Preamble

The level of maths, physics and chemistry covered in these courses is well within the capabilities of everyone enrolled on these courses. Science is interesting, fascinating and *even fun!* which is why we are all here. We know from experience that some of you will find it hard going to start with, but the only thing that will stop you succeeding on this course is if you have convinced yourself that you 'cant do numerical science. There's no such word as can't! Believe that you can do it and you will. On the other hand, some of you will find the early exercises easy. Please bear with us as we try and bring everyone to the same level, you will find the later work more stimulating.

Mathematics in particular causes a great deal of apprehension, but think of it as a way of communicating, like learning a language rather than facts to be learnt. Inevitably there is some jargon involved in maths and science but use the terms and become familiar with them and you will find things will drop into place.

We are here to help! Dont worry or feel nervous about approaching us either during classes or out of class time (even during a lecture, if there is something you dont understand—put up your hand and say so—the chances are that there are others who feel similarly). If there is something you dont understand, keep at it with our help until you do. If you avoid tackling a topic because you are afraid of it or feel you dont like it, you will become lost and demoralised with topics that follow, and we really want to avoid that at all costs.

Dont blindly accept the number that your calculator gives you. Use your common sense and ask yourself whether it seems reasonable. If your answer seems unreasonable, check it and if you cant find a mistake, say why you think the answer is not reasonable.

'Units' means for example, kilograms or grams, metres or centimetres, seconds etc. Mistakes in manipulating and converting units can make your answer wrong by factors of thousands, millions or even more. We will be concentrating on this—its quite straightforward but gives rise to so many wrong answers.

You are not expected to remember formulae or physical constants, information you need will be given at the start of any assessment. We are only interested in you understanding how to approach a scientific problem: which equations to use and how to use them rather than remembering equations and numbers.

Why do we need mathematics?

There is sometimes a misconception that geology or environmental science is a qualitative (i.e. descriptive) science, describing fossils or bedding sequences or how pollution effects organisms, and certainly these are a part of your degree the but it is actually (like all true science) quantitative and what we are trying to teach you in this course is how to take in a lot of numerical data (and which is relevant!) about something we wish to understand (gold seam, power station, the atmosphere, landfill site etc), create a mathematical model and use this to predict what will happen

in the future or happened in the past.

We will start with simpler cases of course but if you ever wonder where we are going and what the relevance of a particular exercise has to geology or environmental science, it is there because it is an example which you should have a 'feel' for the answer, i.e. be able to use your common sense to tell you whether the answer which you have worked out in your head or using your calculator is reasonable. This is another aspect we shall be emphasising—using your head. For example if you work out the mass of a lake 100 m in diameter and several metres deep and get an answer of 2.5 kg you should know that you must have made a mistake. Your critical faculty is one of your most important assets as a scientist—always look at things critically and say, "Does that make sense? does it fit in with what I know already?". In the case of the lake you should think that you weigh probably somewhere in the range 50-80 kg and so your common sense should rebel when faced with an answer of a 100m lake weighing a lot less than you. In another example I asked a class was to calculate how fast a local reservoir would take to fill given the rainfall figures and one answer was 18 million years. This was accepted by the student uncritically but he should have thought that a reservoir that took that long to fill would not be much use to anyone!

The bottom line is, you can all learn how to develop simple mathematical models of real situations and use these to predict what will happen in the future or what has happened in the past. But you must be critical, use your common sense and be accurate. If you are employed by an oil company and work out that there are a billion barrels of oil reserves and after much expensive drilling the company extracts only a million barrels and the difference was because you made a mathematical error, you will not be in a job for long!

Because this course (and many others) are numerically based you should always have your calculator with you and know how to use it!

Units

Where ever possible we will work in the SI unit system. At its simplest, most physical quantities break down into combinations of kilograms, metres and seconds and these are the fundamental units that we should work in. The problems arise when we have to change between units, for instance in geology we will often see measurements being given in cm or kg or weights in grams or densities in grams cm^{-3} (grams per cubic centimetre).

Some of the problems we will coverare taken from Harte (1988) and some are taken from Harte (2001). By all means feel free to look at these books; however, dont expect to find the solutions. They do not contain them. In order to solve these problems you will have to work at them, both by yourself and in groups. We will be working through the problems in this course and hopefully you will learn problem solving and analytical skill by constantly being immersed in lots of different problems.

The problems will require you to become confortable using mathematical methods; for those starting without a firm maths background we recommend the book by Croft and Davison (2006). You will also need to become familiar with scientific concepts; a good all round book that we will be drawing from is Hewitt et al. (2009). The problems start of easy and you will only need to know basic equation manupulation.

The classes will be arranged as follows: for the first period we will talk about some knowledge in maths or science that you will need to solve a particular problem. We will then introduce the problem and you will be expected to calculate something quantitative together in groups. In the second period we will cover data analysis skills and statistics using a practical approach on the computers.

So this is mainly a practical skills class. You are encouraged to seek help from your peers and also from the demonstrators and myself. Doing as much of the problems in class will benefit you as during the week there will be some small assignment on the problems covered in class. You may arrange yourself into groups of around 5-10 people. You may also work in these groups to do the online assessment each week if that helps you. However, for the mid-term test in semester 1 you must work un-aided.

You are expected to do the suggested reading to help you prepare for the next weeks class as well as give you the necessary background knowledge to help you with other courses. I am not going to lecture to you about keeping good notes as that is your responsibility, although I know that I would rather have good notes at my disposal than incomplete fragmented notes. Also, I will not bring copies of the notes each week so you should at least bring those with you.