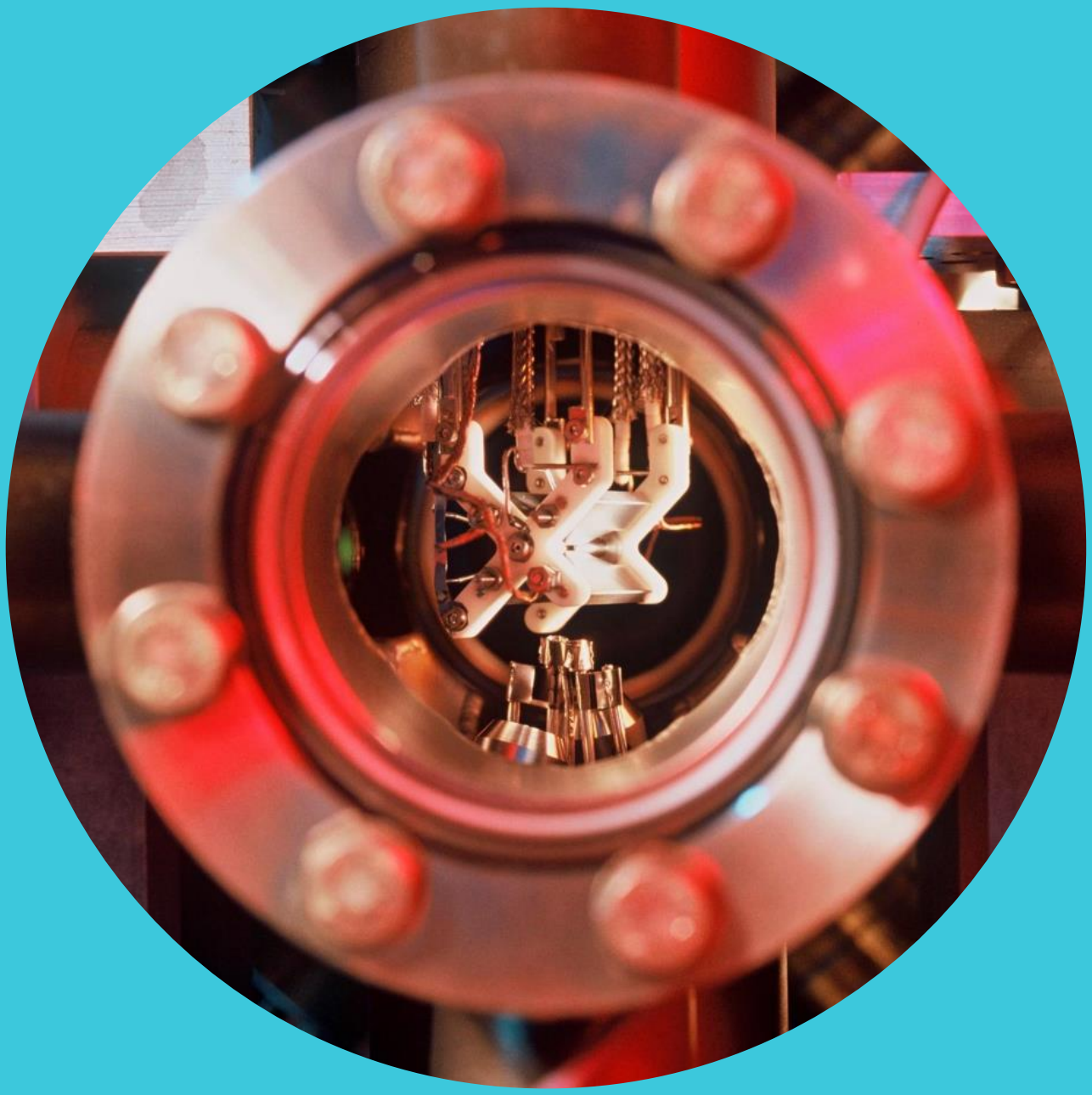
Researchers in Schools



About Time

Clocks, Paradoxes and Time Travel

Pupil Name

Coursebook Designed by **Dr. P. Blythe**

Timetable and Assignment Submission

Timetable – Tutorials

Tutorial	Date	Time	Location
1	2 December 2019	12:30	Senate House
2	14 Jan 2020	15:10	Lampton School
3	21 Jan 2020	15:10	Lampton School
4	28 Jan 2020	15:10	Lampton School
5	4 Feb 2020	15:10	Lampton School
6 (Feedback)	25 Feb 2020	15:10	Lampton School
7 (Feedback)	10 Mar 2020	15:10	Lampton School

Timetable – Homework Assignments

Homework Assignment	Description	Due Date
Tutorial 1	Why can't we remember tomorrow?	7 Jan 2020
Tutorial 2	The twin paradox	21 Jan 2020
Tutorial 3	What is a clock?	28 Jan 2020
Tutorial 4	Choosing an oscillator	4 Feb 2020
Tutorial 5	Final assignment	14 Feb 2020

Assignment Submission – Lateness and Plagiarism

Lateness	
Submission after midnight on 6 March	10 marks deducted
Plagiarism	
Some plagiarism	10 marks deducted
Moderate plagiarism	20 marks deducted
Extreme plagiarism	Automatic fail

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Course Rationale

Often described as the fourth dimension, time is one of the most mysterious aspects of our universe.

