Chemistry 121	Fall 2007	Oregon State University
Final Exam	December 4, 2007	Dr. Richard Nafshun

Instructions: You should have with you several number two pencils, an eraser, your 3" x 5" note card, a calculator, and your University ID Card. If you have notes with you, place them in a sealed backpack and place the backpack OUT OF SIGHT or place the notes directly on the table at the front of the room.

Fill in the front page of the Scantron answer sheet with your test form number (listed above), last name, first name, middle initial, and student identification number. **Leave the class section number and the test form number blank.**

This exam consists of 40 multiple-choice questions. Each question has four points associated with it. Select the best multiple-choice answer by filling in the corresponding circle on the rear page of the answer sheet. If you have any questions before the exam, please ask. If you have any questions during the exam, please ask the proctor. Open and start this exam when instructed. When finished, place your Scantron form and note card in the appropriate stacks. You may keep the exam packet, so please show your work and mark the answers you selected on it.

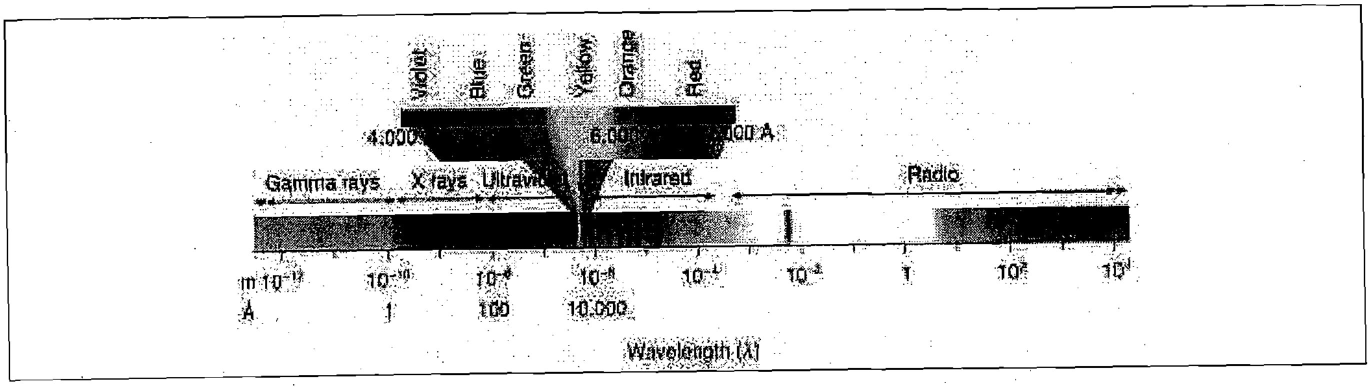
centi (c) = 1/100	milli (m) = 1/000	kilo (k) = 1000
micro (μ) = 10^{-6}	nano (n) = 10^{-9}	1 mole = 6.022×10^{23}
1 inch = 2.54 cm (exact)	1 kg = 2.2 pounds	1 foot = 12 inches (exact)
K = 273.15 + °C	1 atm = 760 mm Hg = 760 Torr	
Hydroxide OH^-	Cyanide CN^-	Nitrate NO_3^-
Acetate CH_3COO^-	Carbonate CO_3^{2-}	Phosphate PO_4^{3-}
Hydronium H_3O^+	Ammonium NH_4^+	Sulfate SO_4^{2-}

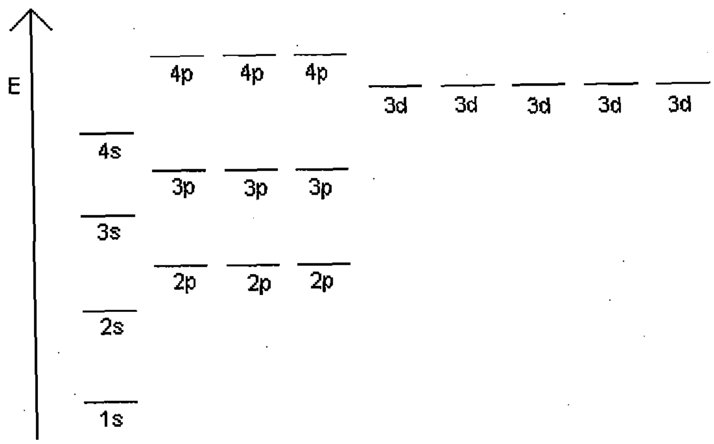
Abbreviated Solubility Rules:
Rule 1: All nitrates, group 1A metal salts and ammonium salts are soluble.
Rule 2: All carbonates, hydroxides, phosphates and sulfides are insoluble.
Rule 3: Rule 1 always takes precedent.

