Waving with computers. Do computers recreate our environment? Let’s wave!

Key Stage 4 Programme

Pupil Name

Handbook Designed by Angela Talarn Zaragoza

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	
Submission after midnight on 9th August	10 marks deducted
Plagiarism	
Some plagiarism	10 marks deducted
Moderate plagiarism	20 marks deducted
Extreme plagiarism	Automatic fail

The Brilliant Club KS5 Programme – Pupil Feedback Report

Grade	Marks	What this means
1st	70+	Performing to an excellent standard at undergraduate level
2:1	60-69	Performing to a good standard at undergraduate level
2:2	50-59	Performing to an excellent standard at A-level
3rd	40-49	Performing to a good standard at A-level
Working towards a pass	0-39	Performing below a good standard at A-level
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 - ***Enter Key Learning Priority Here***	
What you did in relation to this Key Learning Priority *Enter feedback here*	How you could improve in the future *Enter feedback here*
Learning Feedback Comment 2 – *Enter Key Learning Priority Here*	
What you did in relation to this Key Learning Priority *Enter feedback here*	How you could improve in the future *Enter feedback here*
Learning Feedback Comment 3 – *Enter Key Learning Priority Here*	
What you did in relation to this Key Learning Priority *Enter feedback here*	How you could improve in the future *Enter feedback here*
Resilience Comment	
How you showed learning resilience during the course *Enter feedback here*	How you could build learning resilience in the future *Enter feedback here*

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Course Rationale

Which is your favourite computer game or app? Which is the web page that you visit more often? How does your computer understand the commands that you introduce?
The short answer to all those questions is a programming code, which is similar to a language that any computer understands.

Have you ever watched a film called the Matrix? A world ruled by machines which follow specific programming codes. This film, except for the role of humans, is not so far from the reality. For instance, think of different objects that use buttons or a tactile screen. Beneath those simple and common actions, recognizable codes translate your instructions, process the information and send it back to you.

Mathematics is a fascinating subject that describes accurately how our world works. Imagine what can you do merging together mathematics and programming! You can model accurately every event that takes place in our world. This fact provides the opportunity to study and understand complex processes that without computational ability would be out of reach. As an example, you can model the magnetic filed from the Earth, how galaxies interact with each other or how existing species arise from earlier species through natural selection.

Mathematics and programming can contribute to the development and understanding of a wide range of topics. Therefore, programming is a skill or ability highly demanded and with a outstanding future, same as maths. In this book you are going to be introduced to a free software code named R statistic. Using waves as a real example of our world, you will be introduced to programming code. Furthermore, it is an opportunity to realize how many things can be described by a wave and thus, by mathematics.

At the end of the tutorials you will be able to understand the logic behind the programme language, read and perform simple code instructions, graph periodic functions, be fluent in the mathematics beneath the waves, know daily life examples of wave phenomenon and be able to self-learn deeply in the programming world.

Mark Scheme Table

	Skills	1st (70-100)	2:1 (60-69)	2:2 (50-59)
Subject knowledge	Knowledge and Understanding	o All content included is relevant to the general topic and to the specific question/title o Good understanding of all the relevant topics. o Scientific terms are defined and used accurately throughout o Clear justification on how the content included is related to the specific issues that are the focus of the assignment	o Most of the content included is relevant to the general topic and to the specific question/title o Good understanding of most the relevant topics o Scientific terms are used accurately but not always clearly defined. o Adequate justification on how the content included is related to the specific issues that are the focus of the assignment	o Some of the content included is 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 Scientific terms are used mostly accurately with occasional confusion and often not defined. o 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	o Inclusion of rich sources of research findings, data, quotations or other sourced material as evidence for the claims/ ideas o Use evidence/calculations to support claims/assertions/ ideas, consistently clearly and convincingly o Data is effectively analysed and appropriate assumptions/conclusions are reached	o nclusion of adequate sources of research findings, data, quotations or other sourced material as evidence for the claims/ ideas o Use evidence/calculations to support claims/assertions/ideas, mostly clearly and convincingly o Data is analysed and the assumptions/conclusions that are reached are mostly appropriate	o Inclusion of some sources of research findings, data, quotations or other sourced material as evidence for the claims/ ideas o Use evidence/calculations to support claims/assertions/ideas, at times clearly and convincingly o There is an attempt to analyse data is and draw assumptions/conclusions
	Developing an Argument	o Argument/proof exceptionally well-developed and well-justified o Makes links effectively between subjects	o Argument/proof clear and well-developed and position justified o Some evidence of linking subjects	o Argument/proof clear but not well-developed o Limited evidence of linking subjects that have not previously been

