name KEY

University of Louisville **Chem 201 Exam 3 Dr. Hoyt** **Fall 2017**

Scored grade (instructor use only!)_____

1. **(a) [5 pts] Balance the following redox reaction, occuring in aqueous solution. We'll grade the answer in the box.

$2e^- \times 2 = 4e^-$

(work space:) $\underline{2}\ HNO_2 + \underline{2}\ H^+ + \underline{2}\ Cl^- \rightarrow \underline{\ }\ N_2O + \underline{\ }\ H_2O + \underline{2}\ HClO$

(+3, −1, +1, +1)

$2e^- \times 2 = 4e^-$

(final answer:) $\underline{2}\ HNO_2 + \underline{2}\ H^+ + \underline{2}\ Cl^- \rightarrow \underline{\ }\ N_2O + \underline{\ }\ H_2O + \underline{2}\ HClO$

(b) [2 pts each] In the above reaction, what is:

the element oxidized? Cl

the oxidizing agent? HNO_2

2. [2 each] Three identical 5-L flasks each contain a sample of gas (He, Ne or Ar) at 273 K and 1 atm. For each of the following quantities or values, circle the best choice.

a. greatest rate of effusion through a valve:	He	Ne	Ar	all same
b. largest number of atoms:	He	Ne	Ar	all same
c. highest density:	He	Ne	Ar	all same
d. greatest average kinetic energy:	He	Ne	Ar	all same

3. [4]** A 15.4 L container ($= V_1$) holds a gas at 38 °C ($+273 = 360.\ K = T_2$) and 2.19 atm ($= P_1$). The gas is transferred to a new container of 25.6 L ($= V_2$) and the new temperature is 87 °C ($+273 = 311\ K = T_1$). What is the new pressure (in atm) of the gas? **SHOW YOUR WORK** in the area below and write your answer, rounded appropriately, in the space provided.

$$\frac{P_1V_1}{\cancel{n_1}T_1} = \frac{P_2V_2}{\cancel{n_2}T_2}$$

$$P_2 = \frac{P_1V_1T_2}{T_1V_2} = \frac{(2.19\ atm)(15.4\ L)(360.\ K)}{(311\ K)(25.6\ L)}$$

1.52 atm

(3 s.f.)

name KEY

University of Louisville **Chem 201 Exam 3 Dr. Hoyt** **Fall 2017**

4. The following equation is balanced. You'll need to refer to it throughout this problem:

$$2\ Ag_2O\ (s) \rightarrow 4\ Ag\ (s) + O_2\ (g) \qquad \Delta H^\circ = 62.10\ kJ$$

a. [2] Is the reaction above exothermic or endothermic? Endothermic ($\Delta H^\circ > 0$)

b. [4] Calculate the energy change when 20.0 g of Ag_2O reacts according to the reaction above. (Show work, round appropriately, include unit(s).)

Answer: 2.68 kJ (absorbed)

Ag_2O: $2 \times 107.9 = 215.8$
$+ 16.00$
$231.8\ g/mol$

$$20.0\ g\ Ag_2O \times \frac{mol}{231.8\ g} \times \frac{62.10\ kJ}{2\ mol\ Ag_2O} = 2.68\ kJ$$

c. [2] What is the ΔH° value for the reaction below? (reverse of above)

$4\ Ag\ (s) + O_2\ (g) \rightarrow 2\ Ag_2O\ (s)$ $\Delta H^\circ =$ −62.10 kJ

d. [5] In the box below, write the **formation equation** (the **reaction corresponding to the ΔH^0_f**) for Ag_2O (*s*). Include appropriate phase labels on all species.

$$2Ag_{(s)} + \frac{1}{2}O_{2(g)} \longrightarrow Ag_2O_{(s)}$$

e. [2] Calculate the value of the ΔH^0_f for Ag_2O (*s*), using the reaction you wrote in (d). (Show work, round appropriately, include unit(s).)

Answer: −31.05 kJ

The reaction in (d) is $\frac{1}{2}$ of the reaction ~~we wrote~~ in (c), so $-62.10 \div 2 = -31.05$

5. [4]** What is the energy (in J) of the n = 2 level of O^{7+}? SHOW YOUR WORK in the area below and write your answer in the space provided.

