General Chemistry I
Chem 111-01 Exam #3

NAME: Answer Key
Fall 2015

Some Equations and Constants for your use:

$\lambda \times \nu = c \qquad E = h\nu \qquad E_n = \frac{-2.18 \times 10^{-18}\ J}{n^2} \qquad \lambda = \frac{h}{mv}$

$c = 3.00 \times 10^8\ m/s \qquad h = 6.626 \times 10^{-34}\ J \cdot s$

1. Light and Energy

Consider electromagnetic radiation that delivers 2.00×10^{-19} J for each photon. Include units.

a. What is the frequency of the radiation, in Hz?

~~$E = 2.00 \times 10^{-19}\ J$~~ $\qquad \nu = \frac{E}{h} = \frac{2.00 \times 10^{-19}\ J}{6.626 \times 10^{-34}\ J \cdot s} =$ $3.02 \times 10^{14}\ s^{-1}$

b. What is the wavelength of this light, in nm?

$\lambda = \frac{c}{\nu} = \frac{3.00 \times 10^8\ m/s}{3.02 \times 10^{14}\ s^{-1}} = 9.94 \times 10^{-7}\ m$

994 nm

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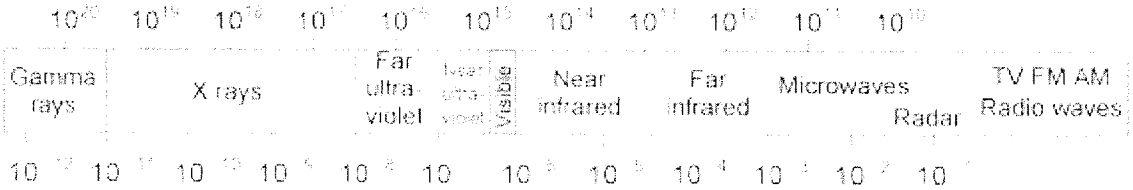
2. Electromagnetic Spectrum

Consider the electromagnetic spectrum below. The labels for the x-axis numbers have been omitted.



a. Which x-axis represents wavelength: top or (bottom)

b. increasing wavelength = increasing or (decreasing) frequency

c. increasing frequency = (increasing) or decreasing photon energy

d. Which type of radiation has greater energy per photon? Radio or (IR)

e. Which type of radiation has greater frequency? (X-rays) or UV

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3. Fill in the following chart regarding orbitals. The answer to at least one of these is zero.

	number of orbitals	number of electrons that can be held
n = 3 shell	9	18
4p subshell	3	6
$3p_x$ orbital	1	2
2f subshell	0	0
5g subshell	9	18

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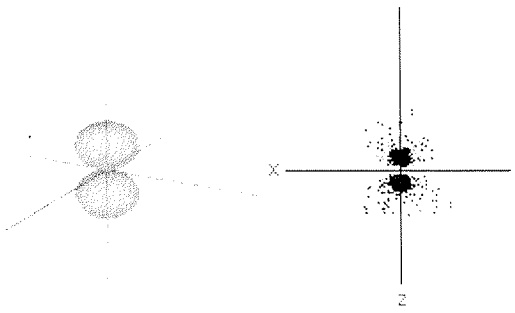
4. Orbital Shapes

Give the orbital designation for each orbital pictured. For example, 2s or $4p_x$.

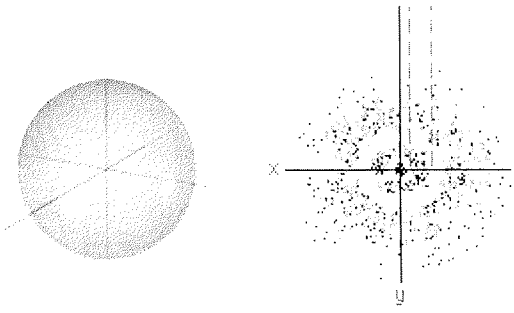


Boundary Surface Dot Picture

Orbital: $2p_z$

how many planar nodes? 1

how many spherical nodes? 0



Boundary Surface Dot Picture

Orbital: 3s

how many planar nodes? 0

how many spherical nodes? 2

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Consider the wavefunction below. r, x, and y = represent distances of the electron from the nucleus. In what regions would it equal zero (that is, have a node)? (Answer something like "when z = 0" and there can be more than one answer.)

$$\psi = (3 - r)xy\, e^{-r}$$

will be zero when $x = 0$ (planar node)

$y = 0$ (planar node)

$r = 3$ (spherical node)

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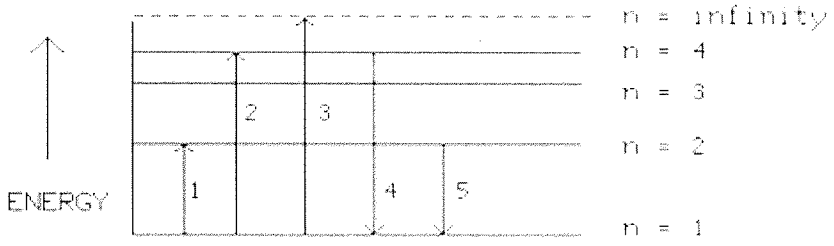
5.