$M_1V_1 = M_2V_2$	$M_{acid}V_{acid} = M_{base}V_{base}$	$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$
$R = 0.0821 \frac{L \bullet atm}{mol \bullet K}$	$\mu_{rms} = \sqrt{\frac{3RT}{Molar\ Mass}}$	$R = 8.314 \frac{kg \bullet m^2}{s^2 \bullet mol \bullet K}$
PV = nRT	$q = mc\Delta T$	$q = m\Delta H$
E = q + w	$R_H = 2.180 \times 10^{-18}$ J/photon	$c = 3.00 \times 10^8$ m/s
$h = 6.626 \times 10^{-34}$ J·s	$\nu = \frac{c}{\lambda}$	E = hν

Substance	FM (g/mol)	MP (°C)	Heat (f) (J/g)	BP (°C)	Heat (v) (J/g)	Specific Heat (J/g°C)* Solid	Liquid	Gas
acetone	58.1	-95.1	96.7	56.1	520	2.26	2.20	1.46
benzene	78.1	5.41	126	80.1	394	1.20	1.90	1.17
ethanol	46.1	-112	100	78.3	852	0.96	2.10	1.71
n-octane	114	-57.0	182	126	339	1.30	2.40	1.30
water	18.0	0.00	334	100	2260	2.09	4.18	1.38

* Values are estimated based on averages over the temperature range





IA		IIIB	IVB	VB	VIB	VIIB	VII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1 H Hydrogen 1.0079																	2 He Helium 4.0026
3 Li Lithium 6.941	4 Be Beryllium 9.01218											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.9984	10 Ne Neon 20.179
11 Na Sodium 22.98977	12 Mg Magnesium 24.305											13 Al Aluminum 26.9815	14 Si Silicon 28.0855	15 P Phosphorus 30.97376	16 S Sulfur 32.06	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.08	21 Sc Scandium 44.9559	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.996	25 Mn Manganese 54.9380	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.70	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.9059	40 Zr Zirconium 91.22	41 Nb Niobium 92.9064	42 Mo Molybdenum 95.94	43 Tc Technetium 98.906	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.4	47 Ag Silver 107.868	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.69	51 Sb Antimony 121.75	52 Te Tellurium 127.60	53 I Iodine 126.9045	54 Xe Xenon 131.30
55 Cs Cesium 132.9054	56 Ba Barium 137.33	57–71 *Rare earths	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.2	77 Ir Iridium 192.22	78 Pt Platinum 195.09	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.37	82 Pb Lead 207.2	83 Bi Bismuth 208.9804	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium 226.0254	89–103 †Actinides	104 Rf Rutherfordium (261)	105 Ha Hahnium (262)	106 Sg Seaborgium (263)	107 Ns Neilsbohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 ‡ (269)	111 ‡			114				

→ Stable region?

57 La Lanthanium 138.9055	58 Ce Cerium 140.12	59 Pr Praseodymium 140.9077	60 Nd Neodymium 144.24	61 Pm Promethium 145	62 Sm Samarium 150.4	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.9254	66 Dy Dysprosium 162.50	67 Ho Holmium 164.9304	68 Er Erbium 167.26	69 Tm Thulium 168.9342	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
89 Ac Actinium 227.0278	90 Th Thorium 232.0381	91 Pa Protactinium 231.0359	92 U Uranium 238.029	93 Np Neptunium 237.0482	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium 259	103 Lr Lawrencium 262

Unit 1 (Material Assessed on Exam 1)

1. A student measures a sample of sodium chloride to be 45.233 g. Another student measures a sample of lithium fluoride to be 1231.43 g. Added together, the sum of these samples is (with the proper number of significant figures):

