Top Marks 33/35 $\bar{x} = 64\%$ (/35)

CHEMISTRY 121

FALL 2011

Term Test 1A

Friday, September 30

Name_____

Student Number_____

Signature_____

Sections: **McNeil / Neeland**

DO NOT TURN THE PAGE UNTIL INSTRUCTED TO DO SO!

- Make sure you have all 5 pages (including this one), plus a periodic table.
- Make note of the point value of each question, and allocate your time accordingly.
- *Carefully* read each question before answering. Where appropriate, you must show your work to receive full credit.
- Include *units* and the proper *significant figures* in all numerical answers.
- With the exception of a non-programmable calculator, no aids or notes of any kind are permitted or required.

Total Points: 35
Total Time: 75 minutes

Potentially Helpful Information:

Constants

electron mass = 9.109×10^{-31} kg

proton mass = 1.673×10^{-27} kg

neutron mass = 1.675×10^{-27} kg

1 u = 1.66054×10^{-27} kg

$h = 6.626 \times 10^{-34}$ Js

$c = 2.998 \times 10^{8}$ m/s

$R_H = 2.178 \times 10^{-18}$ J

$a_0 = 5.29 \times 10^{-11}$ m

$e = 1.602 \times 10^{-19}$ C

$N_A = 6.022 \times 10^{23}$ mol^{-1}

R = 8.3145 J/molK

$k = 1.381 \times 10^{-23}$ JK^{-1}

absolute zero = –273.15°C

Equations

$E = h\nu$

$E = \frac{1}{2}mv^2$

$E = mc^2$

$\lambda\nu = c$

$\lambda = h/mv$

$h\nu = h\nu_0 + KE$

$E_n = -\frac{Z^2}{n^2} R_H$

$\Delta E = R_H\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$

$\Delta x \Delta v \geq h/4\pi m$

Elements

aluminum	Al	magnesium	Mg
barium	Ba	nitrogen	N
calcium	Ca	oxygen	O
carbon	C	phosphorus	P
cesium	Cs	potassium	K
chlorine	Cl	sodium	Na
cobalt	Co	silicon	Si
copper	Cu	sulfur	S
fluorine	F	lead	Pb
hydrogen	H	zinc	Zn
iodine	I		
iron	Fe		

1. (3 POINTS, 1 EACH)

Mark each statement as either True (T) or False (F)

a) An electron has a mass approximately $^1/_{1800}$ of the mass of a proton. T

b) There are 1.81×10^{24} carbon atoms in 3 mol of ethane, C_2H_6. F

c) Radioactivity due to α-decay is the most highly penetrating form of radiation F

2. (4 POINTS, 1 EACH)

Circle the one best answer for each question.

Which of the following statements is false?

a) visible light has less energy than gamma rays
b) radio waves have a longer wavelength than ultraviolet light
c) X-rays have higher frequency than infrared light
(d) blue light has less energy than red light

Which transition in the hydrogen atom results in the emission of a photon with the shortest wavelength?

a) a transition from $n = 2$ to $n = 5$
b) a transition from $n = 3$ to $n = 5$
c) a transition from $n = 5$ to $n = 3$
(d) a transition from $n = 5$ to $n = 2$

In the photoelectric effect, which of the following results in an increased kinetic energy of the electrons ejected from a metal?

(a) increasing the frequency of the incident light
b) increasing the wavelength of the incident light
c) increasing the intensity of the incident light
d) increasing the velocity of the incident light

Which of the following statements is false?

a) A mole of CH_4 contains more atoms than a mole of H_2O
(b) A mole of N_2 has *exactly* the same mass as a mole of CO
c) A mole of CH_4 has less mass than a mole of H_2O
d) A mole of $AlCl_3$ and a mole of PCl_3 contain the same mass of chlorine atoms.

