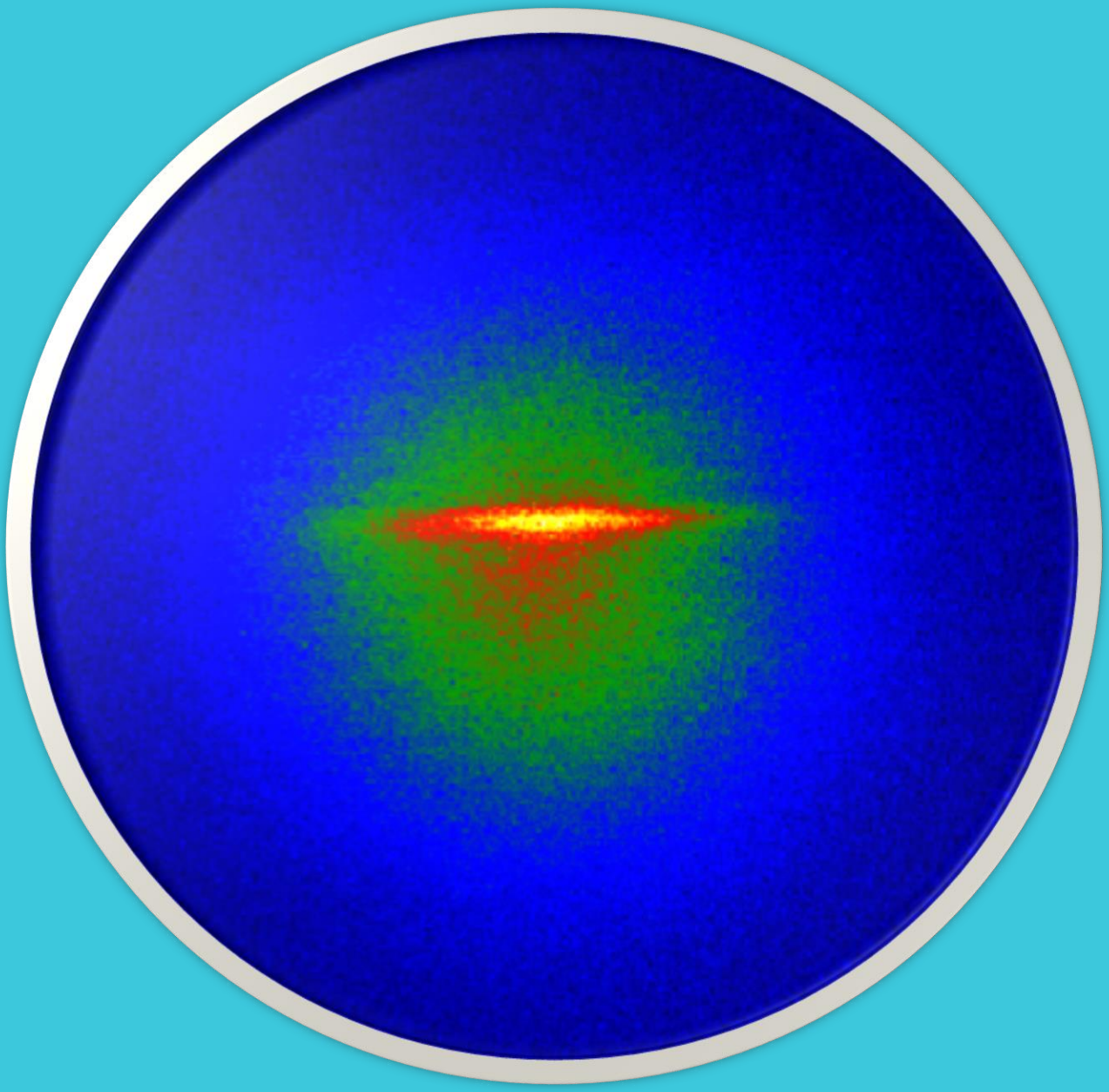

Lasers and other *cool* stuff

Key Stage 4 Programme

Pupil Name	
Handbook Designed by	Dr. Edmunds

Timetable and Assignment Submission

Timetable – Tutorials

1			
2			
3			
4			
5			
6 (Feedback)			

Timetable – Homework Assignments

Tutorial 1		
Tutorial 2		
Tutorial 3		
Tutorial 4		
Tutorial 5		

Assignment Submission – Lateness and Plagiarism

Lateness	
Late submission	10 marks deducted
Plagiarism	
Some plagiarism	10 marks deducted
Moderate plagiarism	20 marks deducted
Extreme plagiarism	Automatic fail

The Brilliant Club KS4 Programme – Pupil Feedback Report

Grade	Marks	What this means
1st	70+	Performing to an excellent standard at A-level
2:1	60-69	Performing to a good standard at A-level
2:2	50-59	Performing to an excellent standard at GCSE
3rd	40-49	Performing to a good standard at GCSE
Working towards a pass	0-39	Performing below a good standard at GCSE
Did not submit	DNS	No assignment received by The Brilliant Club

Lateness	
Any lateness	10 marks deducted
Plagiarism	
Some plagiarism	10 marks deducted
Moderate plagiarism	20 marks deducted
Extreme plagiarism	Automatic fail

Name of PhD Tutor			
Title of Assignment			
Name of Pupil			
Name of School			
ORIGINAL MARK / 100		FINAL MARK / 100	
DEDUCTED MARKS		FINAL GRADE	

If marks have been deducted (e.g. late submission, plagiarism) the PhD tutor should give an explanation in this section:

Learning Feedback Comment 1 -	
What you did in relation to this Key Learning Priority	How you could improve in the future
Learning Feedback Comment 2 –	
What you did in relation to this Key Learning Priority	How you could improve in the future
Learning Feedback Comment 3 –	
What you did in relation to this Key Learning Priority	How you could improve in the future
Resilience Comment	
How you showed learning resilience during the course	How you could build learning resilience in the future

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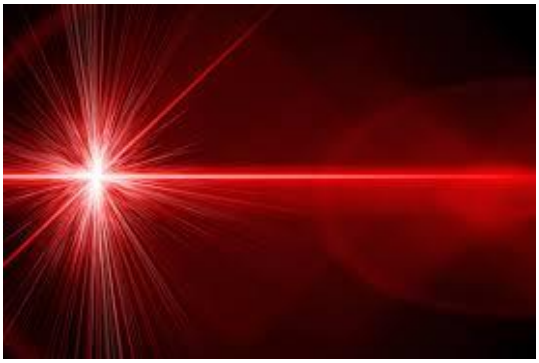
Course Rationale

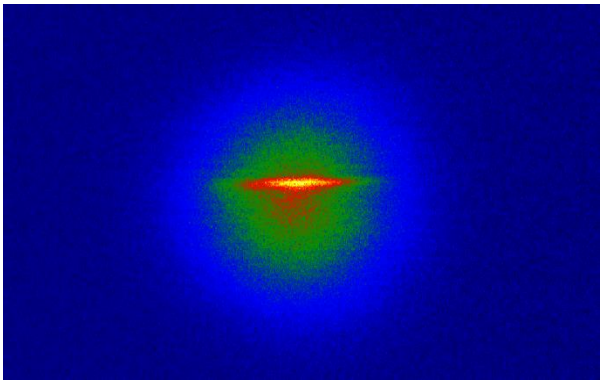


Lasers! We've all probably heard of or seen lasers referred to in books, movies and/or on tv. Lasers can commonly be used to heat things up, right? Yes! But, in the right arrangement they can also be used to cool things down.

