Name (**in ink**) ____________________

Student Number (**in ink**) ____________________

Fall 2014 SC/CHEM 1000 A - Quiz #1

October 2, 2014

Calculators are permitted.
Answer all questions on this paper; **additional paper for rough work is not permitted. You may carry out your work in pencil if you wish, but please write your final answer in ink.**

Assume all gases to be ideal unless otherwise noted

Time Allowed: 50 minutes **Total Marks = 30**

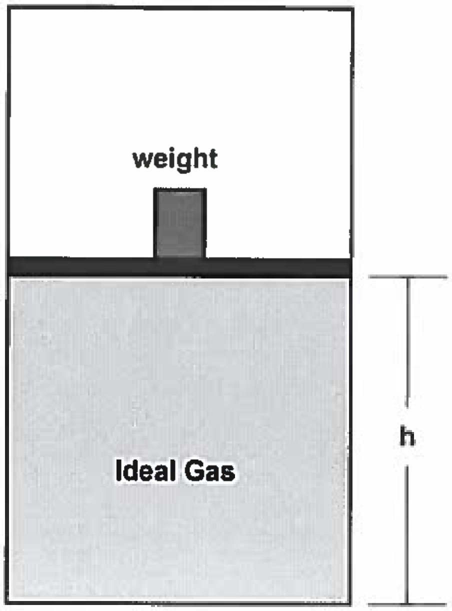
1. **(5 pts)** $H_2(g)$ and excess $O_2(g)$ are mixed in a balloon (H_2 is the limiting reagent), and the balloon is exploded with a spark to produce water via the following reaction

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(l)$$

Before the explosion, the partial pressure of H_2 was 645 torr, the temperature was 25°C, and the volume of the balloon was 1.12 L, how much water (in grams) was produced from the explosion?

$m_{H_2O} = 0.700\ g\ H_2O$

2. **(6 pts)** Air is placed in a cylinder with a piston, as shown below. The area of the bottom of the cylinder is 7.44 cm^2, the height, h, is 14.0 cm, and the



bottom area = 7.44 cm^2

pressure of the air inside the cylinder is equal to ambient pressure, P_{amb}, of 781 torr. A weight is then placed on the piston, and the gas compresses to a new height, h, of 6.85 cm. Please calculate the mass of the weight.

$m_w = 8.24$ kg

3. **(6 pts)** A 22.7 L helium filled chamber at 298K has a tiny hole of area 1.63X10^{-5} mm^2 punched in it through which is leaking helium at a rate of 2.25X10^{15} atoms per second. How many atoms of helium are in the chamber?

$N = 9.98 \times 10^{21}$ atoms

4. **(4 pts)** A fat guy drinks 32 L of ice water at 0.0°C, and his body warms the water to body temperature (37.5°C). How much work (in kJ) did his body have to do to warm the water?

$q = 5.0 \times 10^3$ kJ

5. **(5 pts)** Write down any five postulates used in kinetic molecular theory to define the model of an ideal gas.

a. Particles have no volume

b. Particles have no interaction

c. All energy is kinetic

d. Energy is constant

e. Pressure is caused by particles striking walls.

- Each particle moves in a straight line path at constant speed.
- particles move with a distribution of speeds
- all collisions with walls are elastic

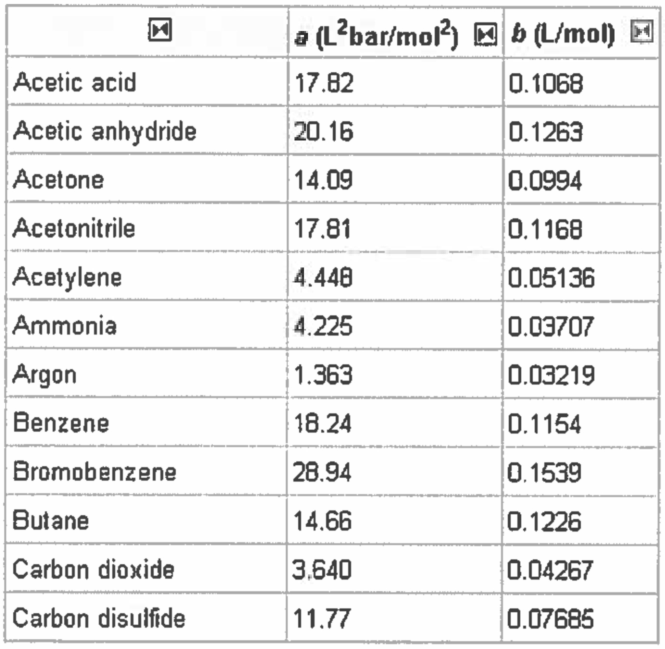
6. **(4 pts)** Referring to the table of van der Waals constants included in this quiz, which real gas in the table has

a. the smallest particle Argon

b. the largest particle Bromobenzene

c. the weakest interparticle forces Argon

d. the strongest interparticle forces Bromobenzene



	a (L^2bar/mol^2)	*b* (L/mol)
Acetic acid	17.82	0.1068
Acetic anhydride	20.16	0.1263
Acetone	14.09	0.0994
Acetonitrile	17.81	0.1168
Acetylene	4.448	0.05136
Ammonia	4.225	0.03707
Argon	1.363	0.03219
Benzene	18.24	0.1154
Bromobenzene	28.94	0.1539
Butane	14.66	0.1226
Carbon dioxide	3.640	0.04267
Carbon disulfide	11.77	0.07685

Equations

$PV = nRT$

$\Delta U = q + w$

$H = U + PV$

$w = -\int PdV$

$U = \frac{3}{2}nRT$

$\Delta x \Delta p \geq \frac{h}{4\pi}$

$E = mc^2$

$E = h\nu$

$$Z_W = \frac{N}{4V}\left(\frac{8RT}{\pi M}\right)^{1/2}$$

$$\overline{u_{RMS}} = \left(\frac{3RT}{M}\right)^{1/2}$$

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

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_V}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$q_A = G_A - N_A - \sum_B \frac{\chi_A}{\chi_A + \chi_B} N_{AB}$$

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

$4r_{BCC} = l\sqrt{3}$ $\quad l_{FCC} = r\sqrt{8}$

$r_{cub} = 0.732R$ $\quad r_{T_d} = 0.225R$

$r_{trig} = 0.155R$ $\quad r_{O_h} = 0.414R$

$$\rho = \frac{NM}{VN_A}$$

$$\lambda = \frac{h}{mv}$$

$$\bar{u}_m = \left(\frac{8RT}{\pi M}\right)^{1/2} \qquad \bar{u}_{mp} = \left(\frac{2RT}{M}\right)^{1/2}$$

Fundamental Constants

$N_A = 6.022 \text{ X } 10^{23}$ mol^{-1}
$g = 9.807$ m s^{-2}
$R_H = 2.179 \text{ X } 10^{-18}$ J
$c = 2.998 \text{ X } 10^{8}$ m s^{-1}
$e^- = -1.602 \text{ X } 10^{-19}$ C
$h = 6.626 \text{ X } 10^{-34}$ J s
$R = 8.314$ J mol^{-1} K^{-1} = 0.08206 L atm K^{-1} mol^{-1}
$m_e = 9.109 \text{ X } 10^{-31}$ kg
$m_p = 1.673 \text{ X } 10^{-27}$ kg
$k = 1.381 \text{ X } 10^{-23}$ J K^{-1}

Conversion Factors

1 atm = 101.325 kPa (exact)
1 atm = 1.01325 bar (exact)
1 kg = 2.2046226 lbs

Useful Data

$S_{H_2O} = 4.184$ J g^{-1} °C^{-1}
$S_{ice} = 2.01$ J g^{-1} °C^{-1}
$\Delta H_V^0(H_2O) = 44.0$ kJ mol^{-1}
$\Delta H_{fus}^0(H_2O) = 6.01$ kJ mol^{-1}

$\rho_{Hg}(l) = 13.6\ g\ cm^{-3}$

$\rho_{H_2O}(l) = 1.00\ g\ cm^{-3}$

hydrogen 1 **H** 1.0079																		helium 2 **He** 4.0026
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.0122												boron 5 **B** 10.811	carbon 6 **C** 12.011	nitrogen 7 **N** 14.007	oxygen 8 **O** 15.999	fluorine 9 **F** 18.998	neon 10 **Ne** 20.180
sodium 11 **Na** 22.990	magnesium 12 **Mg** 24.305												aluminium 13 **Al** 26.982	silicon 14 **Si** 28.086	phosphorus 15 **P** 30.974	sulfur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.948
potassium 19 **K** 39.098	calcium 20 **Ca** 40.078		scandium 21 **Sc** 44.956	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.942	chromium 24 **Cr** 51.996	manganese 25 **Mn** 54.938	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.933	nickel 28 **Ni** 58.693	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.39	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.61	arsenic 33 **As** 74.922	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.80
rubidium 37 **Rb** 85.468	strontium 38 **Sr** 87.62		yttrium 39 **Y** 88.906	zirconium 40 **Zr** 91.224	niobium 41 **Nb** 92.906	molybdenum 42 **Mo** 95.94	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.91	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.87	cadmium 48 **Cd** 112.41	indium 49 **In** 114.82	tin 50 **Sn** 118.71	antimony 51 **Sb** 121.76	tellurium 52 **Te** 127.60	iodine 53 **I** 126.90	xenon 54 **Xe** 131.29
caesium 55 **Cs** 132.91	barium 56 **Ba** 137.33	57-70 *	lutetium 71 **Lu** 174.97	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.95	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.21	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.22	platinum 78 **Pt** 195.08	gold 79 **Au** 196.97	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.38	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.98	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	89-102 * *	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [261]	dubnium 105 **Db** [262]	seaborgium 106 **Sg** [266]	bohrium 107 **Bh** [264]	hassium 108 **Hs** [269]	meitnerium 109 **Mt** [268]	ununnilium 110 **Uun** [271]	unununium 111 **Uuu** [272]	ununbium 112 **Uub** [277]		ununquadium 114 **Uuq** [289]				

*Lanthanide series	lanthanum 57 **La** 138.91	cerium 58 **Ce** 140.12	praseodymium 59 **Pr** 140.91	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.96	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.93	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.93	erbium 68 **Er** 167.26	thulium 69 **Tm** 168.93	ytterbium 70 **Yb** 173.04
* *Actinide series	actinium 89 **Ac** [227]	thorium 90 **Th** 232.04	protactinium 91 **Pa** 231.04	uranium 92 **U** 238.03	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]

Name (in ink) ____

Student Number (in ink) ______________________________________

Fall 2014 SC/CHEM 1000 A - Quiz #2

October 23, 2014

Calculators are permitted.
Answer all questions on this paper; **additional paper for rough work is not permitted. You may carry out your work in pencil if you wish, but please write your final answer in ink.**

Assume all gases to be ideal unless otherwise noted

Time Allowed: 50 minutes **Total Marks = 30**

1. **(6 pts)** For each of the electronic configurations below for neutral atoms, please indicate whether the configuration is a ground state, excited state, or forbidden state.

a. $1s^22s^22p^63s^13d^6$ EXCITED

b. $1s^22s^22p^4$ GROUND

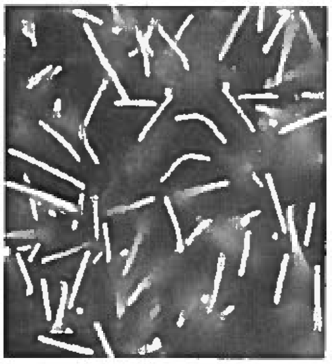
c. $1s^22s^12p^5$ EXCITED

d. $1s^22s^22p^63s^23d^{11}3p^2$ FORBIDDEN

e. $1s^22s^22p^53s^1$ EXCITED

f. $[Ar]5s^2$ EXCITED

2. **(5 pts)** To the right is a photo of methanopyrus kandleri, a microscopic bacterium that converts carbon dioxide and hydrogen to methane by the following overall reaction

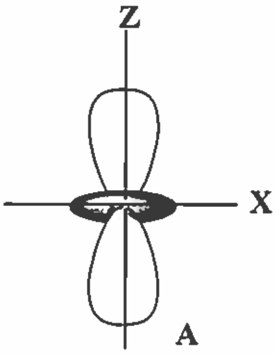


$$4\ H_2(g) + CO_2(g) \rightarrow CH_4(g) + 2\ H_2O(l)$$

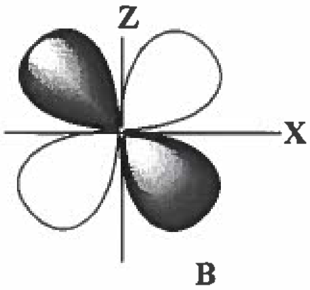
Using the tables of standard enthalpies of formation provided in this test, calculate the enthalpy of this overall reaction under standard conditions.

$\Delta H^\circ_r = -252.9$ kJ

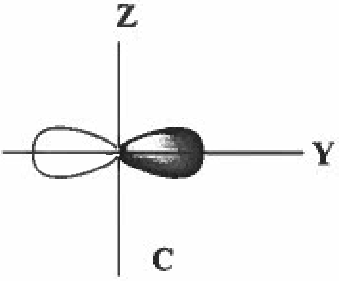
3. **(5 pts)** Identify the following atomic orbitals (assume all of them have n = 3).



