

401 takers

Perfect  $\left(\frac{107\%}{100}\right)$

i/B

Chem 1101A Final  
EXAMINATION  
December 2010

**DURATION: 3 HOURS**

No. of Students: 423

Department Name & Course Number: Chem 1101A

Course Instructor(s)

Dr. Bawagan *NM*

Students MUST count the number of pages in this examination question paper before

Notes written on a ONE-SIDE of an 8.5"x11" sheet is allowed. Use INK pen. Use non-programmable calculators. Write name and student # on page 1. *(excepted)*

beginning to write, and report any discrepancy to a proctor. This question paper has 8 pages.

This examination question paper *may NOT* be taken from the examination room.

In addition to this question paper, students require: an examination booklet yes \_\_\_ no X  
a Scantron sheet yes \_\_\_ no X

Name:

Signature: *KEY*

St. Number:

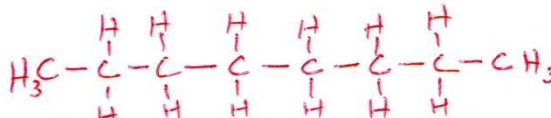
Part I: General Knowledge

1. Provide the **chemical name or the corresponding chemical formula** of the following atoms and molecules: (12 pts).

(a) deuterium

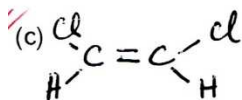


(b) n-octane



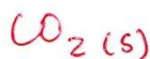
OR  $\text{C}_8\text{H}_{18}$

(d) laughing gas



cis-1,2 dichloroethene

(e) dry ice



(e)  $\text{KClO}_4$

potassium perchlorate

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## 2. History of Chemistry (20 pts)

The SI unit for pressure is the Pascal (name). Here, acronym SI stands for the French words Systeme International.

For example, the earth's atmosphere at sea level exerts a pressure of 101.3 kPa which is also equal to 760 torr, a unit of pressure named after an Italian scientist, Evangelista Torricelli.

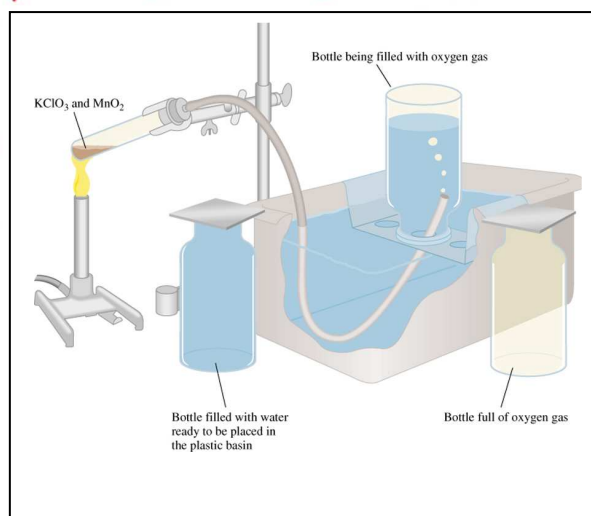
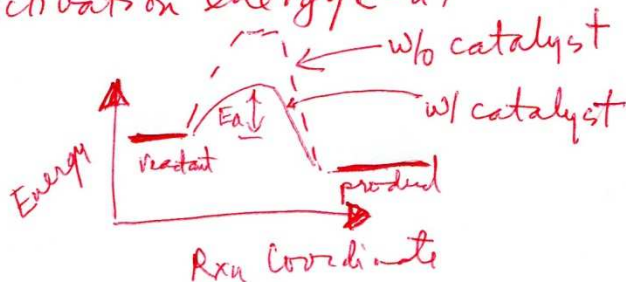
Avogadro's law states that equal volumes of gases contain equal number of moles of gases. For example, 1 mole of ideal gas at STP occupies 22.4 L. Here, the acronym STP stands for standard temperature and pressure

Dalton's law of partial pressures is illustrated in the generation of oxygen by heating solid potassium chlorate with a little  $MnO_2$  and bubbling the liberated oxygen gas over water. Here  $MnO_2$  acts as a catalyst. Write down the balanced chemical equation for the decomposition of potassium chlorate.



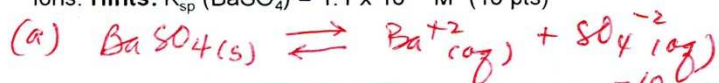
What is a catalyst?

