Formulas and Constants

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$N_A = 6.022\text{x}10^{23}\ \text{mol}^{-1}$ $\quad h = 6.626\text{x}10^{-34}\ \text{J s}$ $\quad c = 2.998\text{x}10^{8}\ \text{m s}^{-1}$

$e = 1.602\text{x}10^{-19}\ \text{C}$ $\quad m_e = 9.109\text{x}10^{-31}\ \text{kg}$ $\quad 1\ \text{Å} = 1\text{x}10^{-10}\ \text{m} = 100\ \text{pm}$

$R_H = 1.0968\text{x}10^{7}\ \text{m}^{-1}$ $\quad hcR_H = 2.178\text{x}10^{-18}\ \text{J}$ $\quad N_A\,hcR_H = 1313.\ \text{kJ mol}^{-1}$

$E_K = \frac{1}{2} m \upsilon^2$ $\quad \Delta E = h\nu$ $\quad \nu\lambda = c$

$V = \frac{k\, q_1 q_2}{d}$ $\quad k = 1.389\text{x}10^{5}\ \text{kJ pm mol}^{-1}$ $\quad E = h\nu = \frac{1}{2} m \upsilon^2 + BE$

$\mu = Q\, r$ $\quad 1\ \text{D} = 3.336\text{x}10^{-30}\ \text{C m}$ $\quad \tilde{\nu} = \frac{1}{\lambda}$

$\Delta E = \frac{hc}{\lambda} = hc\tilde{\nu}$ $\quad p = \frac{h}{\lambda}$ $\quad \lambda = \frac{h}{m\upsilon}$ $\quad p = m\upsilon$ $\quad \Delta x\, \Delta p \geq \frac{h}{4\pi}$

$\frac{1}{\lambda} = R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$ $\quad E = 2.178\text{x}10^{-18}\ \text{J}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$ $\quad \Delta E = -2.178\text{x}10^{-18}\ \text{J}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

$$E_n = (-hcR_H)\left(\frac{Z^2}{n^2}\right) = 2.178\text{x}10^{-18}\ \text{J}\left(\frac{Z^2}{n^2}\right) = -13.6\ \text{eV}\left(\frac{Z^2}{n^2}\right) = -1313.\ \text{kJ mol}^{-1}\left(\frac{Z^2}{n^2}\right)$$

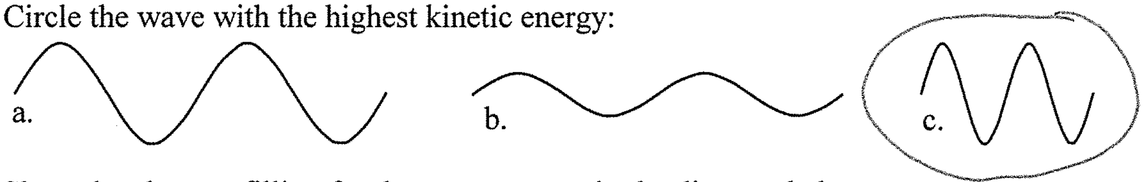
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
IA	IIA	IIIB	IVB	VB	VIB	VIIB	---	VIII	---	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1A	2A	3B	4B	5B	6B	7B	---	8	---	1B	2B	3A	4A	5A	6A	7A	8A
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.47	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 190.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.5	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (210)	85 At (210)	86 Rn (222)

Honors General Chemistry CH145 Test 1
Prof. Shattuck

Name________________________

Part 1. Answer 7 of the following 8 questions. If you answer more than 7 cross out the one you wish not to be graded, otherwise only the first three will be graded. 6 points each.

1. Circle the wave with the highest kinetic energy:



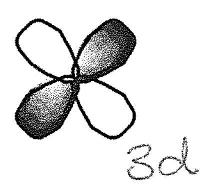
2. Show the electron filling for the oxygen atom in the diagram below:

3. Circle the correct answer in each of the following lists:
   a. The most negative Electron Affinity: Ge, O, Mg
   b. The largest first ionization potential: Al, S, Cl
   c. The largest atomic radius: Rb, K, As

4. Give the process written as a chemical reaction that corresponds to the Electron Affinity of the F-atom. $F(g) + 1e^- \rightarrow F^-(g)$

