November 16, 2017

**Do not open the exam until you are told to do so.**

**Cell phones and other electronic devices must be turned off and stowed out of sight (your sight and mine). Calculator policy is in effect. Infractions will cost you points!**

**ALL outside paper must be stowed out of sight. You have a responsibility to keep your gaze confined to your own desk. Unauthorized materials will result in your exam being removed and a score of 0 assigned.**

If you reach a point where you need more scratch paper than the space available, ask a proctor. Since partial credit is based on showing your work, be sure to write your name on your scratch paper, turn it in, and note on the exam answer sheet if you have work elsewhere that you want considered.

**You have a responsibility to keep your gaze confined to your own desk. Wandering eyes may result in your being asked to move, or may result in your exam being removed and a score of 0 assigned.**

- **Please clearly and legibly write your name at the top of every page of your test. Your score will not be recorded and your exam will not be returned if this is not done.**

All answers should be rounded to the appropriate precision (correct significant figures.)

Atomic weights are provided in the Periodic Table. These values must be used.

Be certain your answers are clear. If an answer is not clear, it will probably be considered wrong.

Use your time effectively.

When authorized to open your exam, you may carefully remove this cover sheet. When you are finished with your exam, please turn in **the two answer sheets.** Make sure your name is clearly written on every page. (Problem numbers may not appear exactly in order in your exam. As long as you have the right number of pages as announced by the Proctors, don't be concerned about it.)

Note: point values should be considered approximate. Values may be adjusted slightly (+/- 1 point) in scoring.

**Time is up at 12:15!!**

# THE PERIODIC TABLE

| | 1 | 2 | | | | | | | | | | | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 H 1.008 | | | | | | | | | | | | | | | | | 2 He 4.003 |
| 2 | 3 Li 6.941 | 4 Be 9.012 | | | | | | | | | | | 5 B 10.81 | 6 C 12.01 | 7 N 14.01 | 8 O 16.00 | 9 F 19.00 | 10 Ne 20.18 |
| 3 | 11 Na 22.99 | 12 Mg 24.31 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 Al 26.98 | 14 Si 28.09 | 15 P 30.97 | 16 S 32.07 | 17 Cl 35.45 | 18 Ar 39.95 |
| 4 | 19 K 39.10 | 20 Ca 40.08 | 21 Sc 44.96 | 22 Ti 47.87 | 23 V 50.94 | 24 Cr 52.00 | 25 Mn 54.94 | 26 Fe 55.85 | 27 Co 58.93 | 28 Ni 58.69 | 29 Cu 63.55 | 30 Zn 65.38 | 31 Ga 69.72 | 32 Ge 72.63 | 33 As 74.92 | 34 Se 78.96 | 35 Br 79.90 | 36 Kr 83.80 |
| 5 | 37 Rb 85.47 | 38 Sr 87.62 | 39 Y 88.91 | 40 Zr 91.22 | 41 Nb 92.91 | 42 Mo 95.96 | 43 Tc (98) | 44 Ru 101.1 | 45 Rh 102.9 | 46 Pd 106.4 | 47 Ag 107.9 | 48 Cd 112.4 | 49 In 114.8 | 50 Sn 118.7 | 51 Sb 121.8 | 52 Te 127.6 | 53 I 126.9 | 54 Xe 131.3 |
| 6 | 55 Cs 132.9 | 56 Ba 137.3 | 57 La 138.9 | 72 Hf 178.5 | 73 Ta 180.9 | 74 W 183.8 | 75 Re 186.2 | 76 Os 190.2 | 77 Ir 192.2 | 78 Pt 195.1 | 79 Au 197.0 | 80 Hg 200.6 | 81 Tl 204.4 | 82 Pb 207.2 | 83 Bi 209.0 | 84 Po (209) | 85 At (210) | 86 Rn (222) |
| 7 | 87 Fr (223) | 88 Ra (226) | 89 Ac (227) | 104 Rf (267) | 105 Db (268) | 106 Sg (271) | 107 Bh (270) | 108 Hs (270) | 109 Mt (278) | 110 Ds (281) | 111 Rg (282) | 112 Cn (285) | 113 Nh (286) | 114 Fl (289) | 115 Mc (289) | 116 Lv (293) | 117 Ts (294) | 118 Og (294) |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 58 Ce 140.1 | 59 Pr 140.9 | 60 Nd 144.2 | 61 Pm (145) | 62 Sm 150.4 | 63 Eu 152.0 | 64 Gd 157.3 | 65 Tb 158.9 | 66 Dy 162.5 | 67 Ho 164.9 | 68 Er 167.3 | 69 Tm 168.9 | 70 Yb 173.1 | 71 Lu 175.0 |
| 90 Th 232.0 | 91 Pa 231.0 | 92 U 238.0 | 93 Np (237) | 94 Pu (244) | 95 Am (243) | 96 Cm (247) | 97 Bk (247) | 98 Cf (251) | 99 Es (252) | 100 Fm (257) | 101 Md (258) | 102 No (259) | 103 Lr (262) |