In this course, we will discover exactly what a laser is and how they are used. This will culminate in us learning how lasers cool atoms and molecules to temperatures tens of thousands of times colder than in outer space! *Cool*, right?

We'll get here firstly by learning about light; what is light? Is it a wave or a particle? We'll also learn how a laser differs from a lightbulb and then learn about atomic structure. From here, we will have sufficient knowledge to understand how lasers can actually cool things to tiny temperatures.

Once we've completed the set of tutorials, the final project will consist of designing and presenting a research-style poster explaining the topic of laser cooling to a lay-person. Posters are one of the most common ways for a researcher to present their work and during this process you will learn invaluable research and presentation skills. The tutorials will also give you a sense of what it's like to study in a university environment.



Mark Scheme Table

	Skills	1st (70-100)	2:1 (60-69)	2:2 (50-59)
Subject knowledge	Knowledge and Understanding	○ All content included is relevant to the general topic and to the specific question/title ○ Good understanding of all the relevant topics. ○ Scientific terms are defined and used accurately throughout ○ Clear justification on how the content included is related to the specific issues that are the focus of the assignment	○ Most of the content included is relevant to the general topic and to the specific question/title ○ Good understanding of most the relevant topics ○ Scientific terms are used accurately but not always clearly defined. ○ Adequate justification on how the content included is related to the specific issues that are the focus of the assignment	○ Some of the content included is relevant to the general topic and to the specific question/title ○ Good understanding on some of the relevant topics but occasional confusion on others. ○ Scientific terms are used mostly accurately with occasional confusion and often not defined. ○ Some justification on how the content included is related to the specific issues that are the focus of the assignment
Critical thinking	Research and Evidence	○ Inclusion of rich sources of research findings, data, quotations or other sourced material as evidence for the claims/ ideas ○ Use evidence/calculations to support claims/assertions /ideas, consistently clearly and convincingly. ○ Evidence of further reading beyond materials provided which were used in an appropriate context.	○ Inclusion of adequate sources of research findings, data, quotations or other sourced material as evidence for the claims/ ideas ○ Use evidence/calculations to support claims/assertions/ideas, mostly clearly and convincingly. ○ Evidence of further reading beyond materials provided.	○ Inclusion of some sources of research findings, data, quotations or other sourced material as evidence for the claims/ ideas ○ Use evidence/calculations to support claims/assertions/ideas, at times clearly and convincingly ○ Limited evidence of further reading beyond materials provided.
	Developing an Argument	○ Argument/proof exceptionally well-developed and well-justified ○ Makes links effectively between subjects that have not previously been associated. ○ Uses concepts	○ Argument/proof clear and well-developed and position justified ○ Some evidence of linking subjects that have not previously been associated. ○ Use some concepts from the tutorials in	○ Argument/proof clear but not well-developed. ○ Limited evidence of linking subjects that have not previously been associated. ○ Limited use of concepts from the tutorials in other contexts.

		from the tutorials in an unfamiliar context and does so accurately and confidently.	an unfamiliar context, but not always accurate.	
	Critical Evaluation	o Moved beyond description to an assessment of the value or significance of what is described o Evaluative points are consistently explicit/systematic/reasoned/justified o Effective critiques on the reliability of sources provided	o Mostly description but some assessment of the value or significance of what is described o Evaluative points are mostly explicit/systematic/reasoned/justified o Some evidence of critiques on the reliability of sources provided	o Only description with minimal assessment of the value or significance of what is described o Evaluative points are at times explicit/systematic/reasoned/justified o Limited evidence of critiques on the reliability of sources provided
Written communication	Structure and Presentation	o Ideas are presented in paragraphs and arranged in a logical structure that is appropriate for the assignment o Introduction clearly outlines the content of the poster. o Conclusion summarises all the main points clearly and concisely. o All sources are referenced correctly in an agreed format.	o Ideas are presented in paragraphs and arranged in a structure that is mostly appropriate for the assignment o Introduction adequately outlines the content of the poster. o Conclusion summarises most of the main points clearly. o Most sources are referenced correctly in an agreed format.	o Ideas are presented in paragraphs and arranged in a structure o Introduction mentions the content of the poster. o Conclusion summarises some of the main points clearly. o Some sources are referenced correctly in the agreed format with occasional errors.
	Language and Style	o No spelling, grammar or punctuation errors o Writing style consistently clear, appropriate for scientific documents and easy to follow o Accurate and consistent use of technical language and vocabulary	o Minimal spelling, grammar or punctuation errors o Writing style mostly clear, appropriate for scientific documents and easy to follow o Some attempts of using technical language and vocab alary, but not always accurate	o Some spelling, grammar or punctuation errors o Writing style moderately clear, appropriate for scientific documents and easy to follow o Use of simple language and vocabulary effectively but struggles to use technical language

Glossary of Keywords

Word	Definition	In a sentence
Photon		
Energy Level		
Ground State		
Excited State		
Diffraction Grating		
Laser		
Coherent		
Collimated		
Spontaneous Emission		
Optical Molasses		
Magneto-Optical Trap		
Doppler Effect		

Tutorial 1 – Light

Figure 1.1: A light bulb!

What is the Purpose of Tutorial 1?

- To introduce the teacher and the course.
- To understand what light is.
- To understand the photoelectric effect in basic terms.

Activity 1.1 – What do we already know about light?

So that we can find out what you already know about light, write down a few sentences below on what you already know about light. Some ideas: is light a wave? Why? What do you think light is made of? What is light used/useful for?

If you wrote down that visible light is a wave: well done! It is a wave (specifically a *transverse* wave that belongs in the electromagnetic spectrum). We know that light is a wave because it *refracts*, *diffracts*, *reflects* and undergoes *interference*.

