MULTIPLE CHOICE. (3 points each)

1) Electromagnetic waves consist of
A) particles of light energy.
B) **vibrating electric and magnetic fields.**
C) high-frequency gravitational waves.
D) compressions and rarefactions of electromagnetic pulses.

2) Consider light energy that is momentarily absorbed in glass and then reemitted. Relative to the absorbed light, the frequency of the reemitted light is
A) slightly more.  
B) **the same.**  
C) considerably more.  
D) considerably less.  
E) slightly less.

3) The color of an opaque object is the same as the light that is
A) absorbed.  
B) **reflected.**  
C) transmitted.  
D) all of these  
E) none of these

4) What color light is transmitted by a piece of blue glass?
A) blue  
B) yellow  
C) white  
D) red  
E) orange

5) Complementary colors are two colors that
A) are additive primary colors.  
B) are right for each other.  
C) look good together.  
D) are subtractive primary colors.  
E) **produce white light when added together.**

6) Magenta light is really a mixture of
A) red and cyan light.  
B) red and yellow light.  
C) yellow and green light.  
D) **red and blue light.**  
E) none of these

7) The worst thing you can do for the health of a green-leafed plant is to illuminate it with only
A) red light.  
B) blue light.  
C) **green light.**  
D) All are equally naughty.  
E) none of these

8) Colors seen when gasoline forms a thin film on water are a demonstration of
A) refraction.  
B) polarization.  
C) reflection.  
D) **interference.**  
E) dispersion.

9) The law of reflection holds for
A) curved mirrors.  
B) plane mirrors.  
C) **both of these**  
D) neither of these
10) Light refracts when traveling from air into glass because light
   A) intensity is greater in glass than in air.       B) frequency is greater in air than in glass.
   C) intensity is greater in air than in glass.    D) frequency is greater in glass than in air.
   E) travels slower in glass than in air.

11) Different colors are dispersed by a prism because different colors in the prism have different
    A) frequencies.         B) speeds.
    C) energies.           D) directions.
    E) none of these

12) The type of lens that spreads parallel light is a
    A) combination converging-diverging lens.
    B) converging lens.
    C) diverging lens.

13) The photoelectric effect best demonstrates the
    A) particle nature of light.       B) wave nature of light.
    C) both of these                   D) none of these

14) What makes an element distinct?
    A) the number of protons
    B) the number of electrons
    C) the number of neutrons
    D) the total mass of all the particles
    E) none of these

15) A molecule has
    A) structure.   B) energy.   C) mass.   D) all of these
    E) none of these

16) Which of the following are electrically neutral?
    A) proton       B) electron  C) neutron  D) all of these
    E) none of these

17) In an electrically neutral atom, the number of protons in the nucleus is balanced by an equal
    number of
    A) orbital electrons.
    B) neutrons.
    C) quarks.
    D) all of these
    E) none of these

18) If two protons are removed from an oxygen nucleus, the result is
    E) none of these

19) Which of these atoms has the greatest number of electrons?
    A) carbon       B) uranium  C) iron     D) gold
    E) helium

20) Why are the atomic masses listed in the periodic table not whole numbers?
    A) The atomic masses are average atomic masses.
    B) That would be too much of a coincidence.
    C) Scientists have yet to make the precise measurements.
    D) Today's instruments are able to measure the atomic masses to many decimal places.
21) How many electrons are in the outermost shell of phosphorus (P, atomic number 15)?
   A) 8   B) 3   C) 5   D) 15

22) How many shells are occupied by electrons in the gold atom (Au, atomic number 79)?
   A) 7   B) 5   C) 6   D) 4

23) Helium, He, is a nonmetallic gas and the second element in the periodic table. Rather than being placed adjacent to hydrogen, H, however, helium is placed on the far right of the table because
   A) the sizes of their atoms are vastly different.
   B) they come from different sources.
   C) hydrogen and helium repel one another.
   D) helium is most similar to other group 18 elements.

24) If an atom has 43 electrons, 56 neutrons, and 43 protons, what is its approximate atomic mass? What is the name of this element?
   A) Atomic mass, 137 amu; Barium
   B) Atomic mass 142 amu; Einsteinium
   C) Atomic mass, 99 amu; Radon
   D) Atomic mass, 99 amu; Technetium

25) If one neutron is added to a helium nucleus, the result is
Problems (5 points each)

1. Determine the color of light in the following combinations:

   Red + Cyan = White

   White – Cyan = Red

   Blue + Red = Magenta

2. Complete the table:

<table>
<thead>
<tr>
<th>element or ion</th>
<th>protons</th>
<th>neutrons</th>
<th>electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{31}_{15}P$</td>
<td>15</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>$^{13}_{6}C$</td>
<td>6</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>$^{6}_{3}Li$</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>$^{51}_{23}V$</td>
<td>23</td>
<td>28</td>
<td>23</td>
</tr>
<tr>
<td>$^{16}_{8}O^{2-}$</td>
<td>8</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

3. How can a hydrogen atom, which has only one electron, create so many spectral lines?

   The one electron can be boosted to many energy levels, and therefore make many combinations of transitions to lower energy levels. Each transition has a specific energy and a specific emitted frequency, thus a variety of spectral lines.
4. Describe the main features of the Bohr model of the atom (solar system model).

There are several features; they all didn’t need to be used for credit:
- Set orbital with a specific energy and radius (energy and angular momentum is quantitized).
- Use of a quantum number (just one, n).
- the model is flat.
- the model is an exact solution.
- the model only works for atoms or ions with one electron.

5. Give the common names for the following groups in the periodic table:

Group 1 (or IA)

Alkali Metals

Group 2 (or IIA)

Alkaline Earth Metals

Group 17 (or group VIIA)

Halogens