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Science is a practical discipline; it's hands-on. Being a scientist is not a spectator sport. It's about *you* finding out: *you* observing, *you* recording, *you* attending to detail, *you* being honest about *your* findings. Then it's about interpreting what *you've* observed. It's about asking questions like, 'How?', 'Why?' and seeking the answers. It's not about making predictions, then looking for evidence to support your ideas.

To do this you must refer to the body of knowledge that we already have, so you're standing on the shoulders of scientists who have gone before you as you reach for the sky. This means that you read textbooks to get the overall picture and learn the language of science, which has differing dialects for the different disciplines. Then, as you become more knowledgeable and specialised in a particular area, you will need to probe deeply into current thinking, searching through journals for academic papers because that is how front-line scientists publish their work.

## What types of coursework are you likely to be asked to produce?

These are the kinds of work you will be expected to do:

- ▶ lab and/or field notebooks/diaries
- ▶ lab and/or field reports
- ▶ essays: scientific, academic
- ▶ posters: scientific, academic
- ▶ problem solving: numerical, statistical, data handling.

You will also be required to sit exams where you will need to produce essays, solve problems, handle data and answer multiple choice questions (MCQs) under time constraints.

This guide is designed (i) to help you understand your lecturers' expectations of you as a science student and (ii) to provide you with step-by-step guidance as you study and prepare work for assessment. I hope that you will be excited by the discoveries you make as you study science and that this little book will help and encourage you to become fully involved and get the most out of your degree.



The secret to success is **PLANNING**: organising your time.

### **Term/semester planning**

It is a good idea to plan your study time for the term/semester:

- ▶ Draw up a plan of the whole term or semester (see sample timetable on next page).
- ▶ Now put in your coursework deadlines and exam dates for each module or unit – the fixed points.
- ▶ Next, write down when you will start each piece of work. For this you will need to decide how much time you need to prepare the work.

Degree-level coursework can seldom be knocked up in one evening!

**Planning the term/semester:** First, note the deadlines; then work backwards to plan your work.

<b>Week</b>	<b>Module/ subject name</b>	<b>Module/ subject name</b>	<b>Module/ subject name</b>	<b>Module/ subject name</b>	<b>Module/ subject name</b>
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

## Why will you do practical work?

Lab and fieldwork classes are designed to support your learning. Often they will demonstrate the principles that you have covered in lectures. In most universities these classes are compulsory because as scientists we are keen that you participate actively in 'doing science'. Practical work is the fun part where you are finding things out for yourself.

## How can you get the most out of your practical class?

You'll get the most out of your practical class if you plan and prepare for your class beforehand.

Normally you will have access to the practical schedule before your lab or field session. If so, be certain to:

- ▶ Read it through carefully and make sure that you understand what the work is about.
- ▶ Look up references if you have been given them – read around the subject area in your textbook and/or lecture notes.
- ▶ Think through the method and make sure that you can follow it easily.
- ▶ Try to visualise what you will be doing. If you have to prepare samples, think through the process and the skills you will need. Think as a scientist!

## Recording science: lab diaries

Science is written down as we do it. We don't rely on remembering what we did, measurements we made and results we obtained. That would be too risky: it wouldn't be accurate. To avoid muddling ourselves and our work, we record everything we do in the laboratory in a diary or notebook *while we are doing it*. This forms a permanent record of our time in the lab. It's a blow-by-blow account of what we did, what we saw and what we found. You do not rewrite your lab diary afterwards; it must remain authentic.

There are particular conventions that we have to follow with regard to writing up and recording information.