		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	that have not previously been associated o Use some concepts from the tutorials in an unfamiliar context, but not always accurate o Analysis of content to support the argument	associated o Limited use of concepts from the tutorials in other contexts o Some analysis of content to support the argument
	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 The introduction clearly outlines how the essay/report will deal with the issues o The conclusion summarises all the main points clearly and concisely o All calculations, formulas and methods are clearly structured, clear to follow and correct o Tables and graphs are effectively constructed including appropriate headings, units and scales.	o Ideas are presented in paragraphs and arranged in a structure that is mostly appropriate for the assignment o The introduction adequately describes how the essay/report will deal with the issues o The conclusion summarises most of the main points clearly o Calculations, formulas and methods are mostly structured, clear to follow and correct o Most tables and graphs are well constructed	o Ideas are presented in paragraphs and arranged in a structure o The introduction mentions how the essay/report will deal with the issues o The conclusion summarises some of the main points clearly o Calculations, formulas and methods are not always structured, clear to follow and correct. o Some tables and graphs are well constructed but contains some errors

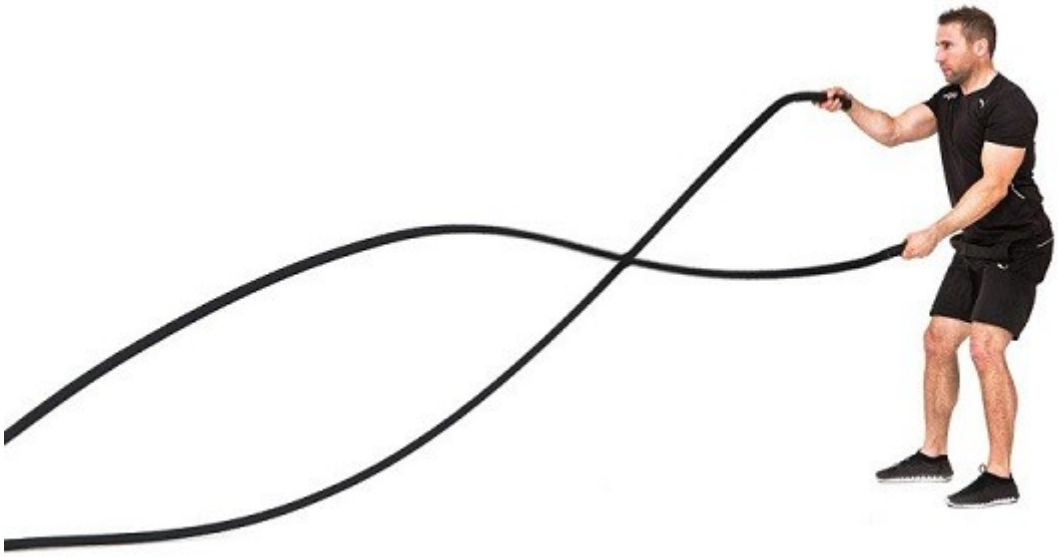
	Language and Style	o No spelling, grammar or punctuation errors o Units and significant figures are presented accurately throughout o Writing style consistently clear, appropriate for scientific documents and easy to follow o Accurate and consistent use of technical language and vocabulary	o Minimal spelling, grammar or punctuation errors o Units and significant figures are presented accurately throughout o Writing style mostly clear, appropriate for scientific documents and easy to follow o Some attempts of using technical language and vocabulary, but not always accurate	o Some spelling, grammar or punctuation errors o Units and significant figures are presented accurately throughout with occasional 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

Compose your own glossary of key words filling the table below. The words should facilitate you the understanding of the addressed book topic

Word	Definition	In a sentence
Wave	It can be described as a disturbance that travels through a medium from one location to another location	A stone disturbing the water creates waves.

