

Name (in ink) _____

Student Number (in ink) _____

Fall 2013 SC/CHEM 1000 A - Quiz #1

October 3, 2013

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.**

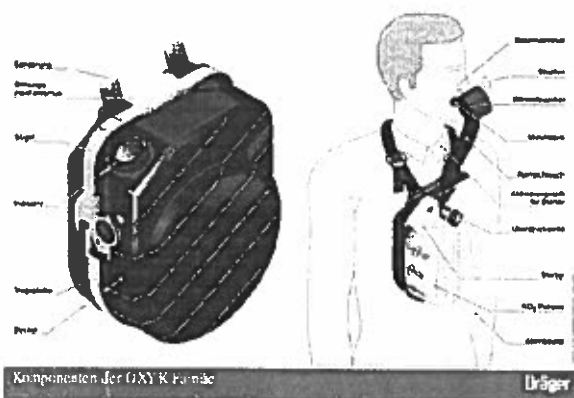
Time Allowed: 50 minutes

Total Marks = 30

1. (4 pts) Students at the University of Washington built a car propelled by compressed nitrogen gas (see <http://www.youtube.com/watch?v=uV5YsAdA9Lg> for a video of this car). The gas was obtained by boiling liquid nitrogen stored in a 182 L tank. Calculate the volume of $N_2(g)$ is released at 0.927 atm pressure and $25^\circ C$ from a full tank of liquid nitrogen (density of $N_2(l) = 0.808 \text{ g mL}^{-1}$).

$$1.38 \times 10^5 \text{ L}$$

2. (4 pts) Self-contained self-rescue emergency breathing devices are used in spacecraft, deep-sea diving, submarines, mines, and pretty much anywhere you might be trapped for some period of time without access to air. These devices, shown in the advertisement below, convert CO_2 into O_2 via the following reaction:



An average human adult takes about 15 breaths per minute, and exhales about 23 mL of CO_2 with each breath. If you're trapped in an air tight cave at 0.963 atm ambient pressure and 11°C , and your only source of oxygen is one of these breathing devices containing 1.0 kg of potassium superoxide (KO_2), how long do you have to live (in hours)?

8.22 h

3. For most practical purposes, nitrogen behaves as an ideal gas at room temperature and normal atmospheric pressures. However, at very high pressures, non-idealities become pronounced.

(a) (3 pts) Use the van der Waals equation to calculate the pressure of 300 mol of N_2 gas in a 20.0 L vessel at 20°C . The van der Waals constants for N_2 are $a = 1.39 \text{ L}^2 \text{ atm mol}^{-1}$, and $b = 0.0391 \text{ L mol}^{-1}$.

559 atm

(b) (2 pts) Use the ideal gas law to estimate the pressure under the same conditions.

361 atm

4. A space capsule contains a pressurized atmosphere of 79% N₂ and 21% O₂ (by mole %) at 822 torr and 25°C. A small particle of space dust moving at 25,000 mph strikes the capsule and punctures a tiny circular hole 0.030 mm in diameter, through which the atmosphere slowly leaks out.

(a) (2 pts) Calculate the partial pressure (in torr) of O₂ in the capsule

$$173 \text{ torr}$$

(b) (4 pts) Derive an equation for the Z_{wall} of O₂ in terms of partial pressure of O₂ (p_{O_2}) and other KNOWN quantities. Your equation MUST NOT contain V, N, or n, since you don't know these values.

$$Z_w = \frac{p_{\text{O}_2} N_A}{4RT} \left(\frac{8RT}{\pi M_{\text{O}_2}} \right)^{1/2}$$

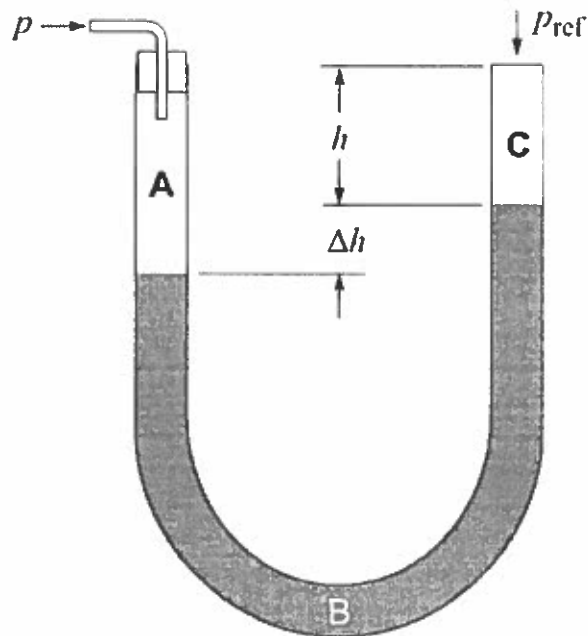
(c) (3 pts) If your equation above is correct, you should get $Z_{\text{wall}}(\text{O}_2) = 2.48 \times 10^{27} \text{ s}^{-1} \text{ m}^{-2}$. Calculate the effusion rate of O₂ through the hole.

$$\text{Rate} = 1.753 \times 10^{18} \text{ s}^{-1}$$

(d) (2 pts) If 24 g of O₂ leaks out of the capsule, the astronaut will die. How long does he have to live (in hours)?

$$71.6 \text{ h}$$

5. An open-ended manometer is connected to a gas filled vessel, as shown in the diagram below.



The gas exerts pressure p on side A of the tube. Side C is exposed to ambient barometric pressure (p_{ref}) of 775 torr. Section B is filled with mercury. Height $h = 142$ mm, $\Delta h = 27$ mm, and the inside diameter of the tube is 1.00 cm.

(a) (2 pts) What is the pressure of the gas in the vessel?

802 torr

(b) (4 pts) What is the total force (in newtons) the gas is exerting on the mercury in side A?

8.39 N

Equations

$$PV = nRT$$

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

$$\Delta U = q + w$$

$$\bar{u} = \left(\frac{3RT}{M} \right)^{1/2}$$

$$H = U + PV$$

$$w = - \int PdV$$

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

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

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

$$E = mc^2$$

$$E = hv$$

Fundamental Constants

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

$$g = 9.807 \text{ m s}^{-2}$$

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

$$c = 2.998 \times 10^8 \text{ m s}^{-1}$$

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

$$h = 6.626 \times 10^{-34} \text{ J s}$$

$$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1} = 0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1}$$

$$m_e = 9.109 \times 10^{-31} \text{ kg}$$

$$m_p = 1.673 \times 10^{-27} \text{ kg}$$

$$k = 1.381 \times 10^{-23} \text{ J K}^{-1}$$

Useful Data

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

$$\rho_{\text{H}_2\text{O}(l)} = 1.00 \text{ g cm}^{-3}$$

hydrogen 1 1.00794	helium 2 4.00260																
lithium 3 6.941	beryllium 4 9.0122																
sodium 11 22.98976928	magnesium 12 24.304																
potassium 19 39.0983	calcium 20 40.078																
rubidium 37 85.4678	strontium 38 87.62																
cesium 55 132.90545196	barium 56 137.327																
francium 87 [223]	radium 88 [226]																
		scandium 21 44.955912	titanium 22 47.867	vanadium 23 50.9415	chromium 24 51.9961	manganese 25 54.938045	iron 26 55.845	cobalt 27 58.933195	nickel 28 58.6934	copper 29 63.546	zinc 30 65.38	gallium 31 69.723	germanium 32 72.61	arsenic 33 74.9216	selenium 34 78.95	bromine 35 79.904	krypton 36 83.80
		yttrium 39 88.905848	zirconium 40 91.224	niobium 41 92.90638	molybdenum 42 95.94	technetium 43 [98]	ruthenium 44 101.07	rhodium 45 102.9055	palladium 46 106.42	silver 47 107.8682	cadmium 48 112.411	indium 49 114.818	tin 50 118.710	antimony 51 121.757	tellurium 52 127.60	iodine 53 126.905	xenon 54 131.29
		barium 56 137.327	lanthanum 57-70 [138.90547]	cerium 58 140.12	praseodymium 59 140.90765	neodymium 60 144.242	promethium 61 [144.9126]	samarium 62 150.35	europium 63 151.964	gadolinium 64 157.25	terbium 65 158.92535	dysprosium 66 162.50	holmium 67 164.93032	erbium 68 167.259	thulium 69 168.93032	ytterbium 70 173.045	radon 86 [222]
		actinium 89 [227]	thorium 90 232.0377	protactinium 91 231.03688	uranium 92 238.02891	neptunium 93 [237]	plutonium 94 [244]	americium 95 [243]	curium 96 [247]	berkelium 97 [247]	californium 98 [251]	einsteinium 99 [252]	mendelevium 100 [258]	fermium 101 [257]	meitnerium 102 [261]	nobelium 102 [261]	roentgenium 108 [268]
		bohrium 107 [264]	hassium 108 [265]	tennessium 109 [269]	darmstadtium 110 [271]	roentgenium 111 [272]	copernicium 112 [285]	nihonium 113 [284]	flerovium 114 [289]	moscovium 115 [288]	livermorium 116 [293]	tennessium 117 [294]	oganessonium 118 [294]	unbinilium 119 [293]	unseptilium 120 [293]	unhennium 121 [293]	unquadium 122 [293]

* Lanthanide series

* * Actinide series

Name (in ink) _____

Student Number (in ink) _____

Fall 2013 SC/CHEM 1000 A - Quiz #2

October 24, 2013

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.

