Contents

Introduction to Laboratory Work

Introduction to Laboratory Work ................................................................. I-1
Purpose of this laboratory course ................................................................. I-1
Preparation (including for the first day) ......................................................... I-1
Lab Organisation ............................................................................................ I-2
Assessment of Practical Physics ................................................................... I-5
What Goes into a Physics Notebook? ............................................................. I-7
Safety Notes ................................................................................................... I-12

Semester 1 Laboratory Exercises

Laboratory Exercise 1 ................................................................. Introduction to Linear Motion
Laboratory Exercise 2 ................................................................. Analysing Motion
Laboratory Exercise 3 ................................................................. Circular Motion
Laboratory Exercise 4 ................................................................. Energy Transfer
Laboratory Exercise 5 ................................................................. Rotational Inertia
Laboratory Exercise 6 ................................................................. Fluids in Motion
Laboratory Exercise 7 ................................................................. Simple Harmonic Motion
Laboratory Exercise 8 ................................................................. Vibrations in an Air Column

Semester 2 Laboratory Exercises

Laboratory Exercise 9 ................................................................. Fun with Charges
Laboratory Exercise 10 ................................................................. Introduction to Electric Circuits
Laboratory Exercise 11 ................................................................. Combining Resistances
Laboratory Exercise 12 ................................................................. Electromagnetic Investigation
Laboratory Exercise 13 ................................................................. Seminar
Laboratory Exercise 14 ................................................................. Optics Workshop
Laboratory Exercise 15 ................................................................. Investigating Lenses
Laboratory Exercise 16 ................................................................. Thin Films

Appendices

Appendix A .................................................................................................. "All you ever wanted to know about errors, but ..."
Appendix B ................................................................................................. Graphs and How to Use Them
Appendix C ................................................................................................. Computing in the Physics Laboratory
Appendix D ................................................................................................. Resistor Colour Code
Introduction to Laboratory Work

1. Purposes of this laboratory course

A considerable proportion of class time in Physics 161/2 is devoted to laboratory work. These classes fulfil a variety of functions in the program. Some exercises are devoted to the development of manual and experimental skills, covering the design, execution and analysis of an experiment. Others are intended to support the learning of concepts introduced in lecture classes, providing experiences that illustrate those concepts or explore their application. The exercises are also intended to provide experience in group work and communication skills. Most laboratory classes will also provide some extra demonstrations of the application of the concepts being explored in the lab.

The success of the program in achieving these aims depends on the partnership between you as a learner and the staff who are there to facilitate your learning. Please make the most of the opportunity - explore fully the physics of each experiment and use the time to develop your skills. … and we hope you enjoy the experience.

2. Preparation

For the laboratory classes to be effective in helping you to learn physics it is crucial that you are prepared for each class.

There are several aspects to this preparation:

1. Make sure that you know, before leaving, what experiment you will be doing in your next class. You should then read the manual account of the lab exercise before you arrive in the lab, as well as the recommended sections of the textbook. This helps you dive into the lab as soon as the class starts.

   The textbook referred to is:

   Giancoli, D C

2. If you find any aspect of the description of the experiment difficult, you will save time by being prepared with questions to ask to ask the demonstrator early in the lab session. Demonstrators will be available for this for the 10 minute period immediately before the session starts.

3. In addition, specific preparation is outlined in this manual near the beginning of some experiments, labeled Pre-lab exercises. This preparation should also be completed before you arrive for the relevant laboratory class.

The amount of preparation varies between experiments, but you should expect to invest an average of half an hour per week, throughout the year. This preparation will be taken into account in your demonstrator’s assessment of your performance in the lab.

Preparation for the First Practical Class

Classes start in the second week of first semester.

Your preparation for the first lab session is to find out where to arrive and to bring the appropriate materials with you. See the following pages.
Where do you go?

The first-year Physics laboratories are located on levels 3 and 4 of the Swanston St extension to the Physics building, called the Physics Podium. The Physics 161/2 lab is on level 4.

When arriving for your practical classes, you should enter the laboratories via the western ramp.