But what is time?

Why does time go forwards and never backwards?

How do we measure time?

Can we travel through time?

If you're interested in these questions, and you want to find out more about how scientists are still developing our understanding of time, then you should come to this Researchers in Schools Uni Pathways course. You'll be exposed to the cutting edge of current scientific research, along with some of the most mind-bending theories we have ever developed.

You'll have the opportunity to engage in university-style learning in a small group and learn about topics not usually covered at school level. You'll develop independent research skills and improve your scientific writing.

Uni Pathways Mark Scheme 2019 – Essay-based assignments

	Skills	1st (70-100)	2:1 (60-69)	2:2 (50-59)	3rd (40-49)	Mark /100
Subject knowledge	Knowledge and understanding	o All content included and materials used are relevant to the general topic and to the specific question/title o Good understanding of all the relevant topics. o Technical terms are defined and used accurately throughout o Clear justification of how the material and content included is related to the specific issues that are the focus of the assignment	o Most of the materials used and content included are relevant to the general topic and to the specific question/title o Good understanding of most the relevant topics o Technical terms are mostly defined and used accurately o Adequate justification of how the material used and content included are related to the specific issues that are the focus of the essay	o Some of the materials used and content included are relevant to the general topic and to the specific question/title o Good understanding on some of the relevant topics but occasional confusion on others o Technical terms are sometimes used and defined accurately o Some justification of how the material used and content included are related to the specific issues that are the focus of the essay	o The content included and materials used are not applied to the question/title in a relevant manner o There is confusion in how understanding of the topics is expressed	
Critical thinking	Research and evidence	o Includes rich sources of research findings, data, quotations or other sourced material as evidence for the claims/ideas o Uses evidence/calculations to support claims/assertions/ideas, consistently clearly and convincingly o Evidence of further reading beyond materials provided which were used in an appropriate context o Data is effectively analysed and appropriate assumptions/conclusions are reached	o Includes adequate sources of research findings, data, quotations or other sourced material as evidence for the claims/ideas o Uses evidence/calculations to support claims/assertions/ideas, mostly clearly and convincingly o Evidence of further reading beyond materials provided o Data is analysed and the assumptions/conclusions that are reached are mostly appropriate	o Includes some sources of research findings, data, quotations or other sourced material as evidence for the claims/ ideas o Uses evidence/calculations to support claims/assertions/ideas, at times clearly and convincingly o Limited evidence of further reading beyond materials provided o There is an attempt to analyse data is and draw assumptions/conclusions	o Inclusion sources and materials is very limited and mostly not attributed o Applicable sources are rarely used to support ideas. o Data is not used or few appropriate conclusions are drawn from it.	
	Developing an argument	o A point of view or position in relation to the title or question is consistently clear. The position is developed effectively and consistently throughout the essay o Argument is exceptionally well-developed and well-justified o Makes links effectively between subjects that have not previously been associated o Uses concepts from the tutorials in an unfamiliar context and does so accurately and confidently. o Content is analysed effectively to support the argument	o A point of view or position in relation to the title or question is adequately clear. The position is well-developed in most of the essay o Argument is clear and well-developed, and position is justified o Some evidence of linking subjects that have not previously been associated o Uses some concepts from the tutorials in an unfamiliar context, but not always accurately o Analyses content to support the argument	o A point of view or position in relation to the title or question is somewhat clear. The position is well-developed in parts of the essay o Argument is clear but not well-developed o Limited evidence of linking subjects that have not previously been associated o Limited use of concepts from the tutorials in other contexts o Uses some analysis of content to support the argument	o There is not a clear point of view or position taken and sometimes the argument is not clearly established	

	Critical evaluation	○ Moves beyond description to an assessment of the value or significance of what is described ○ Evaluative points are consistently explicit/systematic/reasoned/justified ○ Effectively critiques the reliability of sources provided	○ Mostly description but some assessment of the value or significance of what is described ○ Evaluative points are mostly explicit/systematic/reasoned/justified ○ Some evidence of critiques on the reliability of sources provided	○ Describes with minimal assessment of the value or significance of what is described ○ Evaluative points are at times explicit/systematic/reasoned/justified ○ Limited evidence of critiques on the reliability of sources provided	○ The work is descriptive in nature and there is a lack of critical engagement in the value of sources	
Written communication	Structure and presentation	○ Ideas are presented in paragraphs and arranged in a logical structure that is appropriate for the assignment ○ The introduction clearly outlines how the essay/report will deal with the issues ○ The conclusion summarises all the main points clearly and concisely ○ All calculations, formulas and methods are clearly structured, clear to follow and correct ○ Tables and graphs are effectively constructed including appropriate headings, units and scales. ○ All sources are referenced correctly in an agreed format	○ Ideas are presented in paragraphs and arranged in a structure that is mostly appropriate for the assignment ○ The introduction adequately describes how the essay/report will deal with the issues ○ The conclusion summarises most of the main points clearly ○ Calculations, formulas and methods are mostly structured, clear to follow and correct ○ Most tables and graphs are well constructed ○ Most sources are referenced correctly in an agreed format	○ Ideas are presented in paragraphs and arranged in a structure ○ The introduction mentions how the essay/report will deal with the issues ○ The conclusion summarises some of the main points clearly ○ Calculations, formulas and methods are not always structured, clear to follow and correct. ○ Some tables and graphs are well constructed but contains some errors ○ Some sources are referenced correctly in the agreed format with occasional errors	○ Ideas are presented in paragraphs but there is a lack of structure in how the work is presented ○ The work lacks an introduction that establishes the scope of the question ○ The work lacks a conclusion that summarise the main points raised ○ Work is not referenced accurately	
	Language and style	○ No spelling, grammar or punctuation errors ○ Writing style consistently clear, tone appropriate and easy to follow ○ Accurate and consistent use of technical language and vocabulary	○ Minimal spelling, grammar or punctuation errors ○ Writing style mostly clear, tone appropriate and easy to follow ○ Some attempts of using technical language and vocab alary, but not always accurate	○ Some spelling, grammar or punctuation errors ○ Writing style moderately clear, tone appropriate and easy to follow ○ Use of simple language and vocabulary effectively but struggles to use technical language	○ There are a significant number of spelling, grammar and punctuation errors ○ Use of simple language and vocabulary effectively but a lack of technical language	
Overall Mark (average of the 6 marks from the criteria above)						

