CHEMISTRY 211, Lect. Sect. 003
Dr. G. L. Roberts
Exam #3/Fall 2000

Name__________________________
SSN___________________________
Tuesday, November 28, 2000

CLOSED BOOK EXAM—No notes or books allowed. Calculators may be used. <u>CIRCLE ALL OF YOUR ANSWERS TO THE PROBLEMS BELOW</u>. BE SURE TO FILL IN THE CORRECT OVAL ON THE SCANTRON SHEET. <u>ONLY ONE ANSWER</u> SHOULD BE <u>DARKENED FOR EACH PROBLEM ON THE SCANTRON</u> SHEET. Turn in ScanTron ONLY prior to leaving examination area.

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1. In general, at room temperature

   (a) ionic compounds are all solids and covalent compounds are all gases
   (b) ionic compounds are all solids, but covalent compounds may be solids, liquids, or gases
   (c) ionic compounds are all solids, and covalent compounds are liquids or gases
   (d) covalent compounds are all gases, but ionic compounds may be solids, liquids, or gases

2. Which bond should have the highest bond dissociation energy?

   (a) N–N (b) N=N **(c) N≡N** (d) all three have equal energy

3. Arrange the following in order of increasing ionic character; Al_2S_3, MgS, Na_2S, P_4S_3, S_8

   (a) MgS, Na_2S, Al_2S_3, P_4S_3, S_8
   (b) Na_2S, MgS, Al_2S_3, P_4S_3, S_8
   (c) S_8, P_4S_3, Al_2S_3, MgS, Na_2S
   (d) S_8, P_4S_3, Al_2S_3, Na_2S, MgS

4. In general, the more atoms of a given type present in a molecule, the greater the capacity to take up energy and thus the greater the entropy.

   (a) true (b) false

5. Which of the following is not true?

   (I) Group IA and IIA elements primarily form ionic compounds
   (II) Group IIIA elements are more likely to form covalent bonds
   (III) The metalloids usually form metallic bonds
   (IV) Group VA elements are all nonmetals

   (a) *I, II* (b) *II, IV* (c) *I, III, IV* (d) *III, IV* (e) *none of the above*

6. A triple bond is generally composed of

   (a) three π bonds
   (b) two π bonds and one σ bond
   (c) one π bond and two σ bonds
   (d) three σ bonds

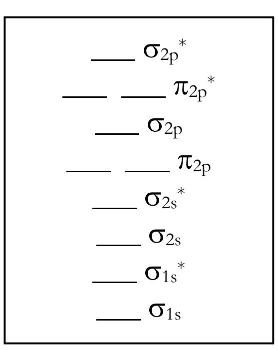
7. The hybridization expected for $SbCl_5^{2-}$ is __________ and the geometry is ___________

   (a) sp^3, tetrahedral
   (b) s^2p^3, square pyramidal
   (c) sp^3d, square pyramidal
   (d) sp^3d^2, octahedral
   (e) sp^3d, trigonal bipyramidal

8. The paramagnetism of O_2 is explained by

   (a) coordinate covalent bonding
   (b) **molecular orbital theory**
   (c) resonance
   (d) valence bond theory

9. The following MO diagram is appropriate for B_2. Based on this diagram, B_2



   (a) has a bond order of one and is diamagnetic
   (b) has a bond order of one and is paramagnetic
   (c) has a bond order of two and is diamagnetic
   (d) has a bond order of two and is paramagnetic.

10. Which of the following can be interpreted as a measure of randomness?
    (a) enthalpy (b) entropy (c) free energy (d) temperature

11. The first law of thermodynamics

(a) defines chemical energy (b) defines entropy
(c) **is a statement of conservation of energy** (d) provides a criterion for reaction spontaneity

12. Use the given standard enthalpies of formation to calculate ΔH° for the following reaction

$$Fe_2O_3\ (s) + CO\ (g) \rightarrow Fe_3O_4\ (s) + CO_2(g)$$

Species	ΔH°_f, kJ/mol
Fe_2O_3 (s)	-824.2
Fe_3O_4 (s)	-1118.4
CO (g)	-110.5
CO_2 (g)	-393.5

(a) -5213.4 kJ (b) -577.2 kJ (**c) -47.2 kJ** (d) +47.2 kJ

13. Calculate ΔG° for the reaction below and tell whether it is spontaneous or nonspontaneous under standard conditions at 25°C.