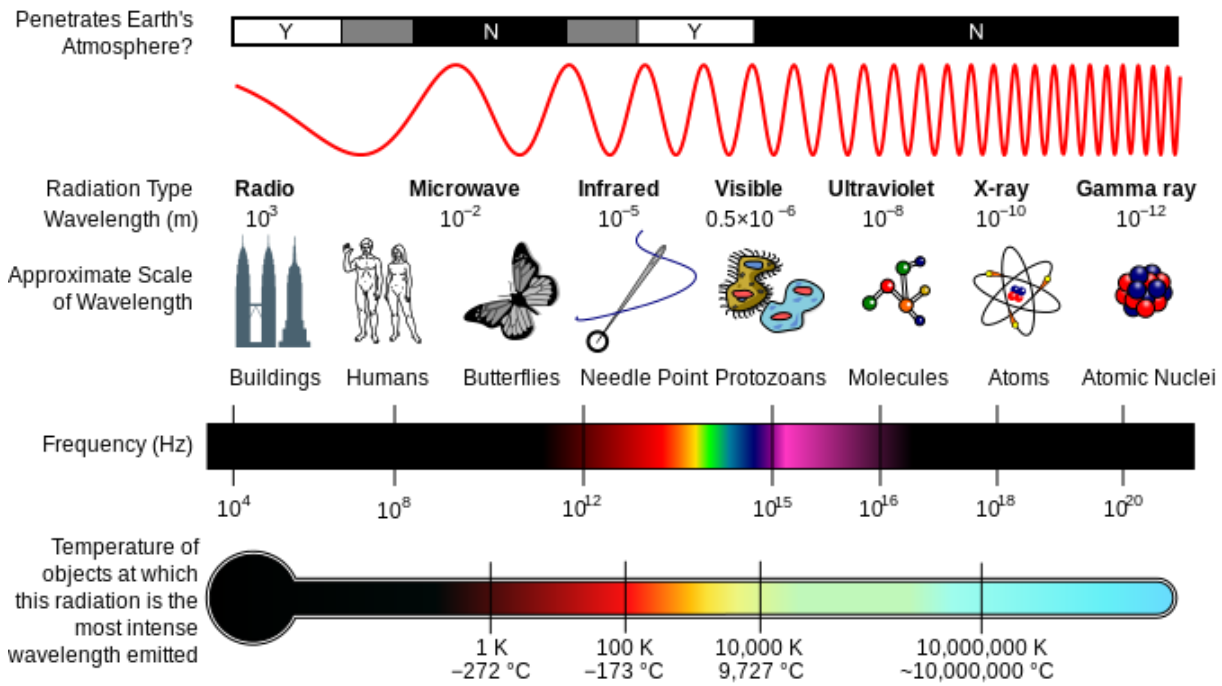


Figure 1.2: Electromagnetic spectrum.

If you suggested something that light is made of then you're correct as well! You might have learnt in your studies so far that light is a *wave*, but it is also a *particle*. Specifically, it is made up of particles called *photons* which are small packets of energy.

The discovery that light is both a wave *and* a particle is called *wave-particle duality*. The first evidence for this was an experiment that showed something called the *photo-electric effect*. In this experiment light is shone onto a metal and it was found that, if the light was of a certain wavelength then electrons would be released from the metal.

Activity 1.2 – Discovering the photo-electric effect.

We're now going to investigate what factors affect how many electrons are ejected from a metal. We'll be doing this on an online applet at:

http://www.thephysicsaviary.com/Physics/Programs/Labs/PhotoelectricEffect/index.html

Photoelectric Effect Lab

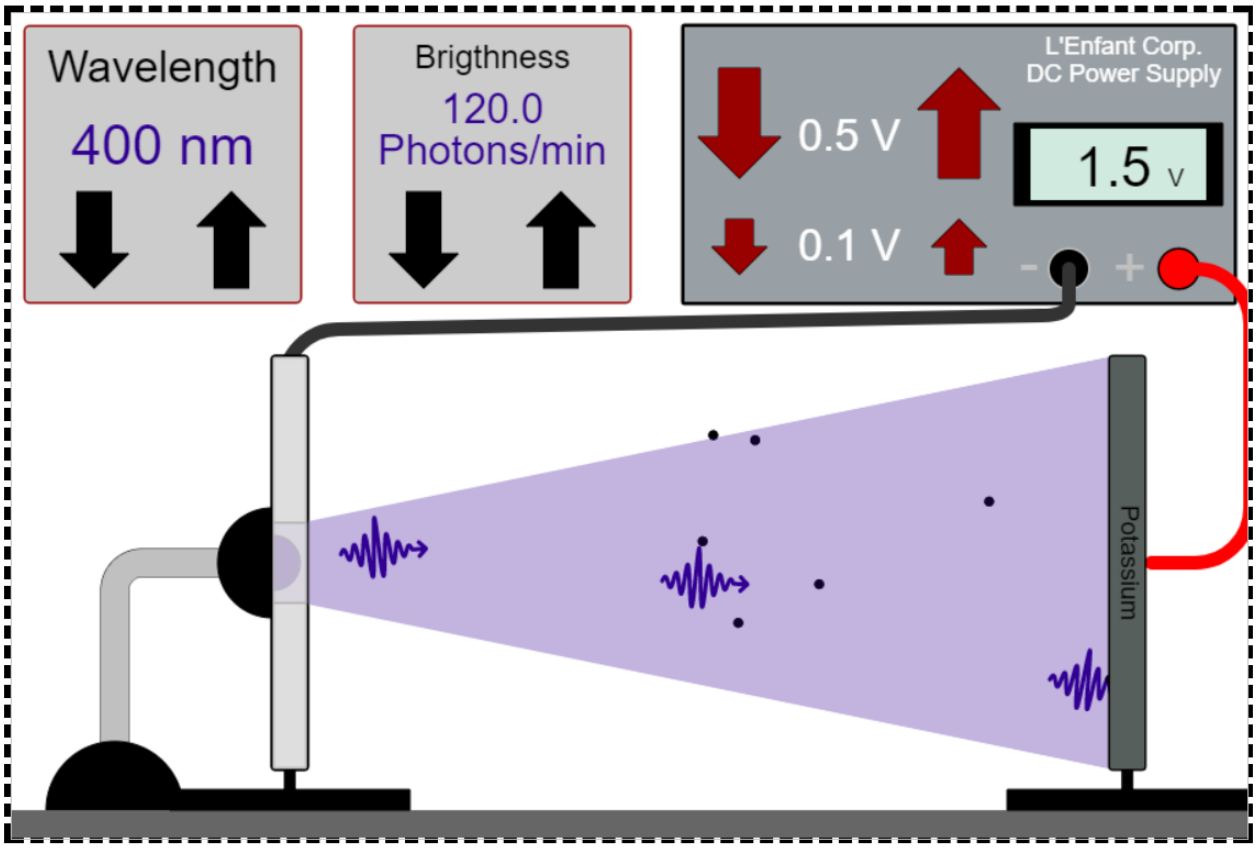


Figure 1.3: How the online applet looks.

Figure 1.3 above shows how the applet looks. Change the *wavelength*, *brightness* and *voltage* and note down below how this effects the number of electrons emitted by the metal.

Tutorial 1 Homework – Baseline Test

The homework assignment for the first tutorial is a baseline test to see your initial level of attainment in this subject area. The assignment will test for some, or all, of the subject specific skills that are required later in the final assignment. However, it is shorter than the final assignment and it will be an introduction to the subject as well as a challenge!