3. (4 POINTS)

Complete the following table of isotopes.

symbol	protons	neutrons	electrons	atomic number	mass number
Fe^{2+}	26	30	24	26	56

4. (2 POINTS)

In the following nuclear reaction, one other product must be produced in order to balance the reaction.

$$^{2}_{1}H + {}^{6}_{3}Li \longrightarrow {}^{7}_{4}Be + \gamma + \; ? \quad {}^{1}_{0}n$$

a) The missing product is a (circle the correct response):

proton / electron / (neutron) / positron / leprechaun

b) This reaction is best described as a (circle the correct response):

fission reaction / (fusion reaction) / decay process / neutralization

5. (2 POINTS)

Write the balanced nuclear reaction for the β-decay of ^{137}Cs, including both mass numbers and charge numbers for all nuclides and sub-atomic particles. (Cs has Z = 55.)

$$^{137}_{55}Cs \longrightarrow {}^{0}_{-1}\beta + {}^{137}_{56}Ba$$

6. (4 POINTS)

3.4403 g of an unknown element X completely reacts with O_2 gas (MW = 32.0 g/mol) to form 3.706 g of a compound with formula XO.

subtract

What mass of O_2 must be consumed? (1)

0.2657 g

Identify element X, showing all calculations to explain your choice. (3)

÷ 32 g/mol

.008303 mol O_2

× 2

.016606 mol X & we have 3.4403 g of X

$2X + O_2 \longrightarrow 2XO$

∵ Moles = Grams / AW ∴ AW = 207.2 g/mol = Pb

7. (9 POINTS)

Copper metal (3.50 g, AW = 63.55 g/mol) reacts with a solution of nitric acid (147.1 mL, 1.25 M) according to the following reaction:

$$Cu_{(s)} + 4\ HNO_{3(aq)} \longrightarrow Cu(NO_3)_{2(aq)} + 2\ NO_{2(g)} + 2\ H_2O_{(\ell)}$$

a) Identify the limiting reagent in this reaction. Show all necessary work. (3)

3.50 g ÷ 63.55 g/mol = .0551 mol

.1471 L × 1.25 M = .1839 mol

.0551 mol ÷ 1 = .0551

.1839 mol ÷ 4 = .04597 ← LR

b) Calculate the mass of the excess reagent which remains after all the limiting reagent is consumed. (3)

$$.1839\ mol\ HNO_3 \times \frac{1\ Cu}{4\ HNO_3} \times \frac{63.55\ g}{mol} = 2.921\ g\ Cu\ needed$$

You have 3.50 g ∴ excess Cu = 0.57869 g

0.58 g Cu

c) What is the % yield of the reaction if 1.48 g of water is obtained? (3)

$$.1839\ mol\ HNO_3 \times \frac{2\ H_2O}{4\ HNO_3} \times \frac{18\ g}{mol} = theo.\ yield = 1.654875\ g$$

$$\%\ Yield = \frac{1.48\ g}{1.654\ldots\ g} \times 100 = 89.4327$$

89.4 %

8. (7 POINTS)

The electron in the hydrogen atom moves from the $n = 4$ state to the $n = 3$ state.

a) Circle the correct responses.

The atom undergoes **relaxation** / **excitation** . (1)

A photon is **emitted** / **absorbed** from the atom. (1)

b) Calculate the energy of this photon, in kJ/mol. (3)

$$\Delta E = \frac{-2.178\times10^{-18}\,J\left(\frac{1}{n_f^2}-\frac{1}{n_i^2}\right)}{\text{photon}} \times \frac{1\,KJ}{1000\,J} \times \frac{6.022\times10^{23}\ \text{photons}}{\text{mole}}$$

$$= -63.7579\ KJ/mol$$

$$\boxed{-63.76\ KJ/mol}$$

not a mole of Hem

c) Calculate the wavelength of this photon, in nanometers. (2)

$$E = \frac{hc}{\lambda}$$

$$1.058\times10^{-19}\,J = \frac{(6.6262\times10^{-34}\,J\,s)\left(3\times10^{8}\,\frac{m}{s}\right)}{\lambda}$$