Time Allowed: 50 minutes

Total Marks = 30

1. A 104 kg fullback runs the 40 yd dash at a measured speed of $31.4 \pm 0.16 \text{ km h}^{-1}$.

(a) (2 pts) What is his de Broglie wavelength in meters?

$$7.31 \times 10^{-37} \text{ m}$$

(b) (2 pts) What is the uncertainty (in meters) in his position at the moment the measurement was taken (0.16 km h^{-1} is the uncertainty in his measured speed)?

$$1.1 \times 10^{-35} \text{ m}$$

(c) (2 pts) If the fullback weighed as much as an electron ($9.109 \times 10^{-31} \text{ kg}$), what would be the uncertainty (in meters) in his position at the moment the measurement was taken?

$$1.3 \times 10^{-3} \text{ m}$$

2. The human eye is a complex sensing device for light in the range $390 \text{ nm} \leq \lambda \leq 750 \text{ nm}$. The optic nerve needs a minimum of $2.0 \times 10^{-17} \text{ J}$ of energy to trigger a series of impulses the eventually reach the brain.

(a) (2 pts) How many photons of red light (705 nm) are needed?

71 photons

(b) (2 pts) How many photons of blue light (475 nm) are needed?

48 photons

3. 1.00 mol of neon gas is confined within a cylinder by a piston. The gas is then heated from 0°C to 819°C and the piston moves upwards, maintaining a constant pressure of 1.00 atm. The molar heat capacity of $\text{Ne}(\text{g})$ at constant pressure is $20.8 \text{ J mol}^{-1} \text{ K}^{-1}$.

(a) (1 pt) How much heat (in joules) was required for this process?

$$1.70 \times 10^4 \text{ J}$$

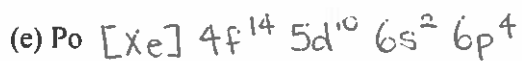
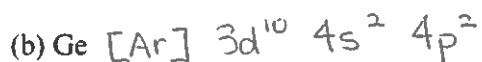
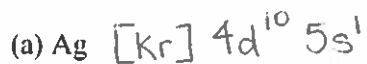
(b) (2 pts) Calculate the work done by the expanding gas in joules.

$$-6.81 \times 10^3 \text{ J}$$

(c) (2 pts) What would be the final temperature of the gas if the same amount of heat was added, but the piston was not allowed to move (thus, the pressure rises)?

$$1365^{\circ}\text{C}$$

4. (4 pts) Write the electron configuration (in *spdf* notation) for each of the following atoms in their ground states.



5. (4 pts) Identify which of the following combinations of quantum number are allowed and which are not. If a combination is NOT allowed, show what's wrong. I'll do the first one for you as a sample.

n	l	m	allowed?	what's wrong?
0	1	+1	no	n = 0
2	0	-1	NO	m > l
4	3	-1	YES	
3	1	0	YES	
5	2	+3	NO	m > l
2	2	+1	NO	l = m
7	1	+2	NO	m > l
3	1	-2	NO	m > l
3	-1	0	NO	l < 0

6. (5 pts) Charcoal is primarily elemental carbon. Determine the mass of CO_2 produced by burning enough carbon to produce 5.00×10^2 kJ of heat. The enthalpy of formation of $\text{CO}_2(\text{g})$ is $-393.5 \text{ kJ mol}^{-1}$.

55.9 g CO_2

7. (2 pts) For each of the following electron configurations for neutral atoms, identify if it represents a ground or excited state.

(a) [Ar] $3d^3 4s^2 4p^1$ EXCITED

(b) [Ne] $3s^2 3p^1$ GROUND

(c) [Ne] $3s^2 3p^6 3d^1$ EXCITED

(d) [Ar] $3d^{10} 4s^1$ GROUND

Equations

$$PV = nRT$$

$$\Delta U = q + w$$

$$H = U + PV$$

$$w = - \int PdV$$

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

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

$$E = mc^2$$

$$E = hv$$

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

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

$$\bar{u}_{RMS} = \left(\frac{3RT}{M} \right)^{1/2}$$

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

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

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

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

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

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

$$r_{cub} = 0.732R \quad r_{T_2} = 0.225R$$

$$r_{trig} = 0.155R \quad r_{O_2} = 0.414R$$

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

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

Fundamental Constants

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

$$g = 9.807 \text{ m s}^{-1}$$

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

$$c = 2.998 \times 10^8 \text{ m s}^{-1}$$

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

$$h = 6.626 \times 10^{-34} \text{ J s}$$

$$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1} = 0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1}$$

$$m_e = 9.109 \times 10^{-31} \text{ kg}$$

$$m_p = 1.673 \times 10^{-27} \text{ kg}$$

$$k = 1.381 \times 10^{-23} \text{ J K}^{-1}$$

Useful Data

$$S_{H_2O} = 4.184 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$$

$$S_{ice} = 2.01 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$$

$$\Delta H_v^0 (\text{H}_2\text{O}) = 44.0 \text{ kJ mol}^{-1}$$

$$\Delta H_{fus}^0 (\text{H}_2\text{O}) = 6.01 \text{ kJ mol}^{-1}$$

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

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

Name (in ink) _____

Student Number (in ink) _____

Fall 2013 SC/CHEM 1000 A - Quiz #3

November 21, 2013

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.

Time Allowed: 50 minutes

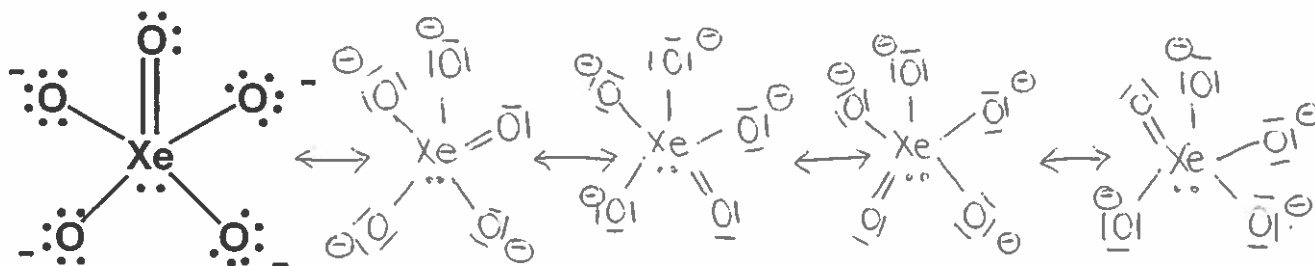
Total Marks = 30

1. (4 pts) The commercial product known as OxyClean is a mild bleach that oxidizes extensively delocalized organic molecules – the kind of molecule most commonly responsible for household stains. OxyClean is simply sodium percarbonate. The percarbonate ion is CO_4^{2-} . Draw the most plausible Lewis structure for percarbonate, relaxing as many degrees of charge separation as possible. Your structure **MUST** include all lone pairs, any equivalent resonance structures, and all formal charges on each atom.



2. A chemist theorizes that pentaoxoxenate ion, XeO_5^{4-} , might be possible to exist. She claims the molecule should have all 5 oxygen atoms equivalent to each other through 5 equivalent resonance structures, enhancing its stability.

(a) (1 pt) In her Lewis diagram below, draw the other four resonance structures.



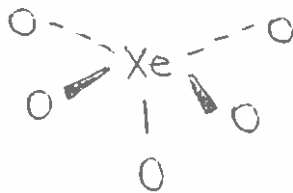
(b) (1 pt) Her Lewis structure contains 4 O^- atoms and one O atom with a 0 formal charge. But all four oxygens are equivalent, and therefore should have the same charge. With all 5 resonance structures taken together, what would that charge be?

$$-\frac{4}{5}$$

(c) (2 pts) Use VSEPR theory to predict the 3-dimensional shape of the XeO_5^{4-} ion. What is the local symmetry of the Xe atom?

O_h

(d) (2 pts) Please draw the ion below using the conventional dotted and exploded line representations for the three dimensionality.

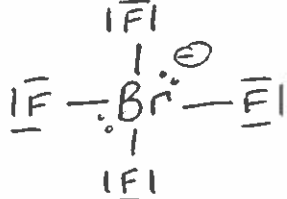


(e) (2 pt) What is the orbital hybridization on the Xe atom?

sp^3d^2

3. Consider the tetrafluorobromate ion, BrF_4^- .

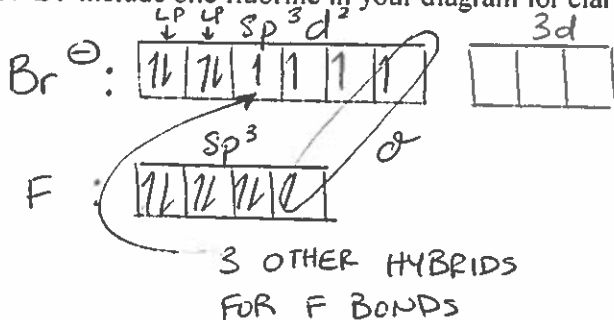
(a) (2 pts) Draw the Lewis structure for this ion.



(b) (1 pt) Which atom carries the negative charge?

Br

(c) (3 pts) Draw a Valence Bond Theory diagram (the little boxes with electron arrows to represent hybrids and orbitals) for this ion. Since all four fluorine atoms are equivalent, please ONLY include one fluorine in your diagram for clarity.



(d) (3 pts) Draw the best VSEPR structure for BrF_4^- , making sure your structure is the one that minimizes electron repulsions. Make sure you draw the structure using dotted and exploded lines to properly represent the three dimensionality.



SQUARE PLANAR
GEOMETRY MINIMIZES
LP-LP INTERACTIONS

4. (3 pts) Predict which of the following species will be diamagnetic and which will be paramagnetic.

- (a) O^{2-} DIA
- (b) Co^{3+} PARA
- (c) ln^+ DIA
- (d) Zn^{2+} DIA
- (e) NO PARA
- (f) NO_2 DIA

5. (2 pts) Identify which of the following molecules will have an exactly zero dipole moment.