Do not worry too much about doing 'well' or 'badly' on the baseline test, it takes into account the fact that you may not be familiar with the subject area. It is designed to help you and your PhD tutor identify where you are at the start of the programme and to help you measure your progress along the way.

Is light a wave or a particle? [300 words]

Hints:

- Research this online.
- Use your own words.
- Describe the properties of a wave, i.e. do waves reflect, refract & diffract?
- Explain the Electro-magnetic spectrum, and discuss which part of the EM spectrum light belong to (include typical wavelengths and frequencies of light).
- Provide evidence that light is a particle and research the photo-electric effect further.
- Include as much as you can of what we've discussed in tutorial 1.

Tutorial 2 – Atomic Structure

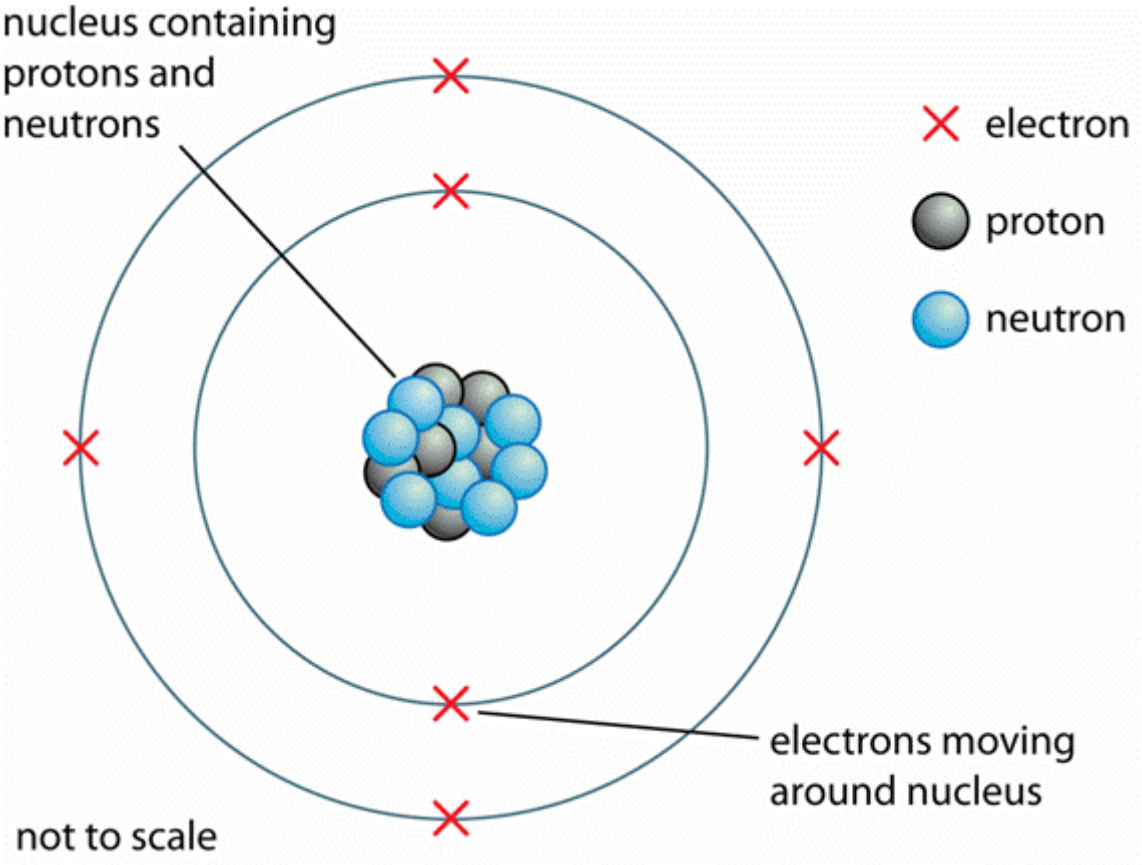


Figure 2.1 Basic structure of an atom.

What is the Purpose of Tutorial 2?

- To recall that an atom is made up of proton, neutrons and electrons and that electrons occupy various shells (or orbitals) around the nucleus.
- To be able to apply this knowledge to further understand the photo-electric effect.
- To further your understanding of light.

Activity 2.1 – Understanding energy levels

Read the text, and highlight any words/sentences you don't understand the meaning of. We'll then go through the text together, and answer the questions below independently.

The electrons in an atom are trapped by the electrostatic force of attraction of the nucleus. They move about the nucleus in allowed orbits, or shells, surrounding the nucleus. The energy of an electron in a shell is constant. An electron in a shell near the nucleus has less energy than an electron in a shell further away from the nucleus. Each shell can only hold a certain number of electrons. For example, the innermost shell (i.e. the shell nearest to the nucleus can only hold eight electrons.

Each type of atom has a certain number of electrons. For example, a helium atom has two electrons. Thus, in its lowest energy state, a helium atom has both electrons in the innermost shell.

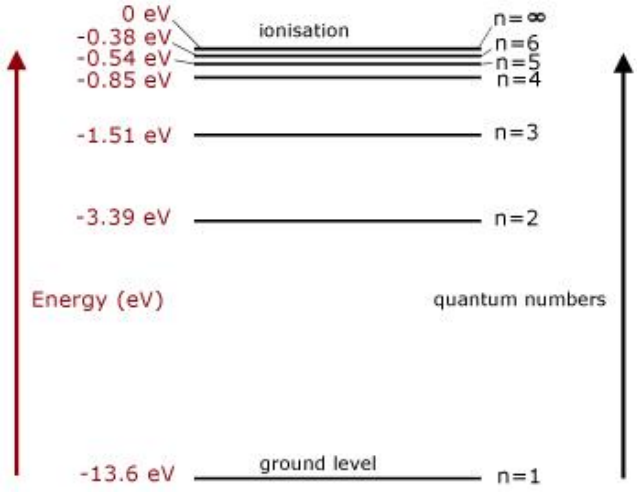


Figure 2.2: Energy level diagram for Hydrogen

The lowest energy state of an atom is called its ground state. When an atom in the ground state absorbs energy, one of its electrons moves to a shell at higher energy, so the atom is now in an excited state. We can use the excitation energy measurements to construct an energy level diagram for the atom, as shown in Figure 2.2. This shows the allowed energy values of the atom. Each allowed energy level corresponds to a certain electron configuration in the atom. Note that the ionisation level may be considered as the zero reference level for energy, instead of the ground state level. The energy levels below the ionisation level would then need to be shown as negative values.

An electron in an atom can absorb a photon and move to an outer shell where a vacancy exists – but only if the energy of the photon is exactly equal to the gain in the electron's energy (Figure 2.3). In other words, the photon energy must be exactly equal to the difference between the final and initial energy levels of the atom. If the photon's energy is smaller or larger than the difference between the two energy levels, it will not be absorbed by the electron.