Students are assigned to lab groups, with labels similar to the following …

Day of class  M (Monday)  U (Tuesday)  W (Wednesday)  H (Thursday)  F (Friday)

Group number  U A 9  9 or 10

Session  A (morning)  P (afternoon)

Lists of students and their groups will be placed on the noticeboards on level 2 of the Physics Podium by the end of the first week of semester.

When you enter the level 4 laboratory the 161/2 labs will be on your right, with the groups' locations as shown on the diagram to the right. There will also be signs to direct you to the appropriate laboratory when you arrive for your first class.

What should you bring?

Each student should bring to the first practical class:

• the Physics 161/2 manual (ie. this book!),
• the Physics I lab notebook,
• a calculator, if you have one,
• pens (for written work) and pencils (for graphs and diagrams), eraser
• ruler.

The cover of your practical notebook should be filled in completely, and your name also written on the two ends of the book.
3. Laboratory Organisation:

(a) Organisation

The 161/2 laboratory course is designed to complement the learning happening in lectures and tutorials, so the content of each exercise should be related to what is being covered in those other classes. There may be times when the learning will happen in the lab first, so that it can be built on during lectures and tutorials and at other times the lab exercise is designed to consolidate the physics first encountered in lectures. The laboratory exercises will run sequentially with numbers 1 to 8 in first semester for 640-161 and 9 to 16 in second semester for 640-162. If there is any change to this order you will be notified in advance.

For organisational purposes the first year laboratory course is divided into 4 segments with segments running for 4 weeks of experiments. You will be led by a different demonstrator for each segment, and also work with a different partner.

(b) Schedule

- The experiments in the first year physics laboratories have been designed so that an average student will complete each experiment within a three (3) hour laboratory session. Experiments cannot be carried on to the following week.

The table below outlines the schedule for semester 1.

<table>
<thead>
<tr>
<th>Week beginning …</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 March</td>
<td>No Lab class. Lab manuals available for sale.</td>
</tr>
<tr>
<td>8 March</td>
<td>Introduction to Linear Motion Segment 1 begins</td>
</tr>
<tr>
<td>15 March</td>
<td>Analysing Motion</td>
</tr>
<tr>
<td>22 March</td>
<td>Circular Motion</td>
</tr>
<tr>
<td>29 March</td>
<td>First lab report written for feedback; no formal lab</td>
</tr>
<tr>
<td>5 April</td>
<td>Easter break Report written on template</td>
</tr>
<tr>
<td>12 April</td>
<td>Energy Transfer Segment 2 begins</td>
</tr>
<tr>
<td>19 April</td>
<td>Rotational Inertia Report written on template</td>
</tr>
<tr>
<td>26 April</td>
<td>no lab class</td>
</tr>
<tr>
<td>3 May</td>
<td>Fluids in Motion</td>
</tr>
<tr>
<td>10 May</td>
<td>Simple Harmonic Motion</td>
</tr>
<tr>
<td>17 May</td>
<td>Vibrations in an Air Column</td>
</tr>
<tr>
<td>24 May</td>
<td>Second report written for assessment</td>
</tr>
</tbody>
</table>

(c) Co-ordination - Who do you see with any concerns?

About a particular exercise …

- Questions related to the exercise you are completing will be handled by your demonstrator, as outlined above.
Timetabling, absences etc. …

- Organisation and co-ordination of the whole of the first-year practical course are handled by the Teaching Administrative Officer Mr Colin Entwisle (Room 3.09 in the first-year labs), to whom you should go with any general problems regarding your practical work, etc. In particular you will find Colin indispensable in handling requests for timetable changes.

Equipment …

- The apparatus for the laboratories is under the care of the Senior Technical Officer, Mr Achilleas Nicola (Nick). Your first port of call should be your demonstrator who will assess the need for further assistance from Nick.

Concerns about teaching …

- Any concerns you may have about teaching you receive in lab classes can be discussed with either of these staff, or the academic co-ordinator of the laboratory, Dr Michelle Livett, in Room 207.

(d) Demonstrators

Each laboratory has a team of demonstrators, one of whom will supervise your time in that particular laboratory. The demonstrators have the responsibility for giving you assistance in understanding and completing each lab exercise. Ask them when you do not understand any feature of what you are expected to do, and for help with developing your experimental physics understanding. Be prepared for demonstrators to reply to your question with another question - they are not trying to be unhelpful, since this is often a good strategy to help your learning!