5. Circle the correct answer in each of the following lists:
   a. The shortest bond: $H_2N\text{-}NH_2$, HN=NH, N≡N
   b. The largest bond dissociation energy : C≡O, O=O, F-F
   c. The largest lattice energy: KCl, $CaCl_2$, CaO   (+2, −2)

6. Which of the following has the bond with the most covalent character? HF, KCl, CH_4.



7. What is the ℓ quantum number for the atomic orbital shown at right?.

$\ell = 2$

8. Which of the following is **not true** about a photon?
   a. the photon energy is proportional to the frequency.
   b. the photon energy is proportional to the wavelength.
   c. the photon has momentum.
   d. the photon energy can be absorbed by an electron in an atom.
   e. the photon has wave-like and particle-like properties.

Part 2. Answer 3 of the following 4 questions. If you answer more than three cross out the one you wish not to be graded, otherwise only the first three will be graded. 9 points each.

9. What effect does orbital penetration have on the energies of the n=3 orbitals?

The 3s orbital penetrates closer to the nucleus than the 3p (or 3d). So the 3s-orbitals feels a greater effective charge than the 3p (or 3d). In turn, the 3p-orbital penetrates more than the 3d-orbital.

10. Give the electron configuration for the following atoms or ions (include deviations from the aufbau principle, you can also simplify by using a noble gas core, e.g. [Ar]):

Si: $[Ne]\,3s^2\,3p^2$

Zn: $[Ar]\,4s^2\,3d^{10}$

S^{2-}: $[Ne]\,3s^2\,3p^6$

11. The frequency of a photon is 6.00×10^{14} sec^{-1}. Calculate the wavelength in nm and the energy in kJ/mol.

$$\lambda = \frac{c}{\nu} = \frac{2.998 \times 10^8\ m\ s^{-1}}{6.00 \times 10^{14}\ s^{-1}} = 500.\ nm$$

$$E = N_A \frac{hc}{\lambda} (1\,kJ/1000\,J) = \frac{6.022 \times 10^{23}\ mol^{-1}\ 6.626 \times 10^{-34}\ J\,s\ 2.998 \times 10^8\ m\ s^{-1}}{500. \times 10^{-9}\ m}$$

$$= 239.\ kJ/mol$$

12. What is the principle quantum number and the azimuthal (angular momentum) quantum number for a 3d orbital? What are the allowable values for m_ℓ for a 3d orbital?

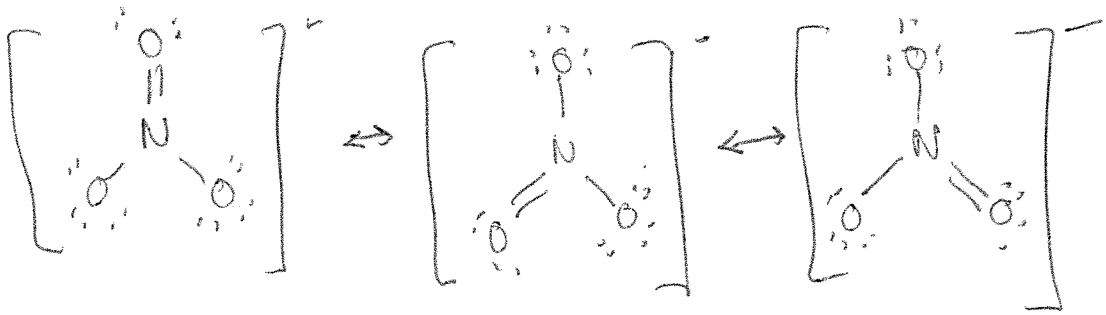
$n = 3$

$\ell = 2$

$m_\ell = -2, -1, 0, +1, +2$

Part 3. Answer 3 of the following 4 questions. If you answer more than three cross out the one you wish not to be graded, otherwise only the first three will be graded. 10 points each.