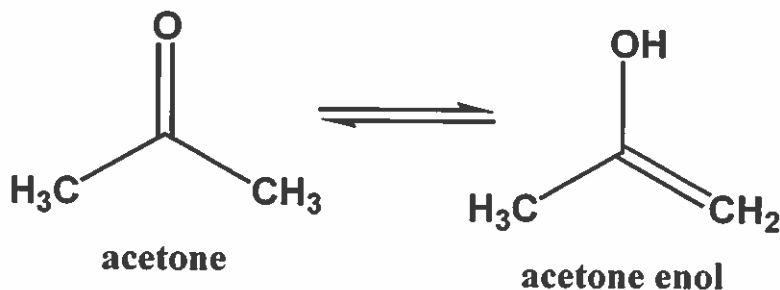
(a) formaldehyde (H_2CO)

(b) CO_2

(c) oxygen difluoride (F_2O)

(d) beryllium difluoride (BeF_2)

6. (4 pts) All ketones are in equilibrium with their enol form, as shown below for acetone.



The equilibrium greatly favors the ketone form. Nevertheless, organic chemists believe that many reactions of ketones actually occur through their enol. Using the table of bond dissociation energies provided in this quiz, please estimate the enthalpy of the above tautomerization between acetone and its enol (in other words, the ΔH^0 of the above reaction).

$$+ 62 \text{ kJ mol}^{-1}$$

Equations

$$PV = nRT$$

$$\Delta U = q + w$$

$$H = U + PV$$

$$w = - \int P dV$$

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

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

$$E = mc^2$$

$$E = hv$$

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

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

$$\bar{u}_{RMS} = \left(\frac{3RT}{M} \right)^{1/2}$$

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

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

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

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

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

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

$$r_{cub} = 0.732R \quad r_{T_2} = 0.225R$$

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

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

Fundamental Constants

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

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

$$c = 2.998 \times 10^8 \text{ m s}^{-1}$$

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

$$h = 6.626 \times 10^{-34} \text{ J s}$$

$$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1} = 0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1}$$

$$m_e = 9.109 \times 10^{-31} \text{ kg}$$

$$m_p = 1.673 \times 10^{-27} \text{ kg}$$

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Useful Data

$$S_{H_2O} = 4.184 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$$

$$S_{ice} = 2.01 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$$

$$\Delta H_v^0(\text{H}_2\text{O}) = 44.0 \text{ kJ mol}^{-1}$$

$$\Delta H_{fus}^0(\text{H}_2\text{O}) = 6.01 \text{ kJ mol}^{-1}$$

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

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

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

General Chemistry CHEM 1000

Student ID: _____

Student Name: _____

FIRST TEST

CHEM 1000-B

OCTOBER 01, 2013

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.
All answers must be in ink.

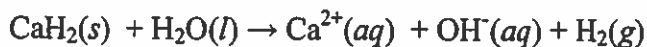
This test has 7 pages
Total Marks are 30

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

- Q.1.a) The pressurized habitat of a Moon colony contains air at a pressure sufficient to raise a 76.0 cm column of mercury in a barometer on Earth. **Estimate the height of the column of mercury in a barometer that operates inside the habitat.** The acceleration of the Moon's gravity is only 0.165 times as large as that of the Earth's. [3]

4.61 m

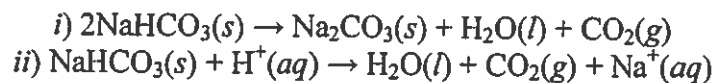
- b) The binary compound of alkali and alkali-earth metals and hydrogen reacts with water to liberate $\text{H}_2(\text{g})$. The H_2 from the reaction of a sample of CaH_2 with an excess of water fills a volume of 0.490 L above the water. The temperature of the gas is 35°C and the total pressure is 758 Torr. **Determine the mass of H_2 liberated and the mass of CaH_2 that reacted.** Vapor pressure of H_2O at $35^\circ\text{C} = 42.25 \text{ mmHg}$ [5]
The **unbalanced** equation for the reaction is given below:



$$\text{mass H}_2 = 0.0365 \text{ g} \approx 0.037 \text{ g}$$

$$\text{mass CaH}_2 = 0.384 \text{ g}$$

Q.2.a) A baker uses sodium hydrogen carbonate (baking soda) as the leavening agent in a banana nut quick bread. The baking soda decomposes according to two possible reactions:



Calculate the volume (in mL) of CO_2 that form at 200°C and 0.975 atm per gram of NaHCO_3 by each of the reaction processes. [4]

$$i) \quad V = 237 \text{ mL}$$

$$ii) \quad V = 474 \text{ mL}$$

b) Suppose you have a 22L cylinder of helium at a pressure of 152 bar and a temperature of 31°C . How many balloons can you fill, each with a volume of 5.0 L, on a day when the atmospheric pressure is 1.00 bar and the temperature is 22°C ? [3]

649 balloons

Q.3.a) A 1.005 g sample of an unknown gas with empirical formula CH_2 , exerts a pressure of 95.3 kPa in a 371 mL container at 23°C . What is the molar mass and molecular formula of the gas? [4]

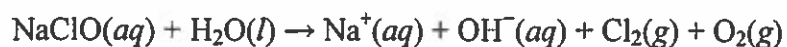
70.0 g/mol

C_5H_{10}

b) At a given pressure and temperature, it takes 4.85 min for 1.5 L sample of He to effuse through a membrane, How long does it take for 1.5 L of F_2 to effuse under the same conditions? [3]

14.9 min.

Q.4.a) House hold bleach (e.g. Javex) contains sodium hypochlorite (NaOCl), that decomposes in water according to the following **unbalanced equation**.



If a 15 mL aqueous bleach sample containing 5.45% NaOCl is allowed to decompose completely than **how many mL of O₂(g)** at 22°C and 755 mmHg can be liberated. Density of aqueous bleach solution is 1.12 g/mL. [4]

74.9 mL

b) In an environmental laboratory an urban air sample was brought in for analysis. The chemist found that it contained 78.08% N₂, 20.95% O₂, 0.93% Ar, and 0.036% CO₂. He recorded a barometric pressure of 748 mmHg. **Calculate partial pressures of each gas in the air sample.** [4]

$$P_{\text{N}_2} = 584 \text{ mmHg}$$

$$P_{\text{O}_2} = 157 \text{ mmHg}$$

$$P_{\text{CO}_2} = 0.27 \text{ mmHg}$$

$$P_{\text{Ar}} = 7.0 \text{ mmHg}$$

$$R = 8.314472 \text{ JK}^{-1} \text{ mol}^{-1} = 0.0820574 \text{ L atm K}^{-1} \text{ mol}^{-1} = 8.314472 \text{ m}^3 \text{ Pa mol}^{-1} \text{ K}^{-1} = 62.364 \text{ L Torr K}^{-1} \text{ mol}^{-1}$$

$$1 \text{ inch} = 2.54 \text{ cm} \quad 1 \text{ cm}^3 = 1 \text{ mL}; \quad 1 \text{ Nm}^2 = 1 \text{ Pa}$$

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

$$1 \text{ standard atmosphere} = 1.013 \times 10^5 \text{ Pa} = 760 \text{ Torr (mmHg)} = 1.013 \text{ bar} \quad d_{\text{Hg}} = 13.6 \text{ g/mL}$$

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

$$\text{Acceleration due to gravity (Earth): } 9.807 \text{ m/s}^2$$

$$\text{rate of effusion} = Z_w \cdot A$$

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

respectively

$$u_{\text{rms}} = \sqrt{\frac{3RT}{M}} \quad u_{\text{av}} = \sqrt{\frac{8RT}{\pi M}} \quad u_m = \sqrt{\frac{2RT}{M}}$$



WebElements: the periodic table on the world-wide web

www.webelements.com

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Hydrogen 1 H	Helium 2 He											Boron 5 B	Carbon 6 C	Nitrogen 7 N	Oxygen 8 O	Fluorine 9 F	Neon 10 Ne	
Lithium 3 Li	Beryllium 4 Be											Aluminum 13 Al	Silicon 14 Si	Phosphorus 15 P	Sulfur 16 S	Chlorine 17 Cl	Argon 18 Ar	
Sodium 11 Na	Magnesium 12 Mg											Gallium 31 Ga	Germanium 32 Ge	Arsenic 33 As	Selenium 34 Se	Bromine 35 Br	Krypton 36 Kr	
Potassium 19 K	Calcium 20 Ca											Copper 29 Cu	Nickel 28 Ni	Cobalt 27 Co	Iron 26 Fe	Manganese 25 Mn	Chromium 24 Cr	
Rubidium 37 Rb	Sr 38 Sr											Ag 47 Ag	Pd 46 Pd	Rh 45 Rh	Ru 44 Ru	Tc 43 Tc	Molybdenum 42 Mo	
Cesium 55 Cs	Ba 56 Ba											Au 79 Au	Pt 78 Pt	Ir 77 Ir	Os 76 Os	Re 75 Re	W 74 W	
Francium 87 Fr	Ra 88 Ra											Ds 110 Ds	Rg 109 Rg	Mt 108 Mt	Hs 107 Hs	Bh 106 Bh	Sg 105 Sg	
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General Chemistry CHEM 1000

Student ID: _____

Student Name: _____

SECOND TEST

CHEM 1000-B

OCTOBER 22, 2013

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.
All answers must be in ink.

This test has 7 pages
Total Marks are 30

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

Q.1.a) A research chemist working with gaseous samples held a sample of an inert gas in a cylinder with a moveable piston of 16.0 cm^2 cross sectional area. The piston that was initially held at 250.0 cm mark moved to 500.0 cm mark when gas was allowed to expand at a constant temperature. Calculate the work (in Jules) done by the gas if it expands (i) against a vacuum and (ii) against a constant external pressure of 102 bar. [4]

$$i) W = 0$$

$$ii) W = 4.08 \times 10^4 \text{ J}$$

b) During the manufacture of sulfuric acid, SO_2 is oxidized to SO_3 according to the following thermo-chemical equation:



Calculate the heat released when 74.6 g of SO_2 is converted to SO_3 under constant-pressure (1 bar) condition. [2]

$$-115 \text{ kJ}$$

Q.2.a) A quantity of 1.435 g of naphthalene ($C_{10}H_8$), a pungent-smelling substance used in moth repellents, was burned in a constant-volume bomb calorimeter. Consequently, the temperature of the water rose from 20.28°C to 25.95°C . If the heat capacity of the bomb plus water was $10.17 \text{ kJ}^\circ\text{C}$. Calculate the heat of combustion of naphthalene on a molar basis. [4]

$$-5.151 \times 10^3 \frac{\text{kJ}}{\text{mol}}$$

b) Pentaborane (B_5H_9) is a colorless, highly reactive liquid that will burst into flame or even explode when exposed to oxygen. The reaction is as follows:



In the 1950's, Pentaborane was considered as a potential rocket fuel because it produces a large amount of heat per gram. However, the solid B_2O_3 formed by the combustion of B_5H_9 is an abrasive that would quickly destroy the nozzle of the rocket, and so the idea was abandoned.