Catalyst is a substance that accelerates speed of the reaction and is re-generated at completion. This substance provides an alternative reaction pathway thereby reducing the activation energy ( $E_a$ )



Part II: Problems. **Support your answers with calculations/arguments.** Encircle final answers and check for significant figures. Useful Hints are provided in last page.

1. Calculate the **molar solubility** of  $\text{BaSO}_4$  (a) in water, (b) in a solution containing 1.2 M  $\text{SO}_4^{2-}$  ions. **Hints:**  $K_{sp}(\text{BaSO}_4) = 1.1 \times 10^{-10} \text{ M}^2$  (10 pts)



$$K_{sp} = [\text{Ba}^{2+}][\text{SO}_4^{2-}] = 1.1 \times 10^{-10} \text{ M}^2$$

$s = \text{molar solubility}$

$$\therefore 1.1 \times 10^{-10} \text{ M}^2 = (s)(s)$$

$$\therefore s = \sqrt{1.1 \times 10^{-10} \text{ M}^2} = \boxed{1.0 \times 10^{-5} \text{ M}}$$

(b) In presence of 1.2 M  $\text{SO}_4^{2-}$  then,

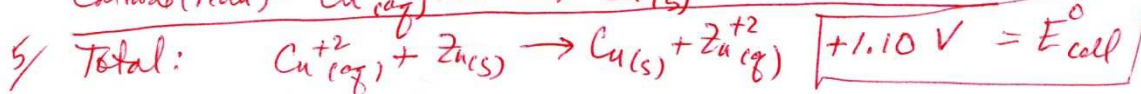
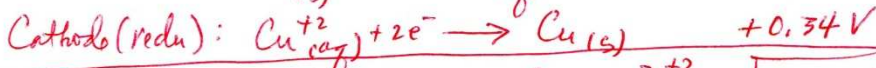
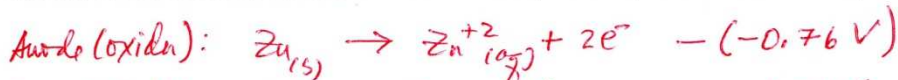
$$1.1 \times 10^{-10} \text{ M}^2 = (s)(1.2 + s) \approx 1.2 \text{ M}(s)$$

$$\therefore s = \frac{1.1 \times 10^{-10} \text{ M}^2}{1.2 \text{ M}} = \boxed{0.92 \times 10^{-10} \text{ M}}$$

$\Rightarrow$  Solubility in presence of common ion is reduced significantly!

2. What is the **potential of a cell** made up of  $\text{Zn}/\text{Zn}^{2+}$  and  $\text{Cu}/\text{Cu}^{2+}$  half-cells at 25 degC if  $[\text{Zn}^{2+}] = 0.24 \text{ M}$  and  $[\text{Cu}^{2+}] = 0.14 \text{ M}$ ? (10 pts)

Standard reduction potentials:  $\text{Zn}^{2+} + 2e^- \rightarrow \text{Zn}$ ,  $-0.76 \text{ V}$ ;  $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$ ,  $+0.34 \text{ V}$



$$\text{Nernst Eq: } E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{RT}{nF} \ln \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]}$$

$$= +1.10 \text{ V} - \frac{(8.314 \text{ J mol}^{-1} \text{ K}^{-1})(298 \text{ K})}{(2) 96500 \text{ Coul mol}^{-1}} \ln \left[ \frac{0.24 \text{ M}}{0.14 \text{ M}} \right]$$

$$\therefore \boxed{E_{\text{cell}} = (+1.10 - 0.006) \text{ V} = +1.09 \text{ V}}$$

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3. Radioactive plutonium-239 ( $t_{1/2} = 2.44 \times 10^5$  yr) is used in nuclear reactors and atomic bombs. If there are  $5.0 \times 10^2$  g of the isotope in a small atomic bomb, how long will it take for the substance to decay to  $1.0 \times 10^2$  g, too small an amount for an effective bomb? Assume first order kinetics (10pts)

