest attraction between valence electrons and nuclei.