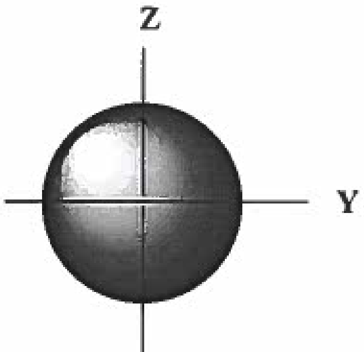
A



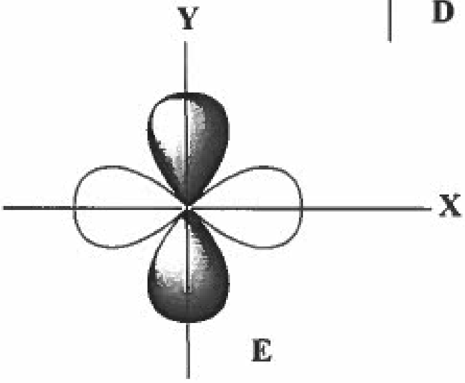
B



C



D



E

(A) $3dz^2$

(B) $3dxz$

(C) $3py$

(D) $3s$

(E) $3dx^2-y^2$

4. Consider the following energy levels of a hypothetical atom,

E_4 = -1.0X10^{-19} J

E_3 = -5.0X10^{-19} J

E_2 = -10.0X10^{-19} J

E_1 = -15.0X10^{-19} J

(a) **(3 pts)** What is the wavelength of the photon needed to excite an electron from E_1 to E_4?

λ = 142nm

(b) **(1 pt)** Is the photon in your answer to part (a) in the infrared, visible, or ultraviolet region of the electromagnetic spectrum?

UV

5. **(6 pts)** Write out the electronic configurations in *spdf* notation for the following species. You can express the core electrons in the standard noble gas notation.

(a) Fe^{2+} $[Ar]3d^6$

(b) Ni $[Ar]3d^8 4s^2$

(c) Pd $[Kr]4d^8 5s^2$

(d) Ge^{2+} $[Ar]3d^{10} 4s^2$

(e) Sb $[Kr]4d^{10} 5s^2 5p^3$

(f) Ir^{4+} $[Xe]4f^{14} 5d^5$

6. **(4 pts)** What is the de Broglie wavelength (in meters) of a 12.4 g hummingbird flying at 194 km h^{-1}?

$\lambda = 9.92 \times 10^{-34}$ m

Inorganic Substances

	ΔH_f°, kJ mol^{-1}	ΔG_f°, kJ mol^{-1}	S°, J mol^{-1} K^{-1}
Cadmium			
$Cd(s)$	0	0	51.76
$Cd^{2+}(aq)$	−75.90	−77.61	−73.2
$CdCl_2(s)$	−391.5	−343.9	115.3
$CdO(s)$	−258.2	−228.4	54.8
Calcium			
$Ca(s)$	0	0	41.42
$Ca^{2+}(aq)$	−542.8	−553.6	−53.1
$CaCO_3(s)$	−1207	−1129	92.9
$CaCl_2(s)$	−795.8	−748.1	104.6
$CaF_2(s)$	−1220.	−1167	68.87
$CaH_2(s)$	−186.2	−147.2	42
$Ca(NO_3)_2(s)$	−938.4	−743.1	193.3
$CaO(s)$	−635.1	−604.0	39.75
$Ca(OH)_2(s)$	−986.1	−898.5	83.39
$Ca_3(PO_4)_2(s)$	−4121	−3885	236.0
$CaSO_4(s)$	−1434	−1322	106.7
Carbon (See also the table of organic substances.)			
$C(g)$	716.7	671.3	158.0
$C(diamond)$	1.90	2.90	2.38
$C(graphite)$	0	0	5.74
$CCl_4(g)$	−102.9	−60.59	309.9
$CCl_4(l)$	−135.4	−65.21	216.4
$C_2N_2(g)$	309.0	297.4	241.9
$CO(g)$	−110.5	−137.2	197.7
$CO_2(g)$	−393.5	−394.4	213.7
$CO_3^{2-}(aq)$	−677.1	−527.8	−56.9
$C_3O_2(g)$	−93.72	−109.8	276.5
$C_3O_2(l)$	−117.3	−105.0	181.1
$COCl_2(g)$	−218.8	−204.6	283.5
$COS(g)$	−142.1	−169.3	231.6
$CS_2(l)$	89.70	65.27	151.3
Chlorine			
$Cl(g)$	121.7	105.7	165.2
$Cl^-(aq)$	−167.2	−131.2	56.5
$Cl_2(g)$	0	0	223.1
$ClF_3(g)$	−163.2	−123.0	281.6
$ClO_2(g)$	102.5	120.5	256.8
$Cl_2O(g)$	80.3	97.9	266.2
Chromium			
$Cr(s)$	0	0	23.77
$[Cr(H_2O)_6]^{3+}(aq)$	−1999	—	—
$Cr_2O_3(s)$	−1140.	−1058	81.2
$CrO_4^{2-}(aq)$	−881.2	−727.8	50.21
$Cr_2O_7^{2-}(aq)$	−1490.	−1301	261.9
Cobalt			
$Co(s)$	0	0	30.04
$CoO(s)$	−237.9	−214.2	52.97
$Co(OH)_2$(pink solid)	−539.7	−454.3	79
Copper			
$Cu(s)$	0	0	33.15
$Cu^{2+}(aq)$	64.77	65.49	−99.6
$CuCO_3 \cdot Cu(OH)_2(s)$	−1051	−893.6	186.2

Organic Substances

	Name	ΔH_f°, kJ mol^{-1}	ΔG_f°, kJ mol^{-1}	S°, J mol^{-1} K^{-1}
$CH_4(g)$	Methane(g)	−74.81	−50.72	186.3
$C_2H_2(g)$	Acetylene(g)	226.7	209.2	200.9
$C_2H_4(g)$	Ethylene(g)	52.26	68.15	219.6
$C_2H_6(g)$	Ethane(g)	−84.68	−32.82	229.6
$C_3H_8(g)$	Propane(g)	−103.8	−23.3	270.3
$C_4H_{10}(g)$	Butane(g)	−125.6	−17.1	310.2
$C_6H_6(g)$	Benzene(g)	82.6	129.8	269.3
$C_6H_6(l)$	Benzene(l)	49.0	124.5	173.4
$C_6H_{12}(g)$	Cyclohexane(g)	−123.4	32.0	298.4
$C_6H_{12}(l)$	Cyclohexane(l)	−156.4	26.9	204.4
$C_{10}H_8(g)$	Naphthalene(g)	150.6	224.2	333.2
$C_{10}H_8(s)$	Naphthalene(s)	77.9	201.7	167.5
$CH_2O(g)$	Formaldehyde(g)	−108.6	−102.5	218.8
$CH_3CHO(g)$	Acetaldehyde(g)	−166.2	−128.9	250.3
$CH_3CHO(l)$	Acetaldehyde(l)	−192.3	−128.1	160.2
$CH_3OH(g)$	Methanol(g)	−200.7	−162.0	239.8
$CH_3OH(l)$	Methanol(l)	−238.7	−166.3	126.8
$CH_3CH_2OH(g)$	Ethanol(g)	−235.1	−168.5	282.7
$CH_3CH_2OH(l)$	Ethanol(l)	−277.7	−174.8	160.7
$C_6H_5OH(s)$	Phenol(s)	−165.1	−50.4	144.0
$(CH_3)_2CO(g)$	Acetone(g)	−216.6	−153.0	295.0
$(CH_3)_2CO(l)$	Acetone(l)	−247.6	−155.6	200.5
$CH_3COOH(g)$	Acetic acid(g)	−432.3	−374.0	282.5
$CH_3COOH(l)$	Acetic acid(l)	−484.5	−389.9	159.8
$CH_3COOH(aq)$	Acetic acid(aq)	−485.8	−396.5	178.7
$C_6H_5COOH(s)$	Benzoic acid(s)	−385.2	−245.3	167.6
$CH_3NH_2(g)$	Methylamine(g)	−22.97	32.16	243.4
$C_6H_5NH_2(g)$	Aniline(g)	86.86	166.8	319.3
$C_6H_5NH_2(l)$	Aniline(l)	31.6	149.2	191.3

Inorganic Substances	ΔH_f°, kJ mol^{-1}	ΔG_f°, kJ mol^{-1}	S°, J mol^{-1} K^{-1}
Copper			
$CuO(s)$	−157.3	−129.7	42.63
$Cu(OH)_2(s)$	−449.8	—	—
$CuSO_4 \cdot 5\,H_2O(s)$	−2280.	−1880.	300.4
Fluorine			
$F(g)$	78.99	61.91	158.8
$F^-(aq)$	−332.6	−278.8	−13.8
$F_2(g)$	0	0	202.8
Helium			
$He(g)$	0	0	126.2
Hydrogen			
$H(g)$	218.0	203.2	114.7
$H^+(aq)$	0	0	0
$H_2(g)$	0	0	130.7
$HBr(g)$	−36.40	−53.45	198.7
$HCl(g)$	−92.31	−95.30	186.9
$HCl(aq)$	−167.2	−131.2	56.5
$HClO_2(aq)$	−51.9	5.9	188.3
$HCN(g)$	135.1	124.7	201.8
$HF(g)$	−271.1	−273.2	173.8
$HI(g)$	26.48	1.70	206.6
$HNO_3(l)$	−174.1	−80.71	155.6
$HNO_3(aq)$	−207.4	−111.3	146.4
$H_2O(g)$	−241.8	−228.6	188.8
$H_2O(l)$	−285.8	−237.1	69.91
$H_2O_2(g)$	−136.3	−105.6	232.7
$H_2O_2(l)$	−187.8	−120.4	109.6
$H_2S(g)$	−20.63	−33.56	205.8
$H_2SO_4(l)$	−814.0	−690.0	156.9
$H_2SO_4(aq)$	−909.3	−744.5	20.1
Iodine			
$I(g)$	106.8	70.25	180.8
$I^-(aq)$	−55.19	−51.57	111.3
$I_2(g)$	62.44	19.33	260.7
$I_2(s)$	0	0	116.1
$IBr(g)$	40.84	3.69	258.8
$ICl(g)$	17.78	−5.46	247.6
$ICl(l)$	−23.89	−13.58	135.1
Iron			
$Fe(s)$	0	0	27.28
$Fe^{2+}(aq)$	−89.1	−78.90	−137.7
$Fe^{3+}(aq)$	−48.5	−4.7	−315.9
$FeCO_3(s)$	−740.6	−666.7	92.9
$FeCl_3(s)$	−399.5	−334.0	−142.3
$FeO(s)$	−272.0	—	—
$Fe_2O_3(s)$	−824.2	−742.2	87.40
$Fe_3O_4(s)$	−1118	−1015	146.4
$Fe(OH)_3(s)$	−823.0	−696.5	106.7
Lead			
$Pb(s)$	0	0	64.81
$Pb^{2+}(aq)$	−1.7	−24.43	10.5
$PbI_2(s)$	−175.5	−173.6	174.9

Equations

$PV = nRT$

$\Delta U = q + w$

$H = U + PV$

$w = -\int PdV$

$U = \frac{3}{2}nRT$

$\Delta x \Delta p \geq \frac{h}{4\pi}$

$E = mc^2$

$E = h\nu$

$\bar{u}_m = \left(\frac{8RT}{\pi M}\right)^{1/2}$

$Z_W = \frac{N}{4V}\left(\frac{8RT}{\pi M}\right)^{1/2}$

$\overline{u_{RMS}} = \left(\frac{3RT}{M}\right)^{1/2}$

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

$\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_V}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

$q_A = G_A - N_A - \sum_B \frac{\chi_A}{\chi_A + \chi_B} N_{AB}$

$\bar{u}_{mp} = \left(\frac{2RT}{M}\right)^{1/2}$

$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$

$4r_{BCC} = l\sqrt{3}$ $\quad l_{FCC} = r\sqrt{8}$

$r_{cub} = 0.732R$ $\quad r_{T_d} = 0.225R$

$r_{trig} = 0.155R$ $\quad r_{O_h} = 0.414R$

$\rho = \frac{NM}{VN_A}$

$\lambda = \frac{h}{mv}$

Fundamental Constants

$N_A = 6.022 \text{ X } 10^{23}\ \text{mol}^{-1}$
$g = 9.807\ \text{m s}^{-2}$
$R_H = 2.179 \text{ X } 10^{-18}\ \text{J}$
$c = 2.998 \text{ X } 10^{8}\ \text{m s}^{-1}$
$e^- = -1.602 \text{ X } 10^{-19}\ \text{C}$
$h = 6.626 \text{ X } 10^{-34}\ \text{J s}$
$R = 8.314\ \text{J mol}^{-1}\ \text{K}^{-1} = 0.08206\ \text{L atm K}^{-1}\ \text{mol}^{-1}$
$m_e = 9.109 \text{ X } 10^{-31}\ \text{kg}$
$m_p = 1.673 \text{ X } 10^{-27}\ \text{kg}$
$k = 1.381 \text{ X } 10^{-23}\ \text{J K}^{-1}$

Conversion Factors

1 atm = 101.325 kPa (exact)
1 atm = 1.01325 bar (exact)
1 kg = 2.2046226 lbs

Useful Data

$S_{H_2O} = 4.184\ \text{J g}^{-1}\ {}^\circ\text{C}^{-1}$
$S_{ice} = 2.01\ \text{J g}^{-1}\ {}^\circ\text{C}^{-1}$
$\Delta H_V^0(H_2O) = 44.0\ \text{kJ mol}^{-1}$
$\Delta H_{fus}^0(H_2O) = 6.01\ \text{kJ mol}^{-1}$