Baseline Assignment (essay based): Pupil Feedback Report

Name of Pupil	
Name of School	
Name of RIS teacher	
Title of Assignment	

How your assignment is graded:

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

Marks

OVERALL MARK / 100		FINAL MARK / 100 (including any deductions)	
DEDUCTED MARKS		FINAL GRADE	

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

Mark Breakdown and Feedback

Knowledge and Understanding		Research and Evidence	
	mark		*mark*
Developing an Argument		**Critical Evaluation**	
	mark		*mark*
Structure and Presentation		**Language and Style**	
	mark		*mark*

Final Assignment (essay based): Pupil Feedback Report

Name of Pupil	
Name of School	
Name of RIS teacher	
Title of Assignment	

How your assignment is graded:

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

Marks

OVERALL MARK / 100		FINAL MARK / 100 (including any deductions)	
DEDUCTED MARKS		FINAL GRADE	

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

Mark Breakdown and Feedback

Knowledge and Understanding		Research and Evidence	
	mark		*mark*
Developing an Argument		**Critical Evaluation**	
	mark		*mark*
Structure and Presentation		**Language and Style**	
	mark		*mark*

Subject Vocabulary

Word	Definition	In a sentence
Arrow of time	The direction that time flows.	I'm glad the arrow of time points forwards every time I use the bathroom.
Entropy	A measure of how useful the energy in a system is. Often linked to how "disordered" it is.	A broken mug has higher entropy than a whole one.
Frequency	The number of oscillations per unit time. Measured in units of hertz (Hz, 1 Hz is one oscillation per second).	The pendulum of the clock has a frequency of 2 Hz.
Oscillation	A regular, repeating motion.	When the pendulum swings back to where it started, it has completed an oscillation.
Oscillator	Something that oscillates (undergoes oscillation).	The oscillator in my watch is a vibrating quartz crystal.
Realisation	The physical system that is used as the reference for a unit of measurement.	The realisation of the kilogram used to be a lump of metal, but now it is an electrical experiment.
Spectrum	A graph of how the observed intensity of waves (such as light or sound) varies with their frequency.	The spectrum of the music shows that it contains a lot of high notes.
Variance	A way of measuring the amount of variation of a quantity. Has symbol σ^2.	The variance of ages of university students is much greater than for Year 9 students.

Tutorial 1
Time's Arrow

"*Time flies like an arrow, fruit flies like a banana.*"

– Adapted from Anthony Oettinger, *Harvard Alumni Bulletin*, **66**:205, 1963

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Tutorial Objectives

By the end of this tutorial I will be able to…

- Describe the "arrow of time."
- State three different arrows of time and describe examples of each.
- Identify physical processes which demonstrate the arrow of time.
- Explain potential causes of the arrow of time.

Starter

Can you remember the future? Do you have a memory of a conversation you will have tomorrow?

What does your answer tell us about the nature of time? Write some thoughts in the space below, then discuss your ideas with the person next to you.

Activity 1

You will see three practical demonstrations. During each one, think about the questions:

- If this was recorded and the video was played backwards, would you be able to tell it was being shown in reverse?
- If so, how could you tell?

After you have thought about your answer, discuss it with the person next to you and make note of your ideas in the space below.

Activity 2

What are the similarities and differences between the three experiments?
In a group of three, list as many similarities and differences as you can.

Similarities	**Differences**

Activity 3

You have a set of cards with descriptions of events. First, pair up the cards – which pairs of events go together? Next, which event in each pair came first? Arrange them in order.

Baseline Assignment - Why can't we remember tomorrow?

Write a report (up to around 500 words) explaining the concept of the "arrow of time."

Your report should include examples and explanations of at least two different arrows of time, from our discussions in lessons and from your own research.

Organise your report in logical paragraphs. You may want to use tables, graphs or calculations to illustrate your points. Optionally, you can also submit reverse videos and refer to them in your report. In your conclusion, explain your answer to the question in the title.

