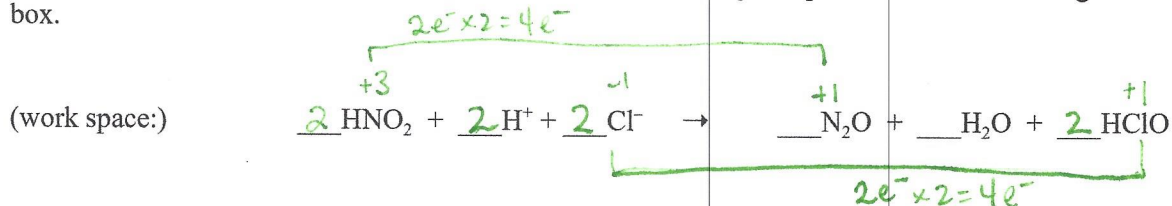


name

Scored grade (instructor use only!)

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



(final answer:)



- (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 holds a gas at 38 °C and 2.19 atm. The gas is transferred to a new container of 25.6 L and the new temperature is 87 °C. 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.

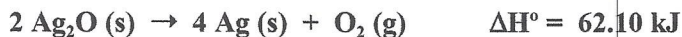
$$\frac{P_1 V_1}{\cancel{R T_1}} = \frac{P_2 V_2}{\cancel{R T_2}}$$

$$P_2 = \frac{P_1 V_1 T_2}{T_1 V_2}$$

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

1.52 atm
(38.f.)

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



a. [2] Is the reaction above exothermic or endothermic?

Endothermic ($\Delta H^\circ > 0$)

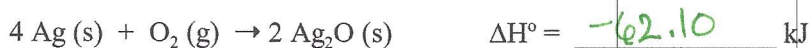
b. [4] Calculate the energy change when 20.0 g of Ag_2O reacts according to the reaction above. (Show work, round appropriately, include unit(s).)

$$\begin{array}{r} \text{Ag}_2\text{O}: 2 \times 107.9 = 215.8 \\ + 16.00 \\ \hline 231.8 \text{ g/mol} \end{array}$$

Answer: 2.68 kJ (absorbed)

$$20.0 \text{ g Ag}_2\text{O} \times \frac{\text{mol}}{231.8 \text{ g}} \times \frac{62.10 \text{ kJ}}{2 \text{ mol Ag}_2\text{O}} = 2.68 \text{ kJ}$$

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



d. [5] In the box below, write the **formation equation** (the reaction corresponding to the ΔH_f°) for $\text{Ag}_2\text{O} (\text{s})$. Include appropriate phase labels on all species.



e. [2] Calculate the value of the ΔH_f° for $\text{Ag}_2\text{O} (\text{s})$, using the reaction you wrote in (d). (Show work, round appropriately, include unit(s).)

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

Answer: -31.05 kJ

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.

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

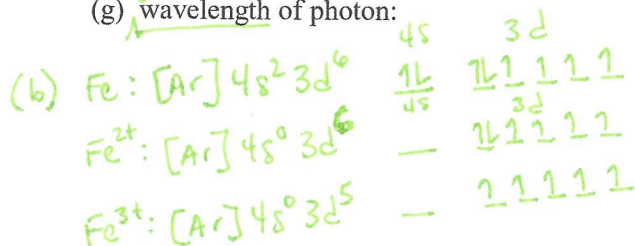
-3.49×10^{-17} J

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. *low 293K 313K → absolute T is not doubled*
- FALSE Gases behave most ideally at high 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, $\Delta H_f^\circ = 0$ 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 electron in an atom. *only works for single e⁻ species*
- True **Most elements in the periodic table have d electrons. $E = -2.18 \times 10^{-18} J \left(\frac{Z^2}{n^2} \right)$
- 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) wavelength of photon: UV blue red all same



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. $120: [\text{Og}] 8s^2$

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

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. $\text{Cl}: [\text{Ne}] \frac{1\downarrow}{3s^2} \frac{1\downarrow 1\downarrow 1\downarrow}{3p^5}$

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

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

(any s in $n > 7$,
p in $n > 7$,
d in $n > 6$,
f in $n > 5$)

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