Calculate the kJ of heat released per gram of the compound reacted with oxygen. [4]

$$\Delta H_f^\circ \text{ for } B_5H_9 = 73.2 \text{ kJ/mol.}$$

$$\Delta H_f^\circ (B_2O_3) = -1273.5 \text{ kJ/mol}$$

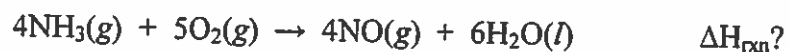
$$\Delta H_f^\circ (H_2O) = -285.8 \text{ kJ/mol}$$

$$72.0 \frac{\text{kJ}}{\text{g}}$$

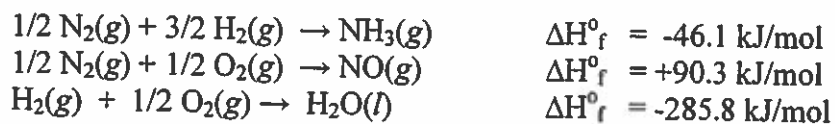
Q.3.a) Calculate the amount of energy (in kJ) needed to heat 346 g of liquid water from 0°C to 182°C. Assume that the specific heat capacity of water is 4.184 J/g.C over the entire liquid range and that the specific heat of steam is 1.99 J/g.°C. [4]
 $\Delta H_{\text{vap}}(\text{H}_2\text{O}) = 40.79 \text{ kJ/mol}$

985 kJ

b) Ammonia reacts with oxygen to form NO, a toxic gas according to the following reaction:



Calculate enthalpy of the above reaction. [4]



-1169.2 kJ

Q.4.a) Suppose you mix together 50.0 mL of 1.00 M HCl with 60.0 mL of 1.00 M NaOH in a coffee cup calorimeter. The initial temperature of the solutions was 23.5°C. Following the reaction, the final temperature was 29.5°C. Calculate ΔH for this reaction per mole of acid that reacts. Assume that the densities of all of the solutions are 1.0 g/mL and that their specific heat capacities are 4.18 J/g.K. [4]

$$-56 \frac{\text{kJ}}{\text{mol HCl}}$$

b) Barcode readers are commonly used in grocery stores and many other places to track the inventory and to process orders. The red light emitted by a barcode scanner has a frequency of $4.62 \times 10^{14} \text{ s}^{-1}$. Calculate the wavelength of this light (in nm) and its energy. [4]

$$\lambda = 649 \text{ nm}$$

$$E = 3.06 \times 10^{-19} \text{ J}$$

12 inch = 1 ft 1 lb = 453.59 g 1.6 km = 1 mile

1 Cal = 1 kcal = 4.184 kJ

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

0°C = 273.15K 1 cm³ = 1 mL, k = 1.38066×10^{-23} JK⁻¹ 1 inch = 2.54 cm

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

q = mcΔT Volume of cylinder = A x h 1 nm = 10^{-9} m

c = vλ E = hν c = 3.0×10^8 m/s h = 6.626×10^{-34} J.s

ΔH = ΔU + PΔV q_{cal} = C_{cal} x ΔT ΔU = q + w

General Chemistry CHEM 1000

Student ID: _____

Student Name: _____

THIRD TEST

CHEM 1000-B

NOVEMBER 19, 2013

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 7 pages
Total Marks are 30**

Question	Question 1	Question 2	Question 3	Question 4	Total
Grade	7	6	8	9	30
Marks					

- Q.1.a) Microwave ovens work by irradiating food with microwave radiation, which is absorbed and converted into heat. Assuming that radiation with $\lambda = 15.0$ cm is used, that all the energy is converted to heat, and that 4.184 J is needed to raise the temperature of 1.00 g of water by 1.00°C , how many photons are necessary to raise the temperature of a 350 mL cup of water from 20°C to 95°C . density of $\text{H}_2\text{O} = 1.00$ g/mL [4]

$$8.3 \times 10^{28} \text{ photons}$$

- b) Calculate percent ionic character in H-F and H-Br bond and predict which has higher ionic character? Dipole moment of HF = 1.86 D and for HBr = 0.82D. [3]
H-F = 91.7 pm, H-Br = 141.4 pm,

$$\% \text{ ionic character}_{\text{HF}} = 42.3 \%$$

$$\% \text{ ionic character}_{\text{HBr}} = 12.1 \%$$

Q.2.a) A minimum energy of $7.21 \times 10^{-19} \text{J}$ is required to produce the photoelectric effect in chromium metal.

a) what is the minimum frequency of light needed to remove an electron from chromium? [2]

$$1.09 \times 10^{15} \text{ s}^{-1}$$

b) In an experiment electrons in an hydrogen atom were promoted to higher energy states by shining a laser of appropriate wavelength. An electron from the excited state than emitted light of 434.1 nm falling in the visible portion of electromagnetic spectrum and returned to a lower state. What state electron was promoted to? [4]

electron was promoted to $n = 5$

Q.3.a) Which of the following ions are likely to form? Give reasoning.

[1]

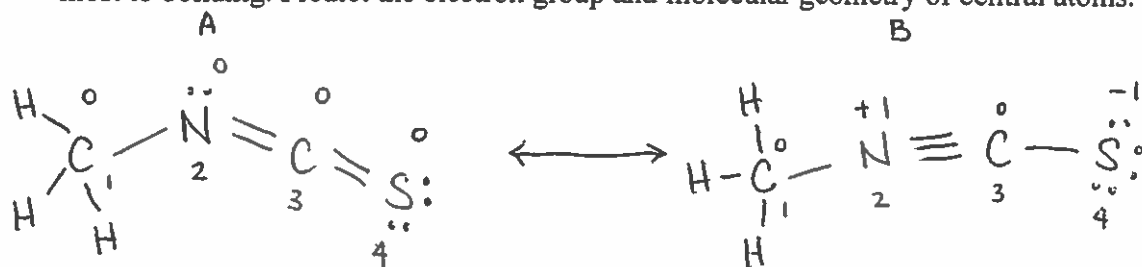
- i) S^{3-} unstable
- ii) Si^{2+} Reactive
- iii) Sr^{2+} will form stable ion, isoelectronic to Kr

b) An electron is moving at a speed of 8.0×10^6 m/s. If the uncertainty in measuring the speed is 1.0 percent of the speed, calculate the uncertainty in the electron's position. The mass of the electron is 9.1094×10^{-31} kg.

[3]

$$7.2 \times 10^2 \text{ pm}$$

c) Broccoli, cabbage, and kale contain compounds that break down in the human body to form isothiocyanates, whose presence may reduce the risk of certain types of cancer. The simplest isothiocyanates is methyl isothiocyanate, CH_3NCS . Draw the Lewis structure for CH_3NCS , including all resonance forms. Assign formal charges and determine which structure is likely to contribute the most to bonding. Predict the electron group and molecular geometry of central atoms. [4]



$$C_1 = Ax_4 \quad Td \quad 109.5^\circ$$

$$N_2 = Ax_2E \quad bent \quad 120^\circ$$

$$C_3 = Ax_2 \quad linear \quad 180^\circ$$

$$S_4 = Ax_2E_2$$

$$C_1 = Ax_4 \quad Td \quad 109.5^\circ$$

$$N_2 = Ax_2 \quad linear \quad 180^\circ$$

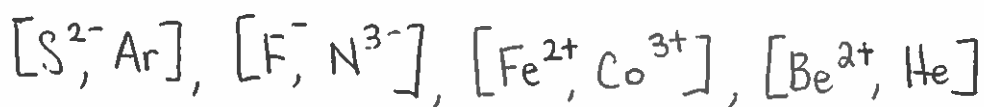
$$C_3 = Ax_2 \quad linear \quad 180^\circ$$

Structure A is more favoured.

Q.4.a) Ground state electron configurations listed here are incorrect. Explain what mistakes have been made in each and write the correct electron configurations. [1.5]

- i) $1s^2 2s^2 2p^4 3s^2 3p^3$ e⁻ were filled in $n=3$ before $2p$ orbital, Al; [Ne] $3s^2 3p^1$
 ii) $1s^2 2s^2 2p^5$ too many e⁻ B; should have $1s^2 2s^2 2p^1$
 iii) $1s^2 2s^2 2p^6$ nobel element Ne configuration, not F; $1s^2 2s^2 2p^5$

b) Group the species that are isoelectronic: Be^{2+} , F^- , Fe^{2+} , N^{3-} , He, S^{2-} , Co^{3+} , Ar. [2]



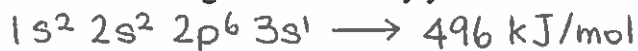
c) In the visible portion of the atomic emission spectrum of hydrogen, are there any bright lines due to electron transitions to the $n=1$ state? Explain your answer. [1]

