1) Microwave radiation has a wavelength on the order of 1.0 cm.
a)Calculate the frequency and the energy of a single photon of this radiation.
b)Calculate the energy of an Avogadro's number of photons (called an einstein) of this radiation.

2) An electron is excited from the ground state to the $n = 3$ state in a hydrogen atom. Which of the following statements are true? Correct any false statement.

(a) It takes more energy to ionize (remove) the electron from $n = 3$ state than in the ground state.
(b) The electron is farther from the nucleus on average in the $n = 3$ state than in the ground state.
(c) The wavelength of light emitted if the electron drops from $n = 3$ to $n = 2$ is shorter than the wavelength of light emitted if the electron falls from $n = 3$ to $n = 1$.
(d) The wavelength of light emitted when the electron returns to the ground state from $n = 3$ is the same as the wavelength of light absorbed to go from $n = 1$ to $n = 3$.
(e) The first excited state corresponds to $n = 3$.

3) How many orbitals in an atom can have the following designation?

$5p$ - $3d_z^2$ - $4d$ - $n = 5$ - $n = 4$

4) What is the maximum number of electrons in an atom that can have the following quantum numbers?

(a) $n = 4$ (b) $n = 5$, $m_l = +1$ (c) $n = 5$, $m_s = +1/2$

(d) $n = 3$, $l = 2$ (e) $n = 2$, $l = 1$ (f) $n = 0$, $l = 0$, $m_l = 0$

(g) $n = 2$, $l = 1$, $m_l = -1$, $m_s = -1/2$ (h) $n = 3$

(i) $n = 2$, $l = 2$ (j) $n = 1$, $l = 0$, $m_l = 0$

5) Write the expected ground-state electron configuration for the following.
(a) the (as yet undiscovered) alkaline earth metal after radium

(b) the first-row transition metal with the most unpaired electrons

6) A certain oxygen atom has the electron configuration $1s^2 2s^2 2p_x^2 2p_y^2$. How many unpaired electrons are present?

Is this an excited state of oxygen?

In going from this state to the ground state would energy be released or absorbed?

7) Which of the following electron configurations correspond to an excited state? (Select all that apply.)

☐ I. $1s^2 2s^2 3p^1$ ☐ II. $1s^2 2s^2 2p^6$ ☐ III. $1s^2 2s^2 2p^4 3s^1$ ☐ IV. $[Ar]4s^2 3d^5 4p^1$

8) Identify the atoms and write the ground state electron configuration where appropriate.

(a) element I ($1s^2 2s^2 3p^1$) (b) element II ($1s^2 2s^2 2p^6$)

(c) element III ($1s^2 2s^2 2p^4 3s^1$) (d) element IV ($[Ar]4s^2 3d^5 4p^1$)

9) In each of the following sets, which atom or ion has the smallest radius?

(a) H, He, B (b) Xe, He, Ne (c) In, Cl, Se (d) Al, Cl, Tl

10) Rank the elements Ne, Be, B, C, O in order of increasing first ionization energy

11) Element 106 is named seaborgium (Sg) in honor of Glenn Seaborg, discoverer of the first transuranium element.
(a) Write the expected electron configuration for Sg
(b) What other element would be most like Sg in its properties?
(c) Write the formula for a possible oxide and a possible oxyanion of Sg.

12) Order the atoms in each of the following sets from the least exothermic electron affinity to the most. (Use the appropriate <, =, or > symbol to separate substances in the list.)

(a) F, Cl, Br, I (b) N, O, F

13) Which has the more negative electron affinity, the Bromine atom or the $Br^-$ ion?

14) The electron affinities of the elements from aluminum to chlorine are -44, -120, -74, -200.4, and -384.7 kJ/mol, respectively. Rationalize the trend in these values.

15) Photogray lenses incorporate small amounts of silver chloride in the glass of the lens. When light hits the AgCl particles, the following reaction occurs.

$AgCl \xrightarrow{h\nu} Ag + Cl$

The silver metal formed causes the lenses to darken. The enthalpy change for this reaction is $3.10 \times 10^2$ kJ/mol. Assuming all this energy must be supplied by light, what is the maximum wavelength of light that can cause this reaction?

16) The successive ionization energies for an unknown element are shown below.

