Polytechnic Tutoring Center

Midterm II REVIEW – CM 1004, Fall 2020

Disclaimer: **This mock exam is only for practice**. *It was made by tutors in the Polytechnic Tutoring Center and is not representative of the actual exam given by the Academic Department.*

The Exam is designed to test concepts, not exact knowledge so please do not worry if some questions seem outside of what you have learned. Watch the solution video when uploaded to see the method of solving each of these problems. The main focus is to understand the approach to problem solving.

Section 1: Long Response

1) Draw and name the molecular geometry of NH3 and NH4+. Give the bond angles between each group.

2) Indicate which intermolecular forces are present in each of the compounds below:

	Ion-Ion	Dipole-Dipole	London	H- Bonding	Ion-Dipole
I_2					
SO_2					
CH_3CH_2OH					
CH_3OCH_3					
KBr (aq)					

3) A 10.00 kg hot iron ball bearing at is placed in a constant-pressure calorimeter containing 394. cubic centimeters of water at 10.75°C, raising the water temperature to 83.20°C. If the specific heat of the ball bearing is 0.450 J/g°C, calculate the initial temperature of the ball bearing. The specific heat of water is 4.184 J/g°C. Assume the calorimeter to have negligible heat capacity.

4) Consider the following sets of ground state electron configurations:

(a) $1s^2 2s^2 2p^6 3s^2$

(b) $1s^2 2s^2 2p^3$

(c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$

(d) $1s^2 2s^2$

(e) $1s^2 2s^2 2p^6$

(f) $1s^2 2s^2 2p^6 3s^2 3p^3$

a) Identify the element in each set

b) Which set would you expect the highest atomic radius? Lowest?

c) Which set would you expect the highest electronegativity? Lowest?

d) Rewrite each set using noble gas core notation

5) Draw the lewis dot structure for SO_4^{2-} and SO_2, and any possible resonance structures. Would you expect them to have different bond lengths? If so, which would you expect to be longer?

Section 2: Short Response

Choose the best answer for each question. Show all work for long response questions for full credit.

1. Which of the following processes is exothermic?
    a. Dry ice sublimes into a higher temperature gas above the solid
    b. Liquid water's boiling point is lowered by a decrease in pressure
    c. Liquid sulfur solidifies when exposed to cool temperatures
    d. Cellular machinery in plant cells use sunlight to synthesize sugars
    e. Water transitions from liquid to vapor in a closed container
2. Find the standard enthalpy of formation of ethylene, $C_2H_4(g)$, given the following data:

$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O\ (l)$	$\Delta H^o_f = -1411$ kJ
$C(s) + O_2(g) \rightarrow CO_2(g)$	$\Delta H^o_f = -393.5$ kJ
$H_2(g) + ½\ O_2(g) \rightarrow H_2O(l)$	$\Delta H^o_f = -285.8$ kJ
$2C(s) + 2H_2(g) \rightarrow C_2H_4\ (g)$	$\Delta H^o_f = ?$

    a. 52.4 kJ
    b. 57.8 kJ
    c. 48.5 kJ
    d. 51.3 kJ
    e. 50.6 kJ
3. An atom of chromium (Cr) has ___ unpaired electrons and is ___.
    a. 3, diamagnetic
    b. 5, diamagnetic
    c. 3, paramagnetic

d. 5, paramagnetic
e. 6, paramagnetic

4. Calculate ΔH^o for this reaction (in kJ):

   $CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$

   $\Delta H^o_f (CH_4(g)) = -74.85$ kJ/mol

   $\Delta H^o_f(H_2O(g)) = -241.8$ kJ/mol

   $\Delta H^o_f(CO(g)) = -110.5$ kJ/mol

   a. 206.09 kJ
   b. 213.87 kJ
   c. 206.15 kJ
   d. 277.45 kJ
   e. 225.23 kJ

5. Copper metal has a specific heat of 0.385 J/g^{o}C. Calculate the amount of heat required to raise the temperature of 0.358 moles of Cu from 20.0 ^{o}C to 875^{o}C
   a. 27.56 kJ
   b. 7.49 kJ
   c. 11.78 kJ
   d. 15.82 kJ