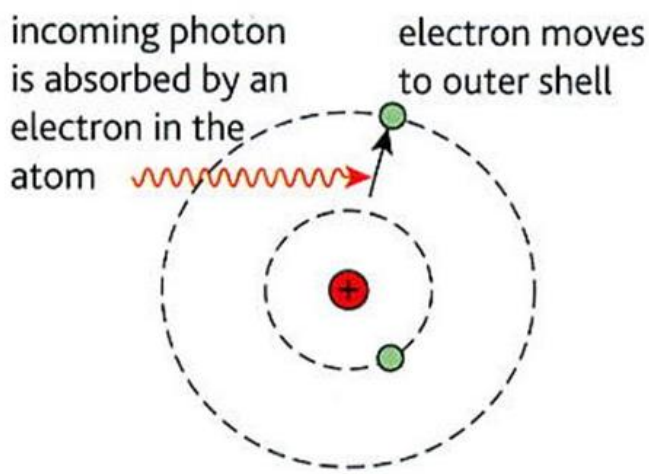


Figure 2.3: Excitation by photon absorption.

Excited states are usually very unstable. Therefore, after a short time, the electron decays from the excited state back down to a lower energy level. During this process a photon is emitted. This is how Neon lights, and fluorescent paint both work.

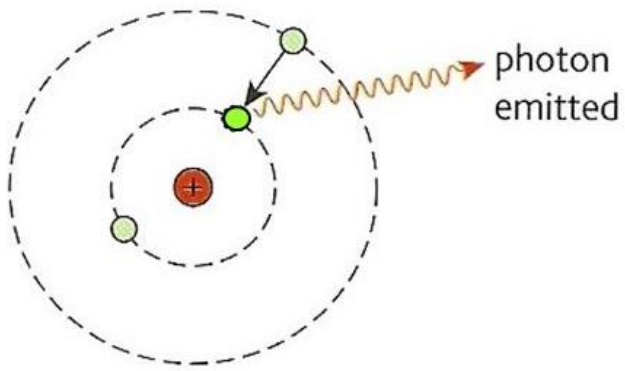


Figure 2.4: Photon emission by de-excitation.

Activity 2.2 – Applications

Figure 2.5: An example of a Neon light.

In a Neon lamp, there are two electrodes across a tube containing Neon gas. These electrodes have a reasonably large voltage across them that accelerates any free electrons inside the tube. These electrons collide with the Neon and cause electrons within shells in the Neon atoms to become excited. Explain in a few sentences what you think happens to the excited electrons and why this causes light to be produced.

Figure 2.6: A painting made of fluorescent paint.

Figure 2.7: Fluorescent nails.

Fluorescent paint gives out light when an Ultra-Violet (UV) light is shone on it. How do you think this works?

Activity 2.3 – Diffraction of a laser through a grating

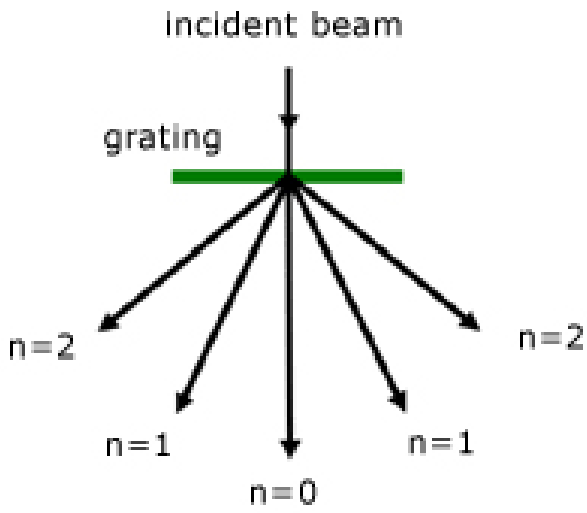


Figure 2.8: Diffraction "orders".

We know that light is not only a particle, but also a wave. Waves diffract, refract, reflect and interfere. A diffraction grating is one proof that light is a wave, as it creates an interference pattern. You will be given a 500 and 1,000 lines/mm diffraction grating, and also a 2d diffraction grating. Point the laser pointer at the ground and put the grating in front of the beam. For the 500 and 1,000 lines/mm gratings measure the distance between orders (or "spots") on the ground, and also the distance between the grating and the ground. Also note down what the pattern from the 2d grating looks like.

Explain why the diffraction orders are different distances apart (using the equation in Figure 2.9) for both of the linear gratings.

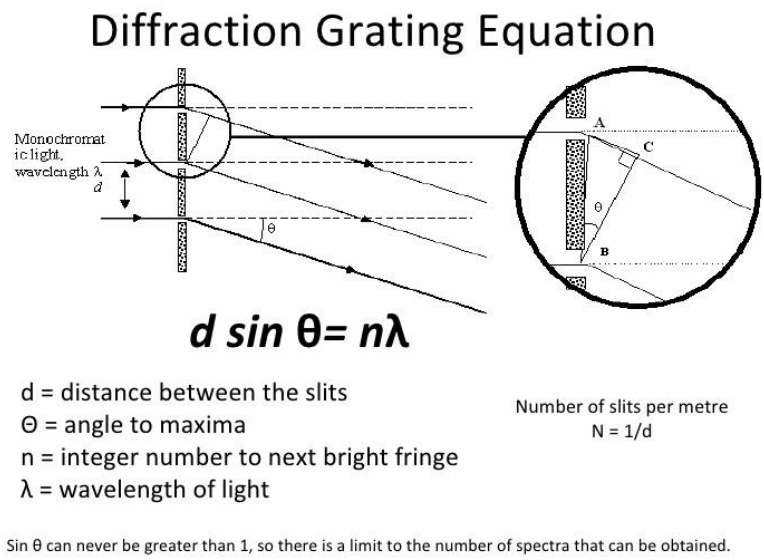


Figure 2.9: Diffraction grating equation.

Tutorial 2 Homework – A short presentation.

At the beginning of next tutorial, you will give a short presentation (max 2 minutes) on one piece of evidence that shows that light is either a wave or a particle (i.e. photoelectric effect, diffraction grating interference or anything else we've talked about in the tutorials). Use of Powerpoint is encouraged, and please make use of any figures/diagrams you can find on the internet.

Success criteria:

- Paraphrase and clarify your message.
- Speak with confidence and avoid reading.
- Use appropriate words and terminology that connect to your topic.
- Ensure your volume and pace are appropriate for the audience.
- Use body language, eye contact and gestures to help communicate your message.

Tutorial 3 – Lasers and their uses

Figure 3.1: Laser used for laser cutting.

What is the Purpose of Tutorial 3?

- To get feedback from your presentation.
- To introduce exactly what a laser is and how it differs from a light bulb.
- To be able to recall some common uses of a laser.

Activity 3.1 – Reflect on your own presentations.

Write down below two things that went well, and two things that could be improved from your own presentation.

What went well (WWW):

1.

2.

Even better if (EBI):

1.

2.

Activity 3.2 – What is a laser?