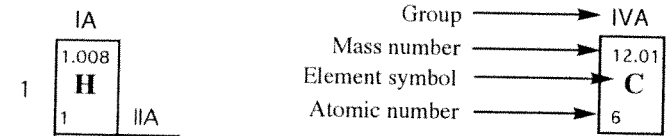
$$\lambda = 1.87755372\times10^{-6}\,m \times \frac{10^{9}\,nm}{1\,m}$$

$$\boxed{= 1.878\times10^{3}\ nm}$$

Question	Points	Score
1	3	
2	4	
3	4	
4	2	
5	2	
6	4	
7	9	
8	7	
TOTAL	35	

Useful Values

R = 8.314 J K^{-1} mol^{-1}
R = 0.08206 L atm K^{-1} mol^{-1}
h = 6.6262 x 10^{-34} J s
1 mole = 6.022 x 10^{23} things
1 dozen = 12 things
c = 3.00 x 10^{8} m/s
STP = 1 atm and 0 °C
760 torr = 1 atm = 101.3 kPa
1 Å = 1 x 10^{-10} m
J = kg m^2 s^{-2}



	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1.008 **H** 1																	4.003 **He** 2
2	6.941 **Li** 3	9.012 **Be** 4											10.81 **B** 5	12.01 **C** 6	14.01 **N** 7	16.00 **O** 8	19.00 **F** 9	20.18 **Ne** 10
3	22.99 **Na** 11	24.31 **Mg** 12											26.98 **Al** 13	28.09 **Si** 14	30.97 **P** 15	32.07 **S** 16	35.45 **Cl** 17	39.95 **Ar** 18
4	39.10 **K** 19	40.08 **Ca** 20	44.96 **Sc** 21	47.88 **Ti** 22	50.94 **V** 23	52.00 **Cr** 24	54.94 **Mn** 25	55.85 **Fe** 26	58.93 **Co** 27	58.69 **Ni** 28	63.55 **Cu** 29	65.39 **Zn** 30	69.72 **Ga** 31	72.59 **Ge** 32	74.92 **As** 33	78.96 **Se** 34	79.90 **Br** 35	83.80 **Kr** 36
5	85.47 **Rb** 37	87.62 **Sr** 38	88.91 **Y** 39	91.22 **Zr** 40	92.91 **Nb** 41	95.94 **Mo** 42	(98) **Tc** 43	101.1 **Ru** 44	102.9 **Rh** 45	106.4 **Pd** 46	107.9 **Ag** 47	112.4 **Cd** 48	114.8 **In** 49	118.7 **Sn** 50	121.8 **Sb** 51	127.6 **Te** 52	126.9 **I** 53	131.3 **Xe** 54
6	132.9 **Cs** 55	137.3 **Ba** 56	138.9 **La** 57	178.5 **Hf** 72	180.9 **Ta** 73	183.9 **W** 74	186.2 **Re** 75	190.2 **Os** 76	192.2 **Ir** 77	195.1 **Pt** 78	197.0 **Au** 79	200.6 **Hg** 80	204.4 **Tl** 81	207.2 **Pb** 82	209.0 **Bi** 83	(209) **Po** 84	(210) **At** 85	(222) **Rn** 86
7	(223) **Fr** 87	(226) **Ra** 88	(227) **Ac** 89	(257) **Unq** 104	(260) **Unp** 105	(263) **Unh** 106	(262) **Uns** 107	(265) **Uno** 108	(266) **Une** 109									

$PV = nRT$

$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$

$\frac{v_1}{v_2} = \left(\frac{m_2}{m_1}\right)^{\frac{1}{2}}$

$E = h\nu$

$\lambda\nu = c$

$E = mc^2$

$E = -2.178 \times 10^{-18}\ J(Z^2/n^2)$

$\Delta E = -2.178 \times 10^{-18} J(1/n_f^2 - 1/n_i^2)$

$\sigma_{1s} < \sigma^*_{1s} < \sigma_{2s} < \sigma^*_{2s} < \pi_{2p_y} = \pi_{2p_z} < \sigma_{2p_x} < \pi^*_{2p_y} = \pi^*_{2p_z} < \sigma^*_{2p_x}$

$\sigma_{1s} < \sigma^*_{1s} < \sigma_{2s} < \sigma^*_{2s} < \sigma_{2p_x} < \pi_{2p_y} = \pi_{2p_z} < \pi^*_{2p_y} = \pi^*_{2p_z} < \sigma^*_{2p_x}$

$F = \frac{2.31 \times 10^{-19} J\ nm\ q_1 q_2}{d}$

$\mu_{rms} = \left(\frac{3RT}{m}\right)^{\frac{1}{2}}$