Baseline assignment success criteria:

- Use technical vocabulary from the tutorial and workbook correctly.
- Use a variety of sources to support your points.
- Structure your report clearly and logically.
- Have an introduction which introduces the main ideas of the report and a conclusion which summarises your answer to the title question.
- Use correct spelling, punctuation and grammar.
- Use correct scientific and mathematical notation, units and symbols.

Tutorial 2

Can we stop time?

"People assume that time is a strict progression of cause to effect, but actually, from a non-linear, non-subjective viewpoint, it's more like a big ball of wibbly-wobbly, timey-wimey... stuff."

- The Doctor, *Blink*, *Doctor Who*, BBC (2005)

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Objectives

By the end of this tutorial I will be able to…

- Describe how relative motion affects the observed passage of time.
- Explain what it means to say "the speed of light is constant"
- Calculate the time dilation factor for an object moving at a given speed.
- Describe the "twin paradox"

Starter

Can we stop time? If so, how? If not, why not?

Discuss in pairs and be ready to share your thoughts with the group.

Activity 1

"The speed of light is constant" – explain what this sentence means to you and describe how measuring the speed at which light passes you is different from measuring the speed that cars pass you.

Notes

You will be given a formula for calculating observed time dilation when observing events in a different inertial reference frame. Note down the formula, the quantities involved, and other other information you might find useful in understanding how to apply the formula.

Activity 2

You and a friend are both wearing accurate watches, which agree with each other when you stand next to each other.

Describe what **each** of you observe about your own watch and your friend's in the following situations:

a) You are standing on a platform while your friend goes past you in a train at 200 km/h.
b) You are both on trains travelling at 200 km/h, moving past each other in opposite directions.
c) You are both on trains travelling at 200 km/h, moving in the same direction.
d) How would your answers above change if the trains were replaced by rockets moving at 90% of the speed of light?

I observe	My friend observes
a)	a)
b)	b)
c)	c)
d)	d)

Activity 3

Calculate the following: [use speed of light $c = 3 \times 10^8$ m/s]

a) What is the time dilation factor γ for an object moving past you at half the speed of light?

b) A rocket passes you at 99% of the speed of light. For every 1 second of time on your watch, how many seconds do you see pass on the rocket?

c) The International Space Station orbits the Earth at 7 kilometres per second. How much less time passes for an astronaut on the ISS for 1 year compared to one who stays on the ground?

Homework – The Twin Paradox

Research the "twin paradox" online. In your own words, write a short description of the apparent paradox and describe why it is not actually a paradox. Reference your sources appropriately. (Approx. 200 words)

Homework success criteria:

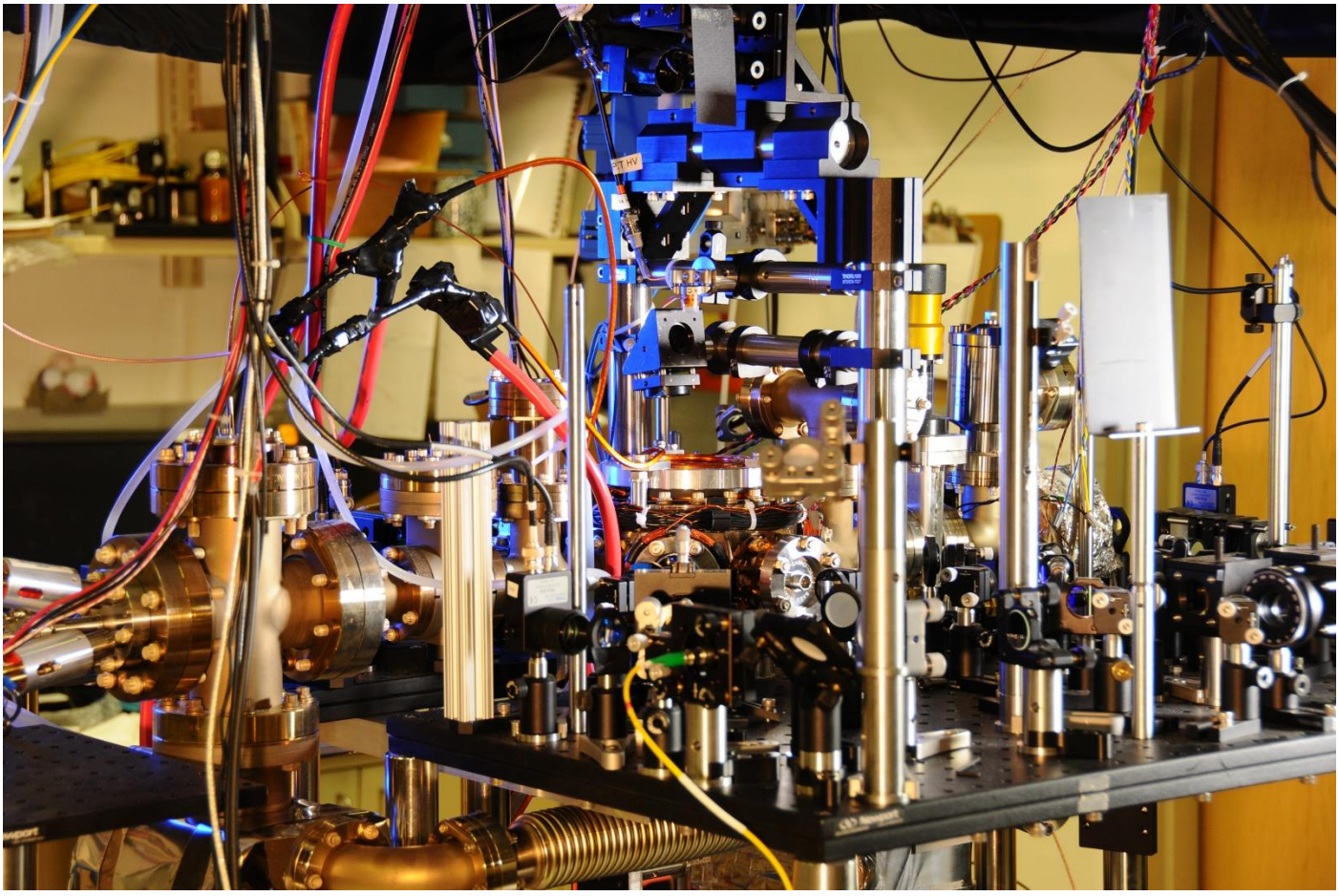
- A clear description of the twin paradox and its solution.
- Correct use of technical vocabulary.
- Correct spelling, punctuation and grammar.
- Correct referencing of sources which back up your points.

