Exam 3 Chm 203 (Dr Mattson) 25 October 2017

Name:

Academic Integrity Pledge: *In keeping with Creighton University's ideals and with the Academic Integrity Code, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.*

Signature:

Chemistry Student Number: _____

Instructions: **Show all work whenever a calculation box is provided!** Write legibly. Include units whenever appropriate. You will receive credit for **how** you worked each problem as well as for the correct answer. If you need more space, you may use the back of the periodic table provided — Write: "See periodic tablet" in the answer box – then write your name on the periodic table and turn it in with your exam. On your desk you are allowed only pencils (but no pencil pouch), an eraser, and a non-programmable calculator without a slipcover. Backpacks, bags, and purse-like items must be stored in the rear section of the room. Cell phones must be silent and placed in your backpack/bag/purse – not in your pocket.

1. (6 pts) Assign oxidation numbers to phosphorus in each of these compounds. Write the oxidation number below the phosphorus in each compound.

P_4O_6 PH_3 PCl_3 PF_5 H_3PO_4 P_2H_4

2. (5 pts) In class we saw the reaction between $CuCl_2(aq)$ and $Al(s)$. The products were $Cu(s)$ and $AlCl_3(aq)$. The balanced net ionic reaction is:

$$3\ Cu^{2+}(aq) + 2\ Al(s) \rightarrow 3\ Cu(s) + 2\ Al^{3+}(aq)$$

2a. Circle what was oxidized. Cu^{2+} Al Cu Al^{3+}

2b. Circle what was reduced. Cu^{2+} Al Cu Al^{3+}

2c. Circle the oxidizing reagent. Cu^{2+} Al Cu Al^{3+}

2d. Circle the reducing reagent. Cu^{2+} Al Cu Al^{3+}

2e. Circle the limiting reagent in the demonstration we saw? Cu^{2+} Al Cu Al^{3+}

3a. (5 pts) In another reaction between $CuCl_2(aq)$ and $Al(s)$, as given in the equation above, suppose 525 mL 0.453 M $Cu^{2+}(aq)$ and 5.11 g aluminum are reacted. Determine the limiting reagent.

You must show work for credit. Guessing does not count

Answer: _____

3b. (2 pts) What is the theoretical yield in grams of metallic copper?

You must show work for credit.

Answer: _____

4. (4 pts) Write and balance the combustion reaction of methane, CH_4. Assign oxidation numbers to each atom below each atom.

$h = 6.626 \times 10^{-34}$ J s $\quad E = h\upsilon = hc/\lambda$

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

$N_A = 6.023 \times 10^{23}$ mol^{-1}

$\Delta E = E_f - E_i = -2.178 \times 10^{-18} J(1/n_f^2 - 1/n_i^2)$

$1/\lambda = 1.097 \times 10^{-2}$ nm$^{-1}(1/n_f^2 - 1/n_i^2)$

4a. (4 pts) What is the frequency of green light with a wavelength of 510 nm?

You must show work for credit.

Answer with units: _____

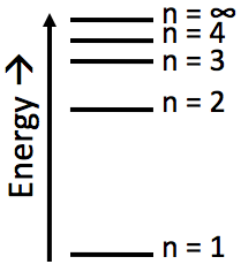
4b. (5 pts). Continuing on with the green light, convert this to energy units of kJ/mol.

You must show work for credit.

Answer with units: _____

5. (6 pts) The first part of the energy level diagram is given here. Compare the transitions

n = 4 → n = 3 and 4 → n = 2



5a. The transition n = 4 → n = 3 **emits** or **absorb** energy.

5b. The transition from n = 4 → n = 3 is associated with **more** or **less** energy than n = 4 → n = 2.

5c. The transition from n = 4 → n = 3 is associated with **longer** or **shorter** wavelength than n = 4 → n = 2.

5d. Give one transition that is associated with a longer wavelength than n = 3 → n = 1.

5e. Give one emission that would appear in the uv.

5f. One of the hydrogen emission lines we saw and discussed in class.

6. (4 pts) What is the wavelength associated with the removal of an electron from a ground state H atom?

You must show work for credit.

Answer with units: _____

7. (6 pts) Provide your answer using a single number or a range of numbers and symbols such as: >, ≥, <, or ≤.

7a. What values for n are allowed for $\ell = 3$?
7b. What values for ℓ are allowed for $m_\ell = 4$?
7c. What values for n are allowed for $m_\ell = 3$?
7d. What values for ℓ are allowed for n = 4?
7e. What values for m_ℓ are allowed for n = 2?
7f. What values for m_ℓ are allowed for $\ell = 1$?

8. (5 pts) Write the atomic symbol for the ground state element with…

8a. five 3p electrons
8b. electronic configuration $1s^2\ 2s^2\ 2p^2$
8c. four unpaired 4d electrons
8d. a diamagnetic element with n = 3
8e. a filled 5p subshell

9. (12 pts) True/False.

T F Atoms with unpaired electrons are called paramagnetic.

T F Atomic radii decrease from left to right across the periodic table due to the effective nuclear charge.

T F Ionization energies are always negative (exothermic).

T F Cations are smaller than anions within the same subshell.

T F Second ionization energies are always less positive than first ionization energies.

T F Electron affinities are zero or close to zero for elements with filled subshells.

T F Tellurium (Te) would be predicted to form an ion with xenon's electron configuration.

T F Lattice energies are always negative (exothermic).

T F Ionic radii can be explained by the effective nuclear charge.

T F The term isoelectronic means having the same effective nuclear charge.

T F Electrons beyond the core in partially filled orbitals are called valence electrons.

T F The nuclear charge is always less than the effective nuclear charge due to shielding.