Demonstrators also have responsibility for ensuring that you work safely in the laboratory. Students are required to obey their demonstrator’s instructions regarding safe practices such as adequate footwear, absence of food, evacuation in the event of a fire alarm etc. Safety guidelines can be found later in this section.

(e) Partners

At the start of the laboratory course you will be allocated a partner. You will be allocated a new partner at the start of each subsequent segment. This policy is designed to develop your skills in working with a variety of people through the year.

(f) Lost Property

See Colin Entwisle or Nick Nicola promptly.

(g) Attendance

Since the skills and the conceptual understanding developed through laboratory work are crucial to your development as a science practitioner or teacher, attendance at all laboratory sessions is compulsory. Satisfactory completion of this important part of the course is a requirement for a pass in the subject. If you are unavoidably absent from any laboratory exercise you must present a medical certificate or equivalent to Mr Entwisle or Mr Nicola as soon as possible. Otherwise you will receive 0 for that experiment.

A maximum of 2 medical certificates in each semester will be accepted.

If you know ahead of time (at least a week’s notice) that you will be unavoidably absent, inform Mr Entwisle or Mr Nicola.

(h) Safety

It is important that practices in the laboratory are consistent with the requirements of safety. As prospective workers in laboratories, knowledge of the rules of safety and adherence to them is essential. Adequate footwear and suitable clothing must be worn in the lab at all times. Food, drink and smoking re not allowed in the lab. Please read the set of rules detailed later in this manual and adhere to them at all times.
4. Assessment of Practical Physics

The learning that happens in the first-year laboratory is important. To recognise this 25% of your assessment in each subject is assigned to laboratory work. This 25% is divided as follows (each category of assessment is explained further below):

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental techniques and Performance</td>
<td>13%</td>
</tr>
<tr>
<td>Template experiment reports</td>
<td>6%</td>
</tr>
<tr>
<td>Final experiment report</td>
<td>6%</td>
</tr>
<tr>
<td><strong>Total lab mark</strong></td>
<td><strong>25%</strong></td>
</tr>
</tbody>
</table>

(a) Experimental Techniques and Performance

This section is what many people consider to be the “practical work”. It includes all aspects of the actual experiment that you performed to end up with your results. The marking criteria will include:

- setting up equipment (remember that, quite apart from its role in your assessment, setting up the experiment is a vital part of your learning in experimental physics);
- choosing the correct equipment for a measurement (of course you will be given guidance on this);
- determining a suitable number of measurements (again your demonstrator will help. Consider whether a reading should be repeated and if so, how many times. Remember, set realistic goals, as you only have 3 hours to complete the experiment);
- accuracy and quality of measurements;
- your own performance, including degree of preparation (don’t let your partner do all the work - share setting up and measurement. Don’t depend on your demonstrator to decide what measurements to make - don’t be afraid to make mistakes - this is a valuable learning process). You should work at a reasonable, constant pace and try to answer questions or determine solutions to problems before asking your demonstrator. This is certainly not meant to discourage you from asking your demonstrator for (or conversely seeking help from other students!!). You should always make a reasonable attempt yourself. If difficulties are still encountered then you should discuss your attempt with your demonstrator, as he/she may be able to prompt you to a solution.

**Note:** You will not be penalised for not attending for a valid reason (eg. medical condition with an appropriate medical certificate).

*This component will be assessed weekly by your demonstrator who will record a mark out of 10 in your laboratory notebook at the end of each session. This mark will be based on the demonstrator’s observation of your work during the session, including working with your partner(s), as well as a scan of your logbook record of the experiment.*

(b) Recording Your Laboratory Work

An integral part of performing each experiment is keeping your own record of all experimental conditions, actions, measurements, etc., so that you, or someone else, could check any part of this experiment and know exactly what was done and how.

Further details of the following requirements can be found in the What Goes Into a Physics Logbook section of the manual two pages further into this manual.
Developing your skills in record keeping will have two components this year.