Tutorial 1 – Waves and periodicity



What is the Purpose of Tutorial 1?

- Introduce basic information regarding periodic waves
- Relate periodicity to trigonometrical functions (sinus and cosinus)

Activity 1

Write down three words that describe some characteristics of a periodic event.

Can you think one example of periodic movement?

Do you know a mathematical function that has a periodic behaviour?

Compare and contrast your answers with a partner.

Activity 2

In pairs, do the following activities and answer the listed questions. Change the activity once you have finished the previous.

A) Bouncing a Basket Ball

One of you should bounce a basket ball with the only help of gravity. Imagine that the ball reaches the same height which was dropped from. Meanwhile, the other partner should measure the initial height and the time taken to bounce as requested on the following table. Fill the table below.

	Time (s)	Position (m)
Initial		
Middle		
Final (same position that the initial one)		

If the height is longer, how does the time of bouncing change?

Do you think bouncing a ball is a periodic event? Explain your answer.

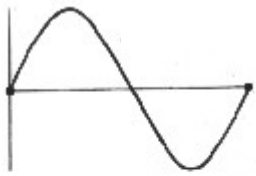
B) The Curved Rope

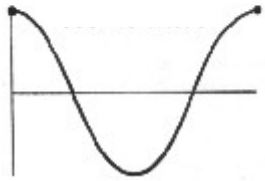
One of you should hold firmly a rope from one end, while the other should shake the counter end. Draw the shape of the rope.

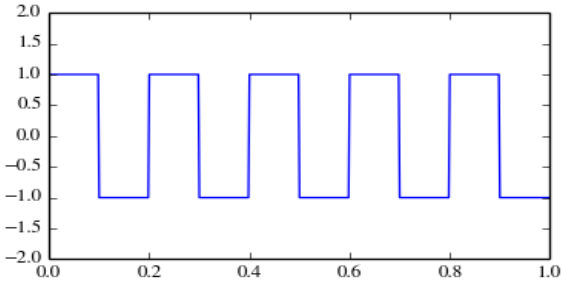
What does it happen if the rope is moved with more intensity? Highlight the differences, try to use specific vocabulary.

Activity 3

From the following functions choose those which shape is more similar to the drawing you have done in Activity 2. Explain yourself.







Homework 1

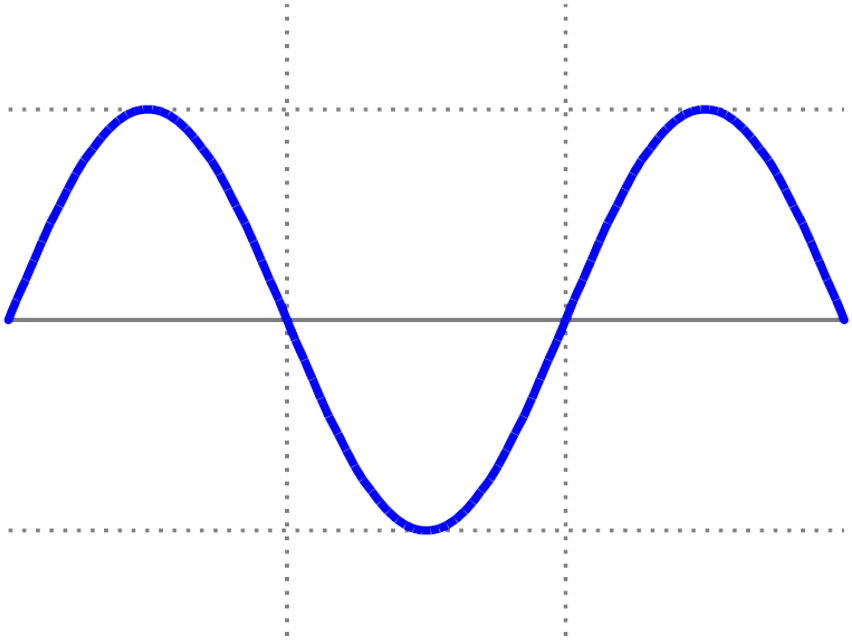
Can you define the following words: amplitude, wavelength, frequency and period. Make a list with each definition and place some of them in the image below.
You can use the following resources to complete this task:

