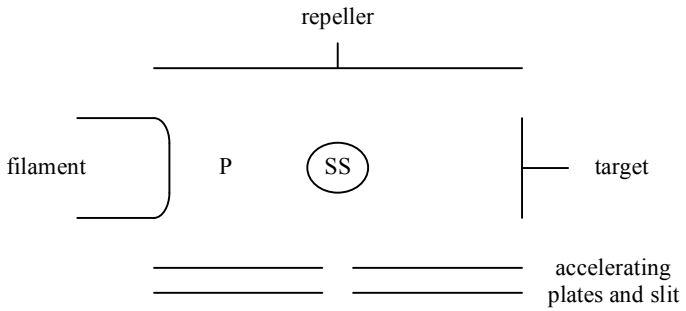
Final Exam Prep Questions

Mass Spectrometry

1. The following figure is a simplified diagram of an electron impact source.
   a. What potential must be applied between the filament and target so that electrons interacting with the molecules at the point marked SS (sample source) will have 70 eV of kinetic energy?
   b. What will happen to a molecule that diffuses toward the filament and is ionized at point P?



2. When a magnetic sector instrument was operated with an accelerating voltage of 3.00×10^3 V, a field of 0.126 T was required to focus the CH_4^+ on the detector.
   a. What range of field strengths would be required to scan the mass range between 16 and 250, for singly charged ions, if the accelerating voltage is held constant?
   b. What range of accelerating voltage would be required to scan the mass range between 16 and 250, for singly charged ions, if the field strength is held constant?

3. The ion-accelerating voltage in a particular quadrupole mass spectrometer is 5.00 V. How long will it take a singly charged benzene ion to travel the length of the rod assembly, a distance of 15.0 cm?

4. Calculate the resolution required to resolve the following peaks:
   a. CH_2N^+ (MW = 28.0187) and N_2^+ (MW = 28.0061)
   b. $C_2H_4^+$ (MW = 28.0313) and CO^+ (MW = 27.9949)
   c. $C_3H_7N_3^+$ (MW = 85.0641) and $C_5H_9O^+$ (MW = 85.0653)
   d. $^{116}Sn^+$ (AW = 115.90219) and $^{232}Th^{2+}$ (AW = 232.03800)

Potentiometry

1. a. Calculate the standard potential for the reaction

   $CuBr(s) + e^- \leftrightarrow Cu(s) + Br^-$

   $K_{sp} = 5.2 \times 10^{-9}$

b. Give a schematic representation of a cell with a copper working electrode as the anode and a saturated calomel electrode (SCE) as the cathode that could be used for the determination of $[Br^-]$

c. Derive an equation that relates the measured potential of the cell to pBr (E^o_{SCE} = 0.244 V)

d. Calculate the pBr of a solution that is saturated with CuBr and contained in a cell described in part b if the potential is E = -0.071 V.

2. The following cell was employed for determination of CrO_4^{2-}:
   $Ag|Ag_2CrO_4$(sat'd), CrO_4^{2-}(x M)||SCE
   Calculate $pCrO_4$ if the cell potential is -0.402 V.

3. The following cell was found to have a potential of 0.124 V:
   SCE||Cu^{2+}(3.25×10^{-3} M)|membrane electrode for Cu^{2+}
   When the solution of known copper concentration was replaced with an unknown solution, the potential was 0.105 V. What was pCu of the unknown solution?

Chromatography

1. What are the effects of temperature on a chromatogram?

2. The following data were obtained from a GC chromatogram performed on a 40 cm column:

compound	t_R(min)	W(min)
air	1.9	--
methylcyclohexane	10.0	0.76
methylcyclohexene	10.9	0.82
toluene	13.4	1.06

a. Calculate the plate height for each compound from the data.

b. Calculate the number of plates for each compound.

3. Explain the differences, including advantages and disadvantages, between open tubular packed GC columns and capillary GC columns.

4. How can the retention factor be manipulated in gas chromatography and liquid chromatography?

5. What are the "figures of merit" used to describe a chromatographic detector? Give examples for gas and liquid chromatography.