Laboratory Report Writing

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Why Write a Lab Report?

• Your lab book will contain a complete, chronological record of the work performed in the lab or computing suite
  – Your thought processes—trial and error in experimental approach or theory and code development
  – Good data will be mixed with bad
  – Sound interpretation will be recorded together with erroneous thoughts

• The lab report pulls together the important findings in a concise and orderly document, to be communicated effectively to the reader
Negative Refraction Makes a Perfect Lens

J. B. Pendry
Condensed Matter Theory Group, The Blackett Laboratory, Imperial College, London SW7 2BZ, United Kingdom
(Received 25 April 2000)

With a conventional lens sharpness of the image is always limited by the wavelength of light. An unconventional alternative to a lens, a slab of negative refractive index material, has the power to focus all Fourier components of a 2D image, even those that do not propagate in a radiative manner. Such “superlenses” can be realized in the microwave band with current technology. Our simulations show that a version of the lens operating at the frequency of visible light can be realized in the form of a thin slab of silver. This optical version resolves objects only a few nanometers across.

Optical lenses have for centuries been one of scientists’ prime tools. Their operation is well understood on the basis of classical optics: curved surfaces focus light by virtue of the refractive index contrast. Similarly their limitations are dictated by wave optics: no lens can focus light onto an area smaller than a square wavelength. What is there new to say other than to polish the lens more perfectly and to invent slightly better dielectrics? In this Letter I want to challenge the traditional limitations on lens performance and propose a class of “superlenses,” and to suggest a practical scheme for implementing such a lens.

Let us look more closely at the reasons for limitation in performance. Consider an infinitesimal dipole of frequency ε in front of a lens. The electric component of the field will be given by some 2D Fourier expansion.

\[ E(r, t) = \sum_{\alpha, \beta, k_\alpha} E_\alpha(k_\alpha) \times \exp(ik_\alpha z + i\omega t) \]

where we choose the axis of the lens to be the z axis. Maxwell’s equations tell us that

\[ k_\alpha = -\sqrt{\omega^2 - k^2} \]

(2)

(1)

The function of the lens is to apply a phase correction to each of the Fourier components so that at some distance beyond the lens the fields reassemble to a focus, and an image of the dipole source appears. However, something is missing: for larger values of the transverse wave vector,

\[ k_\alpha = i\sqrt{k^2 + k^2} - \omega^2 c^2 \]

(3)

These evanescent waves decay exponentially with z and no phase correction will restore them to their proper amplitude. They are effectively removed from the image which generally comprises only the propagating waves. Since the propagating waves are limited to

\[ k_\alpha^2 < \omega^2 c^2 \]

(4)

the maximum resolution in the image can never be greater than

\[ \Delta = \frac{2\pi}{k_{\text{max}}} = \frac{2\pi c}{\omega} = \lambda. \]

(5)

and this is true however perfect the lens and however large the aperture.

There is an unconventional alternative to a lens. Material with negative refractive index will focus light even when in the form of a parallel-sided slab of material. In Fig. 1, I sketch the focusing action of such a slab, assuming that the refractive index

\[ n = -1. \]

(6)

A moment’s thought will show that the figure obeys Snell’s laws of refraction at the surface as light inside the medium makes a negative angle with the surface normal. The other characteristic of the system is the double focusing effect revealed by a simple ray diagram. Light transmitted through a slab of thickness d2 located a distance d1 from the source comes to a second focus when

\[ z = d_2 - d_1. \]

(7)

The underlying secret of this medium is that both the dielectric function, ε, and the magnetic permeability, μ, happen to be negative. In that instance we have chosen

\[ \varepsilon = \mu = -1. \]

(8)

These evanescent waves decay exponentially with z and no phase correction will restore them to their proper amplitude. They are effectively removed from the image which generally comprises only the propagating waves. Since the propagating waves are limited to

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(9)

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(12)

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(13)

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\[ k_\alpha^2 < \omega^2 c^2 \]

(14)

the maximum resolution in the image can never be greater than

\[ \Delta = \frac{2\pi}{k_{\text{max}}} = \frac{2\pi c}{\omega} = \lambda. \]

(15)

and this is true however perfect the lens and however large the aperture.

