Lakehead UNIVERSITY

DEPARTMENT OF CHEMISTRY
Midterm SOLUTIONS
Chemistry 1110 (Modern Chemistry I)
2 November, 2012

Look at the first question on your test. I've called them Tests A, B, and C.

Test A first question has the reaction: $2\ H_2\ (g)\ +\ O_2\ (g)\ \rightarrow\ 2\ H_2O\ (g)$

Test B first question has the reaction: $^{226}Ra\ \rightarrow\ ^{222}Rn\ +\ ^{4}He$

Test C first question has the reaction: $^{218}Po\ \rightarrow\ ^{214}Pb\ +\ ^{4}He$

Question 1 Multiple choice, **select 1 answer only**. Do *all 7* questions (2 points each, 14 total):

Test A: c, c, d, d, b, e, c

Test B: d, c, c, d, e, b, e

Test C: c, e, b, a, a, c, a

Question 2 Fill in the Blanks. (a) = 1 point each, (b, c, d) = 2 points each. (9 points total)

(a) Name these orbitals (your choices are s, p_x, p_y, p_z, d_{xy}, d_{xz}, d_{yz}, $d_{x^2-y^2}$, d_{z^2}).

from left to right, the three orbitals are

Test A: s, d_{xy}, p_y

Test B: $d_{x^2-y^2}$, p_z, d_{xy}

Test C: d_{xy}, p_x, d_{z^2}

(b) Give the electronic configuration for silicon (Si) $1s^2 2s^2 2p^6 3s^2 3p^2$ or $[Ne]3s^2 3p^2$

sulfur (S) $1s^2 2s^2 2p^6 3s^2 3p^2$ or $[Ne]3s^2 3p^4$

phosphorus (P) $1s^2 2s^2 2p^6 3s^2 3p^3$ or $[Ne]3s^2 3p^3$

(c) Place in order of *increasing* size (s to l):

Ni < V < Ca

Kr < Ge < Co

Fe < Ti < K

(d) Place in order of *increasing* ionization energy:

Xe < Kr < Ne

I < Br < Cl

As < P < N

Question Balance the following nuclear equation by supplying the missing particle.

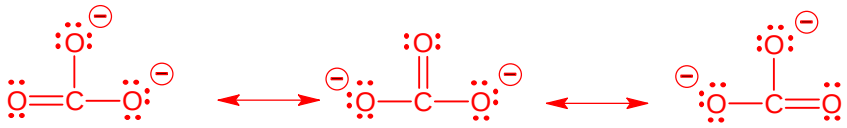
$^{243}_{95}Am + {}^{22}_{10}Ne \rightarrow {}^{260}_{105}Db + 5\ {}^{1}_{0}n$

$^{209}_{83}Bi + {}^{54}_{24}Cr \rightarrow {}^{262}_{107}Bh + {}^{1}_{0}n$

$^{209}_{83}Bi + {}^{58}_{26}Fe \rightarrow {}^{266}_{109}Mt + {}^{1}_{0}n$

1 point for the mass, one point for the proton count

Question Give the Lewis structure of the carbonate anion (CO_3^{2-}), including all resonance structures, formal charges, etc. (4 points)



2 points for basic structure (correct connectivity and number of electrons)
1 point each for formal charges and resonance

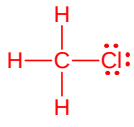
Question The ammonium nitrate-diesel fuel mixture is an explosive common with terrorists. Using the attached table of thermodynamic data, determine the enthalpy of the reaction. The enthalpies of formation ($\Delta H_f°$) for NH_4NO_3 (*s*) is -365.6 and for $C_{10}H_{22}$ (*l*) is -249.7 kJ/mol. (3 points)

$$3\ NH_4NO_3\ (s) + C_{10}H_{22}\ (l) + 14\ O_2\ (g) \rightarrow 3\ N_2\ (g) + 17\ H_2O\ (g) + 10\ CO_2\ (g)$$

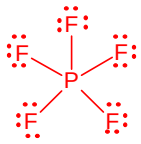
$\Delta H°_{rxn} = \Sigma[\Delta H_f°\ (\text{products})] - \Sigma[\Delta H_f°\ (\text{products})]$
$= 3(0) + 17(-242) + 10(-393.5) - [3(-365.6) + (-249.7) + 14(0)] = 6.70 \times 10^3$ kJ/mol

examples of deductions:
-0.3 if you used too many significant figures
-0.5 if you used a wrong $\Delta H_f°$ *e.g.* if you used H2O (*l*)
-1.5 if you forgot to multiply the stoichiometric amounts

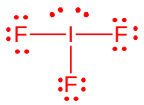
Question For **2 of the following 3**, draw the Lewis structure AND give the molecule's 3-dimensionsal shape by VSEPR theory. (8 points)



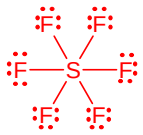
CH_3Cl
tetrahedral



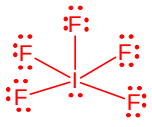
PF_5
trigonal bipyramidal



IF_3
T-shaped



SF_6
octahedral



IF_5
square-based pyramidal

2 points for the Lewis structure, 2 points for the 3-D shape