- **Keeping a logbook record**
  Each week you will keep a logbook record of the experiment you undertake. This log record will record what you did in the lab – written as each item is completed – your results, calculations and answers to questions. It will be a fairly complete record of the experiment but not written in the style of a formal report with aim, method, results, discussion, conclusion etc. headings. It must be sufficiently complete however, to enable you to write a formal report of the experiment (see below).

  To someone who was not present during your laboratory class, the write-up in your notebook is the only indication of what you did, the results you obtained and their analysis and discussion. You logbook record should be clear, concise and readable to such a person. Keep a potential reader in your mind while writing up - a person having similar physics background to your own, but with no knowledge of the exercise. That person should be able to repeat what you did during your laboratory class from reading your logbook alone. The statement “as per lab manual” is not acceptable. You should remember to include all relevant aspects of your experimental procedure and analysis, especially any deviations from the exercise notes that may have been necessary. Writing in point form will be quite acceptable. Use diagrams wherever possible and make sure that your tables and graphs are clearly labeled.

  Your logbook record will also be scanned by demonstrators when assessing your performance in the lab.

  For one lab class in each of the first two segments of each semester your record of the experiment will be done on a template, ie. on a prepared outline that provides spaces for important results, answers to questions etc. The templates will be provided at the beginning of the session.

  Demonstrators will mark these template records and hand them back to you the following week. The two template reports together contribute 6% to your assessment.

- **Writing reports**
  On two occasions during each semester you will write a formal report. Your reports will be based on the logbook record you produced when you performed the experiment earlier in the semester. The first report will be marked carefully by your demonstrator and you will be given feedback on how closely it meets requirements of a report. This will be done in your own time outside formal classes. In semester 1 this will occur during the one-week break in the lab programme following Easter.

  The second report will be written during the final (ninth) laboratory session of each semester. You will be told which experiment to write the report on at the beginning of the report-writing session. Make sure your log-book record is sufficiently complete for you to do this!

  This report will contribute 6% to your subject assessment.

(c) **Satisfactory Completion of Laboratory Requirements**

The University handbook statements describing the assessment for each of the subjects offered by the School of Physics at first-year level state that to obtain a pass students must “complete both laboratory and assignment work satisfactorily”. What does this mean? ...

To complete the laboratory work component satisfactorily each student must:

- attend and submit a logbook record (or template) for at least 80% of the sessions in each semester;
- and earn a mark of at least 50% of the total possible available marks.

If you are unable to attend a laboratory session due to illness or an equivalent reason, you should bring your medical certificate to Colin Entwisle or Nick Nicola as soon as possible. If absence for these reasons leaves your attendance below the minimum required for satisfactory completion, please see Colin or Nick to make appropriate arrangements to enable you to fulfil the requirements for satisfactory completion.
What Goes into a Physics Notebook?

The notes below will guide you through what we expect to find in an effective physics notebook. You will use the notebook for both weekly records of your experiments (logbook) and formal reports.

Remember that the logbook aspect of your notebook is your record - it will be useful later as you review what you have learnt in the laboratory and how it ties in with your learning from lectures, tutorials, problem solving, reading etc. You will use your logbook as the basis for report writing twice during each semester.

A special practical note book is available from the lab, and must be used throughout the year. The cover of your notebook should be filled in completely, and your name also written on the two ends of the book. Pages should be numbered. A “Table of Contents” should be kept up to date at the beginning of the book. When an experiment is recorded on a template this will be stapled into the back of your laboratory notebook.

Please note, laboratory notebooks are NOT to be taken out of the laboratories except when used for writing up the report in mid-semester.

1. Logbook records

First a reminder – your aim is to keep a complete record of your experimental work. To help you in this, use ink at all times to write notes in your logbook, and never use a correction fluid in your physics notebook. Instead you may cross out material you have second thoughts about so that your thinking is transparently clear to your readers. For the same reason, no page should ever be torn out of the book. Use pencil for drawing graphs. You may also use pencil for diagrams.

The logbook is your personal record and may seem disorganized in that it could include both relevant and irrelevant information, fruitful and “dead-end” lines of investigation etc. This contrasts with a more formal report which is a succinct and carefully organised account of the work and its significance.