Tutorial 3

A first look at the second

"It was a bright cold day in April, and the clocks were striking thirteen."

- George Orwell, *1984*



Ytterbium lattice atomic clock, NIST

Objectives

By the end of this tutorial I will be able to…

- Describe how a clock is made of an oscillator, reference and counter.
- Identify the oscillators, references and counters used in traditional pendulum clocks, caesium atomic clocks and optical atomic clocks.
- Describe how units of measurement, in particular the second, are defined and realised in the SI.

Starter

Brainstorming race!

Working in pairs, write a list of as many different types of clock as you can in two minutes.

Activity 1

Working in pairs again, write a short definition of a clock, in your own words.

A clock is:

Activity 2

You have a set of cards in front of you. Line up the headings and clock types in a grid as shown below. Sort the remaining cards into the correct positions in the grid.

Clock Type	Oscillator	Reference	Counter
Pendulum clock			
Sundial			
Quartz watch			
Mechanical watch			

Activity 3

Invent your own unit of time.

We have discussed the advantages and disadvantages of the old and new definitions of the second. If you could invent your own unit of time, what would it be, and why? How would it be defined and realised?

You will need a "primary standard" that all clocks using your new unit are calibrated against!

You have five minutes to invent your own, then we will share our new units.

Homework - What is a clock?

In your own words, answer the title question. You answer should be about 200 words long, and include:

- Your updated answer to the question from Activity 1 – your definition of a clock.
- An explanation of the parts of a clock (oscillator, reference, counter) and what each one does, with examples from real clocks.
- The definition of the second (old and new) and why it was changed.

Homework success criteria:

- Includes a clearly-written definition of a clock, the history of the definition of the second, and details of the parts of a clock.
- Correct use of technical vocabulary
- Correct spelling, punctuation and grammar.
- Correct referencing of sources which back up your points.

Tutorial 4

The colour of time

> "*After the discovery of spectral analysis no one trained in physics could doubt the problem of the atom would be solved…*"
>
> - Arnold Sommerfeld, *Atomic Structure and Spectral Lines*, trans. Henry L. Brose (1923), **8**.

Image by analogicus from Pixabay

Objectives

By the end of this tutorial I will be able to…

- Define the frequency of a wave.
- State that light is an electromagnetic wave with a frequency.
- Describe how complex waves can be made by adding waves of pure frequencies together.
- Interpret graphs of spectra.
- Describe the link between frequency variation and time-keeping accuracy.