$\rho_{Hg}(l) = 13.6\ g\ cm^{-3}$

$\rho_{H_2O}(l) = 1.00\ g\ cm^{-3}$

hydrogen 1 **H** 1.0079																		helium 2 **He** 4.0026
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.0122												boron 5 **B** 10.811	carbon 6 **C** 12.011	nitrogen 7 **N** 14.007	oxygen 8 **O** 15.999	fluorine 9 **F** 18.998	neon 10 **Ne** 20.180
sodium 11 **Na** 22.990	magnesium 12 **Mg** 24.305												aluminum 13 **Al** 26.982	silicon 14 **Si** 28.086	phosphorus 15 **P** 30.974	sulfur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.948
potassium 19 **K** 39.098	calcium 20 **Ca** 40.078		scandium 21 **Sc** 44.956	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.942	chromium 24 **Cr** 51.996	manganese 25 **Mn** 54.938	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.933	nickel 28 **Ni** 58.693	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.39	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.61	arsenic 33 **As** 74.922	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.80
rubidium 37 **Rb** 85.468	strontium 38 **Sr** 87.62		yttrium 39 **Y** 88.906	zirconium 40 **Zr** 91.224	niobium 41 **Nb** 92.906	molybdenum 42 **Mo** 95.94	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.91	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.87	cadmium 48 **Cd** 112.41	indium 49 **In** 114.82	tin 50 **Sn** 118.71	antimony 51 **Sb** 121.76	tellurium 52 **Te** 127.60	iodine 53 **I** 126.90	xenon 54 **Xe** 131.29
caesium 55 **Cs** 132.91	barium 56 **Ba** 137.33	57-70 *	lutetium 71 **Lu** 174.97	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.95	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.21	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.22	platinum 78 **Pt** 195.08	gold 79 **Au** 196.97	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.38	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.98	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	89-102 * *	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [261]	dubnium 105 **Db** [262]	seaborgium 106 **Sg** [266]	bohrium 107 **Bh** [264]	hassium 108 **Hs** [269]	meitnerium 109 **Mt** [268]	ununnilium 110 **Uun** [271]	unununium 111 **Uuu** [272]	ununbium 112 **Uub** [277]		ununquadium 114 **Uuq** [289]				

*Lanthanide series	lanthanum 57 **La** 138.91	cerium 58 **Ce** 140.12	praseodymium 59 **Pr** 140.91	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.96	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.93	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.93	erbium 68 **Er** 167.26	thulium 69 **Tm** 168.93	ytterbium 70 **Yb** 173.04
* *Actinide series	actinium 89 **Ac** [227]	thorium 90 **Th** 232.04	protactinium 91 **Pa** 231.04	uranium 92 **U** 238.03	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]

Name (**in ink**) ______________________________

Student Number (**in ink**) ______________________________

Fall 2014 SC/CHEM 1000 A - Quiz #3

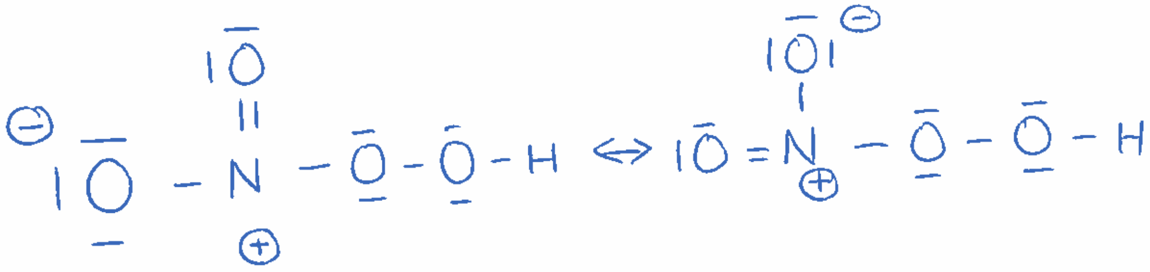
November 20, 2014

Calculators are permitted.
Answer all questions on this paper; **additional paper for rough work is not permitted. You may carry out your work in pencil if you wish, but please write your final answer in ink.**

Assume all gases to be ideal unless otherwise noted

Time Allowed: 50 minutes **Total Marks = 30**

1. **(5 pts)** Peroxynitric acid, HNO_4, is a powerful oxidizing agent formed from the products of air breathing engines, as in automobiles, and is believed to be involved in the production of ozone in the lower atmosphere – a major air pollutant. Draw the most plausible Lewis structure for HNO_4, making sure to indicate all lone pairs and formal charges on each atom. If there are any resonance structures, you must draw them too.

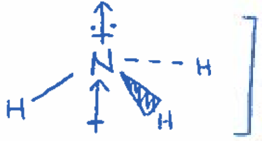


2. **(1 pt each)** BRIEFLY explain each of the following.

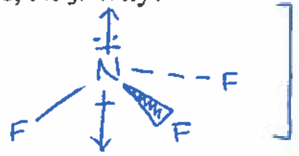
(a) Formaldehyde, $H_2C{=}O$, is a common, stable gas, yet the silicon analogue, $H_2Si{=}O$, does not exist and cannot be made. Why?

Si cannot form double bonds.

(b) An N-F bond is much more polar than an N-H bond, yet ammonia, NH_3, has a much greater dipole moment than nitrogen trifluoride, NF_3. Why?



Dipole Vector Add



Dipole Vector subtract

(c) Tetrachlorosilane, $SiCl_4$, has a dipole moment of zero, even though the Si-Cl bond is highly polar. Why?

T_d geometry ⇒ All dipole vectors cancelled

(d) VSEPR theory incorrectly predicts the structure of methyl radical, CH_3. Why is this not surprising?

VSEPR is based on electron <u>PAIR</u> repulsions

CH_3 has an unpaired e^-

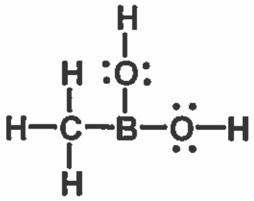
(e) Hypervalence is common in elements having principle quantum number >2, but never found in first-row atoms such as carbon, nitrogen and oxygen. Why not?

First-row atoms do not have accessible d-orbitals

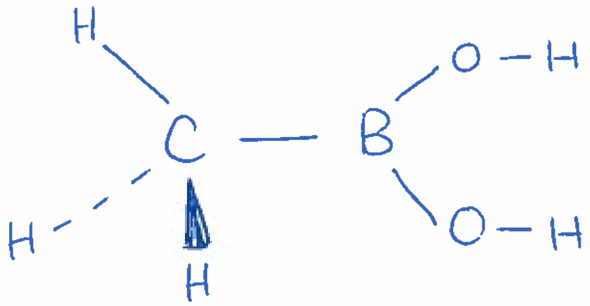
(f) Hypervalence in elements such as sulfur and phosphorus is usually observed when three or more highly electronegative elements are attached (such as oxygen or fluorine). Why are attached electronegative atoms necessary for hypervalence?

To lower the d-orbital energies into the bonding region.

3. Methylboronic acid, $CH_3B(OH)_2$, is a reagent used extensively in the pharmaceutical industry. The Lewis structure for $CH_3B(OH)_2$ is shown below.



(a) **(3 pts)** Using VSEPR theory, draw the 3-dimensional shape of the $CH_3B(OH)_2$ molecule, making sure to clearly express the 3-dimensionality using traditional dotted and wedged lines.



(b) **(1/2 pt each)** Referring to your drawing, please indicate (to within ±5 degrees) the following bond angles

O-B-O	120°
H-O-B	109°
H-C-H	109°

(c) **(1/2 pt each)** Referring to the Lewis diagram for $CH_3B(OH)_2$, please indicate the atomic orbital hybridization for

B	sp^2
O	sp^3
C	sp^3

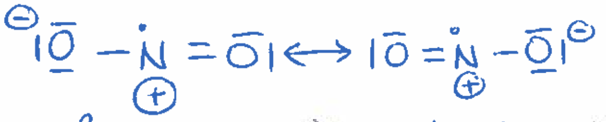
4. (a) **(4 pts)** Using the table of bond energies included in this quiz, estimate the ΔH_f^0 for nitrogen dioxide (NO_2) gas, via the following equation,

$$\frac{1}{2} N_2(g) + O_2(g) \rightarrow NO_2(g)$$

In estimating the enthalpy you don't need to include the Δ(PV) term, as it makes only a negligible contribution. The Lewis structures for each species (with any resonance structures omitted) are shown below.

$\Delta H_f^{\circ}(EST) = +159\ kJ\,mol^{-1}$

(b) **(2 pts)** If you did part (a) correctly, the experimental enthalpy of formation for $NO_2(g)$ is WAY different from your estimate (by more than 120 kJ mol^{-1}). Without doing any further calculations, explain (briefly) why the estimate based on bond energies is so inaccurate.

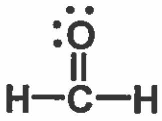
Because NO_2 has a resonance structure  The stabilization due to Resonance is not considered in the estimate

(c) **(1 pt)** Based on your explanation in part (b), indicate whether you expect the estimated ΔH_f^0 to be greater than, or less than, the experimental ΔH_f^0.

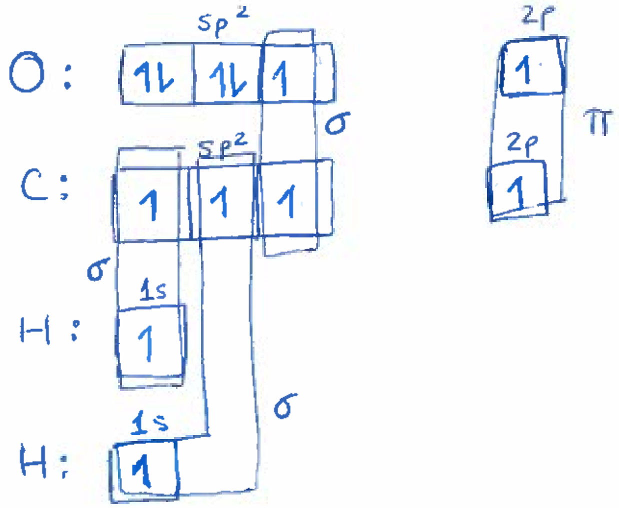
I'd expect $\Delta H_f^{\circ}(EST) > \Delta H_f^{\circ}(EXP)$

[and it is. $\Delta H_f^{\circ}(EXP) = +33\ kJ\,mol^{-1}$]

5. Formaldehyde has the Lewis structure



(a) **(5 pts)** Please draw the valence-bond diagram for formaldehyde below, making sure to label all hybrid orbitals and any unhybridized atomic orbitals. Use the conventional half-arrow symbols for electrons, and show which electrons are shared to form the bonds. You must also label each bond as σ or π.



(b) **(1 pt)** Referring to your Lewis structure, what is the bond order between carbon and oxygen?

2

Equations

$PV = nRT$

$\Delta U = q + w$

$H = U + PV$

$w = -\int PdV$

$U = \frac{3}{2}nRT$

$\Delta x \Delta p \geq \frac{h}{4\pi}$

$E = mc^2$

$E = h\nu$

$$Z_W = \frac{N}{4V}\left(\frac{8RT}{\pi M}\right)^{1/2}$$

$$\overline{u_{RMS}} = \left(\frac{3RT}{M}\right)^{1/2}$$

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

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_V}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$q_A = G_A - N_A - \sum_B \frac{\chi_A}{\chi_A + \chi_B} N_{AB}$$

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

$4r_{BCC} = l\sqrt{3}$ $\quad$ $l_{FCC} = r\sqrt{8}$

$r_{cub} = 0.732R$ $\quad$ $r_{T_d} = 0.225R$

$r_{trig} = 0.155R$ $\quad$ $r_{O_h} = 0.414R$

$$\rho = \frac{NM}{VN_A}$$

$$\lambda = \frac{h}{mv}$$

$$\bar{u}_m = \left(\frac{8RT}{\pi M}\right)^{1/2}$$

$$\bar{u}_{mp} = \left(\frac{2RT}{M}\right)^{1/2}$$

Fundamental Constants

$N_A = 6.022 \times 10^{23}$ mol^{-1}
$g = 9.807$ m s^{-2}
$R_H = 2.179 \times 10^{-18}$ J
$c = 2.998 \times 10^{8}$ m s^{-1}
$e^- = -1.602 \times 10^{-19}$ C
$h = 6.626 \times 10^{-34}$ J s
$R = 8.314$ J mol^{-1} K^{-1} = 0.08206 L atm K^{-1} mol^{-1}
$m_e = 9.109 \times 10^{-31}$ kg
$m_p = 1.673 \times 10^{-27}$ kg
$k = 1.381 \times 10^{-23}$ J K^{-1}

Conversion Factors

1 atm = 101.325 kPa (exact)
1 atm = 1.01325 bar (exact)
1 kg = 2.2046226 lbs

Useful Data

$S_{H_2O} = 4.184$ J g^{-1} °C^{-1}
$S_{ice} = 2.01$ J g^{-1} °C^{-1}
ΔH_V^0 (H_2O) = 44.0 kJ mol^{-1}
ΔH_{fus}^0 (H_2O) = 6.01 kJ mol^{-1}

$\rho_{Hg}(l) = 13.6\ g\ cm^{-3}$

$\rho_{H_2O}(l) = 1.00\ g\ cm^{-3}$

TABLE 10.3 Some Average Bond Energies[a]

Bond	Bond Energy, kJ/mol	Bond	Bond Energy kJ/mol	Bond	Bond Energy kJ/mol
H—H	436	C—C	347	N—N	163
H—C	414	C=C	611	N=N	418
H—N	389	C≡C	837	N≡N	946
H—O	464	C—N	305	N—O	222
H—S	368	C=N	615	N=O	590
H—F	565	C≡N	891	O—O	142
H—Cl	431	C—O	360	O=O	498
H—Br	364	C=O	736[b]	F—F	159
H—I	297	C—Cl	339	Cl—Cl	243
				Br—Br	193
				I—I	151

hydrogen 1 H 1.0079																		helium 2 He 4.0026
lithium 3 Li 6.941	beryllium 4 Be 9.0122												boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305												aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078		scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80
rubidium 37 Rb 85.468	strontium 38 Sr 87.62		yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 *	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 * *	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	ununnilium 110 Uun [271]	unununium 111 Uuu [272]	ununbium 112 Uub [277]		ununquadium 114 Uuq [289]				

*Lanthanide series	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
* * Actinide series	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]

YORK UNIVERSITY

Fall 2014 SC/CHEM 1000 3.0B

Quiz #1

Student number (in ink) ______________

Student name (in ink) ______________

Question#	1 (8)	2 (3)	3 (3)	4 (5)	5 (5)	6 (6)
Mark						

Total: _______

Non-programmable calculators are permitted

Additional paper for rough work is not permitted

Answer all questions in the space provided, additional pages will not be marked

All final answers must be written in ink

Important: The last page of this quiz is a reference page that may be removed

1. [8] The electrolysis of water (H_2O) produces hydrogen (H_2) and oxygen (O_2). In a laboratory experiment, 0.84 g of water is electrolyzed and 3.2 L of gas are collected over water at a pressure of 735 Torr and 25.0 °C. What is the vapor pressure (in Torr) of water at 25.0 °C?