Records should be orderly and legible, and include:

- **Heading**
  A clear heading, together with date, and name of partner

- **Experimental description and Data, Analysis …**
  A sequence of method notes, record of observations and results, analysis and discussion then back to method, etc. will be found throughout this section. Record Method, Observations and Data together, as the experiment proceeds.

- **Experimental description**
  Description of any planning that was necessary.

  Description of the execution of the experiment (diagrams could be helpful here - make sure these are fully labeled). These records should be written as the experiment is performed and should not be based on your reminiscences. Include a description of the conditions when experiment was conducted; any special precautions taken; extra paths of investigation followed …

- **Observations**
  Clearly record your observations for later use in putting together a concise report. There should be sufficient detail to enable you to reconstruct in your mind the observations you describe. Where possible use diagrams instead of wordy statements.
• **Measurements**

All measurements should be carefully made and as precise as is necessary. Remember to think about the appropriate number of repeated measurements to make. Carefully thought-out tables should be used where possible for entering data. Raw data (measurements taken during the experiment) should be recorded in the notebook, as they are obtained. Data are not to be written on scrap paper. Quantities to be recorded (for example, in data tables), should have been defined and their measurement discussed in your logbook immediately before they are recorded. Each column of a table of data must be clearly labelled with both the variable being recorded and its unit of measurement. Clearly labelled tables will communicate clearly to you later when you are writing your report.

Raw data may often be graphed immediately onto graph paper to help you decide what extra data, if any, are needed. In such cases the raw datum (measurement) should be recorded in the Data Table and immediately plotted on graph paper before a new measurement is made.

It is often useful to include derived data (the results of algebraic or graphical manipulations made using the raw data) in the same table as the raw data – this requires some forward planning on your part.

• **Analysis leading to Interpretation**

Frequently you will need to process the raw data obtained from measurements and discuss your results. Make sure that you write a clear account of the process of analysis that you will understand later. In particular what raw data has been used, what calculations have been performed and the strategies of error analysis you have used.

Present the results of this analysis in the form of graphs where appropriate. Graphs should be fully labeled, and display your work informatively.

What does your analysis tell you? Discuss the outcomes of your analysis, including assumptions made, limitations of results etc.

As this is a log book the discussion is likely to be interleaved with your analysis, with comments located immediately after the analysis to which they refer.

• **Questions**

There will usually be some questions asked which you should answer either by considering the theory, the practical method, observations or the data. The questions are designed to help you think through important aspects of the theory behind the experiment, alert you to important features of experimental procedure, or to guide you in thinking about the significance of your observations and measurements.

Your logbook record of your answers should be complete enough for you to answer these questions in full in your formal report.

• **Summary**

Summarise the main outcomes of the experiment. This should set the scene for a more formal conclusion when you write reports later in the semester.

2. **Formal reports**

The teaching staff aim to enable you to develop your report writing skills, with help. So, the process will involve two reports which are carefully marked in each semester. The first, while fully marked, will not count for assessment. It is intended to give you feedback so that you will be well prepared for the second report, written under exam conditions later in the semester. There will be a progression in this, so that in second semester further items, eg. an abstract, will be expected in your report.
(a) Assessment

These reports will be assessed under the following headings:

- **Structure of the report**: Is this logical, under the usual headings (though it is recognised that some variation is appropriate for different experiments)?
- **Communication**: How clearly and concisely do you communicate what the experiment was about and its important findings?
- **Experimental insight**: How effectively was the experiment carried out? Were appropriate numbers of readings taken etc.?
- **Presentation of results**: Are your tables and graphs clearly set out and appropriately labeled?
- **Analysis**: Were appropriate analysis strategies used and error analysis completed?
- **Understanding**: How well do you understand the important physics ideas explored in the experiment?
- **Completeness**: Is the report complete, with all aspects of the experiment addressed adequately?

When demonstrators assess your reports they will consult your logbook record of the experiment.

(b) Requirements

What follows is a description of the requirements of the formal reports you will write up twice in each semester.

These reports will follow standard format as outlined below. The report will be a succinct and carefully organised account of your experimental work based on your logbook account. It may not follow exactly the sequence of your performance of different activities in the laboratory exercise as described in your logbook. Your aim should be to present the most logical sequence for a coherent “story”. The report should be about 4 to 6 pages long plus graphs. Clearly this will vary somewhat, depending on the experiment and student’s writing, but we are not looking for 10 page epics!