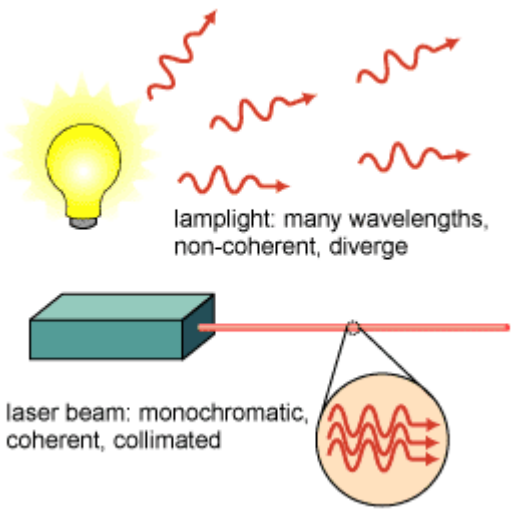


Figure 3.2: Difference between a laser beam and regular light.

A laser beam is different to normal light produced by a lamp in several ways. Firstly, laser light is made up of only one wavelength while a lamp produces a wide variety of wavelength. The laser also produces light that is *coherent* and can be *collimated (your tutor will explain these terms on the board)*. A laser can also be *far more powerful* than it's possible for a lamp to be.

Listen to your tutor explain the terms *wavelength, coherent* and *collimated*. Write down definitions for both and diagrams if possible.

Wavelength

Coherent

Collimated

Activity 3.3 – How a laser works.

You may or may not have realised it by now; but "laser" is an acronym! It stands for *Light Amplification by Stimulated Emission of Radiation*. Not quite as catchy as *laser*! Your tutor will now explain how the first laser was built in 1960 and how it worked. Take notes below, including relevant diagrams.

Activity 3.4 – Stretch & Challenge. How a laser works.

Imagine this is a 6 mark exam question recapping what we've learnt in today's tutorial.

Q: What makes a laser a laser? How does it differ from light produced from a regular light bulb? [6 marks]

Keywords: Collimated, monochromatic, coherent, wavelength, frequency, power, energy levels.

Tutorial 3 Homework – Applications of lasers

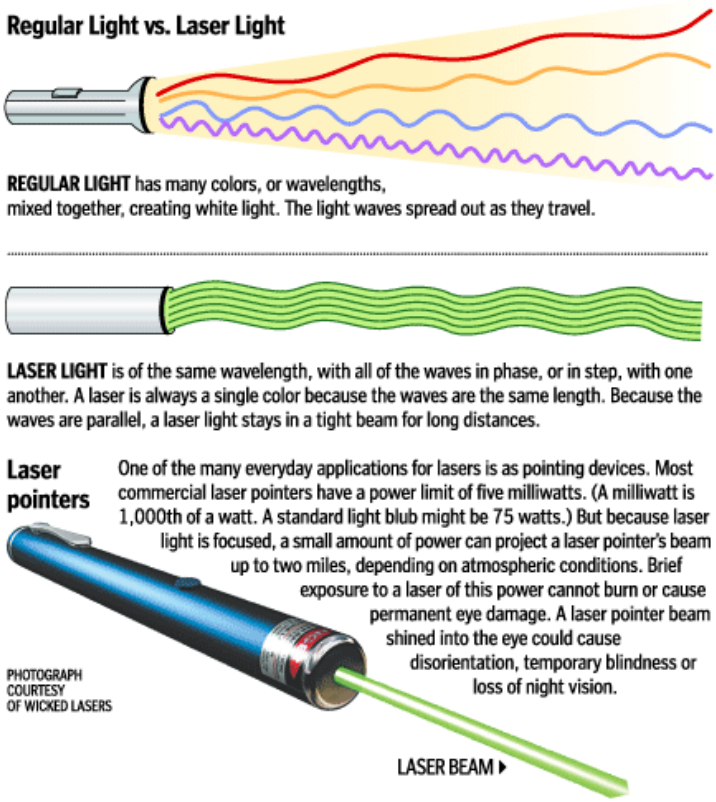


Figure 3.3: Description of laser pointer.

There are many different types of laser that vary both in wavelength and power. These include; solid state (like the Ruby laser), gas, excimer, dye and diode lasers (like a laser pointer).

This weeks homework is to independently research three separate uses of lasers and to write at least 100 words on each application. Include the type of laser used, and some relevant facts like wavelength and power.

Tutorial 4 – Laser slowing and cooling

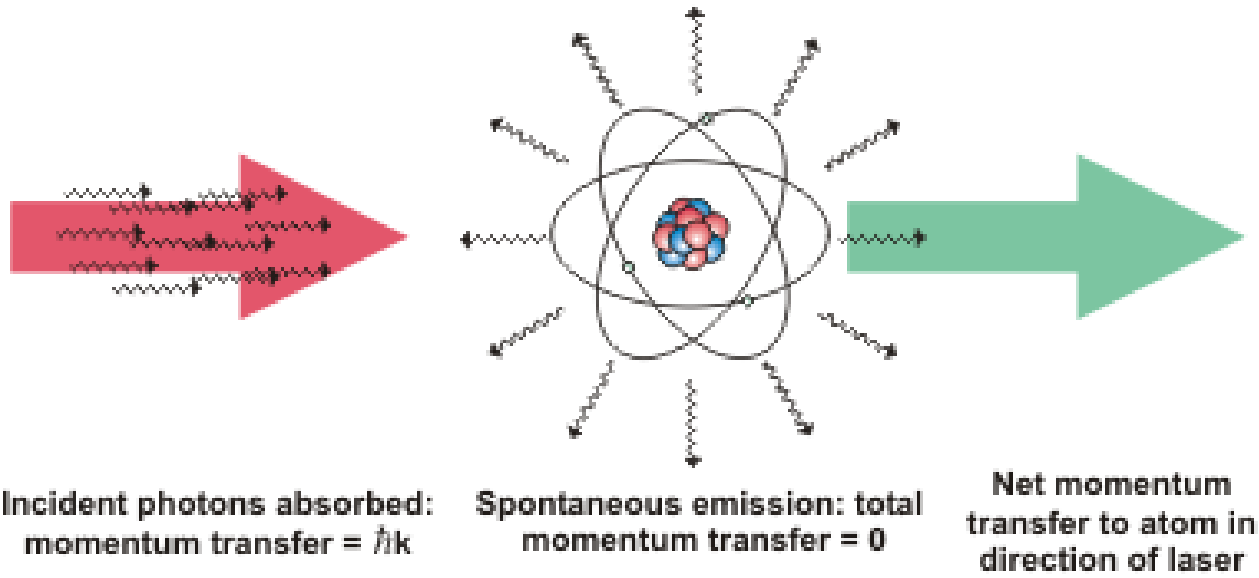


Figure 4.1: How light imparts a force on an atom.

What is the Purpose of Tutorial 4?

- To know that an atom's temperature is linked to its velocity.
- To understand the concept and terminology behind laser cooling.
- To introduce the Doppler effect, & why it means laser cooling light is red-detuned.