NO transition $n_i \rightarrow n_1$ fall in UV region

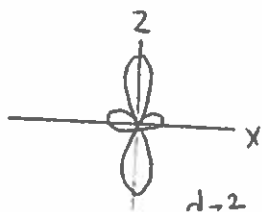
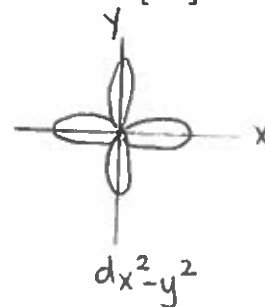
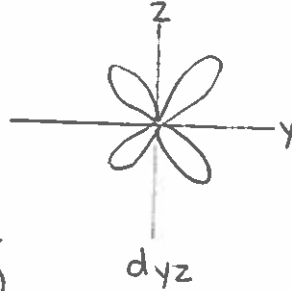
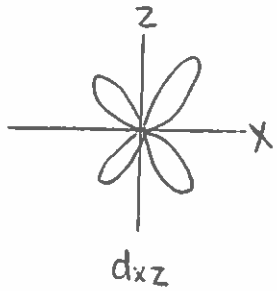
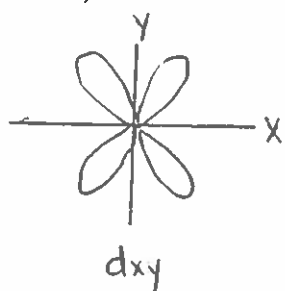
c) Tell which of the following combinations of quantum numbers are not allowed. Explain your answers. [1]

- a) $n=3, l=0, m_l=-1$ $l=0, m_l=0$
 b) $n=3, l=1, m_l=1$
 c) $n=4, l=4, m_l=0$ $n=4, l$ must be $n-1$

d) Two atoms have the electron configurations $1s^2 2s^2 2p^6$ and $1s^2 2s^2 2p^6 3s^1$. The first ionization energy of one is 2080 kJ/mol, and that of the other is 496 kJ/mol. Match each ionization energy with one of the given electron configurations. Justify your choice. [1]



e) Draw the shape of all d orbital with correct labels. [2.5]



1.6 km = 1 mile E_i = ionization energy

1 Cal = 1 kcal = 4.184 kJ, Specific heat of water = $4.184 \text{ J g}^{-1} \text{ } ^\circ\text{C}^{-1}$

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

$c = 3.00 \times 10^8 \text{ ms}^{-1}$ $1 \text{ m} = 10^9 \text{ nm} = 10^{10} \text{ \AA} = 10^{12} \text{ pm}$

$h = 6.626 \times 10^{-34} \text{ J.s} = 6.626 \times 10^{-34} \text{ kgm}^2/\text{s}$ electron charge = $1.602 \times 10^{-19} \text{ C}$ $\mu = \delta d$

mass of e = $9.11 \times 10^{-31} \text{ kg}$

$c = v\lambda$ $R_H = 2.179 \times 10^{-18} \text{ J}$

$$(\Delta x)(\Delta mv) \geq h/4\pi$$

$$1 \text{ DB} = 3.34 \times 10^{-30} \text{ coulomb.meter}$$

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



WebElements: the periodic table on the world-wide web

www.webelements.com

1	hydrogen 1 H	2	helium 2 He	3	lithium 3 Li	4	beryllium 4 Be	5	boron 5 B	6	carbon 6 C	7	nitrogen 7 N	8	oxygen 8 O	9	fluorine 9 F	10	neon 10 Ne	11	sodium 11 Na	12	magnesium 12 Mg	13	aluminum 13 Al	14	silicon 14 Si	15	phosphorus 15 P	16	sulfur 16 S	17	chlorine 17 Cl	18	argon 18 Ar		
19	potassium 19 K	20	calcium 20 Ca	21	scandium 21 Sc	22	titanium 22 Ti	23	vanadium 23 V	24	chromium 24 Cr	25	manganese 25 Mn	26	iron 26 Fe	27	cobalt 27 Co	28	nickel 28 Ni	29	copper 29 Cu	30	zinc 30 Zn	31	gallium 31 Ga	32	germanium 32 Ge	33	arsenic 33 As	34	selenium 34 Se	35	bromine 35 Br	36	krypton 36 Kr		
37	rubidium 37 Rb	38	strontium 38 Sr	39	yttrium 39 Y	40	zirconium 40 Zr	41	niobium 41 Nb	42	molybdenum 42 Mo	43	technetium 43 Tc	44	ruthenium 44 Ru	45	rhodium 45 Rh	46	palladium 46 Pd	47	silver 47 Ag	48	cadmium 48 Cd	49	indium 49 In	50	tin 50 Sn	51	antimony 51 Sb	52	tellurium 52 Te	53	iodine 53 I	54	xenon 54 Xe		
87	francium 87 Fr	88	radium 88 Ra	89-102	actinoids **	103	thorium 103 Th	104	protactinium 104 Pa	105	uranium 105 U	106	neptunium 106 Np	107	plutonium 107 Pu	108	americium 108 Am	109	curium 109 Cm	110	berkelium 110 Bk	111	californium 111 Cf	112	einsteinium 112 Es	113	fermium 113 Fm	114	mendelevium 114 Md	115	nobelium 115 No	116	lawrencium 116 Lr	117	tennessine 117 Ts	118	oganeson 118 Og

Key:
 element name
 atomic number
 symbol
 atomic weight [mean relative mass]

*lanthanoids

lanthanum 57 La	cerium 58 Ce	praseodymium 59 Pr	neodymium 60 Nd	promethium 61 Pm	europium 62 Eu	gadolinium 64 Gd	terbium 65 Tb	dysprosium 66 Dy	holmium 67 Ho	erbium 68 Er	thulium 69 Tm	ytterbium 70 Yb
actinium 89 Ac	thorium 90 Th	protactinium 91 Pa	uranium 92 U	neptunium 93 Np	plutonium 94 Pu	americium 95 Am	berkelium 97 Bk	californium 98 Cf	einsteinium 99 Es	fermium 100 Fm	mendelevium 101 Md	nobelium 102 No

**actinoids

Symbol 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 einsteinium and oganesson 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 6 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.

©2007 Dr Mark J Winter, Newcastle University and University of Sheffield; webelements@sheffield.ac.uk. All rights reserved. For updates to this table see http://www.webelements.com/extra/Printable_Periodic_Table_Version_data_21_September_2007/.

Name (in ink): _____

Student Number (in ink): _____

Fall 2013 SC/CHEM 1000 C - Quiz #1

October 1, 2013

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. A scuba diver releases a balloon containing 115 L of air from the ocean floor where the water temperature is 18°C. When the balloon reaches the water surface the balloon has expanded to a volume of 352 L. If the temperature of the water at the surface is 24°C and the atmospheric pressure is 1.05 atm, what is the pressure experienced by the diver at the ocean floor?

3.15 atm

Marks

- 4 2. Helium effuses twice as fast as a certain gaseous hydrocarbon at the same temperature. What is the probable molecular formula for this hydrocarbon?



- 5 3. A 30.0 mL flask contains 0.078 g of a gaseous oxide of sulfur at a pressure of 750 mmHg and a temperature of 22°C. Is this oxide SO_2 or SO_3 ? Your answer must be supported by a calculation to receive any credit.

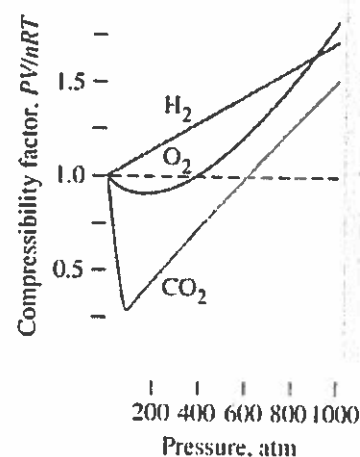


Marks

- 4 4. Calculate the root-mean-square speed of Ar atoms at a temperature at which the average kinetic energy is 5.18 kJ/mol.

509 m/s

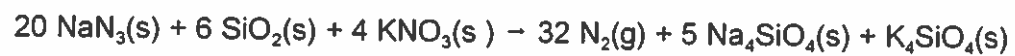
- 2 5. Using the diagram to the right, for which gas, H₂, O₂ or CO₂, is the effect of the volume occupied by the gas molecules more important than the intermolecular forces at a pressure of 200 atm? Briefly explain the reason for your choice.



H₂ → it shows a positive deviation from ideal behaviour

Marks

- 5 6. The following chemical equation describes the overall reaction that occurs in an automobile air bag:



Calculate how many grams of sodium azide, NaN_3 , are needed to inflate a 3.25 L bag to a pressure of 1.25 atm at a temperature of 22°C .

6.82 g

Marks

6 7. Give clear, concise answers to each of the following. Lengthy answers will NOT be marked.

a) Which one of the assumptions in the Kinetic Molecular Theory most readily explains the observation that gases are relatively easy to compress?

molecules occupy very little volume

(most of the container is empty space)

b) Use the Kinetic Molecular Theory to explain why a decrease in volume produces an increase in pressure for a gas at constant temperature.

decreasing the volume increases the number of collisions with the walls of the container and therefore increases the pressure (Note: the number of gas molecules and their energy does NOT change)

c) Dalton's law makes an assumption about intermolecular forces in a mixture of gases. What is it?

intermolecular forces are negligible

Reference Page for CHEM 1000C Quiz 1

Constants:

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

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

$$g = 9.80665 \text{ m s}^{-2}$$

$$1.00 \text{ atm} = 1.013 \times 10^5 \text{ Pa} = 760 \text{ Torr (mm Hg)}$$

$$1 \text{ mL} = 1 \text{ cm}^3$$

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

$$0^\circ\text{C} = 273.15 \text{ K}$$

$$\pi = 3.14159$$

$$\text{density of water} = 0.99707 \text{ g/mL @ } 25^\circ\text{C}$$

$$\text{density of mercury} = 13.5340 \text{ g/mL @ } 25^\circ\text{C}$$

$$1 \text{ inch} = 2.54 \text{ cm}$$

Equations:

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

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

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

$$\text{volume of a sphere} = \frac{4}{3} \pi r^3$$

$$\text{circumference of a sphere} = 2\pi r$$

$$\text{surface area of a sphere} = 4\pi r^2$$

$$\text{diameter of sphere} = 2r$$

$$\text{area of a circle} = \pi r^2$$

$$\text{circumference of a circle} = 2\pi r$$

$$\text{diameter of circle} = 2r$$

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

Name: _____

Student Number: _____

Fall 2013 SC/CHEM 1000 C - Quiz #2

October 22, 2013

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. a) Briefly define the term "state function".