http://theory.uwinnipeg.ca/mod_tech/node120.html

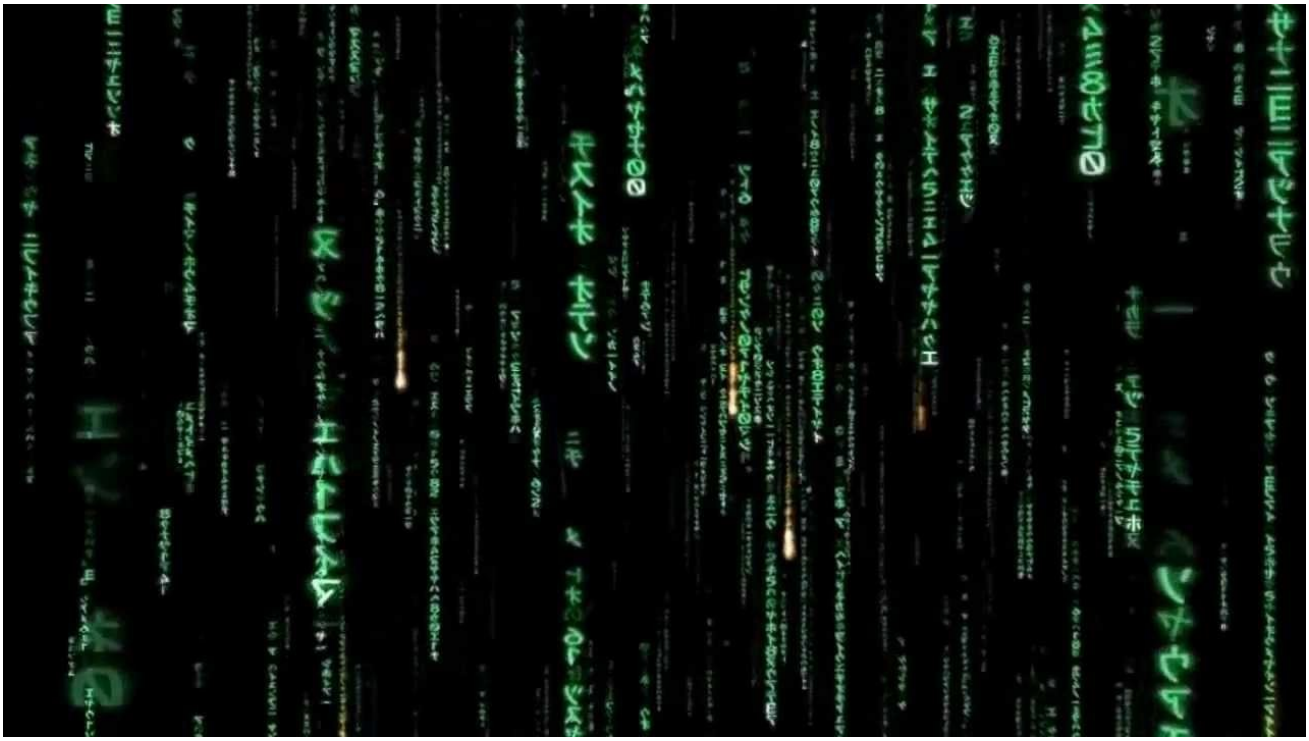
http://www.bbc.co.uk/schools/gcsebitesize/science/ocr_gateway_pre_2011/energy_home/5_light2.shtml

https://www.brightstorm.com/science/physics/vibration-and-waves/wave-characteristics/

https://www.youtube.com/watch?v=TfYCnOvNnFU (Until minute 6)



Tutorial 2 – Programme code



What is the Purpose of Tutorial 2?