A lab diary is a bound book with pages numbered, work dated, written in pen (not water-soluble ink), mistakes crossed out but not erased. Having said all that, you are free to record your work in a personal way and without writing full sentences, e.g.: *'I mixed the 3 solutions – see schedule p4 section 2(a) – then I put the test tube in the 37 °C waterbath to incubate for 20 minutes. Timed it with my stop-clock.'*

It is organised under headings:

**Title:** Should be brief but accurately describe the experiment or activity.

**Introduction:** Why you are doing the work, providing the context and reason.

**Aim:** What you set out to do: be concise (= few words) and precise (= accurate).

**Method:** How you did it. If you have been given a practical schedule containing the method, then refer to it; don't copy it out again. Do note down any points where you departed from your written instructions. For an experiment of your own design, write out your method in full.

**Observations/results:** What you saw and measurements you made, all put into tables (see examples). Do not fabricate any results.

**Data handling:** Any graphs, working out of data etc.; evidence for your conclusions.

**Conclusions:** What you found out – nothing more, nothing less! If your work was inconclusive, say so; there's no disgrace in that!

Data handling and drawing conclusions usually happens after you have left the lab, although there are occasions when you will hand-plot a graph so that you can decide whether you have collected sufficient data, or whether you need to extend your sample range.

Date of work Place of work

17/09/08 Lab: S310

Lab Partner: K. Smith

Who you worked with

Demonstrator: Dr. Jones

Who taught you

Salting out haemoglobin:

Title

Determining the solubility of haemoglobin in ammonium sulfate solution.

Introduction: This is crude method for separating proteins

Aim: To find out the concentration of ammonium sulfate needed to precipitate haemoglobin from a solution containing a mixture of proteins.

Method: Abbreviations:

Hb = haemoglobin

$(\text{NH}_4)_2\text{SO}_4$  = ammonium sulfate

Follow the method as given in the practical booklet by Dr. Jones. (see pages 5-8).

Refer to any prac. manual rather than copy it out

Pipetting schedule:

Tube No.	Vol $(\text{NH}_4)_2\text{SO}_4$ (mL)	Vol $\text{H}_2\text{O}$ (mL)	$(\text{NH}_4)_2\text{SO}_4$ % saturation
1	0.0	10.0	0
2	6.0	4.0	60
3	6.5	3.5	65
4	7.0	3.0	70
5	7.5	2.5	75
6	8.0	2.0	80

Next ...

Observations:

Write down any unusual things that you noticed

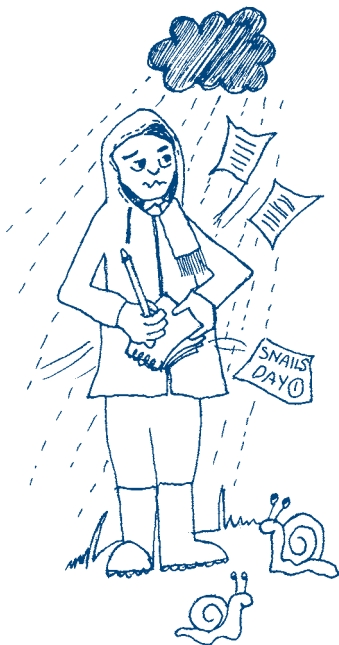
1. Hb solution was very thick which made it difficult to pipette into the test tubes.
2.  $(\text{NH}_4)_2\text{SO}_4$  solution has crystals in the bathroom of the jar, showing that it is a saturated solution.

Figure 1: Example of lab diary

## Recording science: field notebooks

In some areas of science practical work takes place not in the lab, but out in the field. This is particularly the case for environment disciplines. Recording science outdoors presents its own challenges. The weather can be foul, the fieldwork can be aquatic (intentionally or unintentionally!) and a traditional lab diary would disintegrate after a short period of exposure to the elements. So field notebooks are made of waterproof paper and you write on this paper using a pencil rather than a pen. It still must be a permanent record of your time in the field, so put a line through any errors, don't erase them. Have elastic bands to hold the pages down in the open-book position, otherwise the wind might rip them out!

Apart from all that, field notebooks serve the same function and observe the same rules as lab diaries. They are set out in a similar way, particularly using grids of various kinds to log samples and track numbers of observations.



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