Chemistry 448
Fall 1999 Exam #2

This is a 90 minute exam.
It is open notes, but not open book.
You may use any handwritten or typed (by you) notes prepared prior to starting the exam.

Do *NOT* proceed to page 2 until you are ready to start (and continue for 90 consecutive minutes!
Prepare your handwritten or typed notes for the exam before proceeding to the next page.

Name _____

Date _____

Start Time _____

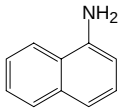
End Time _____

If you have taken longer than allowed, please explain why, unless it is by prior arrangement.

The exam is due at Prof. Weiss' or Prof. Allara's office by 5 PM on Friday 3 December.

Prof. Weiss 407 Davey
Prof. Allara 185 Materials Research Institute

1) *(40 points)*
Two chemists perform an experiment in which napthyl amine (chemical structure below) is adsorbed onto a clean solid surface of a pure material.



After looking at the results the chemists disagree about whether the adsorbate is chemisorbed or physisorbed. You, being a smart student, know this argument is somewhat a matter of definition, but decide to try to resolve the issue. Given that any experimental and theoretical tools you need are at your disposal, what would you do?
Be brief but do take time to explain what you are doing in each step, how your technique will work and what are the types of information that you will obtain, relevant to the main question. Note that the nature of the substrate is left open so consider broadly all the general classes of substrates and their associated adsorbate interactions.
[A good approach might be to list the different specific types of chemisorption and physisorption interactions that are possible and then go about testing for standard characteristics of these interactions one at a time. Consider theory as a tool if you see a way to use it. Organizing your answer is important. A table could be useful.]

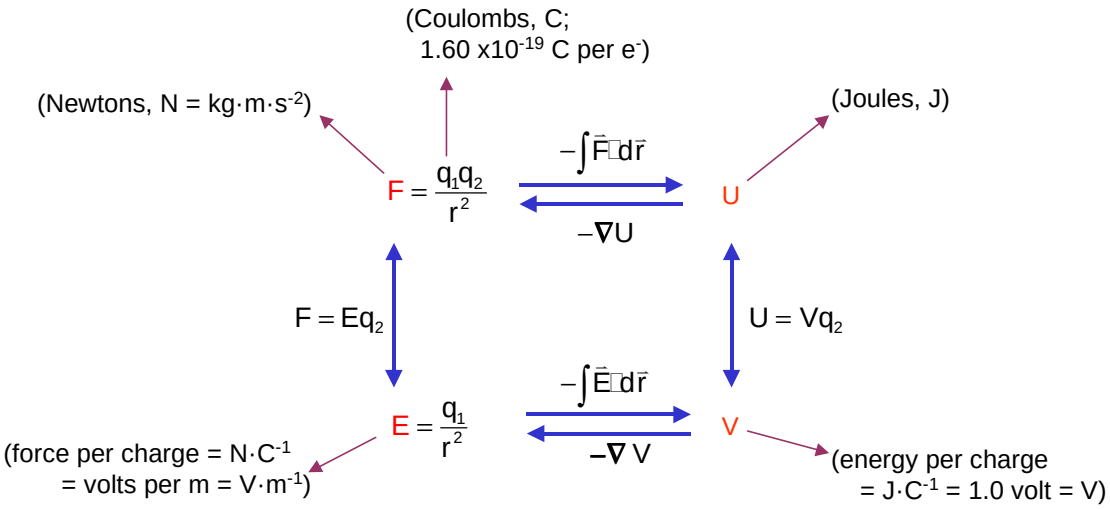
2) *(10 points)*
A chemist prepares a batch of Al_2O_3 in the form of ~50 nm diameter particles. The preparation method results in the particles forming an insoluble aggregate at the bottom of the solution. The precipitate is collected. It is desired to disperse the particles in a colloidal solution. Briefly, how might you do this?
Explain briefly what you are doing from a fundamental point of view (consider discussing in terms of the basis of DLVO theory). Sketches and schematics are often helpful in saving on writing.

3) *(30 points total)*
   a) How surface sensitive is X-ray photoelectron spectroscopy? How can you explain this surface sensitivity? (20 points)
   b) How can you tell the difference between the photoelectrons and Auger electrons? (10 points)

4) *(20 points)*
In the etching of Si by $F_2(g)$ and $XeF_2(g)$, many layers of Si are removed. The surface is substantially roughened in the process.
Briefly describe the experiments you would conduct to determine the reaction intermediates and products.

(Extra credit, 10 points)

From the following information calculate the work in kcal/mol required to move a mole of 10 nm colloid particles, each with a single negative charge (extra electron), from one electrode to another when the electrodes have an electrical potential of 1.0 V between them. [1 cal = 4.184 J] Ignore long range forces. Show work, even if brief.



[Given ~96,500 C per mol of e^-, calculate the work in kcal/mol to move a mole of e^- across 1.0 V]