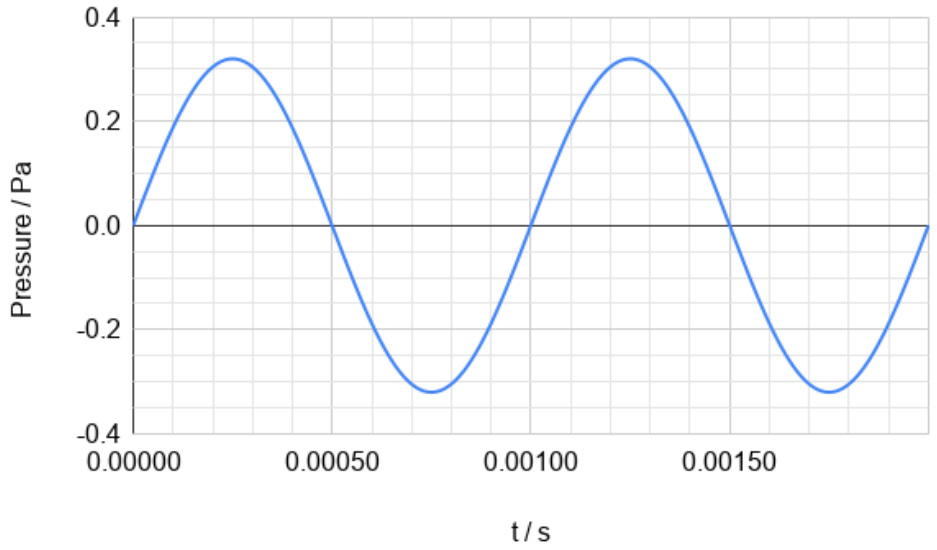
Starter

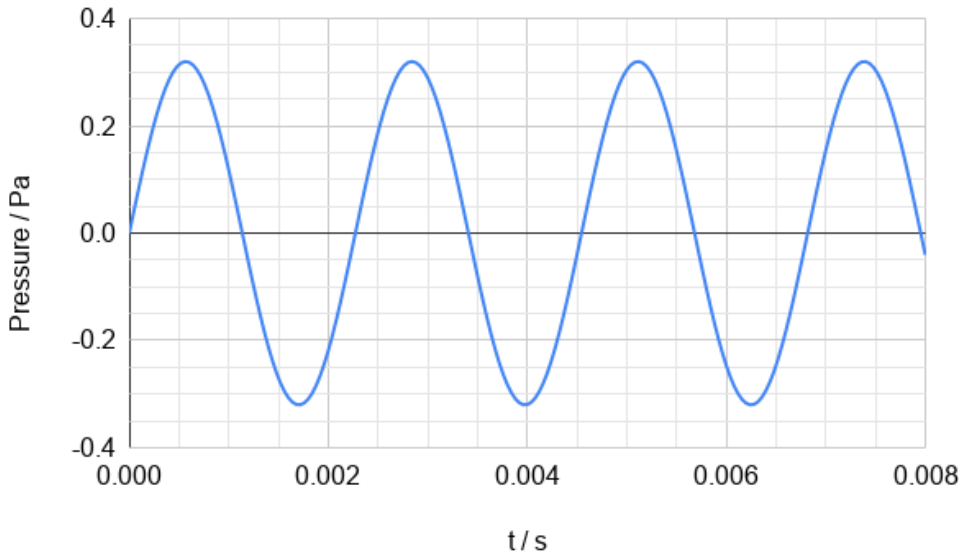
High and low notes

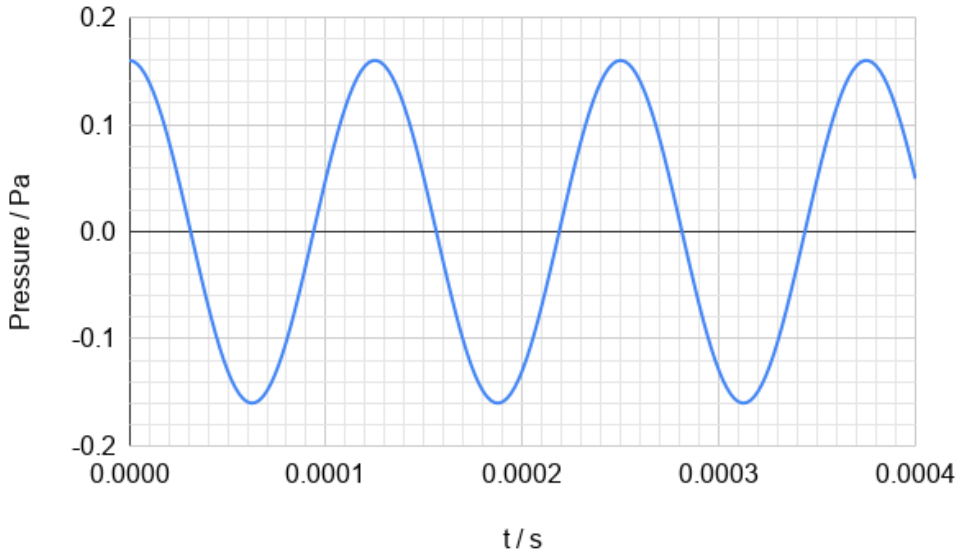
On your tables are a selection of musical instruments and objects which make sound. Arrange them in order of lowest to highest pitch. You may need to play them to find out…

Activity 1

The graphs below show some sound waves. Measure the time period and calculate the frequency of each wave.







Activity 2

You each have some equipment that can split light into its spectrum – each colour is sent in a different direction. Look at the light sources and describe what you see when you look at each.
Daylight:

Red LED:

Fluorescent lamp:

Sodium lamp:

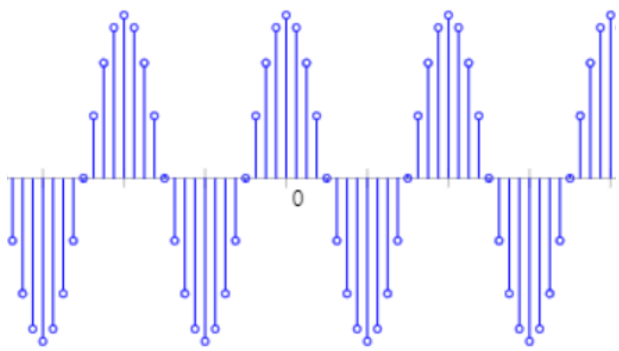
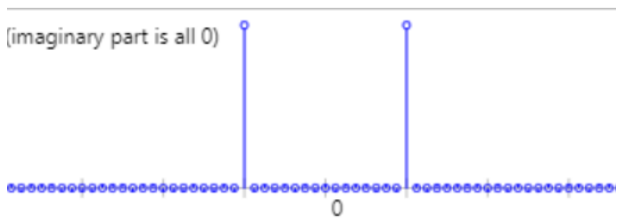
Compare your descriptions with your neighbour's. Discuss which of these light sources would be the best choice to use as a reference to compare other light frequencies to, and why.

