CHM 1045 - General Chemistry I KEY
Exam 4 19992a

I. Matching (Match the BEST answer) (1 point each)

J	1.	Pauli Exclusion Principle	A.	Principle quantum number
B	2.	Transition	B.	The movement of an electron from one energy level to another
N	3.	Photon	C.	Electrons remain unpaired as long as possible
I	4.	Uncertainty Principle	D.	The energy required to add an electron to an atom
C	5.	Hund's Rule	E.	Electrons of polyatomic atoms go in hydrogen-like orbitals starting with the lowest energy first
P	6.	Orbital	F.	The speed of light
O	7.	Amphoteric Substance	G.	The energy required to remove an electron from an atom
E	8.	Aufbau Principle	H.	Azimuthal quantum number
M	9.	Ground State	I.	You can't know both the location and momentum of an electron at once
R	10.	Degenerate Orbitals	J.	No two electrons can have the same 4 quantum numbers
L	11.	Planck's Constant	K.	Magnetic quantum number
G	12.	Ionization Energy	L.	Relates the energy of a photon to its frequency
D	13.	Electron Affinity	M.	The lowest energy state for a given electron
F	14.	c	N.	A quantum of light energy
Q	15.	Isoelectronic	O.	Has both acidic and basic properties
A	16.	n	P.	The 3D region of space in which you might expect to find an electron's wave function
H	17.	l	Q.	Identical electron configurations
K	18.	m_l	R.	Examples include $p_x p_y p_z$ and the d and f orbitals

II. Give the complete electron configurations for the elements shown below. (p^6 notation is OK) (2 points each)

Chromium - $1s^2\ 2s^2p^6\ 3s^2p^6d^5\ 4s^1$

Strontium - $1s^2\ 2s^2p^6\ 3s^2p^6d^{10}4s^2p^6\ 5s^2$

Iron - $1s^2\ 2s^2p^6\ 3s^2p^6d^6\ 4s^2$

Oxygen - (be sure to include all sublevels and electron spins on this one, p^6 notation is NOT OK)

$1s^{\uparrow\downarrow}\ 2s^{\uparrow\downarrow}\ p_x^{\uparrow}\ p_y^{\uparrow}\ p_z^{\uparrow}$

III. Fill in the blanks (1 point each blank)

1. Give three examples of electromagnetic radiation besides visible light. radio waves, x-rays, visible light. (there are other answers)

2. The speed of EMR is always constant in a qiven medium and is equal to 2.99×10^8 m/sec in a vacuum.

3. The wavelength of EMR is equal to the speed of light divided by the frequency.

4. "s" orbitals are believed to be shaped like a sphere, while "p" orbitals are shaped like "dumbbells".

5. The dual nature of light says that sometimes light can act like a wave and sometimes it can act like a particle.

6. The outer electron of a potassium atom has 3 quantum numbers associated with it in addition to its spin. The values of these three quantum numbers are $n = 4$, $l = 0$, $m_l = 0$.

7. If an electron has a principle quantum number equal to 3, what are the allowed values for the magnetic quantum number for the "p" orbitals? All p orbitails are $m_l = -1$, or 0, or +1 .

8. Which atom is larger: Ra or Sr ? Ra , Cs or Bi ? Cs, Ba or Si ? Ba

9. Which atom has a larger 1st ionization energy: Na or Al ?Al , Te or O ? O

10. Which atom has the smallest negative ΔH for the 1st electron affinity: Na or F ? Na

11. What atom has the larger 2nd ionization energy? K or Ca ? K

12. As the atomic number increase from 25 to 26, the additional electron is added to the d orbitals. As the atomic number increase from 60 to 61, the additional electron is added to the

f orbitals. The halogens all have 7 (how many) electrons in outer s and p (what kind) orbitals. The noble gases all have complete outer s and p orbitals (what kind).

13. Chlorine gas is highly reactive but Cl^{-1} ions are nonreactive. Why? A chloride ion has filled s and p orbitals in it's valence shell and has a noble gas configuration.

14. The lower the frequency and longer the wavelength the smaller (greater/smaller) the amount of energy of the radiation.