$P_{water} = 328$ TORR

2. [3] The pressure of 2 moles of CO_2 in a 3 L container at a temperature of 30 °C is 14.72 atm. Calculate the compressibility factor and explain why CO_2 is not behaving as an ideal gas under these conditions.

$Z = 0.8881$

$Z < 1$, Intermolecular forces dominate

deviation (from $Z = 1$)

3. [3] What are the units of the van der Waals "a" and "b" factors?

$$a = \frac{atm \cdot L^2}{mol^2} \qquad b = \frac{L}{mol}$$

4. [5] When a gas container is attached to a mercury manometer, the difference in the height of the columns becomes 15.0 cm with the column attached to the gas container having the lower level. What is the pressure of the gas if the barometric pressure is 735.6 mmHg and the temperature of the gas is 25.0 °C?

$P_{gas} = 886$ mmHg

What will the pressure of the gas be if the temperature of the gas is lowered to 13.0 °C? What will the difference in the mercury level height be in the manometer? Will the column attached to the gas container have a lower or higher level? Assume that the volume of the container of gas is much larger than the volume of the tube used for the manometer.

$P_2 = 850$ mmHg

$\Delta P = 114$ mm or 11 cm

$P_{gas} > P_{bar}$, the column will have a lower level

5. [5] A sample of gas weighing 32.4 g occupies 36.8 L at 100 °C and exerts a pressure of 821.35 Torr. What is the molecular weight of the gas?

M = 24.9 g/mol

What will the pressure be if 20.5 g of another gas with molecular weight of 28 g/mol is added to the same container?

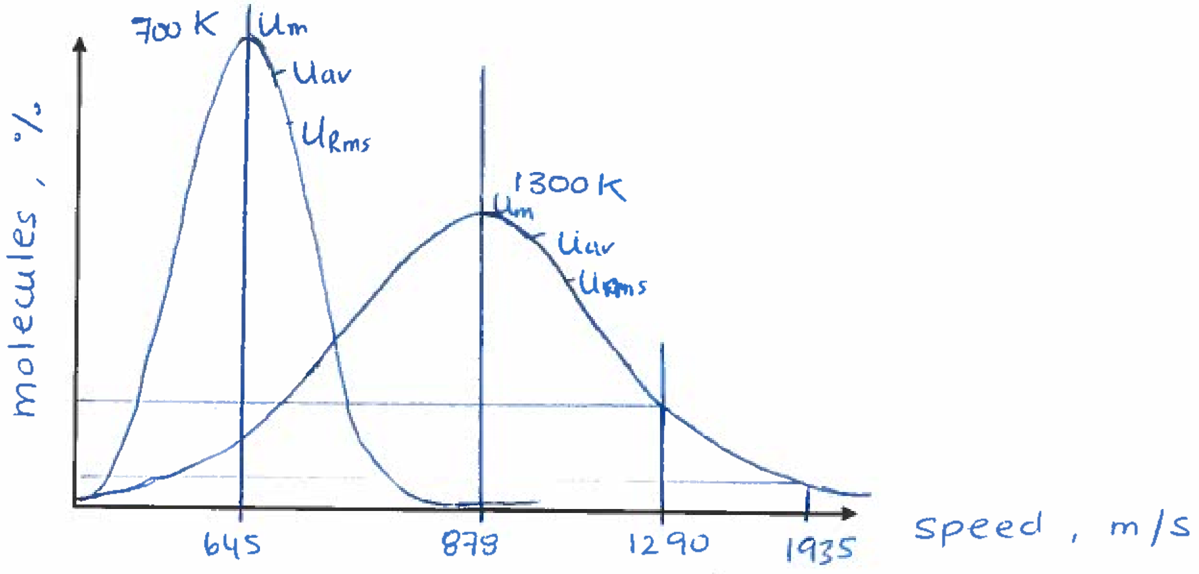
P = 1.7 atm

6. [6] Calculate the most probable speeds for carbon monoxide molecules (CO) at 700 K and 1300 K.

@700K → $U_{mps} = 645 \frac{m}{s}$

@1300K → $U_{mps} = 878 \frac{m}{s}$

Sketch the Maxwell-Boltzmann speed distribution for CO at 700 K and 1300 K (make sure to label axes). Mark the positions of the root mean square speed, the most probable speed, and the average speed. Show how you would determine the fractional number of CO molecules that have a speed that is 2 and 3 times greater than the most probable speed and label on the graph.



700 K	1300
1 Um = 645 m/s	= 878 m/s
2 Um = 1290 m/s	= 1756 m/s
3 Um = 1935 m/s	= 2634 m/s

Reference Page Quiz 1

R=8.314472 J K^{-1} mol^{-1}=0.0820574 L atm K^{-1} mol^{-1}

k=1.38066 x 10^{-23} J K^{-1}

g=9.80665 m s^{-2}

1.0 atm=1.013 x 10^5 Pa= 760 Torr (mm Hg)

N_A= 6.02214199 x 10^{23} molecules mol^{-1}

0°C=273.15 K

π=3.14159

density of water = 0.99707 g/mL (at 25°C)

density of mercury = 13.5340 g/mL (at 25°C)

1 mL=1 cm^3

$$u_m = \sqrt{\frac{2RT}{M}}$$

$$u_{av} = \sqrt{\frac{8RT}{\pi M}}$$

$$u_{rms} = \sqrt{\frac{3RT}{M}}$$

$$Z_w = \frac{1}{4}\frac{N}{V}u_{av}$$

$$Z_A = \sqrt{2}\pi d^2 u_{av}\frac{N}{V}$$

$$Z_{AA} = \frac{1}{\sqrt{2}}\pi d^2 u_{av}(\frac{N}{V})^2$$

$$\lambda = \frac{1}{\sqrt{2}\pi d^2}\frac{V}{N}$$

$$(P + \frac{an^2}{V^2})(V - nb) = nRT$$

Atomic Weights (g/mol)

H	1.00794	He	4.00260	N	14.0067
O	15.9994	C	12.0107	Ar	39.948

YORK UNIVERSITY

Fall 2014 SC/CHEM 1000 3.0B

Quiz #2

Student number (in ink) ________________

Student name (in ink) __________________

Question#	**1 (9)**	**2 (8)**	**3 (2)**	**4 (6)**	**5 (2)**	**6 (3)**
Mark						

Total: ________

Non-programmable calculators are permitted

Additional paper for rough work is not permitted

Answer all questions in the space provided, additional pages will not be marked

<u>All final answers must be written in ink</u>

<u>Important:</u> The last page of this quiz is a reference page that may be removed

1. [9] The combustion of methanol is shown by the following **unbalanced** equation:

$$2\,CH_3OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 4H_2O_{(g)}$$

i) Given the following data:

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} + 393\text{ kJ}$$

$$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O + 242\text{ kJ}$$

$$C_{(s)} + 2H_{2\,(g)} + \frac{1}{2}O_2 \rightarrow CH_3OH_{(l)} + 638\text{ kJ}$$

a. Determine the heat of the methanol combustion reaction

478 kJ

b. Determine the molar heat of combustion of methanol

$x = 239\ \frac{kJ}{mol}$

ii) What mass of water could be heated from 20.0 °C to 35.0 °C by burning of 2.57 mol of methanol? (C_{H2O}=4.184 kJ/(kg°C)

m= 9.79 kg

2. [8] Write out the chemical equation whose ΔH represents the standard heat of formation of acetylene (C_2H_2).

$$2C + H_2 \rightarrow C_2H_2$$

Acetylene gas burns in air to produce carbon dioxide and water vapor. The heat of combustion of acetylene is -1300 kJ/mol. Given the following values of H_f^0 :

$\Delta H_f^0(CO_{2(g)})$=-393.5 kJ/mol

$\Delta H_f^0(H_2O_{(g)})$=-241.8 kJ/mol

a) What is the standard heat of formation of acetylene?

$$\Delta H_f^{\circ} (C_2H_2) = 271.2 \text{ kJ/mol}$$

b) If this reaction produced liquid water, would the calculated heat of formation be larger or smaller? Explain.

It would be smaller, the formation of the gas phase, water is exothermic, but some E is used to convert from $H_2O(\ell) \rightarrow H_2O(g)$

$\Delta H_f^{\circ}(H_2O(\ell))$ would be smaller than $\Delta H_f^{\circ}(H_2O(g))$

3. [2] Determine the radius and energy of an electron in the n=5 orbit.

R = 1325 pm

$E = 8.176 \cdot 10^{-20} J$

4. [6] Magnetite is an oxide of iron (Fe_3O_4). It can be further oxidized by molecular oxygen (O_2) to produce hematite (Fe_2O_3)

$$2\ Fe_3O_{4\ (s)} + \frac{1}{2}\ O_{2\ (g)} \rightarrow 3Fe_2O_{3\ (s)}$$

The standard heat of formation (ΔH_f^0) of magnetite at 25°C is -824.2 kJ/mol. The ΔH for the oxidation of magnetite to hematite is -852.8 kJ/$mol_{magnetite}$. Calculate ΔH_f^0 for hematite at 25 °C. Calculate ΔU for this oxidation reaction.

$\Delta H_f^{\circ}(Fe_2O_3) = -1118\ kJ/mol$

$\Delta U = -852.2\ kJ$

5. [2] What is the difference in energy between the two levels responsible for the emission line in the atomic spectrum of magnesium at 285.2 nm?

$E = 6.965 \times 10^{-19}\ J$

6. [3] Use the Bohr Model of the hydrogen atom to calculate the wavelength of the light emitted when an electron drops from n=7 to n=3

$\lambda = 1.003 \times 10^{-6}\ m$

or

1003 nm

Reference Page Quiz 2

$R=8.314472\ J\ K^{-1}\ mol^{-1}=0.0820574\ L\ atm\ K^{-1}\ mol^{-1}$

1.0 atm=1.013 x 10^5 Pa= 760 Torr (mm Hg)

N_A= 6.02214199 x 10^{23} molecules mol^{-1}

0°C=273.15 K

1 mL=1 cm^3

R_H=2.179 x 10^{-18}J

h= 6.626 x 10^{-34} J s

c=2.9979 x 10^8 m/s

a_0= 53 pm

nm=1 x 10^{-9} m

YORK UNIVERSITY
SC/CHEM 1000 3.0

Name: ____________________
Student Number: ____________________

Quiz # 3 – November 18th 2014

Non-programmable calculators are permitted. The provided periodic table may be removed. Please write all final answers in ink.

Time Allowed: 50 minutes

Total Marks: 30

Q1 (/4)	Q2 (/3)	Q3 (/4)	Q4 (/5)	Q5 (/6)	Q6 (/8)	TOTAL (/30)

---

1. (4 marks) ***If*** the following quantum number combinations ***can exist***, give the atomic orbitals that satisfy them:

Quantum Number Set	**Possible? (Yes/No)**	**Atomic Orbital**
n = 3, ℓ = 1	YES	3p
n = 1, ℓ = 1	NO	N/A
n = 2, ℓ = 4	NO	N/A
n = 4, ℓ = 3	YES	4f

2. (3 marks) Arrange the following isoelectronic species, F^-, Ne and Na^+ according to the following properties from smallest to largest:

a) Ionization Energy:

F^-, Ne, Na^+

b) Ionic Radius

Na^+, Ne, F^-

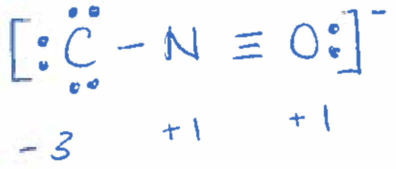
c) Electron Affinity (from least exothermic to most exothermic)

F^-, Ne, Na^+

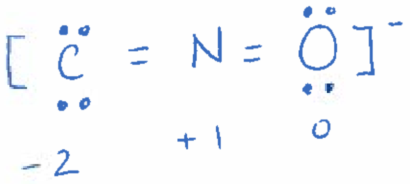
3) (4 marks) Write the electron configurations of the following and state whether they are paramagnetic or diamagnetic.

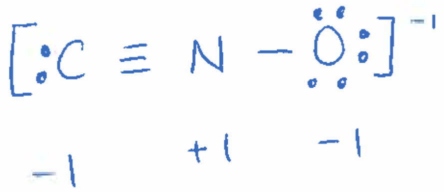
Atom/Ion	Electron Configuration	Paramagnetic or Diamagnetic?
Fe^{3+}	$[Ar]3d^5$	Paramagnetic
Co^{3+}	$[Ar]\ 3d^6$ or $[Ar]\ 4s^1 3d^5$	Paramagnetic
Cr	$[Ar]\ 3d^5 4s^1$	Paramagnetic
Zn	$[Ar]4s^2 3d^{10}$	Diamagnetic

4) (5 marks) Draw three Lewis structures for the fulminate ion (CNO⁻) ion. Using formal charges, determine which the LEAST likely structure is. Nitrogen is the central atom.