A property that has a unique value when the state of the system is defined.

b) Under what conditions is the heat of reaction equal to ΔU ?

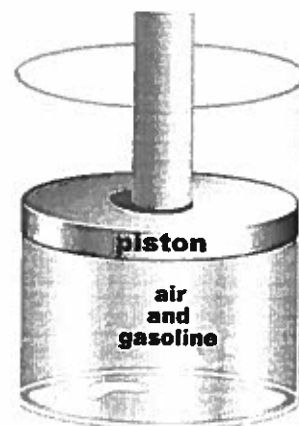
constant volume

c) Solid ice melts to liquid water without a change in temperature. Is this process endothermic, exothermic, or neither? WHY?

endothermic — thermal energy must be absorbed by the solid ice to overcome the attractive force that hold it together if it is to melt

Marks

- 4 2. Consider a mixture of air and gasoline vapour confined in a cylinder with a movable piston for a lid. Assume the combustion of this mixture provides 245 J of energy and all of this is converted into work to push up the piston (i.e. no heat is produced). If the initial volume of the gases in the cylinder was 45.0 cm³, to what volume will the gases expand if the piston moves against a constant external pressure of 0.727 atm?



3.37 L

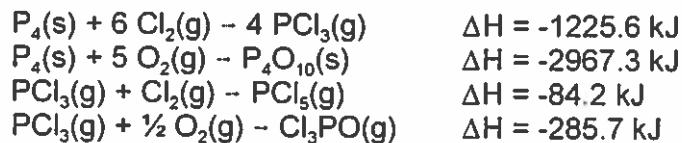
- 4 3. Calculate the change in internal energy for the following reaction at 1.00 atm and 25° C:



-563.5 kJ

Marks

5 4. Given the following data:

Calculate the ΔH for the following reaction:

- 610 kJ

- 4 5. The first ionization energy of gold is 890.1 kJ/mol. Is light with a wavelength of 225 nm capable of ionizing a gold atom in the gas phase? (In other words, can light of this wavelength remove an electron from a gold atom in the gas phase.) Show all of your calculations.

this light does not have enough energy
to remove an electron from gold

Marks

- 2 6. Provide two reasons why the Bohr Model is no longer accepted as an accurate description of the hydrogen atom.
Any 2 of the following may be used to answer the question
Reason 1:
- one quantum number is not sufficient to explain the trends in the Periodic Table
 - it cannot explain the "fine structure" in high resolution atomic spectra
- Reason 2:
- it cannot explain the effect of magnetic fields on atomic spectra
 - orbitals are spherical (i.e. 3D) not circular (i.e. 2D)
 - the Bohr model does not provide an explanation for the fixed, quantized orbits
- 4 7. Identify each of the following as either a ground state or excited state. Also identify the atom for each configuration.

electron configuration	excited or ground state?	atom identity
$1s^2 2s^2 3p^1$	excited	B
$1s^2 2s^2 2p^6$	ground	Ne
$1s^2 2s^2 2p^4 3s^1$	excited	F
$[Ar] 4s^2 3d^5 4p^1$	excited	Fe

- 3 8. a) Arrange the following atoms in order of size: Ga, Ge, In

Smallest	Intermediate	Largest
Ge	Ga	In

- b) Arrange the following atoms in order of first ionization energy: Rb, Be, Na

Smallest	Intermediate	Largest
Rb	Na	Be

- c) Arrange the following atoms in order of increasing electron affinity: P, Ge, Si

Smallest (least exothermic)	Intermediate	Largest (most exothermic)
Ge	Si	P

Reference Page for CHEM 1000C Quiz 2

Constants:

$$0^{\circ}\text{C} = 273.15 \text{ K}$$

$$1 \text{ mL} = 1 \text{ cm}^3$$

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

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

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

$$1.00 \text{ atm} = 1.013 \times 10^5 \text{ Pa} = 760 \text{ torr (mm Hg)}$$

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

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

$$a_0 = 53 \text{ pm}$$

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

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

Properties of Water:

$$\text{specific heat of H}_2\text{O(l)} = 4.184 \text{ J g}^{-1} \text{ }^{\circ}\text{C}^{-1}$$

$$\text{specific heat of H}_2\text{O(s)} = 2.11 \text{ J g}^{-1} \text{ }^{\circ}\text{C}^{-1}$$

$$\Delta H_f^{\circ}(\text{H}_2\text{O(l)}) = -285.8 \text{ kJ mol}^{-1} \text{ @ } 298\text{K}$$

$$\Delta H_f^{\circ}(\text{H}_2\text{O(g)}) = -241.8 \text{ kJ mol}^{-1} \text{ @ } 298\text{K}$$

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

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

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

Some Standard Enthalpies of Formation at 298K:

Substance	ΔH_f° (kJ/mol)
CO ₂ (g)	-393.5
C ₃ H ₈ (g)	-103.8

Atomic Weights (g/mol):

H 1.00794, C 12.0107, O 15.9994, N 14.00674, Mg 24.3050

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 (291)	

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)

Name: _____

Student Number: _____

Fall 2013 SC/CHEM 1000 C - Quiz #3

November 19, 2013

Calculators are permitted.

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

Time Allowed: 50 minutes

Total Marks = 30

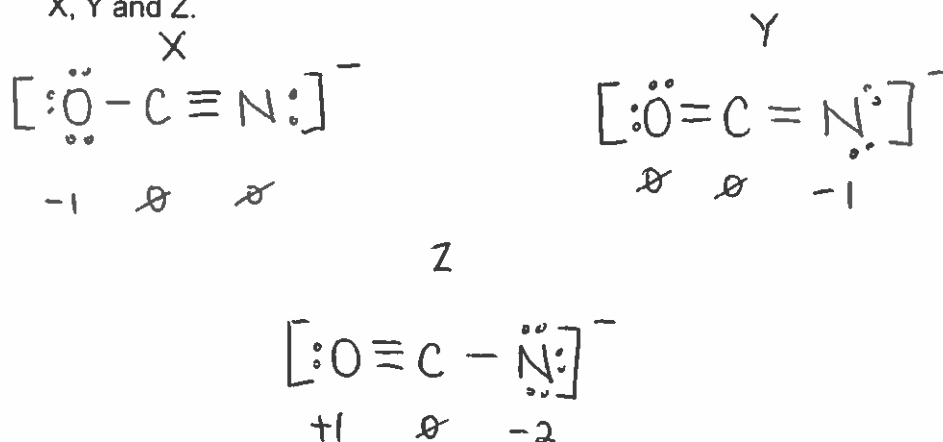
Marks

- 6 1. The molar heat of vaporization of a certain liquid is 9.933 kJ/mol. The vapour pressure of this liquid is 50.0 mmHg at -23.0 °C. At what temperature will the vapour pressure be 300.0 mmHg? Give your answer in °C.

127°C

Marks

- 5 2. a) Draw three resonance structures for OCN^- (carbon is the central atom in the structure; note that this is an anion). Show all lone pair electrons in the structure. Assign formal charges to the atoms in each structure. Label the three structures as X, Y and Z.



- b) Which one of the three structures is the most plausible one? (That is, is it structure X, Y or Z?).

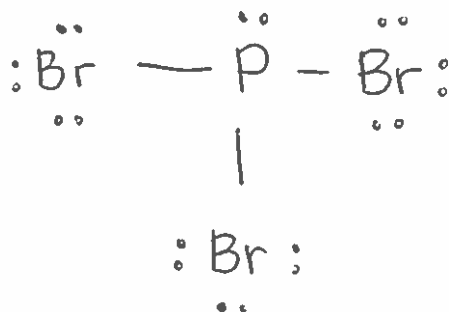


- c) Provide two reasons why the structure selected in part b is the most plausible one.

- the formal charges are as small as possible
- the negative charge is on the most electronegative element

Marks

- 5 3. a) Draw the most plausible Lewis structure for PBr_3 . Show all lone pair electrons in the structure.



b) What is the shape of this molecule? trigonal pyramidal

c) Is this molecule polar? yes

d) What is the ideal bond angle in this molecule? 109.5°

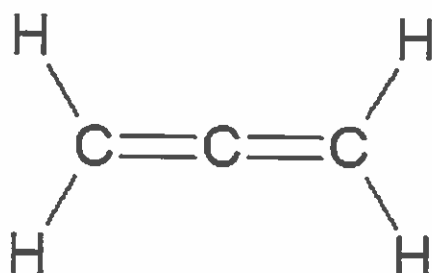
e) The bond angle measured in the molecule will differ from the ideal bond angle. Briefly explain how it will differ and why?

The measured bond angle will be less than the ideal bond angle because the repulsion between the lone pair of electrons on the P and the bonding pair electrons in P-Br is greater than the repulsions between the bonding pairs.

(i.e. $1p - bp > bp - bp$)

Marks

4 4. The allene molecule has the following Lewis structure:



a) What is the hybridization of the center carbon atom?

sp

b) Are the four hydrogen atoms in the same plane or is the CH₂ plane at one end of the molecule perpendicular to the CH₂ plane at the other end? Briefly explain your answer.

- CH₂ planes are perpendicular to one another
- the p-orbitals must overlap to form the π-bonds (i.e. the double bonds) and therefore they must be properly aligned; this is only possible if one set of p-orbitals is perpendicular to the other

c) Briefly describe the important distinctions between σ and π bonds.

A σ (i.e. sigma) bond forms along the internuclear axis (often involves the overlap of hybrid orbitals)

A π (i.e. pi) bond forms above and below the internuclear axis (it always involves the overlap of atomic orbitals; often "p" but sometimes "d" orbitals)

Marks

- 4 5. a) In a crystalline solid composed of nonpolar molecules, what would be the dominant type of intermolecular force?

