**Chem 303 Exam 3. April 2, 2007**

**Name** *Key*

When answering the following questions. Remember: a picture is often worth a thousand words and I will not read a thousand word answer for these questions.

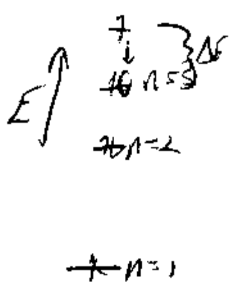
(1)(10 pts) Explain how a hollow cathode lamp or an electrodeless discharge lamp create photons which are specific for one element only.

*The light is emitted from gas phase atoms in the excited state.*

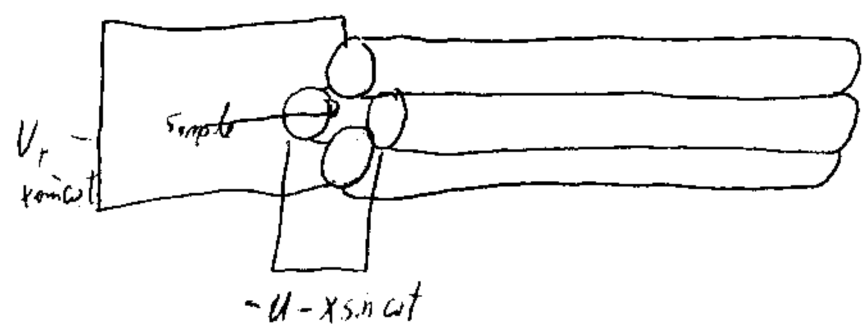
$M^*_{(g)} \rightarrow M_{(g)} + h\nu$

*Atomic energy states have a very narrow energy range which leads to a narrow range of photon frequencies.*

*This energy is specific for the element used in the lamp.*

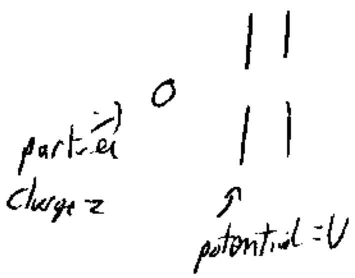



(2)(10 pts) How does a quadrupole mass analyzer select for only 1 m/z ratio?




*alter x + alter which m/z will pass through the quadrupole.*

(3)(10 pts) What is the purpose of the accellerator plates in a mass spectrometer and how do they work?




$zV = \frac{1}{2}mv^2$ The plates give all particles the same amount of kinetic energy/charge.
This allows the ions to be separated based on their $m/z$ ratio

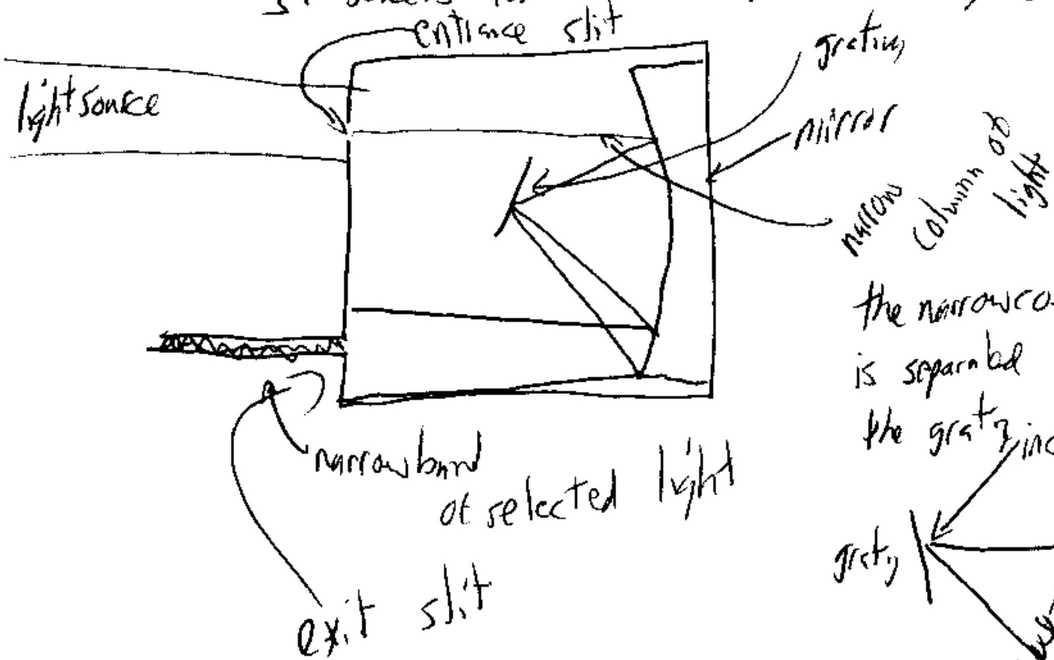
(4)(10 pts) Why is a graphite furnace AA able to detect a smaller amount of sample than a flame AA system?