There is an unconventional alternative to a lens. Material with negative refractive index will focus light even when in the form of a parallel-sided slab of material. In Fig. 1, I sketch the focusing action of such a slab, assuming that the refractive index

\[ n = -1. \]

(16)

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\[ z = d_2 - d_1. \]

(17)

The underlying secret of this medium is that both the dielectric function, ε, and the magnetic permeability, μ, happen to be negative. In that instance we have chosen

\[ \varepsilon = \mu = -1. \]

(18)

These evanescent waves decay exponentially with z and no phase correction will restore them to their proper amplitude. They are effectively removed from the image which generally comprises only the propagating waves. Since the propagating waves are limited to

\[ k_\alpha^2 < \omega^2 c^2 \]

(19)

the maximum resolution in the image can never be greater than

\[ \Delta = \frac{2\pi}{k_{\text{max}}} = \frac{2\pi c}{\omega} = \lambda. \]
First Year Lab Report Objectives

• We would like you to acquire the *professional skill* that is the ability to produce scientific writing

• This is important throughout your time as an undergraduate and beyond

• We want you to **improve through this process**; two lab reports, one computing report, a Electronics course report and a Y1Project report this year, with formative assessment and plenty of feedback

  – and remember the weighting of the first year is much lower than that in later years

• Also provides an opportunity for you to properly record some of the good work you have done in lab
Structure of a Lab Report

• Title (with date and name of author)
• Abstract (a concise summary of the findings in the report)
• Introduction
• Theory
• Method, including uncertainties
• Results and uncertainties, discussion
• Conclusion
• Bibliography
• Appendices

Pages must be numbered.
Report templates to help you structure your report will be posted on First Year Lab web page:
http://www.imperial.ac.uk/physicsuglabs/firstyearlab/assessment
What constitutes a good report?

• The Golden Rule—Aim for **Clarity**
  – Structured statements that flow in a logical manner
  – Good use of diagrams and appropriate level of theory
  – Careful choice of content
    • What needs to be included, what can be referenced
    • Who is your audience?

• **Use good English throughout**
  – Use complete sentences and paragraphs
    • avoid run-on sentences (aka comma splices)
  – Keep your language **clear and simple**
  – Check spelling and grammar
  – Expect to write two drafts and proofread
First Year Lab Report Process

• You write a lab report at the end of each four-week lab cycle

• The report topic and title are agreed with your demonstrator in the last lab session; the R1 date

• Report is on one aspect of what you have done, not an entire experiment
  − A part of an experiment where you have good data to work with
  − Partners must cover different topics (can be the same experiment)
  − Make the most of your data, estimate or measure uncertainties, justify your explanations

• One week to write your report; late reports receive zero

• Report marked by a demonstrator, second-marked by an academic

• On the R3 date, the reports become available for collection from First Year Lab office

• You are encouraged to schedule a follow-up meeting with the marker to clarify points of feedback
# FIRST YEAR LABORATORY REPORT

**ELECTROMAGNETISM/OPTICS**

**Hand-In Date (R2)** 14th Feb  
**Return Date (R3)** 28th Feb  

Note: Reports which are handed in late are subject to a penalty.

<table>
<thead>
<tr>
<th>NAME</th>
<th>LAB GROUP</th>
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<tr>
<td>«Firstname» «Surname»</td>
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**DEMONSTRATOR**  
«Demonstrator»

**REPORT TITLE**

---

**Students:** Please sign the plagiarism statement below and then staple this sheet to the front of your report. It should then be handed in to either Harish or Robert in the First Year Lab before 4pm on the R2 date. The report will be marked (not necessarily by your demonstrator) and then second marked by an experiment coordinator before being returned to you on the R3 date.

Reports should be written following the guidance given in the ‘Introduction to the First Year Laboratory’ and the ‘Guidelines on Report Writing’. You will find it helpful to re-read these documents before you start to write your report. Both documents are available in your lab manual and on the laboratory website: [http://www3.imperial.ac.uk/physicsuclabs/firstyearlab](http://www3.imperial.ac.uk/physicsuclabs/firstyearlab)

I confirm that this report is my own work, and that any material derived from other sources has been appropriately acknowledged. I have read and understood the Physics Department guidelines on plagiarism and state that I am aware of the College definition of plagiarism and the consequences of committing an offence of plagiarism in assessed course work.

