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. 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.

Please clearly and legibly write your name, in ink, at the top of both pages of your answer sheet. 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.

Time is up at 12:15!!

THE PERIODIC TABLE

	1 (1A)												13 (3A)	14 (4A)	15 (5A)	16 (6A)	17 (7A)	18 (8A)
1	1 H 1.008	2 (2A)																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 (3B)	4 (4B)	5 (5B)	6 (6B)	7 (7B)	8	9 (8B)	10	11 (1B)	12 (2B)	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 72.64	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 (265)	105 Db (268)	106 Sg (271)	107 Bh (272)	108 Hs (277)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Uut (284)	114 Uuq (289)	115 Uup (288)	116 Uuh (293)	117 Uus (294)	118 Uuo (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 173.0	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)

Based on IUPAC 2007 (publ 2009).

Potentially useful information:

Avogadro's number: 6.022×10^{23}

Temperature conversion: T(K) = T(°C) + 273

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

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

Heat and heat capacity: q = C × mass × ΔT

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

Electron transitions: $E = -2.18 \times 10^{-18} J\left(\frac{Z^2}{n_f^{\,2}} - \frac{Z^2}{n_i^{\,2}}\right)$

Molar masses: Ag_2SO_4 311.9 g/mol SO_3 80.07 g/mol O_2 (g) 32.00 g/mol

name_____

Scored grade (instructor use only!)_____

For all calculation questions, show your work in the space provided, and write your answer on the line. Round numerical values appropriately and include unit(s).

1. At high temperature, silver sulfate reacts to form Ag metal, SO_3 and O_2. The overall equation is the following.

$$2\ Ag_2SO_4\ (s) \rightarrow 2\ SO_3\ (g) + 4\ Ag\ (s) + O_2\ (g)$$

Consider this overall reaction as derived from two Steps:

Step 1	$Ag_2SO_4\ (s) \rightarrow Ag_2O\ (s) + SO_3\ (g)$	$\Delta H^o = 292.07$ kJ
Step 2	$2\ Ag_2O\ (s) \rightarrow 4\ Ag\ (s) + O_2\ (g)$	$\Delta H^o = 62.10$ kJ

**(a) [4 pts] What is ΔH^o for the overall equation? (Show work/round answer/provide units)

Answer:_____

(b) [1 pt] Is the overall reaction exothermic or endothermic? _____

(c) [1 pt] Ag_2O, in this reaction, is formed and then consumed, and does not appear in the overall equation. What is the term used to describe a species like this? _____

(d) [2 each] What is the value of ΔH^o_f for each of the species below? (Include appropriate unit(s).)

$Ag_2O\ (s)$ _____ $O_2\ (g)$ _____

(e) If 31.2 g of Ag_2SO_4 reacts according to the overall equation above, and the collected product gas mixture from the reaction is cooled to STP:

i. [4 pts] What is the total **volume** of the gaseous products? (Show work/round answer/provide units)

Answer: _____

ii. [3 pts] What is the pressure of the SO_3 gas in the mixture? (Hint: try to think of a simple way to approach this question.)

Answer: _____

(f) [2 pts] Which element is oxidized in the **overall** reaction? _____

name_____

2. [2 each] Supply an appropriate example of each of the following. In some cases there could be more than one acceptable answer; pick **one**.

_____ An element with valence electrons in the n=6 energy level.

_____ An allowed value of m_ℓ for an electron in the 4s sublevel.

_____ An element that exists under standard conditions as **diatomic molecules** in the **solid** state.

_____ A neutral atom with 2 valence electrons.

_____ A neutral atom with 6 electrons in the 6d sublevel.

_____ A neutral atom with 4 unpaired electrons.

_____ The electron capacity of a single 13h **orbital**.

_____ The Period 2 element with the largest value for IE_1.

_____ A neutral atom that is diamagnetic.

_____ The number of unpaired electrons in a Mn^{2+} ion.

3. [2 each] **Clearly** indicate whether each statement is TRUE or FALSE. If we can't tell which you mean, it's wrong.

_____ An electron transition from n=5 to n=3 absorbs a photon.

_____ The energy of a photon is determined by its amplitude.

_____ Gases behave most ideally when the temperature and pressure are both low.

_____ Under similar conditions, lighter gases effuse and diffuse more quickly than heavier gases.

_____ Most elements are metals.

_____ Most elements are solid at room temperature.

_____ Most elements are paramagnetic as individual atoms.

_____ The 5d sublevel has five orbitals.

_____ O^{2-} and Na^+ have the same electron configuration.

_____ O^{2-} has a larger ionic radius than Na^+.

_____ In an exothermic reaction, energy flows from a system into the surroundings.

name_____

4. [1 each] Air is mostly made up of a mixture of about 80% nitrogen gas and 20% oxygen gas. Consider a balloon filled with air. Answer each question below by circling the appropriate answer.

a. Which gas has a greater partial pressure? O_2 N_2 both the same

b. Which has the greater average kinetic energy? O_2 N_2 both the same

c. Which has a faster average molecular speed? O_2 N_2 both the same

d. If the balloon develops a slow leak, which gas's concentration will **increase** in the balloon? O_2 N_2 both neither

e. If the balloon develops a slow leak, what will happen to each parameter for the sample in the balloon?

n:	increase	decrease	no change
P:	increase	decrease	no change
V:	increase	decrease	no change
density:	increase	decrease	no change

5. [2 each] For each of the following, select the **greatest** value and circle your choice.

a. radius:	Al	Al^{3+}	Si	all the same
b. number of orbitals:	in 3d sublevel	in 4d sublevel	in 5d sublevel	all the same
c. energy of photon of light:	10 nm	400 nm	700 nm	all the same
d. number of valence electrons:	O	P	Ge	all the same
e. number of unpaired electrons:	N	O	F	all the same
f. first ionization energy:	Li	Be	B	all the same
g. second ionization energy:	Li	Be	B	all the same
h. effective nuclear charge for valence e^-:	Cl	Ar	K	all the same
i. effective nuclear charge for valence e^-:	Cl^-	Ar	K^+	all the same

name_____

6. [3 each] Write each answer in the box provided.

a. Give the ground-state valence **orbital diagram** (or "box diagram") for a **chromium(II) ion**.

a.

b. Give the ground-state, condensed **electron configuration** for a **sulfide ion.**

b.

c. Give the ground-state, condensed **electron configuration** for a **gallium atom**.

c.

7. [4] If an He^+ ion has its electron in the n=3 level, what is the maximum **wavelength** of electromagnetic radiation required to remove the electron from the ion? (Show work/round answer/include units)

Answer: _____