Activity 3

Go to http://madebyevan.com/dft/

In the formula box, carefully type the following formulas and sketch the results you see in the top two boxes (the signal and its spectrum). Do parts a), b) and c). If you have time and want to explore deeper, try parts d) through h).

a) f(x) = cos(x)

Signal	**Spectrum**
	

b) f(x) = cos(3*x)

Signal	**Spectrum**

c) What is the relationship between the frequencies of f(x) = sin(x) and f(x) = sin(3x)? How does the spectrum show this?

d) f(x) = sinc(x)

Signal	**Spectrum**

e) f(x) = box(x)

Signal	**Spectrum**

f) What is the relationship between f(x) = sinc(x) and f(x) = box(x)?

g) f(x) = gaussian(x)

Signal	**Spectrum**

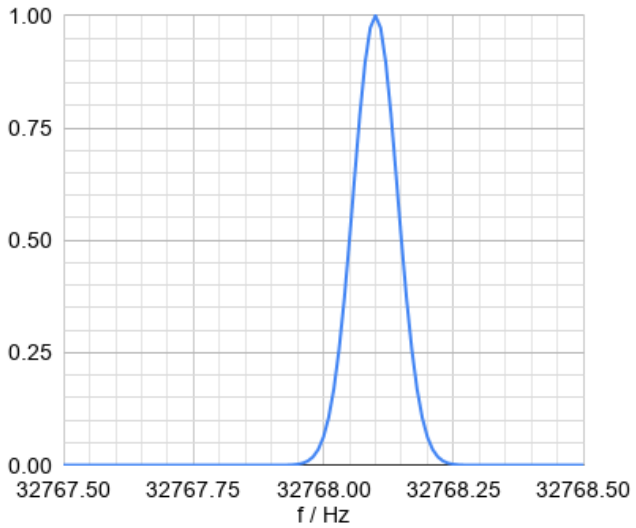
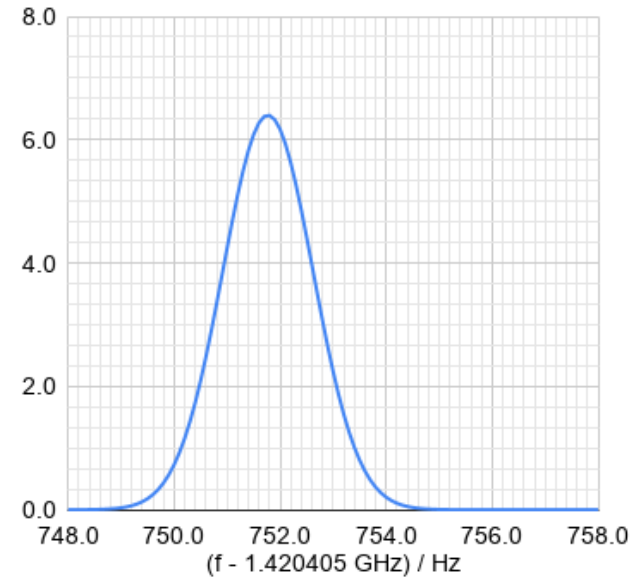
h) What special property does f(x) = gaussian(x) have?

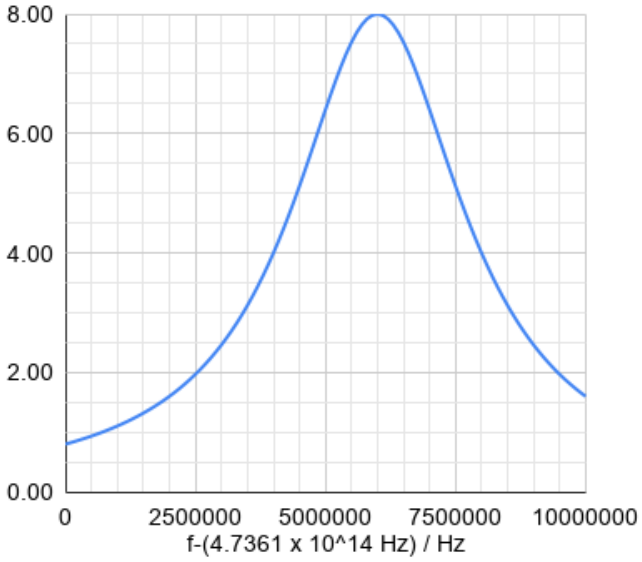
Homework – Choosing an oscillator

You are given spectra of three oscillators – a quartz crystal, a microwave oscillator and a laser. For each, measure the FWHM linewidth of the oscillator. Which would be the most suitable for a high-accuracy clock? Why? Write your answers in the template given.

