Practice Exam A for Fall 2014 Exam 1

First Hour Exam				5.111	Page 1 of 8 pages
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Write your name and your TA's name below. Do not open the exam until the start of the exam is announced. The exam is closed notes and closed book.

1. Read each part of each problem carefully and thoroughly.

2. Read all parts of each problem. MANY OF THE LATTER PARTS OF A PROBLEM CAN BE SOLVED WITHOUT HAVING SOLVED EARLIER PARTS. However, if you need a numerical result that you were not successful in obtaining for the computation of a latter part, make a physically reasonable approximation for that quantity (and indicate it as such) and use it to solve the latter parts.

3. A problem that requests you to "calculate" implies that several calculation steps may be necessary for the problem's solution. You must show these steps clearly and indicate all values, including physical constants used to obtain your quantitative result. Significant figures and units must be correct.

4. If you don't understand what the problem is requesting, raise your hand and a proctor will come to your desk.

5. Physical constants, formulas and a periodic table are given on the last page. You may detach this page once the exam has started.

1.	(16 points)	
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- 2. (20 points) _____
- (10 points) _____ 3.
- 4. (20 points)
- (16 points) 5.
- 6. (18 points) _____

Total (100 points)

Name

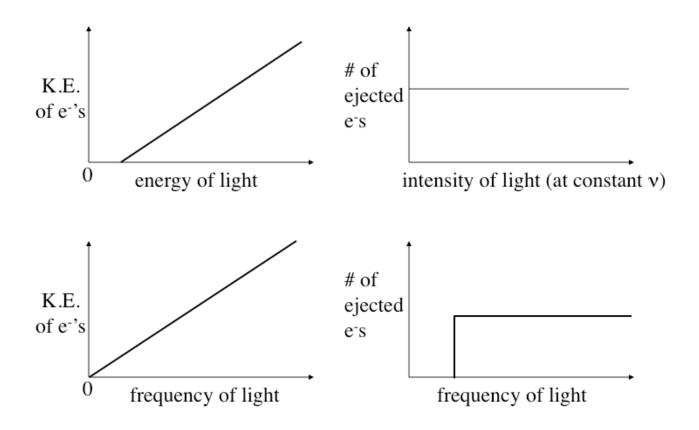
TA

1. (16 points) **Photoelectric effect**

- (a) (8 points) The workfunction for chromium metal is 4.37 eV.
 - (i) Calculate the **frequency** of light required to eject electrons with a kinetic energy of 0.66 eV.

(ii) Is the frequency calculated in part (i) a **minimum** or a **maximum** frequency requirement for an electron to be ejected with at least 0.66 eV?

(b) (8 points) Put an **X** through any of the graphs below that incorrectly depict the relationship between the incident light and the electrons (e⁻'s) ejected from the surface of a metal in the photoelectric effect.



2. (20 points) Binding energies and transitions

For the B^{4+} ion

(a) (12 points) Calculate the **binding energy** to <u>three significant figures</u> of an electron for the (i) ground state and (ii) second excited state. (iii) Calculate the energy difference between these two states.

(b) (4 points) If an electron falls from the n=3 to n=1 state, calculate the wavelength of light emitted.

(c) (4 points) Without doing any calculations, would you expect that an electron in the ground state of Li^{2+} is bound more tightly or less tightly than an electron in the ground state of B^{4+} . Explain your answer.

3. (10 points) **Waves** Calculate the wavelength of an electron that has a kinetic energy of 1.5×10^{-18} J.

4. (20 points) Multi-electron atoms

(a) (2 points) The binding energy of a calcium 4s electron is -6.1 eV. What is the ionization energy, IE, for this 4s electron (in eV)?

(**b**) (8 points) The binding energy of a calcium 2p electron is -349.7 eV. Calculate the effective nuclear charge experienced by a calcium 2p electron.

(c) (10 points) On the plot below,

(i) Graph the radial probability distribution for a 2s orbital (as a solid line) and a 2p orbital (as a dashed line). Label the axes, but do not include numbers or units.)

(ii) Label the r_{mp} , for each orbital, and indicate any nodes with an arrow.

(iii) Would a 2s electron feel more or less shielding than a 2p electron? Briefly explain your answer.

5. (16 points) Electron configurations and quantum numbers

(a) (12 points) Fill in the electron configuration expected for the following atoms or ions. (You may use the noble gas configuration as a means to abbreviate the full configuration).

(i) Po (Z = 84)

(ii) Ag (Z = 47)

(**b**) (4 points) Determine the number of **orbitals** in a single atom that can have the following two quantum numbers: n = 4, $m_l = -2$

6. (18 points) Balancing equations and stoichiometry

Tristearin $(C_{57}H_{110}O_6)$ can be combusted in the presence of oxygen.

 $\underline{\qquad} C_{57}H_{110}O_6(s) + \underline{\qquad} O_2(g) \rightarrow \underline{\qquad} CO_2(g) + \underline{\qquad} H_2O(l)$

(a) (4 points) Balance the above equation for the combustion of tristearin.

(b) (7 points) What mass of water is produced from 1.00 lb (454 g) of tristearin?