Activity 4.1 – Laser cooling introduction

Below is some text from the introduction of your tutor's very own PhD thesis! By now, you should be familiar with the majority of the terminology but highlight any words/sentences you don't understand the meaning of.

To a non-scientist, laser cooling can seem a confusing concept. After all, the popular consensus would be that lasers are generally used to heat things up; think of laser surgery, machining and weaponry. However, in the right arrangement, lasers can also be used to cool things down. An atom or molecule's temperature is inextricably linked to its velocity. Hot particles move around very quickly, while very cold ones are nearly stationary. Touch something hot, and the heat you feel is due to the fast motion of the particles. This is where the basic concept behind laser cooling comes into play. To cool particles down we simply need to slow them down, and we can do this by only using one tool: light.

Light is made up of individual pieces of energy called photons. These photons carry momentum: an extremely small amount of momentum, but still significant enough to matter. Say a hot atom is whizzing towards you at hundreds of miles an hour. You're armed with only a laser to stop it, and aim the beam towards the atom. Momentum from the massive amounts of photons produced by the laser is transferred to the atom and slows it down. Eventually the atom comes to a stop. As its motion has been reduced, it is now "cold". This is the main principle behind laser cooling.

In practice cooling is more complicated than this. The laser beam needs to be close to resonance with an atomic transition, and photons are absorbed by exciting the atom up to a higher energy level. This excited level then decays back down to the original level, with the emission of a photon. This photon is ejected in a

random direction though, and over many cycles these random emissions average themselves out in momentum. There is therefore a net momentum transfer against the atom, which leads to a cooling of it. This is known as Doppler cooling.

For a collection of atoms, three sets of counter-propagating beams need to be set up to cool all of the atoms (as they will all be moving in random and different directions). This is the basis behind optical molasses and magneto-optical traps (MOTs).

The advent of laser cooling first came about in the mid 1970's, when Hansch and Schawlow came up with the theoretical idea to cool and trap atoms with red-detuned light [1]. This soon led to techniques both for slowing atomic beams [2,3] and for their cooling and trapping [4–6]. Particular milestones that should be noted include the first optical molasses experiment5 created by Steven Chu et al. and also the magneto-optical trap [6] by Raab et al.

Several years later a peculiar phenomenon was discovered. It was previously believed that an atom could not be cooled below a lower limit set by the temperature gained from the recoil from an absorbed photon- the Doppler temperature limit. However the advent of sub-Doppler cooling [7,8] changed this perception.

Moreover, in 1995 another method for further cooling atoms was developed. This was evaporative cooling [9], where the trap depth is lowered to allow the warmest trapped atoms to escape. With this, the prospect of creating a Bose-Einstein condensate (BEC) increased, and this was soon achieved by first cooling Rubidium in a MOT and then transferring the cold atoms to a magnetic trap. Here they were evaporatively cooled to form the very first BEC [10], a piece of work that culminated in the award of the 2001 Nobel prize to E. A. Cornell, W. Ketterle and C. E. Wieman.

To this day, magneto-optical traps form the basis of many cold atom experiments. Densities of up to 10^{11} atoms/cm^3 are readily obtainable, and temperatures of $\sim$100 µK can be reached. These properties make the resultant cold atomic clouds ideal candidates to load into a variety of traps, where the trapping dynamics can be precisely studied.

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10. Anderson, M. H., Ensher, J. R., Matthews, M. R., Wieman, C. E. & Cornell, E. A. *Observation of Bose-Einstein condensation in a dilute atomic vapor.* Science 269, 198–201 (1995).

Activity 4.2 – The Doppler effect

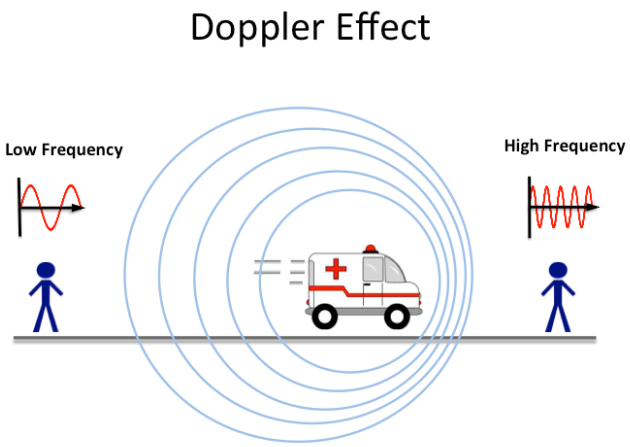

Figure 4.2: Illustration of the Doppler effect.

Imagine an F1 car, or an ambulance is driving past you. As it approaches, the sound the vehicle makes is of high frequency which then reduces as it moves away from you. This effect is known as the *Doppler effect* and is a vital tool in laser cooling.

By using only one laser beam, we can slow atoms in one direction only. By instead using three sets of counter-propagating beams we can slow and therefore cool atoms in all directions (as shown in Figure 4.3). If all beams are red-detuned (that is to say the frequency is less than that of the atomic transition), then if an atom is moving towards one of the beams, it is Doppler-shifted up in frequency and therefore becomes closer to resonance with this beam. Conversely, the atom is Doppler-shifted down in frequency with respect to the beam that is travelling in the same direction as the atom. This leads to the atom being further from resonance with this beam and therefore less likely to absorb a photon. The atom therefore preferentially absorbs photons from the beam that is travelling against the atom's motion and experiences a force that counteracts its movement. This technique is called *Optical Molasses* (named because molasses is a sugary syrup-type substance that moves very slowly; just like the atoms that have been slowed).

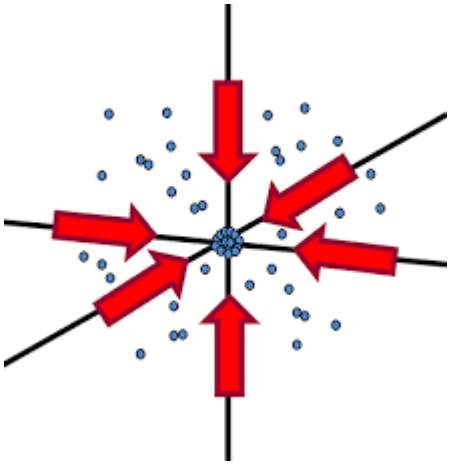

Figure 4.3: Laser layout of optical molasses.

While optical molasses are an effective tool for atomic cooling, they cannot be considered to be a trap as the force is only dependent on the velocity and not the position of the atoms. A common technique is therefore to introduce a magnetic field to trap the cooled traps, and this is called the *magneto-optical trap*.

Activity 4.3 – Laser…heating?

We already know that two counter-propagating red-detuned laser beams have the ability (at the correct frequency) to cool atoms down to incredibly low temperatures. Write below, what you think happens if two **blue-detuned** laser beams (i.e. two beams with frequency that is *more* than that of the atomic transition) interact with some atoms. Explain your answer fully and use scientific terminology that we have learned in the last few tutorials.