$2S(s) + 3O_2\ (g) + 2H_2O(l) \rightarrow 2H_2SO_4(l)$; ΔH° = -1056 kJ/mol; ΔS°= -505 J/mol

(a) ΔG° = -1207 kJ and the process is spontaneous
(b) ΔG° = -1207 kJ and the process is nonspontaneous
(c) ΔG° = -906 kJ and the process is spontaneous
(d) ΔG° = -906 kJ and the process is nonspontaneous

14. Entropy increases when
(*i*) a molecule in a reaction is broken into two or more smaller molecules
(*ii*) the number of moles of gas decreases
(*iii*) phase changes occur

(a) *i, ii* **(b) *i, iii*** (c) *ii,iii* (d) none of the above

15. Calculate the energy as heat required to raise the temperature of 151 kg of water (40 gal, the volume of a typical home water heater) from 18.0°C to 60.0°C, assuming no loss of energy to the surroundings.

(a) 2.65 MJ **(b) 26.5 MJ** (c) 13.3 MJ (d) 11.8 MJ (e) none of these

Key equations

$E = h\nu$
$E = -R_H/n^2$
$\Phi = h\nu_0$
$R_H = 2.18 \times 10^{-18}$ J
$\lambda = h/mv$
K.E. = $mv^2/2$
$m_e = 9.11 \times 10^{-31}$ kg
$m_p = 1.673 \times 10^{-27}$ kg
$m_n = 1.675 \times 10^{-27}$ kg
J = N•m
N = m•kg•s^{-2}
$E_n = -(2.18 \times 10^{-18} J)Z^2(1/n^2)$
$Z_{eff} = Z - \sigma$
$N_0=N_A=6.02 \times 10^{23}$ units/mol
d(Hg) = 13.6 g/mL
d(H_2O) = 1.00 g/mL
$C_p(H_2O, s)$ = 37.7 J/ mol • K
$C_p(H_2O, l)$ = 75.2 J/ mol • K
$C_p(H_2O, g)$ = 33.6 J/ mol • K
R = 0.0821 L•atm/mol•K
R = 8.314 J/mol • K
R = 1.987 cal/(mol • K)
R = 8.314 m•kg•s^{-2} •K^{-1} •mol^{-1}
1 atm = 760 torr = 760 mmHg
1 Pa = 1 kg/(m• s^2) = 1 N/m^2
1 atm = 1.10 x 10^5 Pa = 14.7 psi
g = 9.807 m/s^2
1.00 L•atm = 101 J = 0.101 kJ
M = n/V
M_m= (dRT/P)
P = hda = hdg
$h_x d_x = h_y d_y$
w = -PΔV
$\Delta U = q + w$
$\Delta H^\circ_{rxn} = \Sigma\Delta H_f^\circ(\text{products}) - \Sigma\Delta H_f^\circ(\text{reactants})$
$\Delta H_{rxn} = \Delta U_{rxn} + P\Delta V$
$\Delta H = nC_p\Delta T$
$\Delta H = c_p\Delta T$
$q = ms\Delta T$
$X_i = n_i/n_T$
$P_i = X_iP_T$
$P_T = \Sigma P_i$
$\log (P_2/P_1) = (\Delta H_{vap}/2.303R)(1/T_1-1/T_2)$
$E = U = (½)\ mv^2 = (3/2)\ RT$
$(P + n^2a/V^2)(V-nb)=nRT$
u =rms= $(3RT/M_m)^{1/2}$
F.C. = (#ve) - (#lpe) - ½ (#se)
scc: a = 2r
bcc: $a = 4r/\sqrt{3}$
fcc: $a= \sqrt{8}\ r$
$n\lambda = 2d \sin\theta$
$V_{unit\ cell} = (nM/dN_0)$
B.E. (N-N) = 167 kJ/mol
B.E. (F-F) = 565 kJ/mol
B.E. (N-F) = 283 kJ/mol
B.E. (N=N) = 418 kJ/mol
B.E. (N≡N) = 942 kJ/mol