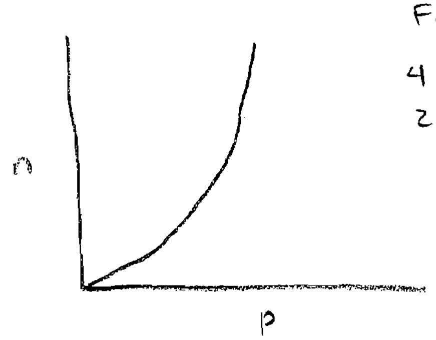
(A) 1276.663 g
(B) 1276.66 g
(C) 1276.7 g
(D) 1277. g
(E) 1.28×10^3 g

$$\begin{array}{rl} & 45.233 \text{ g} \\ + & 1231.43 \text{ g} \\ \hline & 1276.663 \text{ g} \end{array}$$

cannot report

2. Fill in the blank. The ratio of $\frac{\text{neutrons}}{\text{protons}}$ ____________ as the atomic number increases.

(A) increases
(B) decreases
(C) stays the same



For example:

$^{4}_{2}He \rightarrow ^{131}_{54}Xe$

3. Which of the following chemical formulae is **incorrect**?

(A) $Mg_3(PO_4)_2$ ✓
(B) $Ca(NO_3)_2$ ✓
(C) AlO_3 → Al_2O_3 Al^{3+} O^{2-}
(D) Na_2S ✓
(E) $CaCO_3$ ✓

4. $^{208}Pb^{2+}$ has:

(A) 208 **protons**, 206 **neutrons**, 208 **electrons**
(B) 208 **protons**, 208 **neutrons**, 206 **electrons**
(C) 82 **protons**, 126 **neutrons**, 80 **electrons**
(D) 82 **protons**, 126 **neutrons**, 84 **electrons**
(E) 126 **protons**, 126 **neutrons**, 124 **electrons**

$^{208}_{82}Pb$

82 p

208 - 82 = 126 n

82 - 2 = 80 e^-

5. The mass percent composition of oxygen in $Al_2(SO_4)_3$ is:

(A) 4.676 %
(B) 56.12 %
(C) 25.00 %
(D) 14.03 %
(E) 18.71 %

2 Al = 2 x 26.98 g/mol = 53.96 g/mol

3 S = 3 x 32.06 g/mol = 96.18 g/mol

12 O = 12 x 16.00 g/mol = 192.00 g/mol

342.14 g/mol

part

$$\% \text{ oxygen} = \frac{192.00 \text{ g/mol}}{342.14 \text{ g/mol}} = 56.12\%$$

whole

6. The two stable isotopes of bowlium are Bl-323 (mass = 323.045 amu and a percent abundance of 67.22 %) and Bl-325 (mass = 325.011 amu and a percent abundance of 32.78 %). What is the average mass of bowlium?

(A) 323.7 amu
(B) 324 amu
(C) 324.03 amu
(D) 2203 amu
(E) 315.1 amu

$$(0.6722)(323.045 \text{ amu}) + (0.3278)(325.011 \text{ amu}) = 323.7 \text{ amu}$$

7. The chemical formula of ammonium sulfide is:

(A) $AmSO_4$
(B) ~~NH_4SO_4~~
(C) $(NH_4)_2S$
(D) $(NH_4)_2SO_4$
(E) Na_2SO_4

NH_4^+ S^{2-}

8. Which of these pairs of elements would be most likely to form an ionic compound?

metal plus non-metal

(A) P and Br
(B) Cr and K
(C) C and O
(D) Ca and O
(E) Al and Rb

Ca - metal
O - non-metal

ionic - no prefixes
molecule - use prefixes

9. The names of $Mg(NO_3)_2$ and CCl_4 are:

(A) magnesium nitrate and carbon tetrachloride
(B) magnesium nitride and carbon tetrachloride
(C) magnesium dinitrate and carbon tetrachloride
(D) magnesium dinitride and carbon tetrachloride
(E) monomagnesium dinitride and carbon tetrachloride

10. Provide the coefficients needed to balance the following combustion equation:

$$a\ C_9H_{20}\,(l) + b\ O_2\,(g) \rightarrow c\ CO_2\,(g) + d\ H_2O\,(g)$$

$$\underline{1}\ C_9H_{20} + \underbrace{14}_{\text{28 oxygen atoms}}\ O_2 \rightarrow \underbrace{\underline{9}\ CO_2 + \underline{10} H_2O}_{\text{28 oxygen atoms}}$$

(A)	a = 1	b = 14	c = 9	d = 20
(B)	a = 2	b = 9	c = 18	d = 40
(C)	a = 1	b = 9	c = 18	d = 20
(D)	a = 1	b = 10	c = 9	d = 20
(E)	a = 1	b = 14	c = 9	d = 10

