DIXONS
SIXTH FORM
ACADEMY

SUMMER WORK:
A LEVEL PHYSICS

2023

Contents

About the Summer Work

This booklet contains a number of tasks that students are expected to complete to a good standard in order to be able to be enrolled in this subject.

Welcome to Dixons 6th Form Academy and well done for taking A-Level Physics! Please complete this work on A4 lined paper or print and complete as a booklet if you are able to. You should bring your completed summer work with you to your first Physics lesson in September. The Physics summer work should only take 5-6 hours in total so don't spend days on this.

This booklet also contains significant additional information and a range of optional tasks. We would encourage you to complete all the tasks including the optional ones to fully prepare for Sixth Form study.

Welcome to Physics

Subject outline

Physics helps us to understand and explain the Universe around us; from the smallest of particles to the stars and galaxies that make up the Universe itself. In this course you will expand upon a range of familiar topics: forces, energy, motion, waves and electricity as well as introduce to new, unfamiliar and strange areas such as quantum Physics, particle Physics and relativity.

Careers & Higher Education

A Physics degree is highly sought-after and sets you up for a wide range of possible career options. These include Accelerator Operator, Applications Engineer, Data Analyst, Design Engineer, High School Physics Teacher, IT Consultant, Lab Technician, Laser Engineer, Optical Engineer, Research Associate, Software Developer, Systems Analyst, Technical Specialist, Web Developer.

Links to key information

The Institute of Physics guide to studying Physics at A Level:
https://www.iop.org/publications/iop/2015/file_65520.pdf

AQA A level Physics Syllabus:
https://www.aqa.org.uk/subjects/science/as-and-a-level/physics-7407-7408/specification-at-a-glance

Calculators:

If studying maths as well as physics https://www.casio.co.uk/fx-991cw?refSrc=1047&nosto=productpage-nosto-1

If studying just physics https://www.casio.co.uk/fx-85gt-cw?refSrc=1047&nosto=productpage-nosto-1

Summer work tasks

The summer work is arranged into four sections:

Section 1 – Maths skills in Physics

Section 2 – GCSE content review

Section 3 – Research project

Section 4 – Optional extras

Section 1 – Maths skills in Physics

Scientific notation – need some help? Bitesize link.

https://www.bbc.co.uk/bitesize/guides/zxsv97h/revision/1

Physics covers concepts that are very, very small such as subatomic particles, right up to the entire Universe! As such, scientific notation or standard form is essential for calculations. Refresh using the link above if needed or attempt the problems below.

1. Please write these numbers in scientific notation or standard form.
   a. 47399632
   b. 0.0000005428
   c. 10.26
   d. 120
   e. 0.00602×10^{26}
   f. 663×10^{-36}

SI units and prefixes – need some help? Bitesize link.

https://www.bbc.co.uk/bitesize/guides/z3tjrwx/revision/2

SI units, are a system of seven fundamental units and a complex system of derived units which are used throughout the world to allow *international collaboration* in Physics.

1. Research the 7 fundamental units, write them down and describe what they are used for.
   Eg, "candela is the fundamental unit of light intensity or brightness" - this is the only one that you don't need to know for A-level Physics!

Prefixes are used to help Physicists with the enormous range of numbers that are dealt with in the subject. Common ones that you will already be aware of are mili, centi and kilo (as in millimetre, centimetre and kilometre). Physicists use powers of three (ie 10^3, 10^6, 10^9, etc) as their main prefixes and will often present a number to the most appropriate unit (ie width of a human hair = 48 micrometers, power output of a fission reactor = 582 megawatts).

2. Research the name and symbol of the prefixes used for the following powers of ten:
   10^{-15}, 10^{-12}, 10^{-9}, 10^{-6}, 10^{-3}, 10^3, 10^6, 10^9

3. Write the following quantities using the most appropriate prefixes.
   a. Diameter of a single proton = 1.75 x 10^{-15} m
   b. Atomic radius of uranium = 1.56 x 10^{-10} m
   c. Speed of light = 3.0 x 10^8 m/s
   d. Distance from the Earth to the Sun = 150 million km

Rearranging equations

It is an important for A-level Physicists to be able to rearrange equations. This video reminds you of how to do this: https://www.youtube.com/watch?v=r8tEkZbCVDs