- Introducing the basic concepts of programming code
- Plotting sinus and cosine functions

Activity 1

How do mobile or computer games work?

What does “code” mean to you? What does “language” mean to you? Do you think that there are similarities between each other?

To give orders to a computer you first need to learn its language, the code. There are a wide variety of programmes which you can make codes with. However, each of them have their own language. In the following activities we are going to use R Statistics programme. R is a free software program with a lot of resources in Internet, such as https://cran.r-project.org/doc/manuals/R-intro.pdf or https://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf.

Activity 2

Complete Chapter 1 of the following link to get started with R. http://tryr.codeschool.com/
Write down tree things that you have learned doing that tutorial.

Activity 3

First make sure you have the program installed on your computer, if not, ask the teacher how to do so. Secondly, answer the following instructions, it will introduce and guide you throughout your first program coding. Note that the order matters!

A) Variables and numbers

To define a number variable called X type: “x=2.1”
A.1) Define a variable called Y with a decimal value (write down the command you have introduced)

If you want to display the X value type: “print(x)”
A.2) Display the value of Y (write down the command you have introduced)

A.3) You can define a variable with more than one value using the following instruction: “k=seq(0,2,0.2)”
Can you find the pattern that the displayed k shows? How is it related with the sequence order?

A.4) What symbol do you think that means a sum for R program?
Define and display a variable, called Z, which is the sum of X and Y. Write down the code you have used.

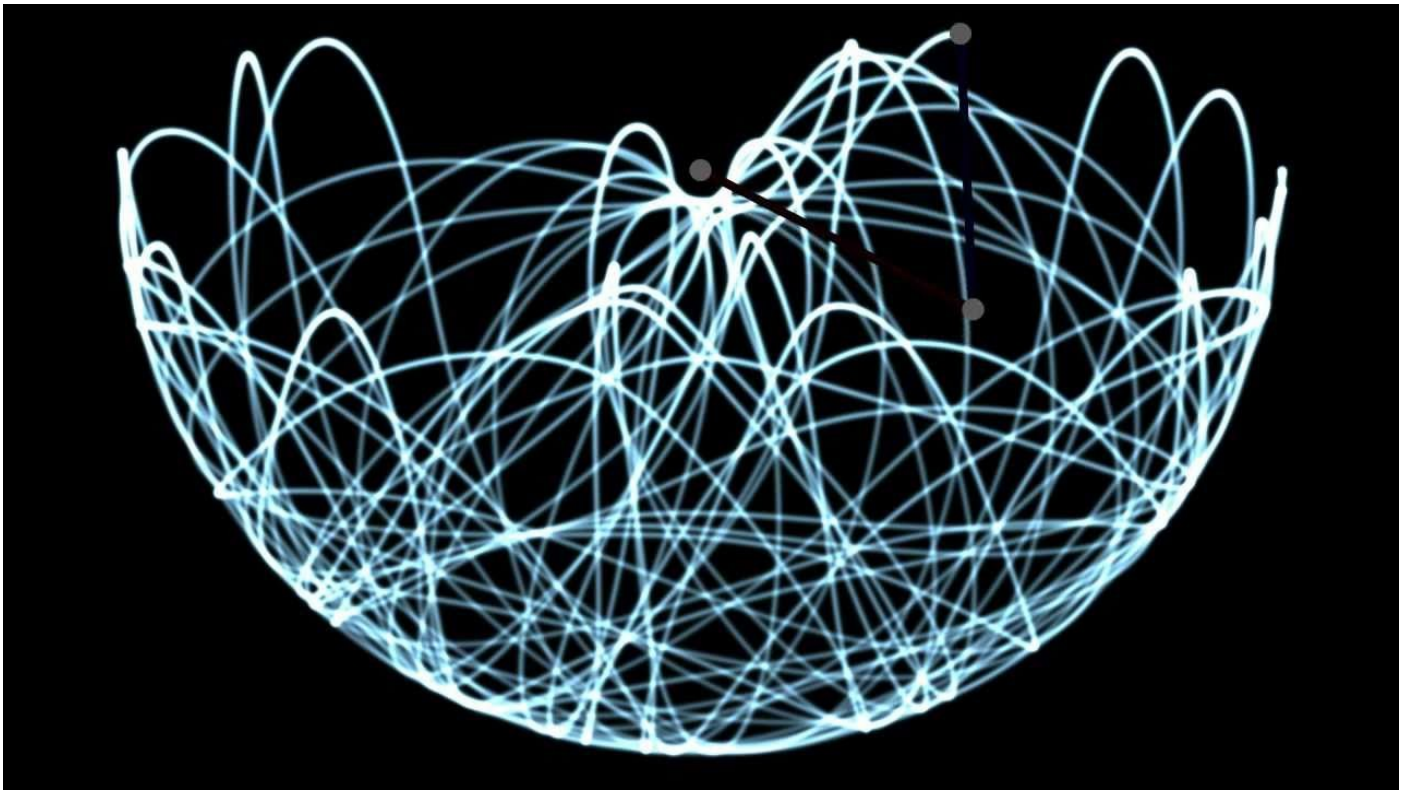
A.5) Type the following: p=sin(pi/2) and q=cos(pi). Display the results and check with your calculator if the results are right.