Signed ………………………………………

---

**Marker:** Please circle the marks on the separately issued ‘Marking Summary Form’ and **NOT** on the pro forma below. The Second Marker will, if appropriate, modify these marks and then assign the final mark.

Please ensure that as well as placing comments throughout the report, you also summarise each category with comments in the boxes below.

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**General Comments:**

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**Second Marker (Print)………………………………………**  
**Date…………………**

**Second Marker (Sign)………………………………………**

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**FINAL MARK / 25**

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**Marker (Print)………………………………………**  
**Date…………………**

**Marker (Sign)………………………………………**
Report Style

• Write in the past tense, third person, passive voice.
  
  – Past tense:
  • “A 300 line/mm grating was used and spectra were taken.”
  
  – Third person:
  • Use impersonal language, write about the experiment and what happened. Do not write: “I used a 300 line/mm grating and Jane took spectra.” If the fact that the two of you were both directly involved (e.g., one person focused and image while the other read off a distance value), you can say “Experimenter 1” and “Experimenter 2” etc.
  
  – Passive voice:
  • “The function generator was connected to the oscilloscope using a coaxial cable” rather than active voice “Experimenter 1 connected the function generator to the ...”
  
• For further details, see lab manual
Report Length

• How long should the report be?
  – The report should be self-contained and cover the principles, methods, results and analysis
  – 4–6 sides of A4 including graphs and figures
  – Supplementary material can go in an appendix; for example program listings and long derivations etc.
  – Keep algebraic manipulation and numerical working in the lab book
The Abstract

• People browse abstracts to **quickly decide whether they are interested in the material contained in the report**

• They are a **brief synopsis of what has been done and what method was used. Any key results (and their associated uncertainties) should be quoted and main conclusions should be stated**

• Example from Eguchi et al, Phys. Rev. Lett. 90 (2003) 021802:

KamLAND has measured the flux of $\bar{\nu}_e$'s from distant nuclear reactors. We find fewer $\bar{\nu}_e$ events than expected from standard assumptions about $\bar{\nu}_e$ propagation at the 99.95% C.L. In a 162 ton $\cdot$ yr exposure the ratio of the observed inverse $\beta$-decay events to the expected number without $\bar{\nu}_e$ disappearance is $0.611 \pm 0.085$(stat) $\pm 0.041$(syst) for $\bar{\nu}_e$ energies $> 3.4$ MeV. In the context of two-flavor neutrino oscillations with CPT invariance, all solutions to the solar neutrino problem except for the “large mixing angle” region are excluded.
Physics

General search tools
- Library Search
- Accessing e-resources

Key e-journal collections
- IOPscience
- Scitation
- SpringerLink
- OpticsInfoBase
- American Geophysical Union

Books and e-books
- AIP conference proceedings online
- CRC Handbook of Chemistry and Physics
- The Feynman Lectures on Physics (free html access)
- Feynman Lectures on Physics (PDF via EBL) Vol 1, Vol 2, Vol 3
- Handbook of Visual Display Technology
- IOP ebook collection NEW
- Oxford Reference premium collection
- Using mobiles and tablets to access e-books

Find articles using databases
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- Web of Science (including Web of Science Core Collection)
- IEEE Xplore
- ProQuest
- Scopus
- SPIE Digital Library NEW

Subject portals / pre-print collections
- Spiral Digital Repository
- arXiv
- INSPIRE
- Astrophysics Data System

Other web based resources
- Physics web links
- Science World
- Wolfram Mathworld

Suggestions
Negative refraction makes a perfect lens

Author(s): Pendry, JB (Pendry, JB)

Source: PHYSICAL REVIEW LETTERS Volume: 85 Issue: 18 Pages: 3966-3969 DOI: 10.1103/PhysRevLett.85.3966
Published: OCT 30 2000

Times Cited: 4,933 (from Web of Science)

Abstract: With a conventional lens sharpness of the image is always limited by the wavelength of light. An unconventional alternative to a lens, a slab of negative refractive index material, has the power to focus all Fourier components of a 2D image, even those that do not propagate in a radiative manner. Such "superlenses" can be realized in the microwave band with current technology. Our simulations show that a version of the lens operating at the frequency of visible light can be realized in the form of a thin slab of silver. This optical version resolves objects only a few nanometers across.

