INTRODUCTION TO PHYSICAL CHEMISTRY

Physical chemistry is probably quite new to a number of you, so don't panic if you haven't yet got to grips with everything (or anything!) in the lecture course, or if you don't understand something you read. After all, if you understood everything perfectly the first time you came across it then all the tutors would be out of a job! If there is anything you're having trouble with, note it down and ask me about it in the tutorial.

Most of your physical chemistry tutorials will be based on solving problems related to the topics covered in lectures; for any of you who were looking forward to tutorials consisting of reading out essays and drinking glasses of sherry, I apologise in advance (I can offer the essay-writers amongst you some consolation though – you'll get to write plenty of them in inorganic chemistry). While it may seem like quite hard work at the time, you will find that nothing tests your understanding of a subject like having to use your knowledge to solve a real problem. Problem solving is a very good way to learn physical chemistry, and I would advise you to make a decent attempt at every question you're set, even if you don't feel like you're getting very far. Even if you can't get started, thinking about possible ways to answer a question is helpful in itself. If you're really stuck on a question and it can't wait until your next tutorial, you can always come and find me or send me an e-mail and I'll give you a hint.

For this first tutorial, read the introductory chapter (Chapter 0) of Atkins *Physical Chemistry* to familiarise yourself with some of the general concepts involved in physical chemistry[1]. You don't need to get too bogged down in details at this point - just try to get a general overview. All of the topics that come up in the 'Introduction to Physical Chemistry' lecture course will be covered in much more detail in later lecture sets. The idea behind the course is to give you a fairly gentle introduction to physical chemistry, not to scare you witless, so if it's had the latter effect just try and forget you ever went to the lectures and read the set chapter with a fresh mind. Of course, if once you've read the introduction you feel inspired to dip into later sections of the book (or any other books) to find out more about a topic that interests you (and hopefully there will be some of those!) then go right ahead. This is true for every course you do over the next three years. Don't expect to learn everything from the lectures – they are just the starting point. Some of the ideas you'll come across during the course of your degree will be quite complicated, you probably won't understand them the first time, and you will need to do a bit of reading around the subject. Often you may find you need to look at three or four books until you find an explanation of a concept or a derivation of an equation that suits you, and you should be prepared to do this. Given that the Radcliffe Science Library is a 'copyright library' with a copy of every book that's ever been published in the UK and millions of others as well, you have no excuse not to!

Once you've read the introductory chapter of Atkins, you should be ready to answer the following:

<u>Questions</u>

1. What is the difference between intensive, extensive, and molar properties? Give three examples of each.

2. a) Why do you think it is useful in chemistry to deal with amounts of substance (i.e. moles) rather than masses (e.g grams)?

   b)Convert the following masses to moles:
   - i) 20 g of ethanol
   - ii) 48 g of carbon
   - iii) 100 g of gold

3. a) What is the difference between kinetic and potential energy? Why do we make the distinction?

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[1] Unless you want to take up residence in the library for the next three years, you <u>MUST</u> get a copy of this textbook. It covers nearly everything in the physical chemistry course and is the one textbook that will last you for your whole degree. It doesn't really matter which edition you get – anything from the 4^{th} edition onwards will do, and since the new edition came out very recently you should be able to pick up one of the older ones fairly cheaply second hand. For second-hand books try upstairs in Blackwells or look around college and university noticeboards for ads – lots of students are only too happy to sell their copy on when they've finished with it!

b) In a semi-classical model of the hydrogen atom, it is found that the speed of the electron 'orbiting' the nucleus is 2.2×10^{6} ms^{-1}. The distance of the electron from the nucleus is 5.29×10^{-11} m.

i) What is the kinetic energy of the electron?

ii) What is the potential energy of the electron in the electric field of the nucleus?

iii) How long does it take the electron to complete one revolution?

4. a) What is the equipartition theorem? Why can it be applied to translational and (usually) rotational motion but not to vibrations?

b) Use the equipartition theorem to determine the average energy (per mole) for the following (NB: you may need to look up how to calculate the number of degrees of freedom in each case)

i) He

ii) Cl_2

iii) H_2O

iv) benzene

v) CO_2

5. What is the frequency, energy (in eV) and wavenumber of light of the following wavelengths:

i) 193 nm (the UV output of an ArF excimer laser)

ii) 550 nm (roughly the wavelength our eyes are most sensitive to)

iii) 12.2 cm (the wavelength of the microwaves in a microwave oven)

iv) 2.922 m (the wavelength of the radio waves from Fox FM)

6. a) On a single diagram, sketch the Maxwell-Boltzmann distribution of molecular speeds for Cl_2 and Br_2 (assuming that both gases are at the same temperature).

b) How do you think the Maxwell-Boltzmann distribution could be used to help understand the variation of chemical reaction rates with temperature?

c) Why is the Maxwell-Boltzmann distribution applicable to the translational motion of molecules, but not to their vibrational motion?