A.6) If you want to plot your values you can use the command plot. For example, if you have that x=2 and y=3, typing plot(x,y) it will appear a plot with a dot on (2,3). Try this order with different x, y values.

Homework 2

Write down the code to draw a sinus function with x values that goes from 0 to 3*pi. Do the same with the cosine function.
If you have any available computer, use R program to draw the functions above specified, and find the values of the amplitude, wavelength and period.
Highlight the differences between the sinus and cosine functions.

Tutorial 3 – Waves II



What is the Purpose of Tutorial 3?

- Introduce simple harmonic movement
- Examples of different types of waves
- Other periodic waves: orbits

Activity 1

Make a list of some real movements which can be seen as waves. Share and discuss with your partners.

What does harmonic mean to you? Can you define what harmonic movement is? Discuss with your peers.

Activity 2

There are different real situations that can be expressed with periodic mathematical equations. Watch the following video: https://www.youtube.com/watch?v=jxstE6A_CYQ.

1) List three real examples of simple harmonic motion.

2) Can you write down the relationship between the following variables? Period, frequency, angular velocity and position. Is there any equivalence between the radius of a circular harmonic movement and other harmonic movements? Share and discuss the answers with your partners.

Activity 3

Pay attention to the following video and take notes.
https://www.youtube.com/watch?v=cx-qHZwsLqs
Do you think we can calculate our Solar System orbits using simple harmonic movement? List the significant variables and how they are related.

Do you think we can represent orbits using computer programming? After answering the question check the following links.

Matlab simulation
http://personalpages.manchester.ac.uk/staff/paul.connolly/teaching/practicals/solar_system.html
Python simulation
https://www.youtube.com/watch?v=nkaCXS5EGRE until 1.18 minute

Homework 3

The moon orbits the Earth in a complex orbit. However, we can approximate it as a circle with radius 385000 km. What is the distance travelled by the moon around the Earth as it completes one full orbit?

If the time taken for one full orbit is 28 days, how fast does the moon have to travel relative to the Earth in meters per second?

What is “sound” for you? How does it propagate? Write down your opinion. After that, watch this video until minute 4.20 https://www.youtube.com/watch?v=qV4lR9EWGlY
Compare your previous knowledge with what you have learned, make a short essay (between 100 to 200 words) that highlight what you have found out.

Tutorial 4 – programming waves II

What is the Purpose of Tutorial 4?