Accession Number: WOS:000090146300056

Document Type: Article

Language: English

KeyWords Plus: LOW-FREQUENCY PLASMONS; TRANSMISSION

Reprint Address: Pendry, JB (reprint author)

The Introduction

• Give background to what you are doing and why
• Introduce the ideas you will need later in the report and review appropriate literature. Details can be referenced
• Put your work in context
Theory

• Use prose and equations. Here, and elsewhere, an important style rule is: always start a new section with a sentence, not with an equation, table, figure etc.
• Be concise, but with enough information such that later sections can be understood (and refer back from Method and Results sections for necessary equations)
• Equations are a part of the sentence they appear in; for example (note small “w” in “where”):

Force $F$ is defined by

$$F = ma,$$  \hspace{1cm}  (3)

where $m$ is the inertial mass and $a$ the acceleration.

• No need to derive all formulae. Reference a source and outline the main steps, if required
Theory

• Use prose and equations. Here, and elsewhere, an important style rule is: always start a new section with a sentence, not with an equation, table, figure etc.
• Be concise, but with enough information such that later sections can be understood (and refer back from Method and Results sections for necessary equations)
• Equations are a part of the sentence they appear in; for example (note small “w” in “where”):

  Force $F$ is defined by

  \[ F = ma, \quad (3) \]

  where $m$ is the inertial mass and $a$ the acceleration.
• No need to derive all formulae. Reference a source and outline the main steps, if required
The description of highly confined modes in optical fibres and microscale dielectric resonators is based on classical waveguide theory. By solving Maxwell’s equations with the appropriate boundary conditions, it follows that excitation of leaky modes occurs in an infinitely long dielectric cylinder of radius $a$ when the following condition is satisfied:

$$\left( \frac{1}{\kappa^2} - \frac{1}{\gamma^2} \right) \left( \frac{\beta m}{a} \right)^2 = k_0^2 \left( n^2 \frac{J'_m(\kappa a)}{\kappa J_m(\kappa a)} - n_0^2 \frac{H'_m(\gamma a)}{\gamma H_m(\gamma a)} \right) \times \left( \frac{J'_m(\kappa a)}{\kappa J_m(\kappa a)} - \frac{H'_m(\gamma a)}{\gamma H_m(\gamma a)} \right),$$

(1)

where $\gamma(\kappa)$ and $n_0(n)$ are the transverse wave vector and refractive index outside (inside) the cylinder, $\beta$ and $k_0$ are the wave vectors along the cylindrical axis and in free space, $J_m$ and $H_m$ are the $m$th-order Bessel function of the first kind and Hankel function of the first kind and the prime denotes differentiation with respect to related arguments. For normal-incidence illumination ($\beta = 0$) of a cylinder in vacuum ($n_0 = 1$), equation (1) can be split into conditions for purely transverse-magnetic modes with the magnetic fields in the plane normal to the nanowire axis $[nJ'_m(nk_0a)/J_m(nk_0a) = H'_m(k_0a)/H_m(k_0a)]$ and transverse-electric modes $[J'_m(nk_0a)/nJ_m(nk_0a) = H'_m(k_0a)/H_m(k_0a)]$ with the electric fields normal to the nanowire axis. From these conditions, it follows...
The general LMRs equation (equation (1)) suggests that a change in the illumination angle, \( \theta \), can cause a change in the absorption spectrum as the relevant wave vectors are angle dependent (\( \kappa = k_0 \sqrt{n^2 - \cos^2 \theta}, \beta = k_0 \cos \theta, \gamma = k_0 \sin \theta \)). Moreover, for oblique incidence, hybrid HE and EH leaky modes will be excited instead of pure transverse-electric or transverse-magnetic modes. In other words, the change of the incident angle should carefully be considered in engineering desired absorption features for a device. Simple design rules can readily be derived from equation (1). For example, it can be shown that the size parameter for the fundamental TM\(_{01}\) mode resonance approximately scales with illumination angle as \( 1/\sin \theta \) (see Supplementary Information for a detailed derivation). This can be used to enable marked shifts in the absorption spectrum. Alternatively, device designs that do not take angle-dependent effects into account can result in serious device underperformance. Figure 5 shows the expected large angle dependence for a 25-nm-radius wire that supports only the TM\(_{01}\) LMR. We also see that the absorption sharply drops when the incident angle changes to 20\(^\circ\), where the wire is effectively too small.
Method

• State what you did and why:
  “A pendulum weighing 10 g was tied to a niobium pin using 22 swg copper wire; a compromise between wire stiffness and mass. The pendulum was displaced from the equilibrium position by 2 cm and released.”