11. A student obtains 450.4 grams of ribose, $C_5H_{10}O_5$ (s). How many ribose molecules are present?

(A) 7.226×10^{24} ribose molecules
(B) 2.408×10^{24} ribose molecules
(C) 3.601×10^{24} ribose molecules
(D) 1.807×10^{24} ribose molecules
(E) 1.204×10^{24} ribose molecules

$5 \times C \Rightarrow 5 \times 12.011\ g/mol = 60.05\ g/mol$
$10 \times H \Rightarrow 10 \times 1.0079\ g/mol = 10.08\ g/mol$
$5 \times O = 5 \times 16.00\ g/mol = 80.00\ g/mol$
$150.13\ g/mol$

$$450.4\,g\ C_5H_{10}O_5 \left(\frac{1\ mol}{150.13\ g}\right) = 3.000\ mol\ C_5H_{10}O_5$$

$$3.000\ mol\ C_5H_{10}O_5 \left(\frac{6.022 \times 10^{23}\ molecules}{1\ mol}\right) = 1.807 \times 10^{24}\ molecules$$

12. A student reacts 309.74 grams of P_4 (s) in an excess amount of oxygen. How many grams of P_2O_5 (s) are produced?

$$P_4\,(s) \quad + \quad 5\ O_2\,(g) \quad \rightarrow \quad 2\ P_2O_5\,(s)$$

309.74 g ↓ 1 — 709.79 g ↑ 3

2.500 mol $\xrightarrow{2}$ 5.000 mol

1 $$309.74\,g\ P_4 \left(\frac{1\ mol}{123.90\ g}\right) = 2.500\ mol\ P_4$$

2 $$2.500\ mol\ P_4 \left(\frac{2\ mol\ P_2O_5}{1\ mol}\right) = 5.000\ mol\ P_2O_5$$

3 $$5.000\ mol\ P_2O_5 \left(\frac{141.95\ g}{1\ mol}\right) = 709.79\ g\ P_2O_5$$

(A) 283.89 grams of P_2O_5 (s) are produced
(B) [redacted] grams of P_2O_5 (s) are produced 709.79 g
(C) 1419.5 grams of P_2O_5 (s) are produced
(D) 2839.0 grams of P_2O_5 (s) are produced
(E) 5677.9 grams of P_2O_5 (s) are produced

13. The mass of a single argon atom is:

(A) 39.948 grams
(B) 39.948×10^{-23} grams
(C) 6.6337×10^{-23} grams
(D) 1.995×10^{-23} grams
(E) 5.014×10^{-22} grams

$$39.948 \frac{g}{mol}\left(\frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ Ar atoms}}\right) = 6.6337 \times 10^{-23} \frac{g}{atom}$$

14. A student () obtains 340.72 grams of gold. This is:

(A) 1.73 gold atoms
(B) 2.05×10^{26} gold atoms
(C) 4.04×10^{28} gold atoms
(D) 1.04×10^{24} gold atoms
(E) 2.87×10^{-24} gold atoms

$$340.72 g\left(\frac{1 \text{ mol}}{196.97 g}\right)\left(\frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol}}\right) = 1.04 \times 10^{24} \text{ atoms}$$

15. There are 6.753×10^{23} penicillin molecules in 375.0 g of penicillin. What is the molar mass of penicillin?

(A) 334.4 g/mol
(B) 180.08 g/mol
(C) 555.3 g/mol
(D) 420.5 g/mol
(E) The answer cannot be calculated without the molecular formula of penicillin.

$$6.753 \times 10^{23} \text{ molecules}\left(\frac{1 \text{ mole}}{6.022 \times 10^{23} \text{ molecules}}\right) = 1.12 \text{ mol}$$

$$\text{Molar Mass} = \frac{g}{mol} = \frac{375.0 g}{1.12 \text{ mol}} = 334.4 \text{ g/mol}$$

Unit 2 (Material Assessed on Exam 2)

16. A student  places 58.66 g of a gas into a 45.0-L container at 305 K and measures the pressure to be 1.02 atm. This gas is:

(A) O_2 (g)
(B) ~~N_2 (g)~~
(C) Cl_2 (g)
(D) H_2 (g)
(E) He (g)

$PV = nRT$

$n = \frac{PV}{RT} = \frac{(1.02 \text{ atm})(45.0 \text{ L})}{(0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(305 \text{ K})} = 1.83 \text{ mol}$

$\text{Molar Mass} = \frac{g}{mol} = \frac{58.66 g}{1.83 \text{ mol}} = 32.00 \, g/mol = O_2$