$I_1$ = 882 kJ/mol
$I_2$ = 1816 kJ/mol
$I_3$ = 15612 kJ/mol
$I_4$ = 17948 kJ/mol

To which family in the periodic table does the unknown element most likely belong?

17) An ion having a 4+ charge and a mass of 49.9 amu has two electrons with $n = 1$, eight electrons with $n = 2$, and ten electrons with $n = 3$. Supply as many of the properties for the ion as possible from the information given. (Hint: In forming ions, the 4*s* electrons are lost before the 3*d* electrons.)

(a) What is the atomic number?

(b) What is the total number of *s* electrons?

(c) What is the total number of *p* electrons?

(d) What is the total number of *d* electrons?

(e) What is the number of neutrons in the nucleus?

(f) What is the mass of 2.05 x$10^{23}$ atoms?

(g) What is the ground-state electron configuration of the neutral atom?

18) Although no currently known elements contain electrons in *g* orbitals in the ground state, it is possible that these elements will be found or that electrons in excited states of known elements could be in *g* orbitals. For *g* orbitals, the value of $l$ is 4.

(a) What is the lowest value of *n* for which *g* orbitals could exist?

(b) What are the possible values of $m_l$?

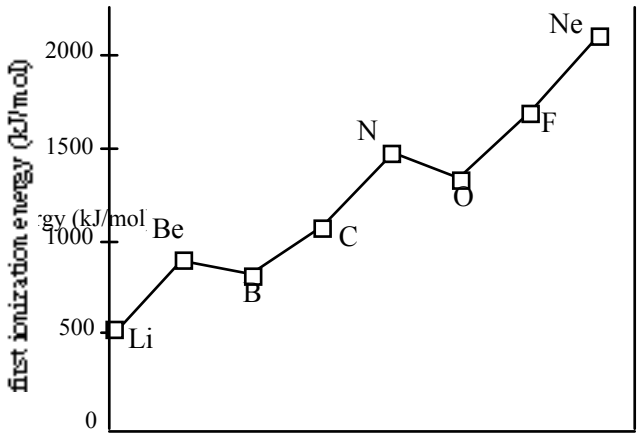
(c) How many electrons could a set of *g* orbitals hold?

19) Calculate the following for the ground state of cadmium (Cd).

(a) How many electrons have $l = 2$ as one of their quantum numbers?

(b) How many electrons have $n = 4$ as one of their quantum numbers?

(c) How many electrons have $m_l = -1$ as one of their quantum numbers?




20) The diagram shows the first ionization energies for the elements from Li to Ne. Briefly (in one to three sentences) explain each of the following in terms of atomic structure.

(a) In general, there is an increase in the first ionization energy from Li to Ne.

(b) The first ionization energy of B is lower than that of Be.

(c) The first ionization energy of O is lower than that of N.

(d) Predict how the first ionization energy of Na compares to those of Li and of Ne. Explain.

21) (a) The average atomic mass of naturally occurring neon is 20.18 amu. There are two common isotopes of naturally occurring neon as indicated in the table below.

| Isotope | Mass (amu) |
|---|---|
| Ne-20 | 19.99 |
| Ne-22 | 21.99 |

(i) Using the information above, calculate the percent abundance of each isotope.

(ii) Calculate the number of Ne-22 atoms in a 12.55 g sample of naturally occurring neon.

(b) A major line in the emission spectrum of neon corresponds to a frequency of $4.34\times10^{14}$ $s^{-1}$. Calculate the wavelength, in nanometers, of light that corresponds to this line.

(c) In the upper atmosphere, ozone molecules decompose as they absorb ultraviolet (UV) radiation, as shown by the equation below. Ozone serves to block harmful ultraviolet radiation that comes from the Sun.

$$O_{3(g)} \xrightarrow{UV} O_{2(g)} + O_{(g)}$$

A molecule of $O_{3(g)}$ absorbs a photon with a frequency of $1.00\times10^{15}$ $s^{-1}$.

(i) How much energy, in joules, does the $O_{3(g)}$ molecule absorb per photon?

(ii) The minimum energy needed to break an oxygen-oxygen bond in ozone is 387 kJ $mol^{-1}$. Does a photon with a frequency of $1.00\times10^{15}$ $s^{-1}$ have enough energy to break this bond? Support your answer with a calculation.