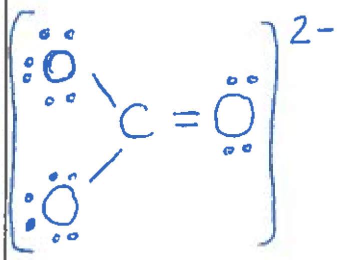
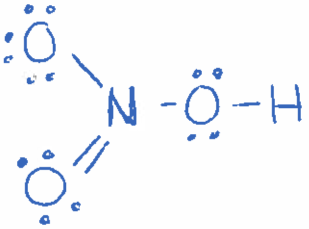
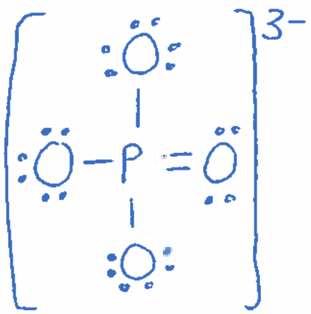


← least likely structure because it has an atom with a formal charge of -3 and positive charges on adjacent atoms.

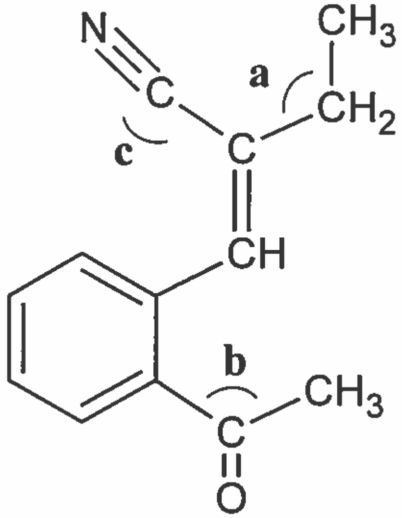




5) (6 marks) Draw the most probable Lewis structures for the following molecules and using VSEPR theory, provide the shape of the molecule and the ideal bond angle.

Molecule	**Lewis Structure**	**VSEPR Shape of Molecule Around Atom:**	**Ideal Bond Angle**
CO_3^{2-}		C: Trigonal planar	120°
$HONO_2$		N: Trigonal planar	120°
PO_4^{3-}		P: Tetrahedral	109.5°

6) Given the following molecular structure, answer the following questions:



a) (3 marks) Give the hybridization of the atoms in the table listed below

Atom	Hybridization
Carbon atom in - C≡N	sp
Carbon atom in one of the CH_3 groups	sp^3
Carbon atom in the benzene ring	sp^2

b) (3 marks) Give the geometry and approximate value of the ideal bond angles for a, b and c

Atom	Geometry	Ideal Bond Angle
a	Tetrahedral	109.5°
b	Trigonal planar	120°
c	linear	180°

c) (1 mark) How many σ bonds exist in the molecule?

28

d) (1 mark) How many π bonds exist in the molecule?

7

1 H																		2 He
3 Li	4 Be												5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg												13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca		21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr		39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57-70 *	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89-102 * *	103 Lr	104 Rf	105 Db	100 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub		114 Uuq				

* Lanthanide series	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb
* * Actinide series	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No

Name (in ink):______________________________

Student Number (in ink):______________________________

Fall 2014 SC/CHEM 1000 C - Quiz #1

September 30, 2014

Calculators are permitted. Answer all questions in the space provided on this paper; **additional paper for rough work is not permitted.**

All final answers must be written in ink!

Important Note: The last page of this quiz is a reference page that may be removed if you wish. You will need information from this sheet to answer some of the questions.

Time Allowed: 50 minutes **Total Marks = 30**

Marks

4 1. The surface of Mars has an average temperature of -47°C and an atmospheric pressure of 500.0 Pa. If a 5.00 L sample was collected in a balloon under these conditions and then returned to a laboratory on Earth at 19°C and 1.00 atm, what would be the volume of this balloon?

0.0319 L or 31.9 mL

Marks

6 2. In a mixture of helium, He, oxygen, O_2, and methane, CH_4, the partial pressures of helium and oxygen are 13.6 kPa and 29.2 kPa, respectively, and the total pressure if 95.4 kPa. The temperature of this mixture is 30°C.

a) What is the partial pressure of methane?

$P_{CH_4} = 52.6$ kPa

b) Methane undergoes a combustion reaction with oxygen to produce carbon dioxide and water. The UNBALANCED reaction is:

$$CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(l)$$

Balance the above equation.

c) If mixture described above is ignited and then cooled back to the original temperature of 30°C, what would be the final pressure inside the container. Assume the volume of the container does not change.

$P_{Total} = 66.2$ kPa

Marks

4 3. Acetylene, C_2H_2, can be produced by the following reaction:

$$CaC_2(s) + 2\ H_2O(l)) \rightarrow C_2H_2(g) + Ca(OH)_2(aq)$$

A sample of acetylene produced in this way was collected over water at 23°C. If the total gas pressure was 738 torr and the volume of gas was 523 mL, how many grams of acetylene were collected?

$m = 0.529 g$

4 4. At what temperature would helium atoms have the same average speed as nitrogen molecules, N_2, at 20°C? **Provide your answer in °C.**

$T_{He} = -231 °C$

Marks

4 5. A gaseous hydrocarbon has an empirical formula of CH_2. This gas has a density of 1.65 g L^{-1} at 27°C and 734 torr. What is the molecular formula of this gas?

C_3H_6

4 6. If it takes 15.1 s for one mole of $N_2(g)$ to escape through a small hole in a container, how long would it take for one mole of He(g) to escape under the same conditions?

effusion time for He = 5.71s

Marks

4 7. What is the mean free path for oxygen gas at 1.00 atm and 20.0°C if the collision diameter for O_2 is 3.00 X 10^{-8} cm? Express your answer in nm.

99.9 nm

Reference Page for CHEM 1000C Quiz 1

Constants:

$R = 8.314472\ JK^{-1}mol^{-1} = 0.0820574\ L\ atm\ K^{-1}\ mol^{-1}$
$1.00\ atm = 1.013 \times 10^5\ Pa = 760$ Torr (mm Hg)
$N_A = 6.02214199 \times 10^{23}\ mol^{-1}$ $1\ mL = 1\ cm^3$

$k = 1.38066 \times 10^{-23}\ J\ K^{-1}$
$g = 9.80665\ m\ s^{-2}$
0°C = 273.15 K

density of water = 0.99707 g/mL @ 25°C
density of mercury = 13.5340 g/mL @25°C

$\pi = 3.141593$
$1\ nm = 10^{-9} m$

Equations:

$$u_m = \sqrt{\frac{2RT}{M}} \quad u_{av} = \sqrt{\frac{8RT}{\pi M}} \quad u_{rms} = \sqrt{\frac{3RT}{M}} \qquad Z = \frac{PV}{nRT}$$

$$Z_w = \frac{1}{4}\frac{N}{V}u_{av} \qquad Z_A = \sqrt{2}\pi d^2 u_{av}\frac{N}{V}$$

$$Z_{AA} = \frac{1}{\sqrt{2}}\pi d^2 u_{av}\left(\frac{N}{V}\right)^2 \qquad \lambda = \frac{1}{\sqrt{2}\pi d^2}\frac{V}{N}$$

Atomic Weights (g/mol):

H 1.00794	He 4.00260	C 12.0107	N 14.0067
O 15.9994	Na 22.9898	S 32.065	Ar 39.948

Vapour Pressure (P) of Water at Various Temperatures:

T (°C)	P (mmHg)	T (°C)	P (mmHg)	T (°C)	P (mmHg)	T (°C)	P (mmHg)
13.0	11.23	19.0	16.48	25.0	23.76	31.0	33.70
14.0	11.99	20.0	17.54	26.0	25.21	32.0	35.66
15.0	12.79	21.0	18.65	27.0	26.74	33.0	37.73
16.0	13.63	22.0	19.83	28.0	28.35	34.0	39.90
17.0	14.53	23.0	21.07	29.0	30.04	35.0	42.18
18.0	15.48	24.0	22.38	30.0	31.82	36.0	44.56

Name:____________________________

Student Number:____________________________

Fall 2014 SC/CHEM 1000 C - Quiz #2

October 21, 2014

Calculators are permitted. Answer all questions in the space provided on this paper; **additional paper for rough work is not permitted.**

All final answers must be written in ink!

Important Note: The last page of this quiz is a reference page that may be removed if you wish. You will need information from this sheet to answer some of the questions.

Time Allowed: 50 minutes **Total Marks = 30**

Marks

4 1. If 359 g of hot tea at 83.9°C is placed in a 235 g cup at 21.2°C, what will be the temperature of the cup and the tea when they reach a uniform temperature? The specific heat of the tea is 4.00 J g^{-1}°C^{-1} while that of the cup is 0.749 J g^{-1}°C^{-1}. Assume that no heat is lost to anything else it is only exchanged between the cup and the tea.

$T_f = 77.1\ °C$

Marks

4 2. Determine the standard enthalpy of formation of $CCl_4(g)$ at 298K.

$$CH_4(g) + 4\ Cl_2(g) \rightarrow CCl_4(g) + 4\ HCl(g), \quad \Delta H^o = -397.3\ kJ$$

$$\Delta H_f^\circ(CCl_4) = -102.9\ kJ$$

2 3. Starting with the First Law of Thermodynamics, develop the expression that the change in internal energy is equal to the heat that is transferred under conditions of constant volume.

$$\Delta u = q_V$$

1 4. Write an equation that defines enthalpy, H, in terms of other state functions.

$$H = u + PV$$

Marks

4 5. Given the following data:

$4\ B(s) + 3\ O_2(g) \rightarrow 2\ B_2O_3(s)$	$\Delta H = -2546$ kJ
$B_2H_6(g) + 3\ O_2(g) \rightarrow B_2O_3(s) + 3\ H_2O(g)$	$\Delta H = -2035$ kJ
$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(l)$	$\Delta H = -572$ kJ
$H_2O(l) \rightarrow H_2O(g)$	$\Delta H = +44$ kJ

Calculate the ΔH for the following reaction:

$2\ B(s) + 3\ H_2(g) \rightarrow B_2H_6(g)$

$\Delta H = 36$ kJ

Marks

2 6. An electron is excited from the ground state to the $n = 3$ state in a hydrogen atom. Answer each of the following as either true or false; circle your answer.

a) It takes more energy to remove the electron from $n = 3$ than from the ground state.

TRUE [✓ FALSE]

b) The electron is farther from the nucleus, on average, in the $n = 3$ state than in the ground state.

[✓ TRUE] FALSE

c) The wavelength of light emitted if the electron drops from $n = 3$ to $n = 2$ is shorter than the wavelength of light emitted if the electron falls from $n = 3$ to $n = 1$.

TRUE [✓ FALSE]

d) The wavelength of light emitted if the electron returns to the ground state from $n = 3$ is the same as the wavelength of light absorbed for the electron to go from $n = 1$ to $n = 3$.

[✓ TRUE] FALSE

3 7. For each of the following, indicate whether the set of quantum numbers provided is allowed. Circle YES for allowed or NO for not allowed.

a) $n = 3$, $l = 3$, $m_l = 0$, $m_s = -½$ YES [✓ NO]

b) $n = 4$, $l = 3$, $m_l = 2$, $m_s = -½$ [✓ YES] NO

c) $n = 4$, $l = 1$, $m_l = 1$, $m_s = +½$ [✓ YES] NO

d) $n = 2$, $l = 1$, $m_l = -1$, $m_s = -1$ YES [✓ NO]

e) $n = 5$, $l = -4$, $m_l = 2$, $m_s = +½$ YES [✓ NO]

f) $n = 3$, $l = 1$, $m_l = 2$, $m_s = -½$ YES [✓ NO]

Marks

4 8. An excited hydrogen atom emits light with a wavelength of 397.2 nm to reach the energy level for which $n = 2$. In which principal quantum level did the electron begin?

$n = 7$

3 9. Provide the ground state electronic configuration for each of the following using the spdf notation. An abbreviation for the noble gas core may be used if you wish.