17. What is the density (in g/L) of F_2 (g) at 280 K and 690 mm Hg?

(A) 0.666 g/L
(B) ~~0.791 g/L~~
(C) 1.50 g/L
(D) ~~3.24 g/L~~
(E) 32.0 g/L

$PV = nRT$

$V = \frac{nRT}{P} = \frac{(1 \text{ mol})(0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(280 \text{ K})}{\left(\frac{690 \text{ mm Hg}}{\frac{760 \text{ mm Hg}}{1 \text{ atm}}}\right)} = 25.32 \text{ L}$

$1 \text{ mol } F_2 = 38.00 g$

$d = \frac{g}{L} = \frac{38.00 g}{25.32 L} = 1.50 \frac{g}{L}$

18. A student obtains a 3.20 liter balloon at 20.0 °C and 0.900 atm. She cools the balloon to 10.0 °C. The volume of the balloon at 10.0 °C is:

293 K

283 K

(A) 0.324 L
(B) 1.60 L
(C) ~~844 L~~
(D) 3.09 L
(E) ~~84.4 L~~

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\qquad \frac{3.20 L}{293 K} = \frac{V_2}{283 K}$

$V_2 = 3.09 L$

19. Consider the following five gases: F_2 (g) CO_2 (g) He (g) Cl_2 (g) Xe (g)

Of these, the gas with the **highest** velocity at room temperature is:

lightest

(A) F_2 (g)
(B) CO_2 (g)
(C) He (g)
(D) Cl_2 (g)
(E) Xe (g)

20. A student combusts 4.000 moles of octane gas, C_8H_{18}. How many liters of CO_2 (g) are produced at a pressure of 1.00 atm and a temperature of 298 K?

$$2\ C_8H_{18}\ (g) + 25\ O_2\ (g) \rightarrow 16\ CO_2\ (g) + 18\ H_2O\ (g)$$

___ L

↑ (2)

4.000 mol $\xrightarrow{(1)}$ 32.000 mol

(1) $4.000 \text{ mol } C_8H_{18} \left(\frac{16 \text{ mol } CO_2}{2 \text{ mol } C_8H_{18}} \right) = 32.000 \text{ mol } CO_2$

(2) $PV = nRT$ | $V = \frac{nRT}{P} = \frac{(32.000 \text{ mol})(0.0821 \frac{L \cdot atm}{mol \cdot K})(298\ K)}{1\ atm} = 783\ L$

(A) 783 L of CO_2 are produced
(B) 97.9 L of CO_2 are produced
(C) 6.12 L of CO_2 are produced
(D) 52461 L of CO_2 are produced
(E) 1566 L of CO_2 are produced

21. A sample of He (g) is observed to effuse through a porous barrier in 2.77 minutes. Under the same conditions, the same number of moles of an unknown gas requires 7.33 minutes to effuse through the same barrier. Which of the following is the unknown gas?

(A) O_2 (g)
(B) N_2 (g)
(C) Cl_2 (g)
(D) H_2 (g)
(E) Xe (g)

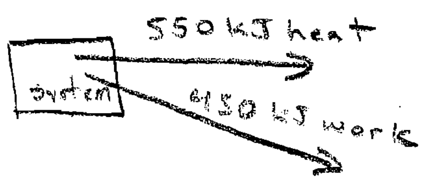
$$\frac{\text{time}_1}{\text{time}_2} = \frac{\sqrt{\text{Molar Mass}_1}}{\sqrt{\text{Molar Mass}_2}}$$

$$\frac{2.77\ \text{min}}{7.33\ \text{min}} = \frac{\sqrt{4\ \text{g/mol}}}{\sqrt{\text{Molar Mass}_2}}$$

Molar Mass$_2$ = 28 g/mol N_2

22. A system gives off 550 kJ of heat and does 450 kJ of work. The change in the internal energy of the system is:

(A) + 100 kJ
(B) - 100 kJ
(C) + 1000 kJ
(D) - 1000 kJ
(E) + 247500 kJ



$\Delta E = q + w$

$= (-550\ \text{kJ}) + (-450\ \text{kJ}) = -1000\ \text{kJ}$

23. Which of the following processes is exothermic?

(A) H_2O (l) → H_2O (g)
(B) 2 CO_2 (g) + 3 H_2O (g) → CH_3CH_2OH (l) + 3 O_2 (g)
(C) H_2O (l) → H_2O (s)
(D) NH_4NO_3 (s) → NH_4NO_3 (aq)
(E) CO_2 (s) → CO_2 (g)

heat is removed (exiting) to make ice from H_2O (l)