10. (10 pts) Write the electron configuration for these ions. You may use core notation if you want.

Al^{3+}
S^{2-}
Co^{2+}
N^{3-}
O^{-}

11. (12 pts) Circle the right answer for each.

Smallest atomic radius: Si P S
Largest atomic radius: Si Ge Sn
Largest effective nuclear charge: Si P S
Smallest first ionization energy: Si Ge Sn
Largest first ionization energy: Si P S
Largest ionic radius: V^{2+} V^{3+} V^{5+}
Smallest ionic radius: Ca^{2+} Sr^{2+} Ba^{2+}
Largest ionic radius: Ca^{2+} Fe^{2+} Se^{2-}
Largest electron affinity: P S Cl
Smallest electron affinity: Ni Cu Zn
Largest lattice energy: K_2S MgO $FeCl_2$
Largest third ionization energy: Mg Si Al

12. (4 pts) The lattice energy for BeO(s) is -4443 kJ/mol. The formula for lattice energy is $U = k\, Z^+ Z^- / d$, where d is the distance between ions. Calculate a value for k/d. (Z has no units)

You must show work for credit. Report answer in kJ/mol

Answer with units: _____

13. (10 pts) Naming. Complete the formula or name for each pair of the following. If you were notified by e-mail that you are nomenclature certified, skip this question.

A. copper(I) sulfite	
B. strontium selenide	
C. hydrobromic acid	
D. chlorous acid	
E. ammonium cyanide	
F.	$(NH_4)_2CrO_4$
G.	$HClO_3(aq)$
H.	$KC_2H_3O_2$
I.	IF_5
J.	BN

Total score (out of 100): _____

A+ ≥ 95% A ≥ 90% B+ ≥ 85% B ≥ 80% C+ ≥ 75% C ≥ 70% D ≥ 60%

Answers.

1. +3, -3, +3, +5, +5, -2

2a. Al; 2b. Cu^{2+}; 2c. Cu^{2+}; 2d. Al; 2e. Cu^{2+}

3a. 0.238 mol Cu^{2+} and 0.189 mol Al. Cu^{2+} is the limiting reagent.

3b. 15.1 g copper

4. $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$

-4 +1 0 +4 -2 +1 -2

4a. $5.9 \times 10^{14}\ s^{-1}$

4b. 234 kJ/mol

5a. **emits**

5b. **less**

5c. **longer**

5d. Possible answers are either (a) $n_i = 2 \rightarrow n_f = 1$ or (b) $n_i > 2 \rightarrow n_f \geq 2$, but $< n_i$

5e. Possible answers are either (a) $n_i \geq 2 \rightarrow n_f = 1$ or (b) $n_i \geq 7 \rightarrow n_f = 2$

5f. $n_i = 3, 4, 5,$ or $6 \rightarrow n_f = 2$

6. 91 nm

7a. What values for n are allowed for $\ell = 3$? $n \geq 4$ (same as $n > 3$)

7b. What values for ℓ are allowed for $m_\ell = 4$? $\ell \geq 4$ (same as $n > 3$)

7c. What values for n are allowed for $m_\ell = 3$? $n \geq 4$ (same as $n > 3$)

7d. What values for ℓ are allowed for $n = 4$? $\ell = 0, 1, 2,$ or 3

7e. What values for m_ℓ are allowed for $n = 2$? $m_\ell = -1, 0, +1$

7f. What values for m_ℓ are allowed for $\ell = 1$? $m_\ell = -1, 0, +1$

8a. Cl

8b. C

8c. Mo or Ru

8d. Mg, Zn or Ar

8e. Xe

9. True/False.

T Atoms with unpaired electrons are called paramagnetic.

T Atomic radii decrease from left to right across the periodic table due to the effective nuclear charge.

F Ionization energies are always negative (exothermic).

T Cations are smaller than anions within the same subshell.

F Second ionization energies are always less positive than first ionization energies.

T Electron affinities are zero or close to zero for elements with filled subshells.

T Tellurium (Te) would be predicted to form an ion with xenon's electron configuration.

T Lattice energies are always negative (exothermic).

T Ionic radii can be explained by the effective nuclear charge.

F The term isoelectronic means having the same effective nuclear charge.

T Electrons beyond the core in partially filled orbitals are called valence electrons.

F The nuclear charge is always less than the effective nuclear charge due to shielding.

10.

Al^{3+} [Ne] (or $1s^2\ 2s^2\ 2p^6$)

S^{2-} [Ar] (or $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$)

Co^{2+} $[Ar]\ 4s^0\ 3d^7$

N^{3-} [Ne] (or $1s^2\ 2s^2\ 2p^6$)

O^- $1s^2\ 2s^2\ 2p^5$

11.

Smallest atomic radius: S

Largest atomic radius: Sn

Largest effective nuclear charge: S

Smallest first ionization energy: Sn

Largest first ionization energy: S

Largest ionic radius: V^{2+}

Smallest ionic radius: Ca^{2+}

Largest ionic radius: Se^{2-}

Largest electron affinity: Cl

Smallest electron affinity: Zn

Largest lattice energy: MgO

Largest third ionization energy: Mg

12. $^k/_d = -1111$ kJ/mol

13.

A. copper(I) sulfite, Cu_2SO_3

B. strontium selenide, SrSe

C. hydrobromic acid, HBr

D. chlorous acid, $HClO_2$

E. ammonium cyanide, NH_4CN

F. ammonium chromate, $(NH_4)_2CrO_4$

G. chloric acid, $HClO_3(aq)$

H. potassium acetate, $KC_2H_3O_2$

I. iodine pentafluoride, IF_5

J. boron mononitride, BN