In the flame AA system, enough sample is needed to aspirate through the burner for several minutes. Over 90% of the aspirated sample will be lost in the burner.

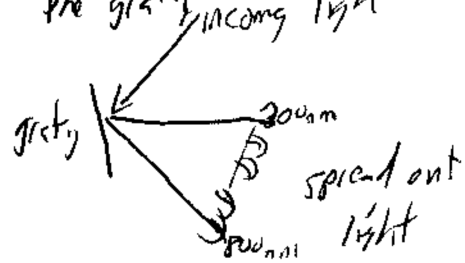
In the graphite furnace AA, the entire sample is vaporized and measured in a short period of time

(5)(10 pts) What does a monochrometer do and how does it work?

It selects for a small range of wavelengths




the narrow column of light is separated by wavelength by the grating




(6)(10 pts) In a mass spectrometer, how are the ions detected after they leave the mass analyzer?

**Chem 3034 Take-Home Test 3. Due Friday, April 4 by 4 PM.**

**Name** Key

(1)(10 pts) For the following cell, 50.0 mL of KSCN solution,and a 15.000 g Ag electrode were used.

Ag(s)|AgSCN(s)| 0.225 M KSCN || SCE

The following reaction occurs in the anode.

$$Ag + SCN^- \text{----->} AgSCN_{(s)} + e^-$$

What is the final mass of the anode after the KSCN has reacted?

0.01125 moles of $SCN^-$ = 0.653 g

the anode should weigh **15.653 g**

$$Ag_{(s)} + SCN^- \rightarrow AgSCN_{(s)}$$

↑ electrode

↑ SCN is the only extra mass

(2)(30 pts) Copper is often purified by electrolysis. First, impure copper is oxidized in the following cell

$$Cu_{(s)}\,|Cu^{2+}{}_{(aq)}||SCE \quad \text{(cell 1)}$$

The idea is to not oxidize the impurity metals, such as Au and Ag, that are in the copper. The aqueous $Cu^{2+}$ solution is then reduced back to Cu metal at a potential that does not rereduce the impurities $Zn^{2+}$ and $Fe^{2+}$ that are in the solution.

$$SCE||\,Cu^{2+}{}_{(aq)}\,|\,Cu_{(s)} \quad \text{(cell 2)}$$

Assume that the concentrations of the impurities (Zn, Fe, Ag, and Au) are no greater than 1%, the $[Cu^{2+}]$ will be 1.00 M at the end of the oxidation (and the entire plate will be oxidized), and the impurity concentration in the final Cu metal for any one contaminant is 0.001%. The initial concentration of each of the contaminating metals is 1%

(a) What potential should cell 1 be at to ensure the fastest oxidation of the copper?

the 1st metal to oxidize after Cu is Ag

to make sure $[Ag^+] < 0.001\%$ of 1M, the $[Ag^+] = 1\times10^{-5}$ M or less

$Ag^+ + e^- \rightleftharpoons Ag \quad E^\circ = 0.799V$ $\quad E = 0.799V - 0.0592V\log(1\times10^{-5}) = -0.503V$

$E_{cell} = -0.503V - 0.242V = -0.745V$ is when $Ag^+$ begins to oxidize

no more positive than this

(b) What potential should the cell 2 be at to ensure the fastest reduction of the copper?