24. How much heat is required to raise the temperature of 250 grams of ethanol from 23.0°C to 60.0°C?

(A) 9250 kJ
(B) 9.25 kJ
(C) 15.0 kJ
(D) ~~5.75 kJ~~
(E) 19.4 kJ

$q = mc\Delta T$

$q = (250g)(2.10\ J/g{\cdot}°C)(60.0°C - 23.0°C)$

$q = 19,425\ J$ or $19.4\ kJ$

25. The heat of formation ($\Delta H°_f$) of $Mg(OH)_2$ (s) is –925 kJ/mol. The chemical equation associated with this reaction is:

(A) $Mg\ (s) + 2\ O\ (g) + 2\ H\ (g) \rightarrow Mg(OH)_2\ (s)$
(B) $Mg\ (s) + 2\ (OH^-)\ (aq) \rightarrow Mg(OH)_2\ (s)$
(C) $Mg\ (s) + 2\ OH^-\ (aq) \rightarrow Mg(OH)_2\ (s)$
(D) ~~$Mg\ (s) + 2\ O_2\ (g) + 2\ H_2\ (g)$~~ $\rightarrow Mg(OH)_2\ (s)$
(E) $Mg\ (s) + O_2\ (g) + H_2\ (g) \rightarrow Mg(OH)_2\ (s)$

Making $Mg(OH)_2(s)$ from the elements in their natural state

26. 25 kJ of heat will cause a 200.0 gram sample of H_2O (l) to increase from 0.0 °C to:

(A) 5000 °C
(B) 0.125 °C
(C) ~~125 °C~~
(D) 29.9 °C
(E) 8.00 °C

$q = mc\Delta T$

$25,000\ J = (200.0g)(4.18\ J/g{\cdot}°C)(T_f - 0.0°C)$

$T_f = 29.9°C$

27. Determine $\Delta H°$ for: $2\ Fe_3O_4(s) \rightarrow 6\ Fe(s) + 4\ O_2\ (g)$ using the following two equations:

(1)	$4\ Fe_3O_4\ (s) + O_2\ (g) \rightarrow 6\ Fe_2O_3(s)$	$\Delta H_1° = -\ 650\ kJ$	$\div 2$
(2)	$6\ Fe_2O_3\ (s) \rightarrow 12\ Fe(s) + 9\ O_2(g)$	$\Delta H_2° = +\ 6906\ kJ$	$\div 2$

$2\ Fe_3O_4(s) + \cancel{\tfrac{1}{2} O_2}\ (g) \rightarrow 3\ \cancel{Fe_2O_3}(s)$ $\quad \Delta H_1' = \dfrac{-650\ kJ}{2}$

$+ \quad 3\ \cancel{Fe_2O_3}(s) \rightarrow 6\ Fe(s) + \cancel{\tfrac{9}{2}}^{4} O_2(g)$ $\quad \Delta H_2' = \dfrac{+6906\ kJ}{2}$

$2\ Fe_3O_4(s) \rightarrow 6\ Fe(s) + 4\ O_2(g)$ $\quad \Delta H = +3128\ kJ$

(A) - 6256 kJ
(B) + 6256 kJ
(C) + 3128 kJ
(D) - 3128 kJ
(E) + 7556 kJ

28. Consider the mixture of two aqueous solutions: one of sodium sulfate and one of calcium nitrate. The net ionic equation for the process that occurs is:

spectator ion

spectator ion

(A) $Ca^{2+}\ (aq) + SO_4^{2-}\ (aq) \rightarrow CaSO_4\ (s)$
(B) $Ca^{2+}\ (aq) + NO_3^-\ (aq) \rightarrow Ca(NO_3)_2\ (s)$
(C) $Na^+\ (aq) + CO_3^{2-}\ (aq) \rightarrow CaCO_3\ (aq)$
(D) $2\ Na^+\ (aq) + SO_4^{2-}\ (aq) \rightarrow Na_2SO_4\ (s)$
(E) $Na_2SO_4\ (aq) + Ca(NO_3)_2\ (aq) \rightarrow CaCO_3\ (s) + 2\ NaNO_3\ (aq)$