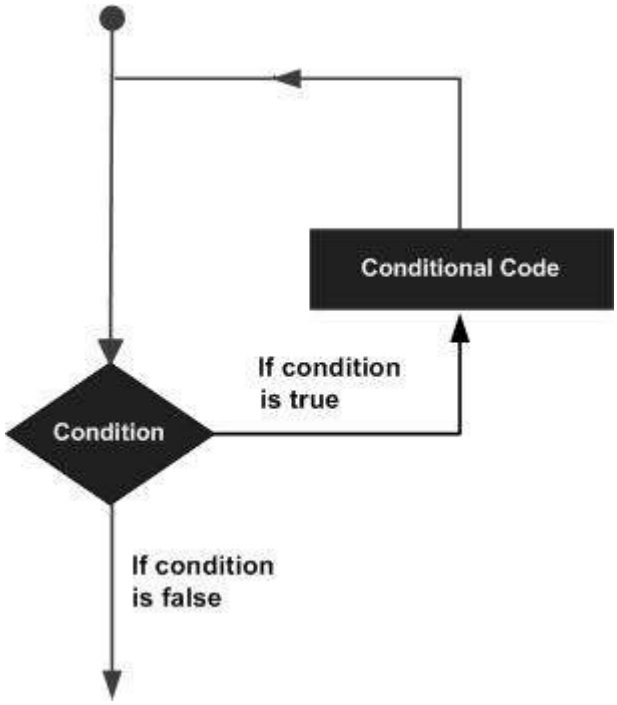
- Introduction to loops in R
- Repeat, for and while loops

Activity 1

Imagine that you would like to write 50 times a sentence on the screen. How would you do it? Can you think in more than one way to do it?

If you have to do the same process using a programme code, which logical orders would you follow? Write it down or do a sketch and discuss it with your partners.

There are various situations which requires you to execute a block of code several times. Programming languages provide various control structures that allows more complicated statements. Therefore, a loop statement is a way to execute a group of simple or complex orders as many times as needed.
There is a general loop form in most the programming languages (see figure below). Regarding R programming code, it provides three kinds of loops: *repeat loop*, *while loop* and *for loop*.
Another resources you can use to do the following activities is:
https://www.datacamp.com/community/tutorials/tutorial-on-loops-in-r#gs.k4DX_s0



Activity 2

In the following sections you will be asked to revise some content from different links and to do three tasks regarding the information you have learned from those links. In each part you should draw a sketch of the used loop and then write the needed code to generate that specific loop. Finally, try your written code in a computer.

A) In the following link you will find an explanation and an example of *repeat loop*.
https://www.tutorialspoint.com/r/r_repeat_loop.htm

Write down a *repeat loop* that starts a sum from 5 and stops when the number is greater than 90. Follow the steps described above.

B) In the following link you will find an explanation and an example of *for loop*.
https://www.tutorialspoint.com/r/r_for_loop.htm

First define a variable and then write down a *for loop* that sum to the variable its own value 5 times. Follow the steps described at the beginning of the activity.

C) In the following link you will find an explanation and an example of *while loop.*
https://www.tutorialspoint.com/r/r_while_loop.htm