Species	electron configuration
P	$[Ne]3s^2 3p^3$
Sn	$[Kr]\ 5s^2 4d^{10} 5p^2$
Cr^{3+}	$[Ar]\ 3d^3$

3 10. a) Arrange the following atoms in order of increasing size (largest sizes to the right): Rb, Al, Na

Al Na Rb

b) Arrange the following species in order of increasing ionization energy (largest ionization energy to the right): Ar, Cs, Ge

Cs Ge Ar

c) Arrange the following atoms in order of increasing electron affinity (largest electron affinity to the right): F, N, O

N O F

Reference Page for CHEM 1000C Quiz 2

Constants:

0°C = 273.15 K

1 mL = 1 cm^3

1 nm = 10^{-9}m

R = 8.314472 $JK^{-1}mol^{-1}$ = 0.0820574 L atm K^{-1} mol^{-1}

N_A = 6.02214199x10^{23} mol^{-1}

1.00 atm = 1.013 x 10^5 Pa = 760 torr (mm Hg)

k = 1.38066 x 10^{-23} J K^{-1}

R_H = 2.179 X 10^{-18} J

a_0 = 53 pm

h = 6.62606876 x 10^{-34} J s

c = 2.99792458 x 10^8 m s^{-1}

Properties of Water:

specific heat of $H_2O(l)$ = 4.184 J g^{-1} °C^{-1}

specific heat of $H_2O(s)$ = 2.11 J g^{-1} °C^{-1}

$\Delta H^\circ_f(H_2O(l))$ = -285.8 kJ mol^{-1} @ 298K

$\Delta H^\circ_f(H_2O(g))$ = -241.8 kJ mol^{-1} @ 298K

heat of fusion for water = 6.01 kJ mol^{-1}

density of water = 1.00 g mL^{-1}

heat of vaporization of water = 44.0 kJ mol^{-1}

Some Standard Enthalpies of Formation at 298K:

Substance	ΔH_f° (kJ/mol)	Substance	ΔH_f° (kJ/mol)
C(graphite)	0	$H_2O(g)$	-241.8
$CH_4(g)$	-74.81	$H_2O(l)$	-285.8
$CO_2(g)$	-393.5	HCl(g)	-92.31
$Cl_2(g)$	0	$O_2(g)$	0

The periodic table

www.webelements.com

Key:
Element Name
Atomic number
Symbol
Atomic weight (mean relative mass)

1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Hydrogen 1 **H** 1.008																		Helium 2 **He** 4.0026
Lithium 3 **Li** 6.94	Beryllium 4 **Be** 9.0122												Boron 5 **B** 10.81	Carbon 6 **C** 12.011	Nitrogen 7 **N** 14.007	Oxygen 8 **O** 15.999	Fluorine 9 **F** 18.998	Neon 10 **Ne** 20.180
Sodium 11 **Na** 22.990	Magnesium 12 **Mg** 24.305												Aluminium 13 **Al** 26.982	Silicon 14 **Si** 28.085	Phosphorus 15 **P** 30.974	Sulfur 16 **S** 32.06	Chlorine 17 **Cl** 35.45	Argon 18 **Ar** 39.948
Potassium 19 **K** 39.098	Calcium 20 **Ca** 40.078(4)		Scandium 21 **Sc** 44.956	Titanium 22 **Ti** 47.867	Vanadium 23 **V** 50.942	Chromium 24 **Cr** 51.996	Manganese 25 **Mn** 54.938	Iron 26 **Fe** 55.845(2)	Cobalt 27 **Co** 58.933	Nickel 28 **Ni** 58.693	Copper 29 **Cu** 63.546(3)	Zinc 30 **Zn** 65.38(2)	Gallium 31 **Ga** 69.723	Germanium 32 **Ge** 72.63	Arsenic 33 **As** 74.922	Selenium 34 **Se** 78.96(3)	Bromine 35 **Br** 79.904	Krypton 36 **Kr** 83.798(2)
Rubidium 37 **Rb** 85.468	Strontium 38 **Sr** 87.62		Yttrium 39 **Y** 88.906	Zirconium 40 **Zr** 91.224(2)	Niobium 41 **Nb** 92.906(2)	Molybdenum 42 **Mo** 95.96(2)	Technetium 43 **Tc** [97.91]	Ruthenium 44 **Ru** 101.07(2)	Rhodium 45 **Rh** 102.91	Palladium 46 **Pd** 106.42	Silver 47 **Ag** 107.87	Cadmium 48 **Cd** 112.41	Indium 49 **In** 114.82	Tin 50 **Sn** 118.71	Antimony 51 **Sb** 121.76	Tellurium 52 **Te** 127.60(3)	Iodine 53 **I** 126.90	Xenon 54 **Xe** 131.29
Caesium 55 **Cs** 132.91	Barium 56 **Ba** 137.33	57-70 *	Lutetium 71 **Lu** 174.97	Hafnium 72 **Hf** 178.49(2)	Tantalum 73 **Ta** 180.95	Tungsten 74 **W** 183.84	Rhenium 75 **Re** 186.21	Osmium 76 **Os** 190.23(2)	Iridium 77 **Ir** 192.22	Platinum 78 **Pt** 195.08	Gold 79 **Au** 196.97	Mercury 80 **Hg** 200.59	Thallium 81 **Tl** 204.38	Lead 82 **Pb** 207.2	Bismuth 83 **Bi** 208.98	Polonium 84 **Po** [208.98]	Astatine 85 **At** [209.99]	Radon 86 **Rn** [222.02]
Francium 87 **Fr** [223.02]	Radium 88 **Ra** [226.03]	89-102 **	Lawrencium 103 **Lr** [262.11]	Rutherfordium 104 **Rf** [265.12]	Dubnium 105 **Db** [268.13]	Seaborgium 106 **Sg** [271.13]	Bohrium 107 **Bh** [270]	Hassium 108 **Hs** [277.15]	Meitnerium 109 **Mt** [276.15]	Darmstadtium 110 **Ds** [281.16]	Roentgenium 111 **Rg** [280.16]	Copernicium 112 **Cn** [285.17]	Ununtrium 113 **Uut** [284.18]	Flerovium 114 **Fl** [289.19]	Ununpentium 115 **Uup** [288.19]	Livermorium 116 **Lv** [293]	Ununseptium 117 **Uus** [294]	Ununoctium 118 **Uuo** [294]

*lanthanoids	Lanthanum 57 **La** 138.91	Cerium 58 **Ce** 140.12	Praseodymium 59 **Pr** 140.91	Neodymium 60 **Nd** 144.24	Promethium 61 **Pm** [144.91]	Samarium 62 **Sm** 150.36(2)	Europium 63 **Eu** 151.96	Gadolinium 64 **Gd** 157.25(3)	Terbium 65 **Tb** 158.93	Dysprosium 66 **Dy** 162.50	Holmium 67 **Ho** 164.93	Erbium 68 **Er** 167.26	Thulium 69 **Tm** 168.93	Ytterbium 70 **Yb** 173.05
**actinoids	Actinium 89 **Ac** [227.03]	Thorium 90 **Th** 232.04	Protactinium 91 **Pa** 231.04	Uranium 92 **U** 238.03	Neptunium 93 **Np** [237.05]	Plutonium 94 **Pu** [244.06]	Americium 95 **Am** [243.06]	Curium 96 **Cm** [247.07]	Berkelium 97 **Bk** [247.07]	Californium 98 **Cf** [251.08]	Einsteinium 99 **Es** [252.08]	Fermium 100 **Fm** [257.10]	Mendelevium 101 **Md** [258.10]	Nobelium 102 **No** [259.10]

Symbols and names: the symbols and names of the elements, and their spellings are those recommended by the International Union of Pure and Applied Chemistry (IUPAC - http://www.iupac.org/). Names have yet to be proposed for elements 113, 115, 117, and 118 and so those used here are IUPAC's temporary systematic names. In some countries, the spellings **aluminum**, **cesium**, and **sulphur** are usual.

Group labels: the numeric system (1–18) used here is the current IUPAC convention.

Atomic weights (mean relative masses): these are the IUPAC 2009 values and given to 5 significant figures. The last significant figure of each value is considered reliable to ±1 except where a larger uncertainty is given in parentheses. Representative values for those elements having an atomic weight interval are given (H, Li, B, C, N, O, Si, S, Cl, Tl). Elements for which the atomic weight is given within [brackets] have no stable nuclides and are represented by the element's longest lived isotope reported in the IUPAC 2009 values.

Name:______________________________

Student Number:______________________________

Fall 2014 SC/CHEM 1000 C - Quiz #3

November 18, 2014

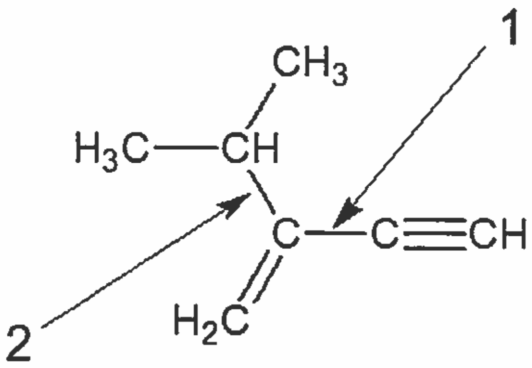
Calculators are permitted.
Answer all questions on this paper; **additional paper for rough work is not permitted.**

Time Allowed: 50 minutes

Total Marks = 30

Marks

4 1. Consider the molecule below:



How many σ-bonds are there **between carbon atoms** in this molecule? 6

How many π-bonds are there **between carbon atoms** in this molecule? 3

According to the Valence Bond Theory, bonds form from the overlap of orbitals. For example, a bond can form from an sp^3-sp^3 overlap.

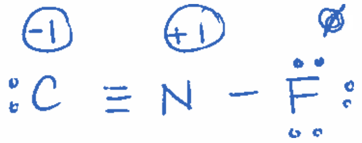
Name the two orbitals that overlap to form the bond labelled by arrow 1. $sp^2 - sp$

Name the two orbitals that overlap to form the bond labelled by arrow 2. $sp^3 - sp^2$

Marks

8 2. Draw the most feasible Lewis structures for each of the following in the space provided below. Determine the ***ideal bond angles*** and ***shape*** for each structure and indicate the ***formal charge on each atom***. Note: ***ALL lone pair electrons must be shown*** on the Lewis structures.

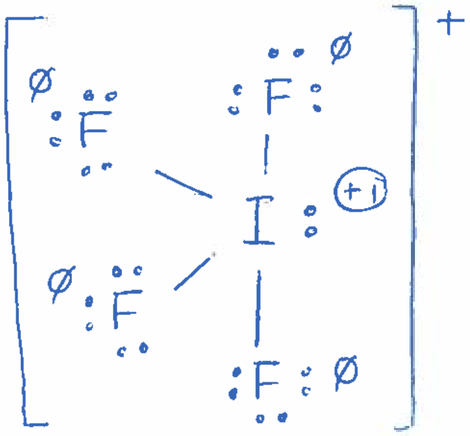
CNF (N is the central atom)



ideal bond angles 180°

shape linear

IF_4^+ (I is the central atom)



ideal bond angles 90° and 120°

shape seesaw

Marks

3 3. For each of the following, specify whether they are polar and if hydrogen bonding is possible. A simple "yes" or "no" answer is sufficient.

Molecule	Polar?	Hydrogen Bonding?
CH_4	NO	No
HBr	Yes	No
NH_3	Yes	Yes

2 4. Which answer below represents all of the true statements?

(I) The vapour pressure of a liquid depends on intermolecular forces.
(II) The vapour pressure of a liquid depends on temperature.
(III) The vapour pressure of a liquid depends on container volume.
(IV) The vapour pressure of a liquid depends on the amount of liquid in equilibrium with the vapour.

A) Both (III) and (IV) are true.
[✓ B) Both (I) and (II) are true.]
C) (I), (II) and (IV) are true.
D) Only (I) is true.
E) All of (I), (II), (III) and (IV) are true.

2 5. Which one of the following substances has the highest boiling point and why?

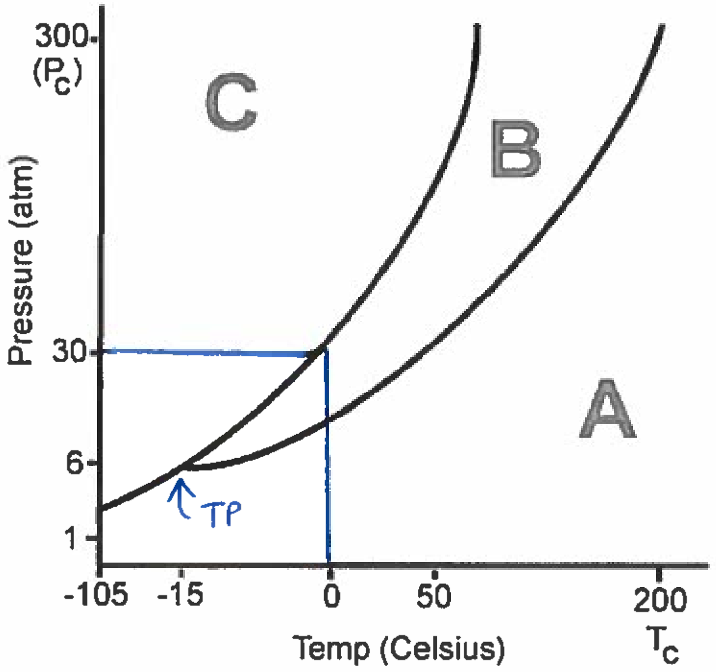
[✓ CBr_4] CCl_4 CF_4 CH_4

In similar compounds, the higher the molar mass, or the higher the number of electrons, the more polarizable the molecule; and therefore, the stronger the London, or dispersion, forces.

CBr_4 has the highest molar mass, and the most electrons in this, in this group; and therefore, will have the highest boiling point.

Marks

5 6. Consider the following phase diagram.



a) What is the melting point of this substance at a pressure of 30 atmospheres?

0 °C

b) Place "TP" at the triple point of this substance.

c) What is a phase change from Phase A to Phase B called?

Condensation

d) What is the line separating Phase C from Phase A known as?

Sublimation Curve

e) What is the line separating Phase A from Phase B known as?

Vapour Pressure Curve

Marks

6 7. Consider the following data for water:

normal melting point = 0.00°C
normal boiling point = 100.00°C
heat of fusion = 6.01 kJ/mol
heat of vapourization = 44.0 kJ/mol

The atmospheric pressure on the surface of Mars is 70.0 torr. At what temperature would water boil there? **Express your answer in °C.**

$T_2 = 46.3°C$

Reference Page for CHEM 1000C Quiz 3

Constants:

$R = 8.314472\ JK^{-1}mol^{-1} = 0.0820574\ L\ atm\ K^{-1}\ mol^{-1}$

1.00 atm = 1.013×10^{5} Pa = 760 torr (mm Hg)

$N_A = 6.02214199 \times 10^{23}\ mol^{-1}$

$h = 6.62606876 \times 10^{-34}$ J s

1 m = 10^{2} cm = 10^{12} pm

$k = 1.38066 \times 10^{-23}\ J\ K^{-1}$

0°C = 273.15 K

$R_H = 2.179 \times 10^{-18}$ J

$c = 2.99792458 \times 10^{8}\ m\ s^{-1}$

Electronegativities (Pauling Scale)

B 2.0   Br 2.8   C 2.5   Cl 3.0   H 2.1   I 2.5   N 3.0   O 3.5   F 4.0

Equations:

$$\ln\left(\frac{P_2}{P_1}\right) = -\frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right); \quad \ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Periodic Table:

1 H 1.00794																1 H 1.00794	2 He 4.002602
3 Li 6.941	4 Be 9.012182											5 B 10.811	6 C 12.0107	7 N 14.00674	8 O 15.9994	9 F 18.9984032	10 Ne 20.1797
11 Na 22.989770	12 Mg 24.3050											13 Al 26.981538	14 Si 28.0855	15 P 30.973761	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.955910	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.938049	26 Fe 55.845	27 Co 58.933200	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.92160	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.90550	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.29
55 Cs 132.90545	56 Ba 137.327	57 La 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.96655	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.98038	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)	112 (277)		114 (289) (287)		116 (289)		118 (293)

58 Ce 140.116	59 Pr 140.90765	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.92534	66 Dy 162.50	67 Ho 164.93032	68 Er 167.26	69 Tm 168.93421	70 Yb 173.04	71 Lu 174.967
90 Th 232.0381	91 Pa 231.03588	92 U 238.0289	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)

Student ID: ____________________ **Student Name:** ______________________

FIRST TEST

CHEM 1000

OCTOBER 02, 2014

DURATION: 50 MINUTES

Aid allowed: non-programmable calculators.