$Ca^{2+}(aq) + SO_4^{2-}(aq) \rightarrow CaSO_4(s)$

29. Consider the electromagnetic spectrum. Which of the following statements is FALSE?

(A) Green light is lower in energy than x-rays.
(B) Red light has a longer wavelength than x-rays.
(C) Blue light has a higher frequency than x-rays.
(D) Red light and x-rays travel at the same velocity.

x-rays blue

$\leftarrow$
Higher E
Higher ν
Shorter λ

30. The frequency of green photons having a wavelength of 520 nm is:

(A) $5.77 \times 10^{14}\ \frac{1}{s}$
(B) $1.73 \times 10^{14}\ \frac{1}{s}$
(C) $5.20 \times 10^{-9}\ \frac{1}{s}$
(D) $5.20 \times 10^{5}\ \frac{1}{s}$
(E) $5.76 \times 10^{5}\ \frac{1}{s}$

$$\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^{8}\ \frac{m}{s}}{520 \times 10^{-9}\ m} = 5.77 \times 10^{14}\ \frac{1}{s}$$

31. The energy of **one mole** of red photons having a wavelength of 685 nm is:

(A) 4.82×10^{-52} kJ
(B) 3.45×10^{18} kJ
(C) 175 kJ
(D) 290 kJ
(E) 2.90 kJ

$$\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^{8}\ \frac{m}{s}}{685 \times 10^{-9}\ m} = 4.38 \times 10^{14}\ \frac{1}{s}$$

$$E = h\nu = \left(6.626 \times 10^{-34}\ \frac{J \cdot s}{photon}\right)\left(4.38 \times 10^{14}\ \frac{1}{s}\right)$$

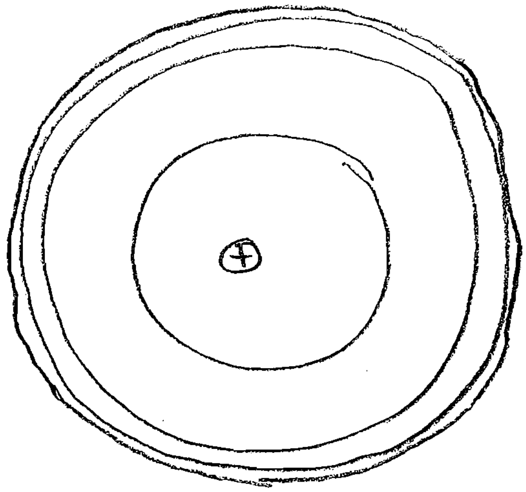
$$E = 2.90 \times 10^{-19}\ \frac{J}{photon}$$

For 1 mol $\Rightarrow$ $2.90 \times 10^{-19}\ \frac{J}{photon} \times 6.022 \times 10^{23}\ \frac{photons}{mole} =$

$E = 174{,}770$ J/mol or 175 kJ/mol

32. Consider the Bohr Model for the Hydrogen Atom. Which of the following electron transitions releases the **most** energy?

(A) n = 9 to n = 8
(B) n = 8 to n = 7
(C) n = 7 to n = 6
(D) n = 6 to n = 5
(E) n = 5 to n = 4



→ as n increases, the different in energy decreases

33. Consider the Bohr Model for the Hydrogen Atom. Which of the following electron transitions releases electromagnetic radiation with the **greatest** frequency?

↓
greatest energy

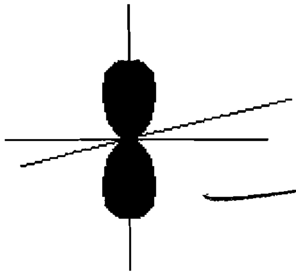
(A) n = 7 to n = 6
(B) n = 6 to n = 5
(C) n = 5 to n = 4
(D) n = 4 to n = 3
(E) n = 3 to n = 2

34. Which of the following sets of quantum numbers is **INCORRECT**?

(A) $n = 1, l = 0, m_l = 0, m_s = +½$
(B) $n = 1, l = 0, m_l = 0, m_s = -½$
(C) $n = 2, l = 0, m_l = 0, m_s = +½$
(D) $n = 2, l = 1, m_l = 2, m_s = +½$
(E) $n = 2, l = 1, m_l = -1, m_s = +½$

When
n = 2
ℓ can be 1
however, when ℓ is 1, $m_\ell = -1, 0, +1$ (cannot be 2)

35. Which set of four quantum numbers describes the orbital pictured below?



peanut p $\ell = 1$

(A) $n = 1, l = 0, m_l = 0, m_s = +½$
(B) $n = 1, l = 0, m_l = 0, m_s = -½$
(C) $n = 2, l = 0, m_l = 0, m_s = +½$
(D) $n = 2, l = 1, m_l = 0, m_s = +½$
(E) $n = 2, l = 2, m_l = 0, m_s = +½$

36. Consider an electron (mass of 9.10939×10^{-31} kg) traveling at 1/40th the speed of light. Which of the following statements is correct?