1<sup>st</sup> Order Kinetics:  $\sum [A] = \sum [A]_0 e^{-kt}$

where  $k = \frac{\ln 2}{t_{1/2}} = \frac{0.693}{2.44 \times 10^5 \text{ yr}}$

$\therefore \ln \left( \frac{\sum [A]}{\sum [A]_0} \right) = -kt$

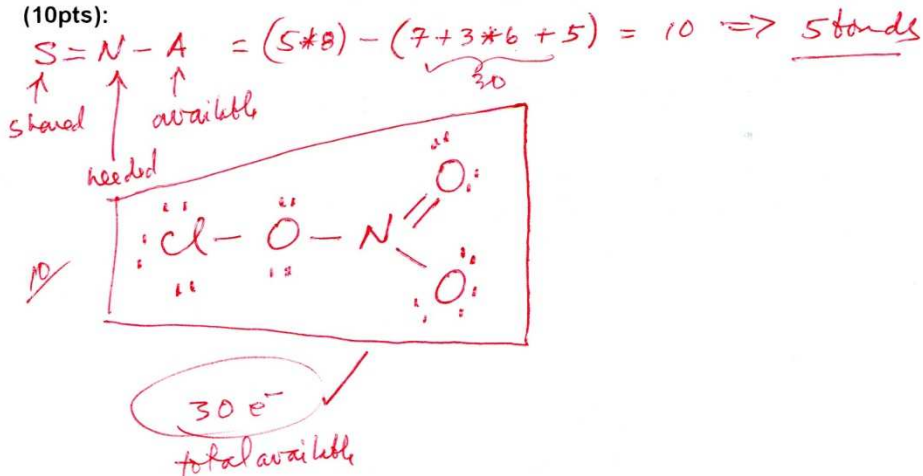
OR  $t = \frac{1}{k} \ln \left( \frac{\sum [A]_0}{\sum [A]} \right) = \frac{2.44 \times 10^5 \text{ yr}}{0.693} \ln \left( \frac{5.0 \times 10^2 \text{ g}}{1.0 \times 10^2 \text{ g}} \right)$

$t = 5.7 \times 10^5 \text{ yrs}$

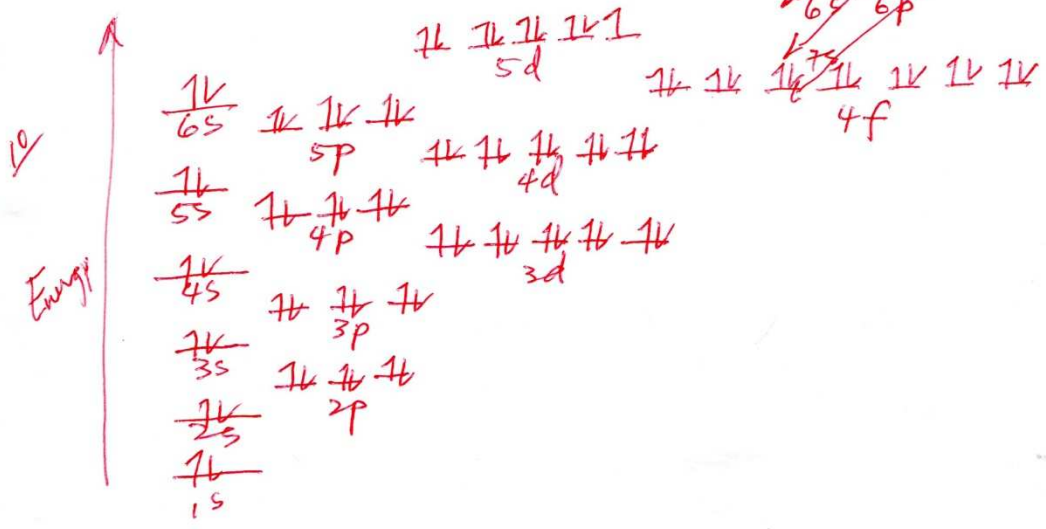
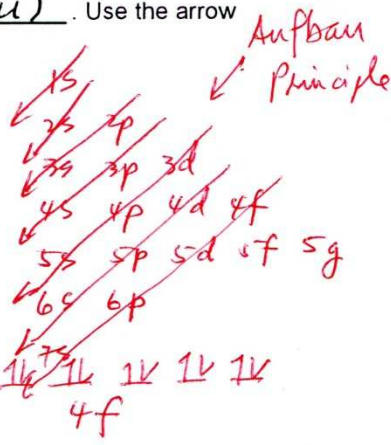
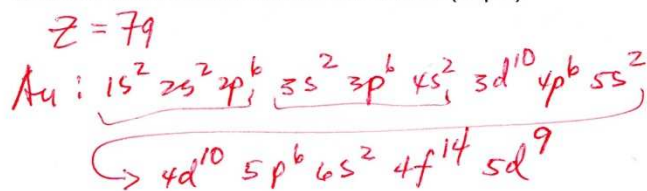
i.e., a long time!