Keywords: Doppler shift, absorb, frequency, blue-detuned, atomic transition, photon.

Tutorial 4 Homework – Description of laser cooling.

There are two parts to this weeks homework:

1. Describe laser cooling in your own words. Do independent research online, and include relevant figures and references (details on how to reference are at the end of this booklet). Should be at least 300 words long.
2. Come up with draft ideas for your final homework (to present a poster on laser cooling). Think of what concepts from the tutorials you want to include, as well as other concepts from independent research. Think of what order you'd like to present things in, as well as what figures you'd like to use.

Next weeks tutorial will focus on a review of the material that we've covered so far, as well as giving guidance on what a good poster should look like. If you have any questions or uncertainties about any of the material we've covered, please prepare questions to ask in the next tutorial.

Tutorial 5 – Review and final assignment preparation

Figure 5.1: What a poster session at a scientific conference looks like.

What is the Purpose of Tutorial 5?

- To solidify our understanding of content covered in tutorials 1-4.
- To understand what makes a good scientific poster.
- To roughly draw up a draft of your final assignment poster.

Activity 5.1 – Question time.

Do you have any questions about the material that we've covered during our tutorials? There is space on the next page to take notes from the answers your tutor gives or to plan for your poster assignment.

Activity 5.2 – What makes a good poster?

Your tutor will show you a few examples of posters. Note down three things that you like, and three things that you don't.

What I like:

3.

4.

5.

What I don't

1.

2.

3.

Notes/Ideas:

A good poster should:

- Use large fonts that can be read from five feet away.
- Have large/high quality images/graphs (with captions).
- Not contain too much text.
- Portray information simply.
- Maintain a colour scheme.
- Try to keep around 40% of poster free from text/images so it doesn't look too cluttered.
- Arrange text in rows/columns.

You will now spend the rest of the tutorial planning some ideas for the poster, ask your tutor for guidance on what you think a good layout would be. You will be provided with a Powerpoint template for the design, and it's strongly encouraged that you use it. Pages for jotting down notes are at the back of the booklet.

A poster on laser cooling should include:

- An abstract that summarises the content of the poster in one short paragraph.
- An introduction that motivates this area of research. This section should also outline applications of both lasers and of laser cooling.
- Three separate sections explaining:
    1. What exactly light is, giving details of experiments that explain what light is made of.
    2. Atomic structure.
    3. A final section bringing together the previous two sections to explain how laser slowing and cooling works.
- A conclusion section summarising the entire content of the poster in a brief and succinct way.
- An appropriate reference section detailing the sources of your information.

Tutorial 6 – Feedback tutorial

What is the Purpose of Tutorial 6?

- To receive feedback on final assignments.
- To share examples of best practice with the other pupils in your group.
- To write targets for improvement in school lessons.
- To reflect on the programme including what was enjoyed and what was challenging.

Final assignment feedback

What went well (WWW)	Even better if (EBI)
•	•
•	•
•	•

My target for future work is…

Reflecting on Uni Pathways

What did you most enjoy about Uni Pathways?
•   •   •

What did you find challenging about the programme?	How did you overcome these challenges?
• • •	• • •

Appendix 1 – Referencing correctly

When you get to university, you will need to include references in the assignments that you write, so we would like you to start getting into the habit of referencing in your Brilliant Club assignment. This is really important, because it will help you to avoid plagiarism. Plagiarism is when you take someone else's work or ideas and pass them off as your own. Whether plagiarism is deliberate or accidental, the consequences can be severe. In order to avoid losing marks in your final assignment, or even failing, you must be careful to reference your sources correctly.

What is a reference?

A reference is just a note in your assignment which says if you have referred to or been influenced by another source such as book, website or article. For example, if you use the internet to research a particular subject, and you want to include a specific piece of information from this website, you will need to reference it.

Why should I reference?

Referencing is important in your work for the following reasons:

- It gives credit to the authors of any sources you have referred to or been influenced by.
- It supports the arguments you make in your assignments.
- It demonstrates the variety of sources you have used.
- It helps to prevent you losing marks, or failing, due to plagiarism.

When should I use a reference?

You should use a reference when you:

- Quote directly from another source.
- Summarise or rephrase another piece of work.
- Include a specific statistic or fact from a source.

How do I reference?

There are a number of different ways of referencing, and these often vary depending on what subject you are studying. The most important to thing is to be consistent. This means that you need to stick to the same system throughout your whole assignment. Here is a basic system of referencing that you can use, which consists of the following two parts:

1. A marker in your assignment: After you have used a reference in your assignment (you have read something and included it in your work as a quote, or re-written it your own words) you should mark this is in your text with a number, e.g. [1]. The next time you use a reference you should use the next number, e.g. [2].
2. Bibliography: This is just a list of the references you have used in your assignment. In the bibliography, you list your references by the numbers you have used, and include as much information as you have about the reference. The list below gives what should be included for different sources.

    a. Websites – Author (if possible), title of the web page, website address, [date you accessed it, in square brackets].

    E.g. Dan Snow, 'How did so many soldiers survive the trenches?', http://www.bbc.co.uk/guides/z3kgjxs#zg2dtfr [11 July 2014].

    b. Books – Author, date published, title of book (in italics), pages where the information came from.

    E.g. S. Dubner and S. Levitt, (2006) *Freakonomics*, 7-9.

    c. Articles – Author, 'title of the article' (with quotation marks), *where the article comes from* (newspaper, journal etc.), date of the article.

    E.g. Maev Kennedy, 'The lights to go out across the UK to mark First World War's centenary', Guardian, 10 July 2014.

Appendix 2 – Using the VLE

VLE username	
VLE password	

Please remember the following key details…

- You are able log into the VLE either through the link on our website (www.thebrilliantclub.org) or going directly to the VLE site at (https://portal.thebrilliantclub.org/sign-in).
- Please update your profile with your full name and email address- this will allow you to retrieve forgotten passwords or usernames
- If you forget your log-in details you can request them to be emailed to you by clicking the link on the VLE home page. (If you are still having problems you can email: schools@thebrilliantclub.org)

What is the VLE?

The VLE is a virtual learning environment for all pupils on Uni Pathways it is used for:

- messaging your tutor
- submitting homework
- submitting your final assignment
- accessing resources for your tutorials
- finding out more information about university and careers

How should I use the VLE?

The VLE is a professional academic environment in which pupils are able to message their PhD Tutor. Here are a few things to consider:

- Ensure you keep a professional tone in the messages you send to your tutors.
- Ensure you always reply to your tutors in a timely manner.
- Thank your tutor for the effort they are putting in to give you your feedback etc.
- Submit all homework to your tutor on time.

IMPORTANT: Final assignment

- When you submit your final assignment, please remember that you need to do so through the 'My Activities' tab and not as an attachment to a message.

Notes

Notes

Notes

UNI PATHWAYS

Course Title

Key Stage 4 Programme

researchersinschools.org