−3.49 × 10^−17 J

$$E = -2.18 \times 10^{-18}\ J \left(\frac{Z^2}{n^2}\right) = -2.18 \times 10^{-18}\ J \left(\frac{8^2}{2^2}\right)$$
$$= -2.18 \times 10^{-18}\ J \left(\frac{64}{4}\right)$$
$$= -3.49 \times 10^{-17}\ J$$

name KEY

University of Louisville **Chem 201 Exam 3 Dr. Hoyt** **Fall 2017**

9. [2 each] **Clearly** assign each statement as TRUE or FALSE. If we can't tell which you mean, it's wrong.

True **In a redox reaction, the oxidant is reduced.

FALSE If the temperature of a gas sample rises from 20°C to 40°C, the average kinetic energy of the molecules is doubled. 293 K 313 K → absolute T is not doubled

FALSE Gases behave most ideally at ~~high~~ low pressures and high temperatures.

FALSE When the temperature of a sample of gas increases, its density decreases. only if volume increases

True Breaking bonds is always an endothermic process.

True For an element in its stable state, $\Delta H_f^o = 0$ and oxidation number = 0.

FALSE Humans can see most of the electromagnetic spectrum.

FALSE Electrons in atoms can orbit at any distance and can have any energy.

FALSE The equation to the right can be used to calculate the energy of ~~any~~ only works for single-e^- species electron in an atom.

$$E = -2.18 \times 10^{-18} J \left(\frac{Z^2}{n^2} \right)$$

True **Most elements in the periodic table have d electrons.

True When an electron in an atom relaxes from n=3 to n=2, a photon is emitted.

FALSE The more electrons an atom has, the larger its radius. only down a group - not across a period

10. [2 pts each] For each of the following sets of items, circle the choice that best fits the given description.

(a) **greatest number of unpaired electrons:	N^{3-}	O^{2-}	F^-	all same (isoelectronic)	
(b) **greatest number of unpaired electrons:	Fe (4)	Fe^{2+} (4)	Fe^{3+} (5)	all same	
(c) greatest atomic radius: decreases →	N	O	F	all same	
(d) greatest magnitude of first ionization energy (IE_1): increases ↗	C	O	Si	all same	
(e) greatest electron capacity in a single orbital: always 2	1s	3d	7f	all same	
(f) greatest energy of photon emitted by electron transition from:	3p to 3s	3p to 2s	2p to 2s	all same	
(g) greatest wavelength of photon:	UV	blue	red	all same	

(b) Fe: [Ar] $4s^2 3d^6$ 4s: ↑↓ 3d: ↑↓ ↑ ↑ ↑

Fe^{2+}: [Ar] $4s^0 3d^6$ — 3d: ↑↓ ↑ ↑ ↑

Fe^{3+}: [Ar] $4s^0 3d^5$ — ↑ ↑ ↑ ↑ ↑

name KEY

University of Louisville **Chem 201 Exam 3 Dr. Hoyt** **Fall 2017**

6. a. [2] Predict the **ground-state electron configuration** for element #120, which has not yet been reported. (Write your answer in the box; you may use noble gas core.)

a. 120: [Og] $8s^2$

b. [2] Give the **ground-state electron configuration** for a **mercury (II) ion**. (Write your answer in the box; you may use noble gas core.)

b. Hg^{2+}: [Xe] $6s^0 4f^{14} 5d^{10}$

c. [2] Give a **ground-state orbital diagram** (or "box diagram") for a **chlorine** atom. (Write your answer in the box; you may use noble gas core.)

c. Cl: [Ne] $\underset{3s^2}{\uparrow\downarrow}$ $\underset{3p^5}{\uparrow\downarrow\uparrow}$

7. [2 each] Provide appropriate answers for the following. Assume ground state, neutral atoms unless otherwise specified. *In some cases there may be more than one answer that earns full credit. Give **one** answer.*

the electron capacity of the 8p subshell 6

the number of orbitals in the 4f subshell 5

the value of *l* for an electron in the 4f subshell $l = 3$

a main-group metal with two unpaired electrons Sn (also Pb, Fl, Po, Lv)

a subshell that exists, but is not populated in the ground state of any known elements 8s (any s in n>7, p in n>7, d in n>6, f in n>5)

the highest n level that is populated in the ground state of the known elements 7

8. The yellow light produced by some streetlamps comes from sodium-vapor bulbs, which emit most of their photons at about 589.0 nm.

[2 each] Circle the appropriate choice to fill in the blank in each sentence.

(a) The value "589.0 nm" is a measure of the photon's _____.

energy **frequency** **mass** **wavelength** **speed** **none of these**

(b) These photons are emitted when an electron in a sodium atom moves from 3p to 3s. This transition is _____.

a reduction **an oxidation** **a relaxation** **an excitation**