Answer all questions in the space provided on the examination paper. Please read each question carefully and answer only what is asked in each question.

Neat writing is highly appreciated. Read each question carefully before answering.
<u>All answers must be in ink.</u>

This test has 7 pages
Total Marks are 30

Question	Question 1	Question 2	Question 3	Question 4	Total
Grade	8	8	8	6	30
Marks					

Q1) A chemist has synthesized a greenish-yellow gaseous compound of chlorine and oxygen and find that its density is 7.71 g/L at 36°C and 2.92 bar. Calculate the **molar mass** of the compound and determine its **molecular formula.** [5]

ClO_2

Molar Mass $ClO_2 = 67.5$ g/mol

b) A 60.0 L tank of chlorine gas at 27 °C and 125 atm springs a leak. When the leak was discovered, the pressure was reduced to 50 atm. How many **moles of chlorine** gas escaped? [3]

$\Delta n = 182.7$ mol

Q2) Butene gas readily burns with oxygen according to the following **unbalanced equation**

$$C_4H_8(g) \quad + \quad O_2(g) \quad \rightarrow \quad CO_2(g) \quad + \quad H_2O(g)$$

What volume of butene at 188°C and 2.50 atm can be burned with 12.0 L of O_2 at 745 torr and 25.0°C? [4]

$V_{C_4H_8} = 1.21$ L

b) A certain hydrate has the formula $MgSO_4.xH_2O$. A quantity of 54.2 g of the compound is heated in an oven to drive off the water. If the steam generated exerts a pressure of 24.8 atm in a 2.00 L container at 120°C. **Calculate x.** [4]

$x = 6.97 \approx 7$

$MgSO_4 \cdot 7H_2O$

Q3) In alcohol fermentation, yeast converts glucose to ethanol and carbon dioxide according to the following **unbalanced equation**:

$$C_6H_{12}O_6(s) \rightarrow C_2H_5OH(l) + CO_2(g)$$

If 5.97 g of glucose are reacted and 1.44 L of CO_2 gas are collected at 293K and 0.984 atm. What is the **percent yield** of the reaction? [4]

% yield = 88.7%

b) Hydrogen gas is produced when zinc reacts with sulfuric acid:

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(s) + H_2(g)$$

If 159 mL of wet H_2 is collected over water at 24°C and a barometric pressure of 738 torr. How many **grams of Zn** have been consumed? [4]
P (H_2O) at 24°C = 22.38 torr

g_{Zn} = 0.402 g Zn

Q4) In an atmospheric research laboratory an experiment was conducted to investigate interactions of liquid pollution particles with other atmospheric gases. In one such experiment a spherical liquid particle with a diameter of 300 nm was investigated. Calculate the rate of collisions (number/sec) of NO_2 (g) with the surface of a particle if the mole fraction (mixing ratio) of NO_2(g) in the chamber at 1 atm is $X = 1 \times 10^{-11}$ (i.e. 1 part per trillion). The chamber temperature was kept at 25°C [6]

For your convenience I have broken the solution into the following steps.

N/V = $2.462 \times 10^{14} \frac{mol}{m^3}$

U_{av} = $370.4 \frac{m}{s}$

Rate = $6.45 \times 10^3 \frac{collisions}{sec} \approx 6 \times 10^3 \frac{collisions}{sec}$

$R = 8.314472\ JK^{-1}mol^{-1} = 0.0820574\ L\ atm\ K^{-1}\ mol^{-1}$

1 inch = 2.54 cm $1cm^3 = 1mL$ $1\ nm = 1x10^{-9}\ m$

$k = 1.38066 \times 10^{-23}\ JK^{-1}$ 12 inch = 1 ft 1 lb = 453.59 g 1.6 km = 1 mile

1 standard atm = 1.013×10^5 Pa (N/m^2) = 760 torr (mmHg) = 14.70 lb/in^2 = 1.01325 bar

Avogadro's number (N_A) = $6.02214199 \times 10^{23}$ molecules mol^{-1} 1000 mL = 1L

$1\ dm^3 = 1.00 \times 10^{-3}\ m^3$ 1 mole of a gas at STP = 22.717L

$0^oC = 273.15K$ $\frac{Rate(A)}{Rate(B)} = \sqrt{\frac{M_B}{M_A}}$ where Rate (A) & B are rate of effusion of A & B respectively

$[P + a(n/v)^2](V-nb) = nRT$ Area of a sphere = $4\pi r^2$

$$u_m = \sqrt{\frac{2RT}{M}} = \sqrt{\frac{2kT}{m}} \qquad u_{av} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8kT}{\pi m}} \qquad u_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3kT}{m}}$$

$$\text{Rate of effusion} = Z_{wall}.A = \frac{1}{4}\frac{N}{V}.u_{av}.A \qquad Z_{wall} = \frac{1}{4}u_{av}\frac{N}{V}$$

$$Z_A = \sqrt{2}\pi d^2 u_{av}\frac{N}{V} \qquad Z_{AA} = \frac{1}{\sqrt{2}}\pi d^2 u_{av}\left(\frac{N}{V}\right)^2 \qquad \lambda = \frac{u_{av}}{Z_A}$$

WebElements: the periodic table on the world-wide web

www.webelements.com

Key:

element name
atomic number
symbol
atomic weight (mean relative mass)

1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
hydrogen 1 **H** 1.0079																		helium 2 **He** 4.0026
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.0122												boron 5 **B** 10.811	carbon 6 **C** 12.011	nitrogen 7 **N** 14.007	oxygen 8 **O** 15.999	fluorine 9 **F** 18.998	neon 10 **Ne** 20.180
sodium 11 **Na** 22.990	magnesium 12 **Mg** 24.305												aluminium 13 **Al** 26.982	silicon 14 **Si** 28.086	phosphorus 15 **P** 30.974	sulfur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.948
potassium 19 **K** 39.098	calcium 20 **Ca** 40.078		scandium 21 **Sc** 44.956	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.942	chromium 24 **Cr** 51.996	manganese 25 **Mn** 54.938	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.933	nickel 28 **Ni** 58.693	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.38	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.61	arsenic 33 **As** 74.922	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.80
rubidium 37 **Rb** 85.468	strontium 38 **Sr** 87.62		yttrium 39 **Y** 88.906	zirconium 40 **Zr** 91.224	niobium 41 **Nb** 92.906	molybdenum 42 **Mo** 95.96	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.91	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.87	cadmium 48 **Cd** 112.41	indium 49 **In** 114.82	tin 50 **Sn** 118.71	antimony 51 **Sb** 121.76	tellurium 52 **Te** 127.60	iodine 53 **I** 126.90	xenon 54 **Xe** 131.29
caesium 55 **Cs** 132.91	barium 56 **Ba** 137.33	57-70 *	lutetium 71 **Lu** 174.97	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.95	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.21	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.22	platinum 78 **Pt** 195.08	gold 79 **Au** 196.97	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.38	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.98	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	89-102 **	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [267]	dubnium 105 **Db** [268]	seaborgium 106 **Sg** [271]	bohrium 107 **Bh** [272]	hassium 108 **Hs** [270]	meitnerium 109 **Mt** [276]	darmstadtium 110 **Ds** [281]	roentgenium 111 **Rg** [280]	ununbium 112 **Uub** [285]	ununtrium 113 **Uut** [284]	ununquadium 114 **Uuq** [289]	ununpentium 115 **Uup** [288]	ununhexium 116 **Uuh** [293]	ununseptium 117 **Uus** —	ununoctium 118 **Uuo** [294]

*lanthanoids	lanthanum 57 **La** 138.91	cerium 58 **Ce** 140.12	praseodymium 59 **Pr** 140.91	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.96	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.93	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.93	erbium 68 **Er** 167.26	thulium 69 **Tm** 168.93	ytterbium 70 **Yb** 173.06
**actinoids	actinium 89 **Ac** [227]	thorium 90 **Th** 232.04	protactinium 91 **Pa** 231.04	uranium 92 **U** 238.03	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]

Symbols and names: the symbols and names of the elements, and their spellings are those recommended by the International Union of Pure and Applied Chemistry (IUPAC - http://www.iupac.org/). Names have yet to be proposed for the most recently discovered elements beyond 112 and so those used here are IUPAC's temporary systematic names. In the USA and some other countries, the spellings aluminum and cesium are normal while in the UK and elsewhere the common spelling is sulphur.
Group labels: the numeric system (1–18) used here is the current IUPAC convention.
Atomic weights (mean relative masses): Apart from the heaviest elements, these are the IUPAC 2007 values and given to 5 significant figures. Elements for which the atomic weight is given within square brackets have no stable nuclides and are represented by the element's longest lived isotope reported at the time of writing.

For updates to this table see http://www.webelements.com/nexus/Printable_Periodic_Table (Version date: 21 September 2007).

General Chemistry CHEM 1000

Student ID: ____________________ Student Name: ________________________

SECOND TEST

CHEM 1000

OCTOBER 23, 2014

DURATION: 50 MINUTES

Aid allowed: non-programmable calculators.

Answer all questions in the space provided on the examination paper. Please read each question carefully and answer only what is asked in each question.

Neat writing is highly appreciated. Read each question carefully before answering. <u>All answers must be in ink.</u>

This test has 7 pages
Total Marks are 30

Question	Question 1	Question 2	Question 3	Question 4	Total
Grade	7	8	8	7	30
Marks					

Q1.a) At a petrochemical research facility a scientist was working to determine the heat released in combustion reactions for various potential fuels. One of the sample bottle contained 2-propanol. The scientist found that the heat of combustion of 2-propanol at 298.15K, determined in a bomb calorimeter, is -33.41 kJ/g. For the combustion of one mole of 2-propanol, determine ΔU and ΔH. **Unbalanced** equation is given below: [4]

$$C_3H_8O(l) + \frac{9}{2}O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$$

$\Delta U = -2008 \ \frac{kJ}{mol}$

$\Delta H = -2012 \ \frac{kJ}{mol}$

b) A moveable piston in a cylinder holding 5.0L $N_2(g)$ is used to lift a 1.23 kg object to a height of 4.5 meters. How much work (in J) was done by the gas? [3]

$E_p = 54.24 J \approx 54.2 J$

Q.2.a) A city of 100,000 people used approximately 1.0 x 10^{11} kJ of energy per day. Suppose all of the city's energy comes from the combustion of liquid octane (C_8H_{18}) to form gaseous water and gaseous carbon dioxide. Use standard enthalpies of formation to calculate ΔH^o_{rxn} for the combustion of octane and determine how many kilograms of octane are necessary to provide this amount of energy. [4]

ΔH^o_f $C_8H_{18}(l)$ = -250.1 kJ/mol
$CO_2(g)$ = -393.5 kJ/mol
$H_2O(g)$ = -241.8 kJ/mol

$\Delta H^o_{rxn} = -5074.1$ KJ/mol

Mass of $C_8H_{18} = 2.3 \times 10^6$ kg C_8H_{18}

b) To determine whether a shiny gold-colored rock is actually gold, a chemistry student decided to measure its heat capacity. She first weighs the rock and find it has a mass of 4.7 g. She then finds that upon absorption of 57.2 J of heat, the temperature of the rock rises from 25°C to 57°C. Find the specific heat capacity of the substance composing the rock and determine whether the value is consistent with the rock being pure gold. [4]

$C = 0.38 \frac{J}{g\,°C}$

Since Gold has specific heat capacity of 0.129 J/g°C ; therefore, the rock cannot be of Gold.