Atomic weights based on IUPAC 2009, 2007 (publ 2011, 2009).

**Potentially useful information:**

$6.022 \times 10^{23}$

Solubility trends:

1. Group 1 (1A) compounds, ammonium compounds, and acids are soluble.
2. All nitrates, acetates, chlorates, and perchlorates are soluble.
3. Silver, lead, mercury(I) and copper(I) compounds are INSOLUBLE.
4. Chlorides, bromides, and iodides are soluble.
5. Sulfates are soluble except calcium sulfate and barium sulfate.
6. Compounds with anions of 2– or 3– charge are INSOLUBLE.
7. Hydroxides are INSOLUBLE except calcium hydroxide and barium hydroxide.

T(K) = T(°C) + 273

one atm = 760 mmHg = 760 torr PV = nRT R = 0.08206 (L atm)/(mol K)

$$d = \frac{M \times P}{RT} \qquad u_{rms} = \sqrt{\frac{3RT}{M}} \qquad \frac{rate_A}{rate_B} = \sqrt{\frac{M_B}{M_A}}$$

Electromagnetic Radiation: $E = h\nu = hc/\lambda$ $h = 6.626 \times 10^{-34}$ J·s $c = 3.00 \times 10^{8}$ m/s

Electron energy in single-electron species: $E = -2.18 \times 10^{-18} J\left(\frac{Z^2}{n^2}\right)$

Electron transitions in H atom:

$$\Delta E = -2.18 \times 10^{-18} J\left(\frac{1}{n_{final}^2} - \frac{1}{n_{initial}^2}\right)$$

name_____

**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.

(work space:) $\_\_\_HNO_2 + \_\_\_H^+ + \_\_\_Cl^- \rightarrow \_\_\_N_2O + \_\_\_H_2O + \_\_\_HClO$

(final answer:)
$\_\_\_HNO_2 + \_\_\_H^+ + \_\_\_Cl^- \rightarrow \_\_\_N_2O + \_\_\_H_2O + \_\_\_HClO$

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

the element oxidized? _____ the oxidizing agent? _____

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 ºC and 2.19 atm. The gas is transferred to a new container of 25.6 L and the new temperature is 87 ºC. 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.

_____atm

name_____

**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:

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

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

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:_____

c. [2] What is the $\Delta H^o$ value for the reaction below?

$4\ Ag\ (s) + O_2\ (g) \rightarrow 2\ Ag_2O\ (s)$ $\Delta H^o =$ _____ kJ

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

| |
|---|
| |

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

Answer:_____

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.

_____ J

name_____

**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.

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.

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.

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 _____

the number of orbitals in the 4f subshell _____

the value of *l* for an electron in the 4f subshell _____

a main-group metal with two unpaired electrons _____

a subshell that exists, but is not populated in the ground state of any known elements _____

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

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**

name_____

**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.

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

_____ If the temperature of a gas sample rises from 20ºC to 40ºC, the average kinetic energy of the molecules is doubled.

_____ Gases behave most ideally at high pressures and high temperatures.

_____ When the temperature of a sample of gas increases, its density decreases.

_____ Breaking bonds is always an endothermic process.

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

_____ Humans can see most of the electromagnetic spectrum.

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

_____ The equation to the right can be used to calculate the energy of any electron in an atom.

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

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

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

_____ The more electrons an atom has, the larger its radius.

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

(b) **greatest number of unpaired electrons: **Fe** **$Fe^{2+}$** **$Fe^{3+}$** all same

(c) greatest atomic radius: **N** **O** **F** all same

(d) greatest magnitude of first ionization energy ($IE_1$): **C** **O** **Si** all same

(e) greatest electron capacity in a single orbital: **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) longest wavelength of photon: **UV** **blue** **red** all same