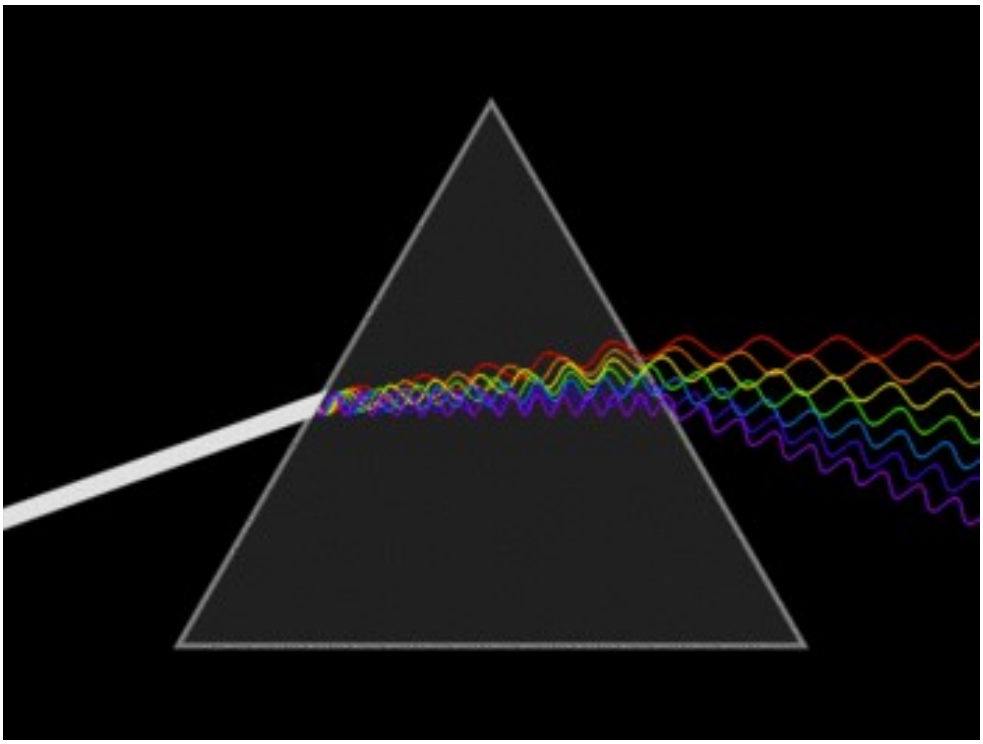
Write down a while loop that subtracts one to 98 until the final result is 65. Clue: use a counter variable. Follow the steps described at the beginning of the activity.

Homework 4

Find and note down a reliable resource, from tour point of view, that explains and gives some example of at least one of the loop’s type.

Sketch, write and try to create a R program code that sum all the pair numbers from 1 to 200. What are the final result?

Tutorial 5 – Light and electromagnetic radiation



What is the Purpose of Tutorial 5?

- Basic information about light
- Present electromagnetic radiation

Activity 1

What is light for you? How is it related to the other tutorials?

Do you think that exists a connection between the sun light and a rainbow?
Discuss with your peers.

Activity 2

Watch the following video: https://www.youtube.com/watch?v=9Vsl0Iom3S0
Highlight three surprising things that you have learned watching the video. Check the answers you have provided in the Activity 1, compare them with your knew knowledge and re-write the answers of it.

Activity 3

Watch the following video: https://www.youtube.com/watch?v=jjy-eqWM38g
What are electromagnetic spectrum? How is a spectrum split? List the different categories that it has. What can we figure out due to the light according to the video?

Final assignment

The final assignment is composed of two parts. Part one is an exercise where you will apply what you have learned in order to solve the London Eye problem. The second part consist of writing an essay in which you should communicate your ideas clearly about what has this book addressed; creativity and critical thinking will be highly valued. Please check the mark scheme on page 7 for more details on how will you be evaluated.

Part One

London Eye is a giant Ferris wheel on the River Thames in London, also known as the Millennium Wheel. When it was built in 1999, London Eye was the world's tallest Ferris wheel. Solve what you are asked at the following questions.

1) Is London Eye's motion periodic?

2) You are given the diameter of the London Eye which is 120 metres. Calculate its amplitude in meters, period in seconds, angular velocity (rad/s), constant speed (m/s), frequency (Hz) and wavelength (m) knowing that the same motion are repeated every 30 minutes.

3) Draw the mathematical function that describes the London Eye movement and locate the above variables in the correct place on your drawing.

4) Write down the R program code to print the function you have drawn. If you want to sum the same wave four times, how does the R code change? Write your answers below. If you have access to a computer you can check your own code!

Part Two

How can a periodic mathematical function describe our world? How many things do you imagine that mathematics can describe? Respond to those questions in different paragraphs and give two practical examples supporting your arguments (between 400 and 600 words).

What do you think that programming is useful for? What do you think that a restricting variable is in programming? Reflect on what you have learned and think deeply on the above questions, each question should be answered in different paragraphs. Write a final paragraph summarizing and relating both writing parts (between 400 and 600 words).

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 I did well…	What I could have improved on…
•	•
•	•
•	•

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

Waving with computers. Do computers recreate our environment? Let’s wave!

Key Stage 4 Programme

researchersinschools.org