(c) (7 points) What mass of oxygen is needed to fully react with 1.00 lb of tristearin?

												$c = 2.9979 \times 10^8 \text{ m/s}$
VIII 2 4.0026 He Beltom	10 20.180 Ne	18 39.948	Ar	36 83.798 Kr strpton	54 131.29 Xe	86 (222) Rn			70 173.04 Yb		102 (259) NO Nobelium	h = 6.6261 x 10^{-34} J s N _A = 6.022 x 10^{23} mol ⁻¹
ПЛ	9 18.998 F	35.453	Chlorine	35 79.904 Br Br	53 126.90 I	85 (210) At			69 168.93 Tm Thothan		101 (258) Md Mendelevium	$m_e = 9.1094 \text{ x } 10^{-31} \text{ kg}$
IV	8 15.999 0 0ygm	16 32.065	Sulfar	34 78.96 Se	52 127.60 Te	84 (209) Po			68 167.26 Er Erbium		100 (257) Fm	$a_0 = 5.292 \text{ x } 10^{-11} \text{ m}$ 1 amu = 1.66 x 10 ⁻²⁷ kg
Λ	7 14.007 N ^{Nitrogen}	15 30.974	Phosphorus	33 74.922 AS Arrente	51 121.76 Sb	83 208.98 Bi			67 164.93 HO Rotanian		99 (252) ES	$R_{\rm H} = 2.1799 \text{ x } 10^{-18} \text{ J}$
N	6 12.011 C Carbon	14 28.086	Silicon	32 72.64 Ge	50 118.71 Sn	82 82 Pb	114 (289) Uuq		66 162.50 Dy ^{Dyspresium}		98 (251) Cf Cattorniun	$\Re = R_{\rm H}/h = 3.2898 \text{ x } 10^{15} \text{ Hz}$
Ш	5 10.811 B B	13 26.982	Alminim	31 69.723 Ga	49 114.82 In	81 81 204.38 TI			65 158.93 Tb Techium		97 (247) BK Bertelium	$E_n = -\frac{Z^2 R_H}{n^2}$
	1			30 65,409 Zn	48 112.41 Cd	80 200.59 Hg	112 (285) Uub Unb		64 157.25 Gd Gd		96 Cm Cm	$E_{nl} = -\frac{Z_{eff}^2 R_H}{n^2}$
				29 63.546 Cu copper	47 107.87 Ag	79 79 Au Cont	111 (272) Uuu		63 151.96 Eu		95 (243) Am Amritium	$E_{nl} = -\frac{n^2}{n^2}$
				28 58.693 Ni Nickel	46 106.42 Pd	78 195.08 Pt	110 (281) Uun		62 150.36 Sm		94 (244) Pu	$1 W = 1 J s^{-1}$ $1 J = 1 kgm^2 s^{-2}$
				27 58.933 C0 cobuit	45 102.91 Rh	77 192.222 Ir	109 (268) Mt		61 (145) Pm Promethium		93 (237) Np	$1 \text{ eV} = 1.6022 \text{ x } 10^{-19} \text{ J}$
		elements		26 55.845 Fe	44 101.07 Ru	76 190.23 Os	108 (277) HS Hastum		60 144.24 Nd Neotymium		92 0 0 0 0	$E = hv = hc/\lambda$ $c = v\lambda$
		Transition elements $_{\lambda}$		25 54.938 Mn Minimenee	43 (98) Tc	75 186.21 Re	107 (264) Bh Itabitiun		59 140.91 Pr		91 231.04 Pa	$KE = (\frac{1}{2})mv^2$
		Τ		24 51.996 Cr	42 95.94 Mo	74 183.84 W	106 (266) Sg	series	58 58 140.12 Ce Ce	S	90 Th Thorise	p = mv
Metals Semimetals	onmetals			23 50.942 V	41 92.906 Nb	73 73 180.95 Ta	105 (262) Db	anthanide series	57 138.91 La Lanthamma	Actinide series	89 Ac Actinium	$\lambda = \frac{h}{p}$
Me	Nor			22 47.867 Ti	40 91.224 Zr	72 178.49 Hf	104 (261) Rf therfordium	[]		Ac		for s wavefunction: RPD = $4\pi r^2 \Psi^2 dr$
				21 24.956 Sc	39 38.906 Y	71 71 174.97 Lu	103 (262) LT avrendam Ra		/			for $n_f < n_i$
п	4 0.0122 Be	12	Mg	20 20 Ca	38 87.62 Sr	56 56 Ba	88 (226) Ra tottum					$v = \frac{Z^2 R_H}{h} \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$
			6			55 55 CS CS com	-					$\begin{array}{c} h \left(\begin{array}{cc} n_{\rm f}^2 & n_{\rm i}^2 \end{array} \right) \\ \text{for } n_{\rm f} > n_{\rm i} \dots \end{array}$
		2		(7) ž	× ×	-						$v = \frac{Z^2 R_H}{h} \left(\frac{1}{n_i^2} - \frac{1}{n_f^2} \right)$
												× 1 1 /

Periodic Table with constants and equations for Exam 1:

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