Homework success criteria:

- Correct procedure for the measurement of linewidth, shown graphically.
- Correct measurements and calculations of all quantities, with appropriate units.
- Appropriate choice of oscillator with a clear explanation of the reason for its choice.

Quartz crystal  	Linewidth (FWHM) Δf =	
	Central frequency f_0 =	
	Fractional linewidth ($\Delta f/f_0$) =	
Microwave oscillator  	Linewidth (FWHM) Δf =	
	Central frequency f_0 =	
	Fractional linewidth ($\Delta f/f_0$) =	

Helium-neon laser  	Linewidth (FWHM) Δf =	
	Central frequency f_0 =	
	Fractional linewidth ($\Delta f/f_0$) =	

Which oscillator would be most suitable for a high-accuracy clock? Why?

Tutorial 5

How to be a very stable genius

"[T]here is nothing stable in the world; uproar's your only music"

- John Keats, *Letter to George and Thomas Keats* (1818), in *Letters of John Keats to his Family and Friends*, ed. Sidney Colvin (1891).

Balance I, Jan Koblasa (1972)
Photo © CC-BY-SA 3.0 by NoJin (2014), Wikimedia Commons

Objectives

By the end of this tutorial I will be able to…

- Describe what is meant by the "stability" of an oscillator
- Calculate and compare the relative frequency stability of different oscillators at multiple timescales
- Using software, calculate the Allan Variance of an oscillator.

Starter

If you have a clock, how do you know it is correct? Can you think of a way to check?

Think on your own for two minutes, then discuss your ideas in pairs.

Activity 1

You will be given (electronically) a data set of the frequency of two oscillators, measured against a primary standard, over time. Use the AlaVar software to plot the Allan Deviation of each and save the graphs for comparison.

AlaVar

Webpage	http://www.alamath.com/alavar/
Help PDF	http://www.alamath.com/help/ALAVAR.pdf
Download	http://www.alamath.com/progs/Alavar52_setup.exe

Activity 2

Of the two oscillators you analysed, which would be a better choice for:

a) A high accuracy measurements in a time-of-flight mass spectrometer, which measures microsecond intervals to identify atoms and molecules?
b) A reference clock for recording the time of astronomical events recorded at a radio telescope for the next ten years?

Explain and justify your answers using your analysis of the frequency data.

Final Assignment – How to tell the time

© Image by Anne & Saturnino Miranda from Pixabay

Write a report on the subject "How to tell the time."

Your report should demonstrate your understanding of:

- The historical development of timekeeping.
- The key parts of a clock and how they work.
- The definition and realisation of the second, the SI unit of time.
- Measures of frequency variation, including linewidth and Allan variation
- The basic principles behind the operation of at least one historical timekeeping method (solar, pendulum etc.) and one modern timekeeping method (atomic or quartz).

You will be given data sets of the frequency of two different clocks over time. Calculate their Allan deviation and linewidth, presenting your data in graphical form. Using your results, and other knowledge about their characteristics, compare the suitability of the two methods of timekeeping for:

- Measuring the time difference between two blinks of an eye.
- Measuring the time for a complete orbit of the earth around the sun.

Success criteria:

- Demonstrate the knowledge and understanding specified in the assignment.
- Use technical vocabulary from the glossary and elsewhere, correctly and appropriately.
- Include research from a variety of sources, including those you have found during the course.
- Give reasons and evidence to support your analysis and conclusions. Explain how the evidence supports your points.
- Organise your work in paragraphs, with a logical structure. You may use section headings if you like. Include an introduction that outlines the topics your assignment covers. Include a conclusion that refers to your analysis and evaluation.
- Analyse your data correctly and accurately and use your evaluation of the data to support your conclusions.
- Make sure your spelling, grammar, punctuation and use of scientific notation are accurate.

Tutorial 6 – Feedback tutorial

What is the Purpose of Tutorial 6?

- To receive feedback on your final assignment
- To respond to the feedback from your Uni Pathways teacher
- To write targets for improvement on your final assignment

Final assignment feedback from your Uni Pathways Teacher

(Remember to look at the mark scheme to help you understand what you have done well so far, and how you can do even better in your final assignment)

Here are three things that my Uni Pathways Teacher thought I did well in my draft assignment
•   •   •

Here are three things that my Uni Pathways Teacher thinks that I could do to get a higher mark in my final assignment
•   •   •

Tasks from my Uni Pathways Teacher to do during the feedback tutorial to help me improve
•   •   •
My response:

Actions I will take to improve my final assignment after this tutorial…
•   •   •

Hand in date for my final assignment:	

Tutorial 7 – Final tutorial

What is the Purpose of Tutorial 7?

- To receive feedback and a grade on your final assignment.
- To reflect on the programme including what you enjoyed and what was challenging.
- To ask any questions you may have about university.

Final assignment feedback from my Uni Pathways Teacher

Final mark:	University style grade:
Feedback: Here are three things that my Uni Pathways teacher thought I did well in my final assignment • • •	

Here are three things that my Uni Pathways teacher thinks I should remember for when I am doing this kind of study in the future
• • •

University

What questions do you still have about University after taking part in Uni Pathways?
•   •   •

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.

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