London or dispersion forces

- b) If wet laundry is hung outside on a clothesline on a cold winter day, it will freeze. However, the clothes will eventually dry under these conditions. What process makes this possible?

sublimation

- c) What kind of molecules tend to have high polarizabilities? Provide two features of these molecules.

large and elongated

- d) Distinguish between intermolecular and intramolecular forces.

intermolecular forces are between molecules

intramolecular forces are within molecules

Marks

6 6. Aluminum crystallizes in a face-centered cubic structure. The radius of an aluminum atom is 143.1 pm.

a) What is the volume of the unit cell for aluminum in cm^3 ?

$$6.631 \times 10^{-23} \text{ cm}^3$$

b) What is the density of aluminum in g/cm^3 ?

$$2.703 \text{ g}/\text{cm}^3$$

Reference Page for CHEM 1000C Quiz 3

Constants:

$$0^{\circ}\text{C} = 273.15 \text{ K}$$

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

$$1.00 \text{ atm} = 1.013 \times 10^5 \text{ Pa} = 760 \text{ torr (mm Hg)}$$

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

Atomic Weights (g/mol):

H 1.0079, C 12.011, N 14.0067, O 15.9994, Al 26.9815

Some Average Bond Energies:

Bond	Bond Energy (kJ/mol)	Bond	Bond Energy (kJ/mol)	Bond	Bond Energy (kJ/mol)	Bond	Bond Energy (kJ/mol)
H - H	436	C - C	347	C - N	305	N - N	163
H - C	414	C = C	611	C = N	615	N = N	418
H - N	389	C \equiv C	837	C \equiv N	891	N \equiv N	946

Periodic Table:

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	58 Ce 140.12	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	
87 Fr (223)	88 Ra (226)	89 Ac (227)	90 Th (232)	91 Pa (231)	92 U (238)	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)	

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)

Last Name (in ink): _____ First Name (in ink): _____

Student Number (in ink) _____

Fall 2013 SC/CHEM 1000 D – Quiz #1; October 03, 2013; 8:30am

Attention: Calculators are permitted but cannot be borrowed or exchanged during the quiz. Additional paper is not allowed. Calculations can be done in pencil but the final answers should be in ink.

Time Allowed: 50 minutes

Total Marks: 30

1. (8pts) A mixture of nitrogen and neon gases contains equal moles of each gas and has a total mass of 10.0 g. What is the density of this gas mixture at 500 K and 15.0 atm? Assume ideal gas behavior. Report the density in Kg/L.

0.008810 kg/L

2. (5pts) You are given an envelope containing a piece of magnesium and a piece of zinc with a total mass of 0.0833 grams and you are asked to calculate the mass of each individual piece. You threw both of the pieces of Mg and Zn in concentrated sulphuric acid, together at the same time and collect the generated H₂ gas (see the equations below). The volume of gas collected at 25.0°C and P = 755 torr is 59.74 mL. Calculate the mass of each piece of metal in the envelope (m_{Mg} and m_{Zn} while "m" denotes mass).



$$m_{\text{Mg}} = 0.0451 \text{ g}$$

$$m_{\text{Zn}} = 0.382 \text{ g}$$

3. (6pts) We have a container of a mixture of gases 1.03 mol of gas A and 0.97 mol of gas B with a total pressure of 680 torr. If we make a tiny hole on the container so that the gases can escape the container, gas A will have 0.76 mol and gas B will have 0.32 mol left in the container after 12 hours of gases leaking. During this time, pressure drops to 425 torr. a) What is the ratio of the molar masses of the two gas molecules (i.e. M_A/M_B). b) What is the ratio of the collision frequency of the molecules A and B? Assume that both molecules have the same diameter.

a) 0.217

b) 0.217

4. (3pts) In the European Organization for Nuclear Research known as CERN, 27 tons of krypton is used for one of the experiments. Although Kr is a rare and expensive gas, but its size makes it suitable for high-resolution experiments in physics. Considering that Kr is a noble gas, there is almost no intermolecular forces between its atoms. But what is the size of a Kr atom if a 1.09L cylinder of 1.87mol of Kr at CERN, exerts a pressure of 27500 Pa at 298 K? Consider that Kr atoms are spherical. Report the size in m^3 .

$$1.4889 \times 10^{-25} \text{ m}^3$$

5. a) (4pts) 0.97 mol of gas A occupies a volume of 1.8L and has a pressure of 650 mmHg at 32°C. Does gas A have an ideal behaviour? If not, does it show a positive deviation from ideal behaviour or a negative deviation? (show calculations) If the gas molecules do not occupy any space, are there any intermolecular forces between the molecules of this gas? (explain very briefly)

There are intermolecular forces, which reduce the pressure, causing negative deviation.

- b) (4pts) A molecule of H₂ can travel an average distance of 92nm before it collides with another H₂ molecule in a 2.09L container that has 0.87 mol of H₂(g) with a total pressure of 0.98atm. What is the temperature of the container in K? Assume the diameter of H₂ to be 1.09 angstrom.

$$T = 40 \text{ K}$$

Equations

$$PV = nRT$$

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

$$\frac{\text{rate of effusion of A}}{\text{rate of effusion of B}} = \frac{P_A \sqrt{M_B}}{P_B \sqrt{M_A}}$$

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

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

$$Z = \frac{PV}{nRT}$$

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

Universal Constants

$$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1} = 0.08205 \text{ L atm K}^{-1} \text{ mol}^{-1}$$

$$N_A = 6.022 \times 10^{23}$$

$$g = 9.807 \text{ m s}^{-1}$$

Useful Conversion Factors

$$T = ^\circ\text{C} + 274.15$$

$$1 \text{ pascal} = 0.00750061683 \text{ torr} = 9.86923267 \times 10^{-6} \text{ atm}$$

Useful Molar Masses

$$N = 14.004, \text{ Ne} = 20.180, \text{ Zn} = 65.38, \text{ Mg} = 24.305, \text{ H} = 1.008, \text{ Kr} = 83.798$$

Last Name (in ink): _____ First Name (in ink): _____

Student Number (in ink) _____

Fall 2013 SC/CHEM 1000 D – Quiz #2; October 24, 2013; 8:30am

Attention: Calculators are permitted but cannot be borrowed or exchanged during the quiz. Additional paper is not allowed. Calculations can be done by pencil but the final answers should be in ink.

Time Allowed: 50 minutes

Total Marks: 30

-
1. (4pts) By throwing a piece of sodium into an open beaker containing 30mL of water, the temperature of water increases from 25°C to 42°C. If the heat capacity of water is $4.184 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$, calculate the mass of sodium in grams.



Enthalpy of reaction for number of moles of Na is $-184.00 \text{ KJ mol}^{-1}$ and the density of water is 1.00 g mL^{-1} . Assume that the heat capacity of the surrounding is negligible.

0.267g

2. (3pts) a) Use the provided information to calculate the heat for the following reaction:
 $\text{CH}_4(\text{g}) + 4\text{Cl}_2(\text{g}) \rightarrow \text{CCl}_4(\text{l}) + 4\text{HCl}(\text{g})$

Reaction	ΔH°_f (kJ mol ⁻¹)
$\text{C}(\text{s}) + 2\text{H}_2 \rightarrow \text{CH}_4(\text{g})$	-74.8
$\text{C}(\text{s}) + 2\text{Cl}_2(\text{g}) \rightarrow \text{CCl}_4(\text{l})$	-106.4
$\frac{1}{2} \text{H}_2(\text{g}) + \frac{1}{2} \text{Cl}_2(\text{g}) \rightarrow \text{HCl}(\text{g})$	-92.3

$$-401 \text{ kJ/mol}$$

- (4pts) b) Use the bond energies given at the end of the quiz to calculate the heat of the same reaction.

$$-452 \text{ kJ/mol}$$

3. (6pts) In the following table, write the number of electrons that have the shown quantum numbers and specifications:

Element	$n = 3$	$l = 2$	$m_l = 0$	Number of unpaired electrons
Kr	18	10	16	0
Ti	10	2	12	2
Si	4	0	9	2
Se	18	10	15	2
Na	1	0	6	1
Cr	13	5	12	6

4. (4pts) From the list of atoms: Ca, N, Mg, Ne, Cl, S

a) Which one has the largest atomic radius?

Ca

b) Which one has the highest value for the first ionization energy?

Ne

c) Which one has the lowest value for the first ionization energy?

Ca

d) Which one has the highest electron affinity?

Cl

5. (4pts) In order to generate X-rays, a target (normally a piece of metal) is bombarded by high-velocity electrons. When these electrons collide with the target, they give their kinetic energy to the electrons in the orbitals of the metal atoms of the target and excite these electrons. Upon relaxation, these excited electrons emit their energy in the form of X-rays. If the wavelength of the X-ray photons emitted is 9.67nm, calculate the velocity of the electrons that were used to bombard the target. Assume that upon bombarding, all of the kinetic energy of the electrons is transferred to the electrons inside the target atoms.

$$6.72 \times 10^6 \text{ m/s}$$

6. (3pts) a) What would be the wavelength of the light photon that can be used to break a Br-Br bond? Use the bond energies given in the table at the end of the quiz.



$$6.1979 \times 10^{-7} \text{ m}$$

- (2pts) b) Is the wavelength of this light larger or smaller than the wavelength of the light needed to break a Cl-Cl bond? (No calculation needed)

Smaller (shorter) wavelength

Equations

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

$$\Delta H = \Delta U + P\Delta V$$

$$q = mc\Delta T$$

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

Constants

$$N_A = 6.022 \times 10^{23} \text{ mol}^{-1} \quad k = 1.38066 \times 10^{-23} \text{ J K}^{-1}$$

$$m_e \text{ (mass of electron)} = 9.10938291 \times 10^{-31} \text{ kg} \quad R_H = 2.179 \times 10^{-18} \text{ J}$$

$$h = 6.62606876 \times 10^{-34} \quad c = 2.99792458 \times 10^8 \text{ m s}^{-1}$$

$$0^\circ\text{C} = 273.15\text{K} \quad R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1} = 0.08205 \text{ L atm K}^{-1} \text{ mol}^{-1}$$

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

^aAlthough all data are listed with about the same precision (three significant figures), some values are actually known more precisely. Specifically, the values for the diatomic molecules H₂, HCl, HBr, HI, N₂ (N=N), O₂ (O=O), F₂, Cl₂, Br₂, and I₂ are actually bond-dissociation energies, rather than average bond energies.