**Introductory Items**

1. **Title, Partner’s Name(s), Date**

2. **Introduction and Aims**

   In the introduction you outline the main motivations of the experiment and the ideas it explores. You need to have a clear idea of the experiment’s objectives for the remainder of your report to be clear and logically sequenced and this is also necessary for your reader.

   This section should also include a brief account of any physical principles underlying the experiment. For example in the Investigating Resistance experiment the idea of voltage dividers in a Wheatstone bridge circuit will be used so an account of these ideas should be included. Keep this short – you are not writing a textbook!

   The introduction should conclude with a concise statement of the purpose of the experiment. Typical statements of purpose begin …

   The purpose of this experiment is

   to show...

   to gain confidence in...

   to investigate...

   It is not appropriate to state that you aim "to prove" formulae or physical principles - in a single experiment it is only possible to gain a concrete experience of the general usefulness of the formula or principle.
Record of the experiment itself

1. **Method**

   A clear, labelled diagram of the experimental set up should be drawn.

   A **brief** description of the way each part of the experiment was done should be given. The description should be in note form and written in your own words. Each note should contain one idea, and take no more than a couple of lines. It should say what you did rather than give instructions. Be short, sharp and succinct.

   **Do not** reproduce the description of method given in the manual - statements such as “The Cathode Ray Oscilloscope was calibrated as described in the manual” would be appropriate. Any variations from or additions to the manual outline, however, should be described in enough detail so that others could repeat your procedure. Sources of error should be identified and discussed.

2. **Observations and Data**

   Present a summary of observations and measurements, clearly stating the relevant data from your logbook. In general tables of raw data would not be included – summarise the data as an average, with error estimate, of each measurement. Take care to include units and the appropriate number of significant figures.

   It will often be appropriate to divide the experimental report into sections and so observations and data would then appear in the report immediately after the relevant section of the method.

Analysis and Discussion

1. **What the observations and measurements mean**

   The observations and data provided earlier are interpreted and evaluated here. How consistent are they? What do they reveal about the subject under investigation? Is there a theoretical explanation of the results? This process may involve finding the relationship between measured quantities, taking into account any errors associated with their measurement. When plotting graphs take care to write down an appropriate title and label axes with both the quantity being plotted and its unit. Graphs should make full use of a page of graph paper.

2. **Questions**

   Many answers to questions posed in the manual account of the experiment belong in the discussion section, but some should be placed in the introduction, depending on where they come in the experiment. They should always be answered in complete sentences that can be understood without reference to the manual. eg. For the question “What power supply settings were required for this result?” The answer should begin “The power supply settings required for this result were ...”

   Answers to questions should be seen as part of an integrated report, with their purpose being to improve your reporting of the experiment. They should **not** be used as the structure of the report.
Conclusion

The conclusion summarises the outcome of the experiment and the significance of the results. The conclusion should be specific.

If the main purpose of the experiment was to ...

measure a physical quantity, then state the result precisely, with error estimates.

explore the function of a device eg. a power supply, then summarise how the device works.

investigate the truth of a particular hypothesis, then state the extent to which these hypotheses were supported or unsupported.

Before writing the conclusion it is helpful to:
1. Look back at the Introduction.
2. Look back at the Observations, Data, analysis and Discussion.

(c) Semester 2 reports

In semester 2 the plan is for you to build on the report writing skills developed in semester 1. To reflect this progress in your ability to write reports it will be expected that in semester 2 your reports will include:

- an abstract of your report as the first item in the report – a few lines summarising the whole report;

- integration of the answers to questions in your report ie. in semester 1 these answers will appear explicitly in your report and be labeled as answers to questions. In semester 2 it is expected that the issues addressed by the questions will be included in the appropriate part of the report, eg in the introduction where they help you to explain the principles underlying the experiment, in the discussion where the answers to the questions guide you to discuss important issues coming out of your results and observations.