13. Draw the Lewis dot resonance structures for the nitrate ion, NO_3^- . Give the average bond order for the bonds. Don't forget to include the charge in your structures. (N in the center)



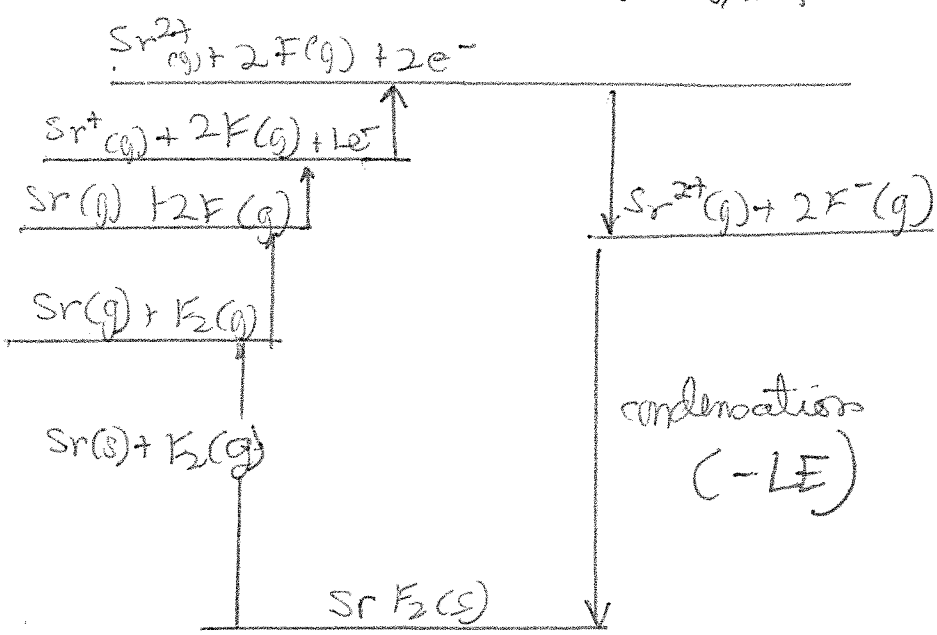
BO = $1\frac{1}{3}$

14. From the following data calculate the lattice energy for SrF_2.

$Sr(s) \rightarrow Sr(g)$	163 kJ/mol
$Sr(g) \rightarrow Sr^+(g) + e^-$	549 kJ/mol
$Sr^+ \rightarrow Sr^{2+}(g) + e^-$	1064 kJ/mol
$F_2(g) \rightarrow 2\ F(g)$	154 kJ/mol
$F(g) + e^- \rightarrow F^-(g)$	-327 kJ/mol
$Sr(s) + F_2(g) \rightarrow SrF_2(s)$	-1212 kJ/mol

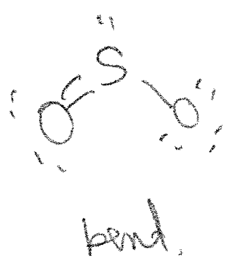
$LE = 163 + 154 + 549 + 1064 - 2(327) + 1212$ kJ/mol

$= 1276 + 1212$ kJ/mol $= 2488$ kJ/mol

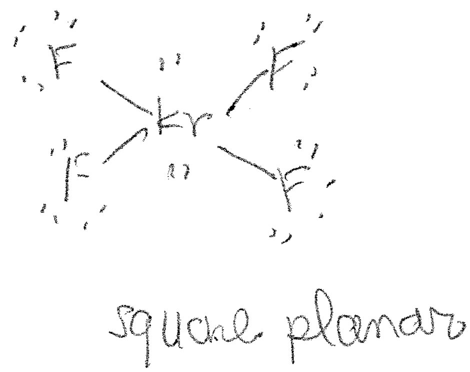


15. Use VSEPR theory to predict the shape of the following <u>molecules</u>. (Central atom listed first)

SO_2

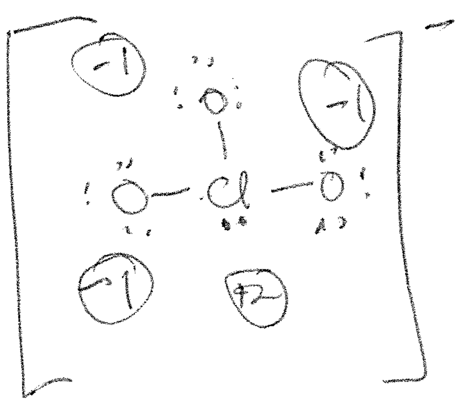


KrF_4



16. Give the Lewis dot formula and calculate the formal charge on <u>each</u> atom in the following two ions: (make sure to include the overall ionic charge in your structure)

ClO_3^- (Cl in the center)



CO_3^{2-}