(A) The wavelength of the e^- is 5.22×10^{-9} m and this has practical significance.
(B) The wavelength of the e^- is 5.22×10^{-9} m and this does not have practical significance.
(C) The wavelength of the e^- is 1.21×10^{-10} nm and this has practical significance.
(D) The wavelength of the e^- is 9.70×10^{-11} m and this has practical significance.
(E) The wavelength of the e^- is 9.70×10^{-11} m and this does not have practical significance.

$$\lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34}\ \text{J} \cdot \text{s}}{(9.109 \times 10^{-31}\ \text{kg})(\frac{1}{40} \times 3.00 \times 10^{8}\ \frac{\text{m}}{\text{s}})} = 9.70 \times 10^{-11}\ \text{m}$$

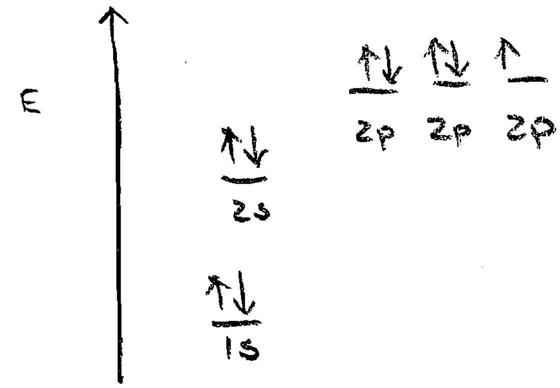
and this has practical significance for an e^-

37. deBroglie's proposition regarding the nature of matter was:

(A) The wavelength of electromagnetic radiation is proportional to the energy
(B) All photons are in the visible region of the electromagnetic spectrum
(C) The frequency of electromagnetic radiation is equal to the energy
(D) All masses in motion exhibits a wavelength
(E) The mass of x-ray photons are greater than the mass of red light photons

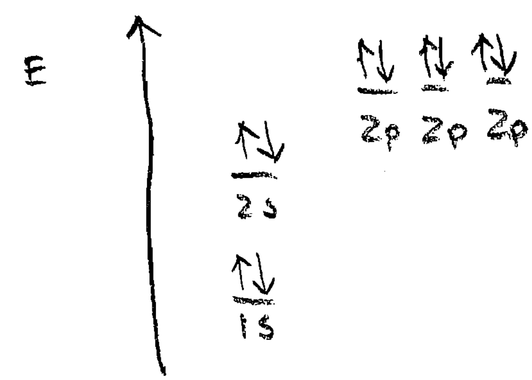
38. The ground-state electron configuration of a fluorine **atom** is: F (9 e-)

(A) $1s^2 2s^2 3s^2 3p^1$
(B) $1s^2 2s^2 3s^1$
(C) $1s^2 2s^2 2p^5$
(D) $1s^2 2s^2 2p^3$
(E) $1s^2 2s^2 3s^3$



39. The ground-state electron configuration of a fluoride **ion** (F^-) is: $F^- = 9+1 = 10\ e^-$

(A) $1s^2 2s^2 3s^2 3p^2$
(B) $1s^2 2s^2 3s^1$
(C) $1s^2 2s^2 2p^6$
(D) $1s^2 2s^2 2p^6 3s^2 3p^2$
(E) $1s^2 2s^2 2p^4$



40. Because of CH 121...

(A) I dream of electrons, orbitals, and Hayden Panettiere and/or Patrick Dempsey
(B) I love cats and dogs; but not OWLs
(C) I like corn flakes
(D) I had the periodic table of the elements tattooed on my butt
(E) I now understand the nature of the universe and use this knowledge to increase my popularity

Questions 1 through 40 each have 4 points attached. Any response to Question 40 will receive full credit (4 Points); even no response.

The point total for this exam is 160 points. See the grade sheet or CH 121 web syllabus for grade computation details.

Final exam keys, scores, and course grades will be posted on the CH 121 website as they become available.

Have an excellent and safe Winter Break ☺