Q3.a) Magnesium metal reacts with hydrochloric acid according to the following **unbalanced** equation:

$$\mathrm{Mg}(s) \quad + \quad \mathrm{HCl}(eq) \quad \longrightarrow \quad \mathrm{MgCl_2}(eq) \quad + \quad \mathrm{H_2}(g)$$

In an experiment to determine the enthalpy change for this reaction, you combine 0.158 g of Mg metal with enough HCl to make 100.0 mL of solution in a coffee-cup calorimeter. The HCl is sufficiently concentrated so that the Mg completely reacts. The temperature of the solution rises from 25.6°C to 32.8°C as a result of the reaction. Find ΔH_{rxn} for the reaction as written. Assume density of the solution to be 1.00 g/mL and specific heat capacity of the solution to be 4.18 J/g°C. [4]

$\Delta H_{rxn} = -4.6 \times 10^5$ J/mol

b) You are planning a lecture demonstration to illustrate an endothermic process. You want to lower the temperature of 1400 mL water in an insulated container from 25°C to 10°C. Approximately what mass of $NH_4Cl(s)$ should you dissolve in the water to achieve this result? The heat of solution of NH_4Cl is +14.7 kJ/mol NH_4Cl. [4]

4.2×10^2 g NH_4Cl

Q.4.a) Fall colors are produced due to the ceasing of Chlorophyll production in the plant leaves. The bright yellow, violet and red give a magnificent display of colors. If the wave length of the violet color is 370nm, **calculate frequency and energy of the color**. **[3]**

$E = 5.4 \times 10^{-19} J$

$\nu = 8.1 \times 10^{14} s^{-1}$

b) When atoms absorbs energy electrons move to higher energy states. These excited electron relax back to the ground state by emitting energy in the form of light, this is detected by electronic spectroscopy. What electron transition in a hydrogen atom falling in Paschen series will produce light of wavelength 1090 nm? [4]

$n_f = 6$

The transition is from $n = 6$ to $n = 3$

$1\text{m} = 10^9\,\text{nm}$ $\text{Å} = 10^{-8}\,\text{cm}$

1Cal = 1kcal = 4.184 kJ   1 cal = 4.184 J   1.00 oz = 28.4g

Avogadro's number (NA) = $6.02214199 \times 10^{23}$ molecules mol^{-1}
$0^\circ\text{C} = 273.15\text{K}$

Specific heat of water = $4.184\ \text{J g}^{-1}\ ^\circ\text{C}^{-1}$
gold = $0.129\ \text{J g}^{-1}\ ^\circ\text{C}^{-1}$

$c = 3.00 \times 10^8 \text{ms}^{-1}$ PE = m x g x h $KE = 1/2\, mv^2$

h: 6.626×10^{-34} J.s $= 6.626 \times 10^{-34}\text{kgm}^2/\text{s}$

mass of e = 9.11×10^{-31} kg $g = 9.8\ \text{m/s}^2$

$c = \nu\lambda$ R_H: 2.179×10^{-18}J $(\Delta x)(\Delta mv) \geq h/4\pi$

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

General Chemistry CHEM 1000

Student ID: ____________________ **Student Name:** _______________________

THIRD TEST

CHEM 1000

NOVEMBER 20, 2014

DURATION: 50 MINUTES

Aid allowed: non-programmable calculators.

Answer all questions in the space provided on the examination paper. Please read each question carefully and answer only what is asked in each question.

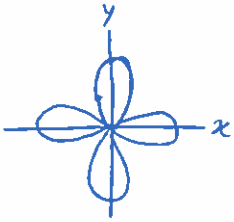
Neat writing is highly appreciated. Read each question carefully before answering. You must write your final answer in ink (not with pencil).

This test has 6 pages
Total Marks are 30

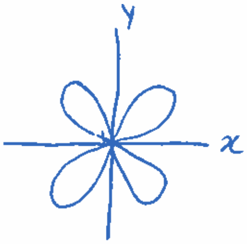
Question	**Question 1**	**Question 2**	**Question 3**	**Question 4**	**Total**
Grade	**9**	**5**	**7**	**9**	**30**
Marks					

1 J = 1kg/m^2.s^2
Avogadro's number (NA) = 6.02214199 x 10^{23} molecules mol^{-1}
c= 2.998 x 10^8 ms^{-1} *h*= 6.626 x 10^{-34} J.s = 6.26 x 10^{-34} kg.m^{2}s^{-1}
1.0 inch = 2.54 cm Hz = cycles/s = s^{-1}

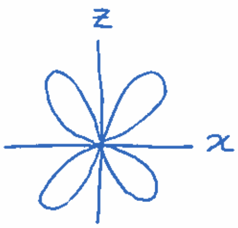
Q.1.a) Sketch all **d-orbital** and label them correctly with their coordinates. [2.5]



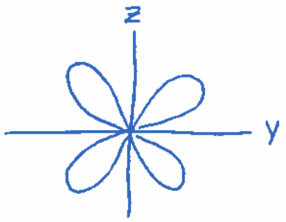
$d_{x^2-y^2}$



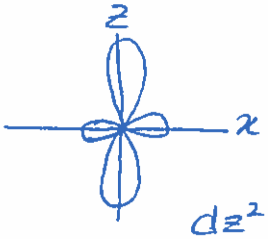
d_{xy}



d_{xz}



d_{yz}



d_{z^2}

b) Using periodic table provided, name each element corresponding to each of the following electronic configurations. [2.5]

Configuration of element	**Name of element**
[Kr]$4d^{10}5s^25p^3$	Sb
[Ar]$3d^54s^2$	Mn
[Ne]$3s^23p^1$	Al
[Ar]$3d^{10}4s^2$	Zn
[Xe]$4f^{14}5d^56s^2$	Re

c) Consider the elements Si, F, Cl and Cs

i) Rank these elements in order of increasing first ionization energy. [2]

Cs < Si < Cl < F

ii) Rank these elements in order of increasing atomic radius. [2]

F < Cl < Si < Cs

Q.2.a) For each of the listed electronic configurations, select the option given below the table that best describes it. Only one option is to be chosen for each electronic configuration. The options that are listed below in option table may be used more than once. [3]

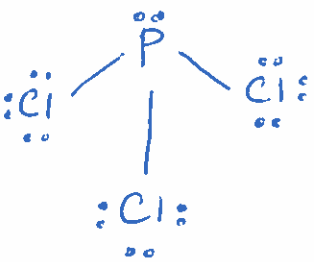
Element	Electron Configuration	Option
Be	$1s^2 2s^2$	A
H	$1s^2$	D
B	$1s^2 2s^2 2p^2$	D
N	$1s^2 2s^2 2p^2 3s^1$	B
F	$1s^2 2s^2 2p^4 2d^1$	E
F	$1s^2 2s^2 2p^6$	D

Option table:

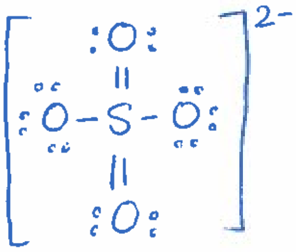
A	B	C	D	E
A ground state atom of the listed element	An excited state	A cation formed by the element in question	An anion formed by the element in question	A forbidden configuration

b) Identify species that have complete, incomplete and expanded octet. [2]

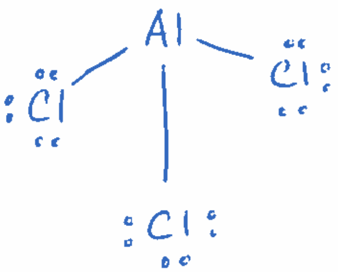
i) PCl_3 ii) SO_4^{2-} iii) $AlCl_3$ iv) SF_6



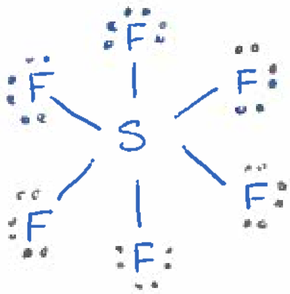
Complete



Expanded

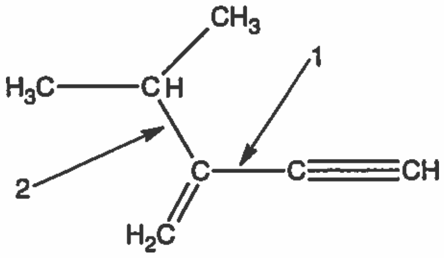


Incomplete



Expanded.

Q.3) Consider the molecule below:



a) How many σ-bonds are there between carbon atoms in this molecule? 6 [1]

b) How many π-bonds are there between carbon atoms in this molecule? 3 [1]

According to the Valence Bond Theory, bonds form from the overlap of orbitals. For example, a bond can form from an sp^3-sp^3 overlap.

c) Name the two orbitals that overlap to form the bond labeled by **arrow 1.** [1]

$sp^2 - sp$

d) Name the two orbitals that overlap to form the bond labeled by **arrow 2.** [1]

$sp^3 - sp^2$

d) Consider the 2 molecules: oxygen (O_2) and hydrogen peroxide (HOOH). Describe your expectations for the relative bond strengths and bond lengths of the oxygen-oxygen bond in these two molecules. Explain your reasoning. [3]

$:\ddot{O} = \ddot{O}:$

Double Bond

Shorter O-O bond

Stronger O-O bond

$H - \ddot{\underset{..}{O}} - \ddot{\underset{..}{O}} - H$

Single Bond

Longer O-O bond

Weaker O-O bond

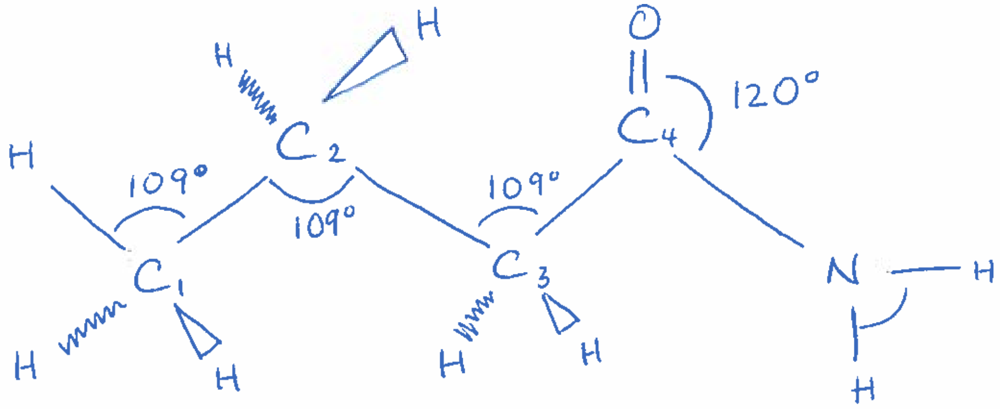
Q.4.a) Circle the species that best satisfies the condition from the possibilities on the right. [2]

Condition	**Possibilities?**					
Greatest electronegativity	Se	[✓ S]	Sb	Rb	P	Si
Most polar bond	C-O	[✓ C-F]	C-C	C-N		

b) Give an example of a molecule with a polar covalent bond SO_2 , H_2O , etc [1]

c) Give an example of a molecule with a non-polar bond N_2 , O_2 , H_2 , etc [1]

e) Butanamide is a useful amide with chemical formula $CH_3CH_2CH_2CONH_2$. Sketch the structure of the molecule and indicate the various bond angles? Also indicate hybridization scheme for the central carbon atoms. [5]



C_1 , C_2 , C_3 sp^3

C_4 $sp^2 + p$

WebElements: the periodic table on the world-wide web

http://www.webelements.com/

Key:

element name
atomic number
symbol
atomic weight (mean relative mass)

1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
hydrogen 1 **H** 1.0079																		helium 2 **He** 4.0026
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.0122												boron 5 **B** 10.811	carbon 6 **C** 12.011	nitrogen 7 **N** 14.007	oxygen 8 **O** 15.999	fluorine 9 **F** 18.998	neon 10 **Ne** 20.180
sodium 11 **Na** 22.990	magnesium 12 **Mg** 24.305												aluminium 13 **Al** 26.982	silicon 14 **Si** 28.086	phosphorus 15 **P** 30.974	sulfur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.948
potassium 19 **K** 39.098	calcium 20 **Ca** 40.078		scandium 21 **Sc** 44.956	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.942	chromium 24 **Cr** 51.996	manganese 25 **Mn** 54.938	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.933	nickel 28 **Ni** 58.693	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.39	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.61	arsenic 33 **As** 74.922	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.80
rubidium 37 **Rb** 85.468	strontium 38 **Sr** 87.62		yttrium 39 **Y** 88.906	zirconium 40 **Zr** 91.224	niobium 41 **Nb** 92.906	molybdenum 42 **Mo** 95.94	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.91	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.87	cadmium 48 **Cd** 112.41	indium 49 **In** 114.82	tin 50 **Sn** 118.71	antimony 51 **Sb** 121.76	tellurium 52 **Te** 127.60	iodine 53 **I** 126.90	xenon 54 **Xe** 131.29
caesium 55 **Cs** 132.91	barium 56 **Ba** 137.33	57-70 *	lutetium 71 **Lu** 174.97	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.95	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.21	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.22	platinum 78 **Pt** 195.08	gold 79 **Au** 196.97	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.38	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.98	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	89-102 **	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [261]	dubnium 105 **Db** [262]	seaborgium 106 **Sg** [266]	bohrium 107 **Bh** [264]	hassium 108 **Hs** [269]	meitnerium 109 **Mt** [268]	darmstadtium 110 **Ds** [271]	unununium 111 **Uuu** [272]	ununbium 112 **Uub** [277]		ununquadium 114 **Uuq** [289]				

*lanthanoids	lanthanum 57 **La** 138.91	cerium 58 **Ce** 140.12	praseodymium 59 **Pr** 140.91	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.96	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.93	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.93	erbium 68 **Er** 167.26	thulium 69 **Tm** 168.93	ytterbium 70 **Yb** 173.04
**actinoids	actinium 89 **Ac** [227]	thorium 90 **Th** 232.04	protactinium 91 **Pa** 231.04	uranium 92 **U** 238.03	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]

Symbols and names: the symbols and names of the elements, and their spellings are those recommended by the International Union of Pure and Applied Chemistry (IUPAC - http://www.iupac.org/). Names have yet to be proposed for the most recently discovered elements 111–112 and 114 so those used here are IUPAC's temporary systematic names. In the USA and some other countries, the spellings **aluminum** and **cesium** are normal while in the UK and elsewhere the common spelling is **sulphur.**

Group labels: the numeric system (1–18) used here is the current IUPAC convention.

Atomic weights (mean relative masses): Apart from the heaviest elements, these are the IUPAC 2001 values and given to 5 significant figures. Elements for which the atomic weight is given within square brackets have no stable nuclides and are represented by the element's longest lived isotope.

For updates to this table see **http://www.webelements.com/webelements/support/media/pdf/. Version date: 17 March 2003.**