*WJW*

4. The chlorine nitrate molecule (ClONO<sub>2</sub>) is believed to be involved in the destruction of ozone in the Antarctic stratosphere. Draw a plausible Lewis structure for this molecule. (10pts):

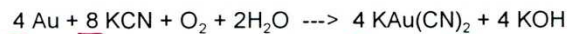


5. Write the ground state electron configuration of Gold (Au). Use the arrow notation and illustrate all the electrons. (10pts)



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6. For many years the **recovery of gold**, that is, the separation of gold from other materials involved the use of potassium cyanide,



← balanced rxn ✓

what is the minimum amount of KCN in moles needed to extract 27.5 g of gold? (10pts)

$$\text{S/ (a) } \text{mol Au} = \frac{27.5 \text{ g}}{196.966569 \text{ g/mol}} = 0.13962 \text{ mol}$$

$$\text{(b) } \text{mol KCN} = 0.13962 \text{ mol Au} \left( \frac{8 \text{ KCN mol}}{4 \text{ Au mol}} \right)$$

$$\text{S/} = \boxed{0.279 \text{ mol KCN}}$$

minimum needed

Happy Holidays to  
All!

7. **Dimensional Analysis (15pts):** Some birds (*Parus major* also known as Great tits) and humans share a common dopamine receptor D4 gene associated with exploration behaviour. **Dopamine (C<sub>8</sub>H<sub>11</sub>O<sub>2</sub>N) is a brain chemical.** Scientists have speculated that in the near-future it may be possible to play poker with Great tits. Assume a game of poker with one of these birds with the number of oxygen atoms as poker chips. At the end of the match the bird has 4.5 g of dopamine whereas you have 8.0 g of ethanol (C<sub>2</sub>H<sub>6</sub>O). **Who has more oxygen atoms?** Ref: Korsten et al, Mol. Ecol. 19, 832 (2010).

Bird

$$\text{atoms O} = 4.5 \text{ g dopamine} \left( \frac{\text{mol dopamine}}{153.178 \text{ g}} \right) \left( \frac{6.022 \times 10^{23} \text{ molecules}}{\text{mol}} \right) \left( \frac{2 \text{ atoms O}}{\text{molecule}} \right)$$

$$= 0.35 \times 10^{23} \text{ O atoms}$$

You

$$\text{atoms O} = 8.0 \text{ g EtOH} \left( \frac{\text{mol EtOH}}{46.068 \text{ g}} \right) \left( \frac{6.022 \times 10^{23} \text{ molecules}}{\text{mol}} \right) \left( \frac{1 \text{ atom O}}{\text{molecule}} \right)$$

$$= 1.0 \times 10^{23} \text{ O atoms}$$

Since  $1.0 \times 10^{23} > 0.35 \times 10^{23}$  then

You wins! ie. You have more O atoms than Bird!



#### Helpful Hints:

Avogadro's number  $6.022 \times 10^{23}$   
 Planck's constant  $6.62 \times 10^{-34}$  J s  
 Speed of light  $3.00 \times 10^8$  m/s  
 atomic mass unit  $1.66 \times 10^{-24}$  g  
 1 inch = 2.54 cm

#### Atomic weights (amu):

H 1.008    He 4.00    C 12.01  
 Na 23.00    Mg 24.30    Al 26.98  
 Ni 58.69    Cu 63.55    Mn 54.94

"Great tits: Birds with character"

ref: [www3.sciencedaily.com](http://www3.sciencedaily.com) / released Feb 9, 2010

1 Faraday (F) = 96500 Coulomb/mol e<sup>-</sup>

Specific Heat (Au) = 0.129 J/g-°C

Specific Heat (Fe) = 0.444 J/g-°C

Rydberg's Constant =  $2.18 \times 10^{-18}$  J

R = 0.082 L atm / (mol K) = 8.314 J/(mol K)

1 pound = 2.2 kg    1 tonne = 1000 kg

N 14.01    O 16.00    Ne 20.18

Si 28.08    P 30.97    Ar 39.95

Br 79.90    K 39.10    Cl 35.45

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