CHEMISTRY 121

FALL 2011

Term Test 2

Friday, October 28

Name_____

Student Number_____

Signature_____

***Circle your section*: McNeil / Neeland**

DO NOT TURN THE PAGE UNTIL INSTRUCTED TO DO SO!

- Make sure you have all 4 pages (including this one), plus a periodic table data page.
- Make note of the point value of each question, and allocate your time accordingly.
- *Carefully* read each question before answering. Where appropriate, you must show your work to receive full credit.
- Include *units* and the proper *significant figures* in all numerical answers.
- With the exception of a non-programmable calculator, no aids or notes of any kind are permitted or required.

Total Points: 35
Total Time: 75 minutes

Potentially helpful information:

Constants

electron mass = 9.109×10^{-31} kg

proton mass = 1.673×10^{-27} kg

neutron mass = 1.675×10^{-27} kg

1 u = 1.66054×10^{-27} kg

$h = 6.626 \times 10^{-34}$ Js

$c = 2.998 \times 10^{8}$ m/s

$R_H = 2.178 \times 10^{-18}$ J

$a_0 = 5.29 \times 10^{-11}$ m

$e = 1.602 \times 10^{-19}$ C

$N_A = 6.022 \times 10^{23}$ mol^{-1}

R = 8.3145 J/molK

$k = 1.381 \times 10^{-23}$ JK^{-1}

absolute zero = –273.15°C

Equations

$E = h\nu$

$E = \frac{1}{2}mv^2$

$E = mc^2$

$\lambda\nu = c$

$\lambda = h/mv$

$h\nu = h\nu_0 + KE$

$E_n = -\frac{Z^2}{n^2} R_H$

$\Delta E = R_H \left(\frac{1}{n_i^2} - \frac{1}{n_f^2} \right)$

$\Delta x \Delta v \geq h/4\pi m$

Elements

aluminum	Al	magnesium	Mg
barium	Ba	molybdenum	Mo
calcium	Ca	nitrogen	N
carbon	C	oxygen	O
cesium	Cs	phosphorus	P
chlorine	Cl	potassium	K
cobalt	Co	sodium	Na
copper	Cu	silicon	Si
fluorine	F	sulfur	S
hydrogen	H	lead	Pb
iodine	I	zinc	Zn
iron	Fe		

CHEMISTRY 121 MIDTERM 2

Oct. 28, 2011

(2) 1) Answer the following statements as True (T) or False (F). No explanation required.

a) From the Aufbau diagram, an electron in a 4s orbital is at a higher energy level than a 3d orbital. _____

b) A potassium cation has a smaller atomic radius than a chlorine anion _____

(3) 2) Consider this invalid set of quantum numbers: n = 3, l = 3, m_l = 0, m_s = $^1/_2$. Correct the error and specifically name and draw the orbital that it now describes. Choose your correction carefully…

(2) 3) A number of electrons are described by n = 3, l = 1 and l = 2, m_s = $^1/_2$.

a) How many different electrons in an atom can be described by these quantum numbers? _____

b) Write the symbol of an element whose highest energy electrons correspond with n = 3, l = 2, ms = $^1/_2$. _____

(3) 4) Circle the bond with the greatest ionic character. Pauling's EN scale: H = 2.2, Ca = 1.0, C = 2.6, O = 3.4 Te = 2.1. Briefly explain your answer.

Ca-H C-O O-Ca O-Te Te-Ca

(2) 5) An atom is weakly repelled by a magnet. The atom is either aluminum, magnesium or sulfur. Choose the correct element and explain your reasoning.

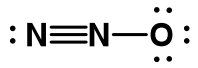
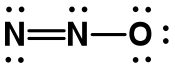
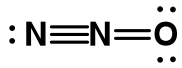
(3) 6) Write an excited state electronic configuration and an impossible state electronic configuration for an atom with 15 electrons. Explain why one is excited and the other is impossible in each case.

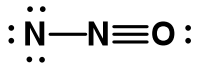
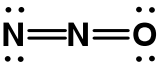
7) Circle the best answer for each question.

(1) i) The VSEPR configuration with the smallest expected bond angles is:

a) AX_4, as in CF_4
b) AX_3E, as in PF_3 (where E represents a lone pair of electrons)
c) AX_2E_3, as in $[IF_2]^-$
d) AX_4E_2, as in $[BrF_4]^-$

(1) ii) The most stable Lewis structure of nitrous oxide, N_2O, is:

a)  b)  c) 

d)  e) 

(1) iii) Consider the ionization energies of fluorine (F) and oxygen (O). Which statement is true?

a) Fluorine has a larger IE because its electrons experience a greater effective nuclear charge.
b) Fluorine has a smaller IE because its electrons experience greater e^--e^- repulsion.
c) Fluorine has a larger IE because it has fewer unpaired electrons.
d) Fluorine has a smaller IE because it has more electrons.
e) Fluorine has a larger IE because it is closer to a stable closed-shell configuration.

(1) iv) Adding an electron to a Mg atom is less favourable than the addition of an electron to a Na atom because:

a) Removing an electron from Mg is harder than removing one from Na.
b) Adding an electron to Mg results in an unpaired electron.
c) Adding an electron to Mg populates a higher-energy orbital subshell than adding an electron to Na.
d) Mg is larger than Na, so it holds onto its electrons less tightly
e) Mg has a lower electronegativity than Na.

(2) 8) Write the most stable electronic configuration of an Ru^{3+} ion (Z = 44). Do not use the noble gas shorthand notation, write the complete configuration out in full.

(5) 9a) Draw Lewis structures for both nitrosyl chloride (ClNO) and nitryl chloride ($ClNO_2$). If resonance forms are required for either molecule, include them, and show the corresponding electron flow arrows.

9b) Use your Lewis structures from 9a) above to explain the following observations.

(2) **i)** The NO bond in ClNO (114 pm) is shorter than the NO bonds in $ClNO_2$ (120 pm).

(2) **ii)** The polarity of ClNO (1.90 Debye units) is greater than that of $ClNO_2$ (0.53 Debye units)

10) Consider the monofluorophosphate ion, $[FPO_3]^{2-}$, which is used to treat osteoporosis.

(1) **a)** Provide a Lewis structure for this ion <u>that maintains an octet at all atoms</u>.

(1) **b)** Name the molecular geometry of the ion as predicted by VSEPR. _____

(1) **c)** Determine the formal charge at the P atom for the Lewis structure you have drawn in a). _____

(2) **d)** Indicate whether the molecule should be polar or non-polar. Use dipole moment arrows to explain your reasoning.

(1) **Bonus.** Both Dr. McNeil and Dr. Neeland have an office in the Fipke building.
Write either office room number. Fipke - _____