The 1st metal to reduce after Cu will be Fe.

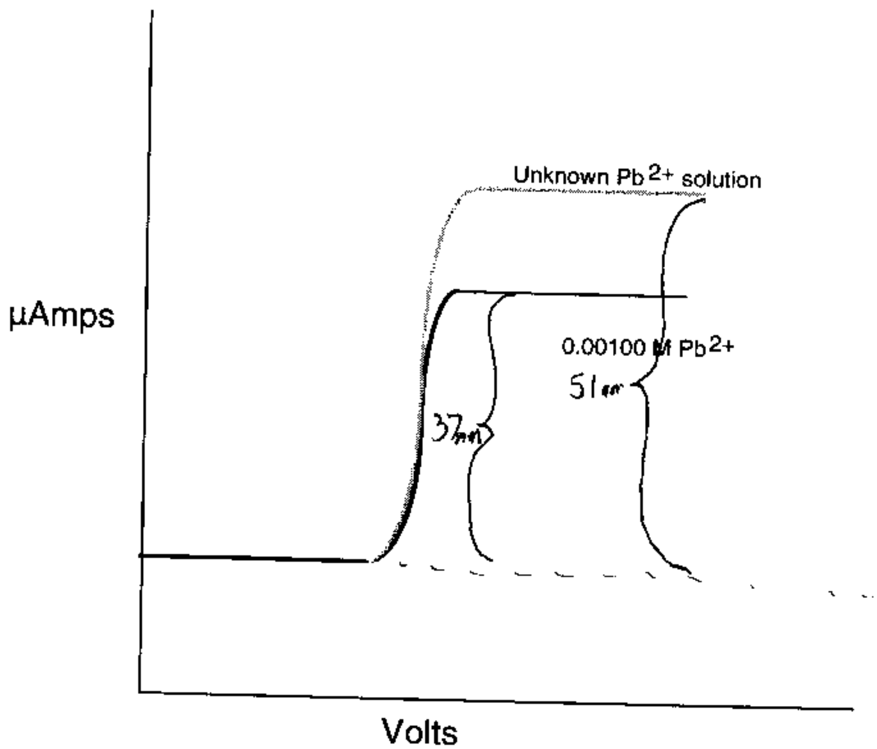
Since $[Fe^{2+}] = 1\%[Cu^{2+}]$ $\quad [Fe^{2+}] = 0.01\,M$ $\quad ([Cu^{2+}] = 1.0\,M)$

$Fe^{2+} + 2e^- \rightarrow Fe \quad E^\circ = -0.44V$

$E = -0.44V - \frac{0.0592V}{2}\log 0.01 = -0.49\,V$

$E_{cell} = -0.49V + 0.242V$ $\boxed{-0.26V}$

(4)(10 pts) From the voltammogram below, determine the [$Pb^{2+}$] in the unknown solution.




$37 mm = 0.00100 M\ Pb^{2+}$

$$\frac{2.7 \times 10^{-5} M\ Pb^{2+}}{mm} \times 51 mm = 1.4 \times 10^{-3} M$$

(3)(10 pts) From problem 2, determine how much current would be required to produce 5 tonnes of copper/hour?

for each Cu atom, 4$\bar{e}$ are needed

5 tonnes = 5000 kg = $5 \times 10^6$ g Cu = $8 \times 10^4$ moles Cu

$8 \times 10^4$ moles Cu $\times \frac{4\bar{e}}{Cu}$ = $32 \times 10^5$ moles $\bar{e}$

$96{,}500 \frac{C}{mole\ \bar{e}} \times 32 \times 10^5$ moles $\bar{e}$ = $3.0 \times 10^{10}$ C needed/hr

$1A = \frac{1C}{s}$ 1h = 3600s

$\frac{3.0 \times 10^{10} C}{hr} \times \frac{1hr}{3600s} = 8 \times 10^6 \frac{C}{s} = 8 \times 10^6 A$