^bThe value for the C=O bonds in CO₂ is 799 kJ mol⁻¹.

Last Name (in ink): _____ First Name (in ink): _____

Student Number (in ink) _____

Fall 2013 SC/CHEM 1000 D – Quiz #3; November 21, 2013; 8:30am

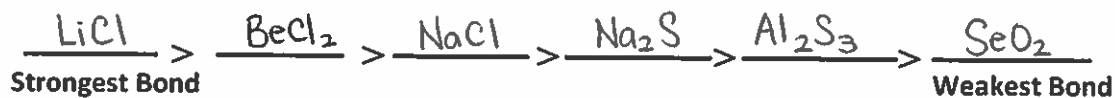
Attention: Calculators are permitted but cannot be borrowed or exchanged during the quiz. Additional paper is not allowed. Calculations can be done by pencil but the final answers should be in ink.

Time Allowed: 50 minutes

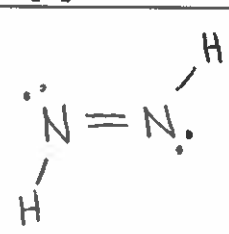
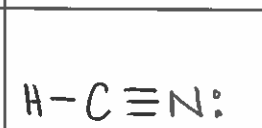
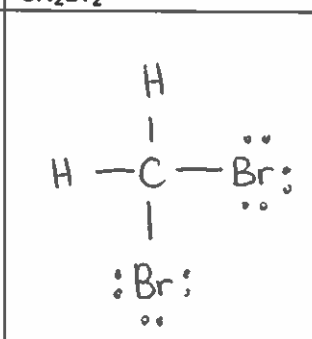
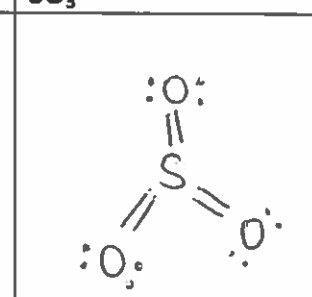
Total Marks: 30

1. (3pts) Arrange the following molecules based on the strength of the bonds between the two atoms forming the molecules. (Write down the arrangement by having the strongest bond on the left and the weakest one on the right; write on the template provided)

NaCl, LiCl, Na₂S, BeCl₂, Al₂S₃, SeO₂



2. (6pts) Draw the Lewis structure of the following molecules. (Only write in the provided box and only write the most stable structure. Show the resonance, if any).

N ₂ H ₂	HCN	CH ₂ Br ₂	SO ₃
			

3. (2.5pts) Arrange the following molecules based on their boiling points:

Br₂, NaCl, CH₃CH₂NH₂, N₂, CH₃OH

NaCl > CH₃OH > CH₃CH₂NH₂ > Br₂ > N₂
Highest Boiling Point Lowest Boiling Point

4. (8pts) Based on the information provided at the end of the quiz, calculate the lattice energy of CaCl₂(s) in kJ/mol. The overall reaction is as follows:



-1790 kJ/mol

5. (6pts) Calculate the boiling point temperature of Acetone (in Kelvin). Acetone has a vapour pressure of 200mmHg at 20°C. For Acetone ΔH_{vap} is 31.3 kJ/mol.

327.1 K

6. Answer the following questions based on the table below, which is describing the behaviour of Propane (C_3H_8):

Condition Number	Pressure of Propane (atm)	Temperature (°C)
1	1.00	-42.00
2	41.9 (Critical Pressure)	96.65 (Critical Temperature)

- a) (1pt) What state(s) is (are) available when Propane is at 25.00°C and has the pressure of 30.00atm?

Liquid

- b) (1pt) When at -42.00°C, which of the following pressures can liquefy the Propane gas? Circle the entire correct answer. If you need to revise your answer, draw a cross on the incorrect answer and write "correct" under the correct one.

1) 1.00atm 2) 12.50atm 3) 0.52atm 4) 0.66atm

- c) (2.5pts) How much of energy is needed to turn one mole of Propane from liquid to gas?

-1696.3 J/mol

Equations

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

Constants and Conversions

$$N_A = 6.022 \times 10^{23} \text{ mol}^{-1} \quad R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1} = 0.08205 \text{ L atm K}^{-1} \text{ mol}^{-1}$$

$$0^\circ\text{C} = 273.15\text{K} \quad 1 \text{ mmHg} = 0.00131578947 \text{ atm}$$

Useful Information



Ionization Energies (kJ/mol):

Ca 1st ionization energy=589.50

Ca 2nd ionization energy=1145.00

Electron Affinity (kJ/mol):

Cl 1st electron affinity=349.00

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
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H—S	368	C=N	615	N=O	590
H—F	565	C≡N	891	O—O	142
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H—I	297	C—Cl	339	Cl—Cl	244
				Br—Br	193
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^a Although all data are listed with about the same precision (three significant figures), some values are actually known more precisely. Specifically, the values for the diatomic molecules H₂, HCl, HBr, HI, N₂ (N=N), O₂ (O—O), F₂, Cl₂, Br₂, and I₂ are actually bond dissociation energies, rather than average bond energies.

^b The value for the C—O bonds in CO₂ is 799 kJ/mol.

The Periodic Table of the Elements

1	2																																																	
H Hydrogen 1.00794	He Helium 4.003																																																	
3	4	5	6	7	8	9	10																																											
Li Lithium 6.941	Be Beryllium 9.012182	B Boron 10.811	C Carbon 12.0107	N Nitrogen 14.00674	O Oxygen 15.9994	F Fluorine 18.9984032	Ne Neon 20.1797																																											
11	12	13	14	15	16	17	18																																											
Na Sodium 22.989770	Mg Magnesium 24.3050	Al Aluminum 26.981538	Si Silicon 28.0855	P Phosphorus 30.973761	S Sulfur 32.066	Cl Chlorine 35.4527	Ar Argon 39.948																																											
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36																																	
K Potassium 39.0983	Ca Calcium 40.078	Sc Scandium 44.955910	Ti Titanium 47.867	V Vanadium 50.9415	Cr Chromium 51.9961	Mn Manganese 54.938049	Fe Iron 55.845	Co Cobalt 58.933200	Ni Nickel 58.6934	Cu Copper 63.546	Zn Zinc 65.39	Ga Gallium 69.723	Ge Germanium 72.61	As Arsenic 74.92160	Se Selenium 78.96	Br Bromine 79.904	Kr Krypton 83.80																																	
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54																																	
Rb Rubidium 85.4678	Sr Strontium 87.62	Y Yttrium 88.90585	Zr Zirconium 91.224	Nb Niobium 92.90638	Mo Molybdenum 95.94	Tc Technetium (98)	Ru Ruthenium 101.07	Rh Rhodium 102.90550	Pd Palladium 106.42	Ag Silver 107.8682	Cd Cadmium 112.411	In Indium 114.818	Sn Tin 118.710	Sb Antimony 121.760	Te Tellurium 127.60	I Iodine 126.90447	Xe Xenon 131.29																																	
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86																																	
Cs Cesium 132.90545	Ba Barium 137.327	La Lanthanum 138.9055	Hf Hafnium 178.49	Ta Tantalum 180.9479	W Tungsten 183.84	Re Rhenium 186.207	Os Osmium 190.23	Ir Iridium 192.217	Pt Platinum 195.078	Au Gold 196.96655	Hg Mercury 200.59	Tl Thallium 204.3833	Pb Lead 207.2	Bi Bismuth 208.98038	Po Polonium (209)	At Astatine (210)	Rn Radon (222)																																	
87	88	89	104	105	106	107	108	109	110	111	112	113	114																																					
Fr Francium (223)	Ra Radium (226)	Ac Actinium (227)	Rf Rutherfordium (261)	Db Dubnium (262)	Sg Seaborgium (263)	Bh Bohrium (262)	Hs Hassium (265)	Mt Meitnerium (266)	Ds Darmstadtium (269)	Cn Copernicium (283)	Fl Flerovium (287)	Mc Moscovium (288)	Lv Livermorium (293)																																					
																	65	66	67	68	69	70	71																											
																	Tb Terbium 158.92534	Dy Dysprosium 162.50	Ho Holmium 164.93032	Er Erbium 167.26	Tm Thulium 168.93421	Yb Ytterbium 173.04	Lu Lutetium 174.967																											
																	95	96	97	98	99	100	101	102	103																									
																	Am Americium (243)	Cm Curium (247)	Bk Berkelium (247)	Cf Californium (251)	Es Einsteinium (252)	Fm Fermium (257)	Md Mendelevium (258)	No Nobelium (259)	Lr Lawrencium (262)																									
																	58	59	59	58	59	58	59	58	59	58	59	58	59	58	59	58	59	58																
																	Ce Cerium 140.116	Pr Praseodymium 140.90765	Nd Neodymium 144.24	Pm Promethium (145)	Sm Samarium 150.36	Eu Europium 151.964	Gd Gadolinium 157.25	Tb Terbium 158.92534	Dy Dysprosium 162.50	Ho Holmium 164.93032	Er Erbium 167.26	Tm Thulium 168.93421	Yb Ytterbium 173.04	Lu Lutetium 174.967																				
																	90	91	92	93	94	95	96	97	98	99	100	101	102	103																				
																	Th Thorium 232.0381	Pa Protactinium 231.03588	U Uranium 238.0289	Np Neptunium (237)	Pu Plutonium (244)	Am Americium (243)	Cm Curium (247)	Bk Berkelium (247)	Cf Californium (251)	Es Einsteinium (252)	Fm Fermium (257)	Md Mendelevium (258)	No Nobelium (259)	Lr Lawrencium (262)																				