More details about these additional requirements will be made available in semester 2.
1. **Emergency Procedures**

If the emergency alarm bell sounds continually, the building **MUST** be evacuated. Switch off all equipment, clear walkways and leave by the suggested emergency exit route. This is:

- **the door at Eastern end of lab, and down stairs to the ramp area.**

If this exit is not accessible, leave by the **Western** stairway.

If a fire occurs in the laboratory, alert people near you and also others on your level. Turn off all equipment and leave the area immediately. Do not get in the way - your demonstrator will take control.

Note: (a) Remember that it is very easy to be overcome by smoke and fumes; these may be extremely toxic, especially if electrical equipment is involved.

(b) Furthermore, the application of an inappropriate type of fire extinguisher can be very dangerous. The two most common types of extinguishers are: water (or soda acid) which is most effective on ordinary combustibles, such as paper, wood, etc., and should not be used on electrical, oil or grease fires; and carbon dioxide which can be used on combustible, electrical and flammable liquid fires.

2. **Accidents**

If you are first on the scene of an accident and the casualty is in danger of further injury, observe the area for hazards and, **if it is safe**, pull the casualty clear. However, do not move the casualty unnecessarily.

If the cause of the accident is electrical and the casualty is still receiving the charge, first ensure that you will not be in danger of electric shock by attempting to help the casualty. Switch off the current at the wall and pull out the plug. If this is not safe, free the person by using something non-conductive (eg. dry wood, rubber, etc.). **Do not touch the casualty or you will receive a shock yourself.**

Once the casualty is out of immediate danger, **summon aid immediately** by reporting the accident to (1) your demonstrator and (2) any lab staff (in eastern end of the labs) or the front office in the Physics building. There are a number of people available who are qualified in First Aid - attempt to find one of them by asking your demonstrator.

3. **Electrical Hazards**

The mains electrical supply is 240 volts, alternating current. Such a supply is hazardous and can be lethal. Therefore, **care must be taken at all times**.

- **Do not** attempt to service any electrical equipment yourself. This includes changing fuses.

- If an accident occurs, act quickly. Ensure that you will not be in danger of electric shock by attempting to help the casualty. Switch off the electrical supply at the wall and pull out the plug. If this is not safe, free the person by using something non-conductive (eg. dry wood, rubber, etc.). **Do not touch the casualty or you will receive a shock yourself.**

- Alert your demonstrator.
Remember the following:

- be aware of live parts and take appropriate precautions;
- when working with live equipment, work one-handed, keeping the other hand at your side;
- make sure all connections are clean, dry and secure; and
- always connect the supply voltage to your circuit last and then, at first, only connect on for an instant.

4. Radiation Hazards

All types of ionising radiation produce changes in living cells, but actively dividing cells (eg. blood-forming and reproductive cells) are particularly susceptible to damage. All doses of radiation, therefore, must be kept as low as possible.

Each of the radioactive sources is sealed or shielded to prevent the active material from dispersing into the surroundings, where it could be inhaled, ingested or absorbed. Take care not to break these enclosures. If any sources appear to be damaged, tell your demonstrator immediately.

When the sources are not in use, return them to the trolley. Radioactive sources must never leave the laboratory.

The dose received is directly proportional to the exposure time and inversely proportional to the distance squared. The main safety procedures are:

- minimise your exposure time;
- maximise the distance between yourself and the source;
- where appropriate use shielding, with lead blocks for example, to reduce the intensity of radiation.
- after leaving the laboratory, wash your hands thoroughly.

5. Safety Measures

Whilst in any of the laboratories the following rules should be remembered.

- Try to maintain a neat and clean bench and work area. Keep aisles and doors clear. Switch off and tidy up the equipment after use.
- Never run or throw objects in the laboratory. Do not adopt a casual attitude - be aware of the potential hazards and act accordingly.
- Never work alone in a laboratory - a colleague should always be within call.
- Adequate footwear and suitable clothing should be worn at all times in the laboratory.
- Eating, drinking and smoking is forbidden. After leaving the laboratory (especially Radiation), wash your hands thoroughly.
- All accidents, injuries, mishaps and “near misses” must be reported to your demonstrator immediately. This also includes breakages, faulty equipment, etc. If you are the cause of some mishap or accident, do not cover up, tell your demonstrator immediately: in doing so you may save injury to others.