Equations and Values

$c=\lambda\nu$

$E_{electron}= - 2.178X10^{-18}J(1/n^2)$

$1/\lambda = 109700cm^{-1}(1/n^2_{lower} - 1/n^2_{upper})$

$E_{photon}=h\nu$

$c = 2.99X10^{10}cm/sec$

$h = 6.63X10^{-34}J\bullet$ sec

Rydberg's $R = 109700cm^{-1}$

IV. Problems (All three problems are related. Use the answer to 1 to do 2, etc.)

1. What is the energy of an electron in the 5th energy level of a hydrogen atom? (6 points)

$E_{5th} = - 2.178 \times 10^{-18}J\ (1 / 5^2) = - 8.71 \times 10^{-20}J$

2. If the energy of an electron in the 1st energy level of a hydrogen atom is -2.180×10^{-18}J, how much energy is released when the electron in problem 1 (5th energy level) falls to the 1st energy level? (6 points)

$$E_{photon} = E_{5th} - E_{1st} = (-8.71 \times 10^{-20}J) - (-2.18 \times 10^{-18}J) = 2.09 \times 10^{-18}J$$

3. What is the FREQUENCY AND WAVELENGTH of the photon of light produced when an electron on a hydrogen atom falls from the 5th energy level to the 1st energy level? Hint – You can solve this problem even if you didn't do problems 1 and 2. (12 points)

$f = E_{photon} / h = 2.09 \times 10^{-18}J / 6.63 \times 10^{-34}$ J sec $= 3.16 \times 10^{15}$ sec^{-1}

$\lambda = hc/E = (6.63 \times 10^{-34}Jsec)(2.99 \times 10^{10}cm/sec) / (2.09 \times 10^{-18}J) = 9.49 \times 10^{-6}cm$

V. MULTIPLE CHOICE (Circle the best answer) (2 points each)

1. Which radiation has the shortest wavelength?

   a. Microwaves

b. Infrared Radiation
c. Blue light
d. Red light
e. Radio waves

2. Which of the following has the highest energy per photon?

a. Radio waves
b. Infrared radiation
c. Microwaves
d. Red light
e. Ultraviolet light

3. The contribution for which de Broglie is remembered in modern science is

a. his statement that an electron can exist in an atom only in discrete energy levels.
b. his statement that no electron can have identical values for all four quantum numbers.
c. his proposal that particles of matter should be associated with wavelike behavior.
d. his statement that elements show periodic repetition of properties.
e. his statement that electrons occupy all the orbitals of a given sublevel singly before pairing begins.

4. All the following statements are true except

a. The n = 5 energy level has five different kinds of orbitals.
b. The 2p orbitals can have a maximum of 6 electrons.
c. Each p orbital has a dumbbell shape.
d. There are 7 *f* orbitals in a set.
e. The second major energy level has two sets *p* orbitals.

5. All of the following quantum number combinations are allowed EXCEPT

a. n=1, l=0, m_l=0, m_s= + ½ .
b. n=4, l=0, m_l=0, m_s= + ½.
c. n=3, l=3, m_l=+3, m_s= - ½.
d. n=3, l=1, m_l=0, m_s= + ½.
e. n=4, l=3, m_l=+2, m_s= - ½.

6. The two quantum numbers which represent a 3d electron are

a. n = 4, l = 2.
b. n = 3, l = 3.
c. n = 4, l = 3.
d. n = 3, l = 2.
e. n = 3, l = 1.

7. Which of the following does not have noble gas configuration?

a. P^{-3}
b. Al^{+3}
c. F^{-1}
d. K^{+1}
e. Zn^{+2}

8. The maximum number of 2d electrons is

a. 10.
b. 7.
c. 5.
d. 4.
e. 0.

9. The total number of electrons in "s" orbitals in a zirconium atom $_{40}Zr$ is

a. 2.
b. 6.
c. 10.
d. 18.
e. 40.

10. Which of the following species is isoelectronic with Kr?

a. Xe
b. K^{+1}
c. In^{+3}
d. S^{-2}
e. Sr^{+2}