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Match each of the responses below with the correct arrow from the figure.

4 a) The emission line with the **shortest** wavelength.

1 b) The absorption line with the **longest** wavelength.

4 c) The emission line with the **highest** energy.

6. Which of the following sets of quantum numbers are allowed (circle each that is allowed):

6

a. n = 3, l = 2, m_l = -1

~~b.~~ n = 3, l = 3, m_l = 0

c. n = 9, l = 0, m_l = 0

7. Complete the electron configuration for nitrogen using the diagram below. I have labeled the 1s subshell. You need to add arrows for electrons and label all the other subshells.

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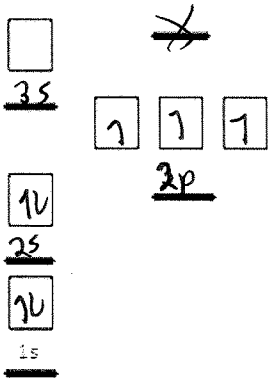

Is a nitrogen atom paramagnetic or diamagnetic?

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8. Give electron configurations for the following (using spdf ($1s^2$ $2s^2$ etc. notation, **or** noble gas notation):

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a. Na $1s^2 2s^2 2p^6 3s^1$

b. S^{2-} $1s^2 2s^2 2p^6 3s^2 3p^6$

c. Mg^{2+} $1s^2 2s^2 2p^6$

d. Cr^{3+} $[Ar] 3d^3$

9. Trends!

9

10

Which is larger:

Radius of:	P	or	As
Radius of:	Ar	or	Na
Radius of:	Na^+	or	F^-
Radius of:	O	or	O^{2-}

Ionization energy of:	S	or	Ar
Ionization energy of:	Na	or	Be
Ionization energy of:	N	or	O

Energy of 2p orbital in C	or	Energy of 2p orbital in O
Energy of 2p orbital in C	or	Energy of 3p orbital in Si

An atom has the following attributes:

a. it is smaller than As
b. it is smaller than Te
c. it has lower energy orbitals than Se
d. it is larger than Cl
e. it forms a 1- ion

What element is it? Br

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10.

Given the standard enthalpy changes for the following two reactions:

(1) $2C(s) + 2H_2(g) \longrightarrow C_2H_4(g)$ $\Delta H° = 52.3$ kJ -52.3

(2) $2C(s) + 3H_2(g) \longrightarrow C_2H_6(g)$ $\Delta H° = -84.7$ kJ -84.7

$= -137$ kJ

what is the standard enthalpy change for the reaction:

(3) $C_2H_4(g) + H_2(g) \longrightarrow C_2H_6(g)$ $\Delta H° = ?$ -137 kJ

11.

A student determines the heat of dissolution of solid **magnesium chloride** using a coffee-cup calorimeter of negligible heat capacity.

When **0.630** g (= 0.00662 mol) of $MgCl_2(s)$ is dissolved in **119.00** g of water, the temperature of the solution increases from **25.00** to **27.19**°C. Calculate the enthalpy of dissolution of $MgCl_2(s)$ in kJ/mol. Assume the specific heat of the solution is 4.184 J/g°C.

$\Delta H = \frac{\#J}{\#mol}$ ← $= 4.184 \frac{J}{g \cdot °C} \times 119.63 g \times 2.19 °C = 1096 J$

0.00662 mol

$\Delta H = \frac{1096 J}{0.00662 mol} = -166{,}000 J/mol$

$= -166$ kJ/mol

(negative because temperature increases.)

$\Delta H_{dissolution} = -166$ kJ/mol

12.

Using standard heats of formation, calculate the standard enthalpy change for the following reaction.

$\mathbf{2H_2S(g) + 3O_2(g) \longrightarrow 2H_2O(l) + 2SO_2(g)}$

	ΔH_f°, kJ/mol
$H_2S(g)$	-20.6
$H_2O(l)$	-285.8
$SO_2(g)$	-296.8

$\Delta H = [2(-285.8) + 2(-296.8)] - [2(-20.6)] = -1124\ kJ/mol$

ANSWER: [ ] kJ