• Note that the method is written differently to the instructions in the lab script, which is often written as a series of commands or instructions
  – Do not write: “Attach the 10 g pendulum to the niobium pin. Displace from equilibrium by 2 cm.”

• Do not list the items of apparatus used. Describe each piece of apparatus in the text as it becomes necessary. For example, the niobium pin was simply mentioned in the example above

• Consider the uncertainties in your method, before you report any data. State how accurately can you make the measurement
Results, Uncertainties & Discussion

• Describe your **results**, an important part of which will be an **analysis of the effect uncertainties have**

• **Remember**, a comparison with the “accepted value” does not help you estimate the systematic uncertainties!
  – it can tell you if your experiment is wrong, but you should check this as you go by plotting measured quantities and verifying orders of magnitude etc.

• **Discuss** what your results mean i.e. draw conclusions from your results

• Three constructs—**text, tables, figures** (graphs, drawings, charts and plots etc.)

• All figures should have a **figure number and a caption** and you must refer to the figure somewhere in the text
  – “as shown in Figure 5, the data follow a linear relationship”
  – not “as is shown in the figure below, a linear relationship is followed”
Tables

• You can present ordered sets of data in tables, for example:

J.Barnes et al., Journal Applied Physics 79:10 (1996) p7775,

<table>
<thead>
<tr>
<th>Sample name</th>
<th>No. of QWs</th>
<th>Barrier width (Å)</th>
<th>Indium fraction (%)</th>
<th>QW width (Å)</th>
<th>(Q_e)</th>
<th>CL results (dark line density/μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QT458</td>
<td>1</td>
<td>1200</td>
<td>15.5±0.5</td>
<td>107±3</td>
<td>0.64±0.02</td>
<td>No dark lines seen</td>
</tr>
<tr>
<td>QT459b</td>
<td>10</td>
<td>500</td>
<td>15.5±0.5</td>
<td>106±3</td>
<td>0.62±0.02</td>
<td>0.02±0.01</td>
</tr>
<tr>
<td>QT459c</td>
<td>15</td>
<td>300</td>
<td>15.5±0.5</td>
<td>110±4</td>
<td>0.64±0.03</td>
<td>0.22±0.07</td>
</tr>
<tr>
<td>SA8M42</td>
<td>25</td>
<td>150</td>
<td>18.5±0.5</td>
<td>80±4</td>
<td>0.66±0.03</td>
<td>Too great to count</td>
</tr>
<tr>
<td>SA8M43</td>
<td>20</td>
<td>200</td>
<td>19.0±0.5</td>
<td>74±4</td>
<td>0.62±0.02</td>
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<tr>
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<td>300</td>
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<td>74±3</td>
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<td>0.24±0.05</td>
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<tr>
<td>RM971</td>
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<td>300</td>
<td>19.0±0.5</td>
<td>76±4</td>
<td>0.64±0.02</td>
<td>0.09±0.02</td>
</tr>
</tbody>
</table>

TABLE II. Summary of results from this section, detailing number of quantum wells, well width, indium fraction, band offset, and CL results.

• But usually a graph is the best way to present data.
  – If you have a graph, you don’t need a table! (leave the numbers for your lab book)

• For more ideas, see E. R. Tufte, Envisioning Information.
**TABLE II.** Estimated systematic uncertainties (%).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Uncertainty</th>
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<tr>
<td>Total LS mass</td>
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</tr>
<tr>
<td>Fiducial mass ratio</td>
<td>4.1</td>
</tr>
<tr>
<td>Energy threshold</td>
<td>2.1</td>
</tr>
<tr>
<td>Efficiency of cuts</td>
<td>2.1</td>
</tr>
<tr>
<td>Live time</td>
<td>0.07</td>
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<tr>
<td>Reactor power</td>
<td>2.0</td>
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<td>Fuel composition</td>
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<td>Time lag</td>
<td>0.28</td>
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<td>$\bar{\nu}$ spectra [11]</td>
<td>2.5</td>
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<tr>
<td>Cross section [14]</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Total systematic error: 6.4%
The Conclusions