6. Which atom has the electron configuration [Kr] $5s^2 4d^6$?
   a. Tc
   b. Rh
   c. Ru
   d. Fe
   e. Co

7. What is the ground state configuration for a W atom?
   a. $[Xe]6s^1 4f^{15} 5d^4$
   b. $[Xe]6s^2 4f^{14} 5d^4$
   c. $[Xe]6s^2 4f^{10} 5d^8$
   d. $[Xe]6s^1 4f^{12} 5d^7$
   e. $[Xe]6s^2 4f^{12} 5d^6$

8. Which atom has the largest atomic radius?
   a. Rb^+
   b. Kr
   c. Fr^+
   d. Co
   e. At^-

9. Which of the following elements will have the largest first ionization energy?
   a. C, because carbon rarely forms C^+ or C^- ions
   b. He, because it is the most stable noble gas
   c. Na, because it is easily oxidized
   d. Al, because metals from strong metallic bonds
   e. F, because it is electronegative enough to form polar covalent bonds

10. Which element is oxidized in the following reaction?
    $3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$
    a. Cu
    b. H

c. N
d. NO3
e. HNO3

11. Which element has the highest electronegativity?
    a. Fr, because it is lowest and most left on the table
    b. F, because it is highest and most right on the table
    c. Ne, because noble gases have the most energetic valence electrons
    d. H, because it is highest and most left on the table
    e. Ag, because it is the most conductive metal
12. Carbon is hybridized sp3 in which of the following molecules?
    a. C_6H_6 because benzene has both single bond and double bond character
    b. CO_2 because oxygen's electronegativity is more stability bonded to sp3
    c. CH_4 because hydrogen is allowed to form only one single bond
    d. CN^- because sp3 satisfies both the octet rule for carbon and nitrogen
    e. CH_2 because an sp3 lone pair exists on the central atom
13. What are the VSEPR geometries of CO_2 and H_2O?
    a. Both bent due to the lone electrons on central atom
    b. Both linear because there are two groups around a central atom
    c. Linear CO_2 and bent H_2O because oxygen has two lone pairs
    d. Seesaw CO_2 and square planar H_2O because CO_2 is nonpolar and H_2O is
    e. Both T-shaped because there are two groups and one electron pair around the central atom
14. Consider a rare compound formed by Xenon, XeF_2. What is the hybridization of Xe in this molecule?
    a. sp3d because there are 5 orbitals in the bonding
    b. sp2d because Xe has a filled valence shell in its ground state
    c. sp because Xe uses two orbitals to bond with both F
    d. sp3d2 because two d orbitals are used to satisfy the octet rule
    e. sp3sp because F hybridized sp to be able to form covalent bonds
15. What is the VSEPR geometry of XeF_2?
    a. Tetrahedral pyramidal because there are 2 F and 2 electron pairs around Xe
    b. Trapezoidal planar because F is dual hybridized as spsp and there are 2 electron pairs
    c. Conic bipyramidal because three electron pairs around Xe form a cone
    d. Pentagonal planar because 5 electronegative groups form a pentagon on a constant plane
    e. Trigonal Bipyramidal because 5 groups exist around the central atom
16. Consider a linear, a pyramidal branched and a ringed hydrocarbon of similar molecular mass. All are contained in a closed conduit under similar pressure and volume. Which would you expect to have a higher melting point? Do not assume ideal gases.
    a. Ringed hydrocarbon because ring structures occupy less volume in the liquid state and therefore have higher van der Waals forces of attraction
    b. Linear hydrocarbon because alkanes have many possible conformations and are able to form van der Waals attractions with a greater number of nearby molecules
    c. Pyramidal hydrocarbon because branches allow for conformational isomers and stronger dipole-dipole attractions between branches
    d. All are similar in melting point because carbon in organic molecules behaves similarly under different physical conditions

e. Cannot be determined without the empirical formulas, chirality and bonding hybridizations for each molecular sample