• Briefly restate the aims of the experiment and method used
• Draw all the elements of the report together
• Point out successes and failures
• Say how the experiment could be improved
• Say what you have achieved and learned (use the passive voice here)
• Avoid making subjective or personal statements like “…the experiment was a great success and I learned how to use an oscilloscope…. “.
• The ending can be abrupt
Appendices

• Extra material, included for completeness
• Do not put your results here
Example Papers

• Notice I am not using past student reports to provide examples of reports
  – refer to real, professionally-produced physics papers at examples instead
  – any reputable paper/journal is fine
• In the slides that follow I am using the short paper:
  *First results from KamLAND: Evidence for reactor anti-neutrino disappearance*
  KamLAND Collaboration
  Published in Phys.Rev.Lett. 90 (2003) 021802
  • see today’s announcement of the Fundamental Breakthrough Prizes....
• Templates for lab reports are on the usual website
  – both for LaTeX and Word
Bibliography

• List all your reference material:
  – Books, papers, the lab script, URLs
    • but do not cite Wikipedia
    • except perhaps for images
• Read around your subject!
• Visit the library!
Physics

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Suggestions
Use of other people’s work

• Your report should be a unique record of your own work and be produced entirely by you

• **Use of supporting material from books, papers etc is strongly encouraged.** However any text or figures copied from a source other than your own unique work must be clearly referenced as such

• Use quotes or italics and reference to the original source etc. to make it clear where your work stops and other people’s starts

• Failure to do this can result in severe penalties up to and including expulsion from the course and revocation of University awards
Use of other people’s work

• Unreferenced cutting and pasting of material from web pages, other people’s reports (including your partner’s), unreferenced quotations of text books and published papers will all be viewed as plagiarism.
• Use of such material is often very obvious to the members of staff who mark reports and will be penalised in all cases.
• In previous years students have lost all lab marks and a full course unit as a result of plagiarism.
• It is up to you to make sure you do things correctly.
How To Reference Material

• The most usual way of referencing a paper, book, figure or quote in the text is to use a number clearly associated with the item you want to reference [1], an author name in brackets (Zweiback, 2000) or a superscript number³. Choose one method and stick to it.

• In the Bibliography you must give the full source for the reference:

Bibliography


Two Correct Examples

1) The mass-energy equivalence is clearly a fundamental principle central to 20th century physics. French [1] for example says that “The prime example of the mass-energy equivalence, to which we owe our continuing existence, is provided by thermonuclear reactions occurring in stars such as the sun”.

or

2) Thermonuclear fusion reactions have been of interest to the scientific community for many years, and recent work carried out at the Lawrence Livermore National Laboratory (Zweiback, 2000) has shown how such reactions can now be undertaken using small scale, table top laser systems.
The neutrino oscillation parameter region for two neutrino mixing is shown in Fig. 6. The dark shaded area is the MSW-LMA [19] region at 95% C.L. derived from [16]. The shaded region outside the solid line is excluded at 95% C.L. from the rate analysis with $\chi^2 \geq 3.84$ and are taken from [11].

FIG. 6 (color). Excluded regions of neutrino oscillation parameters for the rate analysis and allowed regions for the combined rate and shape analysis from KamLAND at 95% C.L. At the top are the 95% C.L. excluded region from CHOOZ [17] and Palo Verde [18] experiments, respectively. The 95% C.L. allowed region of the large mixing angle (LMA) solution of solar neutrino experiments [16] is also shown. The solid circle shows the best fit to the KamLAND data in the physical region: $\sin^2 2\theta = 1.0$ and $\Delta m^2 = 6.9 \times 10^{-5}$ eV$^2$. All regions look identical under $\theta \leftrightarrow (\pi/2 - \theta)$ except for the LMA region from solar neutrino experiments.
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Also include a reference if a figure is taken directly from another document.

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**Note meaningful caption; not just “Graph of $\Delta m^2$ against $\sin^2 2\theta$”, but caption stands on its own as an explanation of the figure**

FIG. 6 (color). Excluded regions of neutrino oscillation parameters for the rate analysis and allowed regions for the combined rate and shape analysis from KamLAND at 95% C.L. At the top are the 95% C.L. excluded region from CHOOZ [17] and Palo Verde [18] experiments, respectively. The 95% C.L. allowed region of the large mixing angle (LMA) solution of solar neutrino experiments [16] is also shown. The solid circle shows the best fit to the KamLAND data in the physical region: $\sin^2 2\theta = 1.0$ and $\Delta m^2 = 6.9 \times 10^{-5}$ eV$^2$. All regions look identical under $\theta \leftrightarrow (\pi/2 - \theta)$ except for the LMA region from solar neutrino experiments.
Diagrams Taken From Elsewhere

- These can be used, but of course must be cited properly in the caption.
- But preferable to draw your own diagrams (hand-drawn or with a drawing program), or adapt existing ones
  - in which case, you often can say "(adapted from [4])" etc.

in the caption

Fig 7: The instruments on the Philae spacecraft [3]. The present experiment focuses on the APXS (Alpha Proton X-ray Spectrometer), shown here in green.
Important Points to Note

• Plagiarism – do not copy the work of others
  – Check the lab manual for details

• Do not copy/transcribe the lab script

• Ensure your graphs and text are clear

• Write meaningful figure captions

• Proofread! Computers catch spelling mistakes, but they do not detect nonsense!
Report submission

• By **4pm on R2 date**, hand in your **report on paper** (with signed cover page) to the 1Y lab office
  And

• **Electronically via Blackboard**
  - [https://bb.imperial.ac.uk](https://bb.imperial.ac.uk)

• Late submissions receive zero (College policy)

• Instructions will be emailed to you closer to the date
Assessment: Criteria

- **Organisation**: Logical order; sensible headings and sections; appropriate abstract; conciseness; references; results supported by findings

- **English & Style**: Correct tense and grammar; clear, direct language

- **Graphs/Figures/Layout**: Clarity; well-drawn figures; full, meaningful captions and referencing of figures from main text

- **Error Analysis**: Presentation of uncertainties throughout report; justification of fundamental measurement uncertainty; clear analysis approach (no need for explicit calculations); error bars in plots; uncertainties on fitted values
Assessment: Marks

- **80–100%**: OUTSTANDING. Exceptional, independent work which shows thorough understanding and excellent technique together with substantial initiative.
- **70–80%**: FIRST CLASS. Excellent work: shows very good understanding and originality or correct method and clear reporting together with significant initiative.
- **60–70%**: UPPER SECOND. Good work: shows some initiative without being brilliant.
- **50–60%**: LOWER SECOND. Below average work or generally competent work but containing a few shortcomings such as poor data, some incomplete interpretation, etc.
- **40–50%**: THIRD. Well below average in all respects or containing substantial flaws or omissions.
- **0–40%**: FAIL. Unsatisfactory work: poor in all aspects or containing major mistakes in interpretation and analysis.
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• **40–50%**: THIRD. Well below average in all respects or containing substantial flaws or omissions.

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- **60–70%:** UPPER SECOND. Good work: shows some initiative with occasional inaccuracy, or work which is unexciting but competent.

- **50–60%:** LOWER SECOND. Below average work or competent work but containing a few shortcomings such as poor data, some incomplete interpretation, etc.

- **40–50%:** THIRD. Well below average in all respects or containing substantial flaws or omissions.

- **0–40%:** FAIL. Unsatisfactory work: poor in all aspects or containing major mistakes in interpretation and analysis.

70% is a good mark!
Marking Process

• A demonstrator who is familiar with the experiment will mark your report and provide written feedback
• A small number of academics will go over all of the marked reports, and adjust any marks or provide additional feedback in necessary
  – this is to ensure consistency of marking and feedback across the 40 or so demonstrators
• You are encouraged to meet your marker for oral feedback, and sometimes the second marker will ask you to talk to them
Summary

- **Read the guidelines in the lab manual!** Review this presentation
- Strive for **clarity**—Use correct, plain English
- Write a first draft early—not the night before the deadline
- Review the report critically. For example, ask yourself:
  - Does it satisfy the guidelines?
  - Are your statements scientific and justified?
  - Is there duplication in the writing? Can it be condensed? Are there gaps in the explanations or background? Check that all information presented is relevant to the content of the report
- **Proofread**