4. Show your working and *annotate* with an explanation of how to rearrange the following equations.
   a. $\rho = \frac{m}{V}$ rearrange for V
   b. $v = u + at$ rearrange for t
   c. $F = \frac{mv^2}{r}$ rearrange for v
   d. $F = \frac{Gm_1m_2}{r^2}$ rearrange for r

Section 2 – GCSE content review

Atomic and Nuclear Physics

Atomic structure	**Rutherford's gold leaf scattering experiment**
Sketch and label an atom	Why were some of the alpha particles scattered? Why did some go through undeflected? Why did some go directly backwards

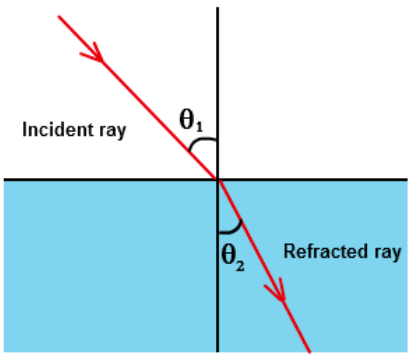
Radioactive decay	**What are the properties, range, decay equations and uses of each type?**
Alpha decay Beta decay Gamma decay	

Light and the EM Spectrum

What are the properties and uses of the EM spectrum?

EM wave	*Properties and uses*
R	
M	
I	
V	
U	
X	
G	

Describe the refraction of light as an incident ray goes from low density material (air) to high density (glass or water).



Research Snell's law:

What is the angle of refraction when light goes from water (n = 1.33) to glass (n = 1.50) if the angle of incidence is 50°?

Motion

Motion graphs

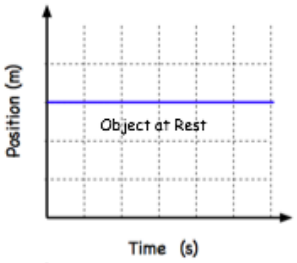
Define the key terms and research the equations for each

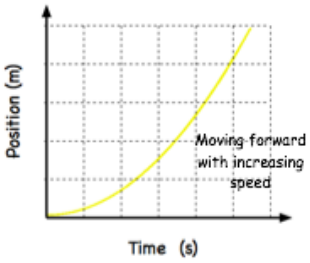
Displacement

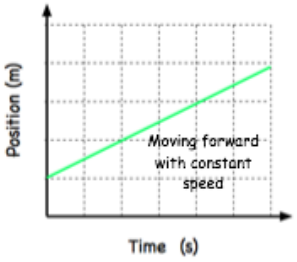
Velocity

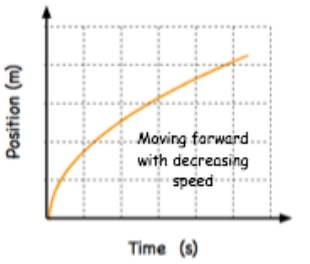
Acceleration

Displacement-time graphs



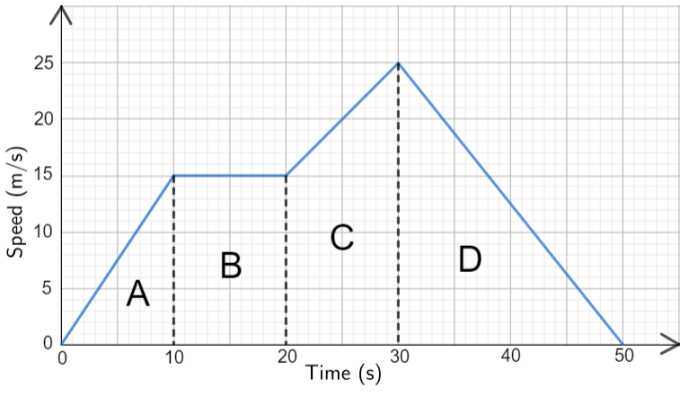






Describe what the gradient of a displacement-time graph tells us, and how it can be used in each of the scenarios above.

Describe this graph using the key words above. Calculate anything that you can!



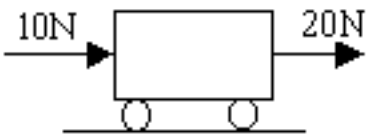
Forces and Motion

What are Newton's 3 laws of motion. Give examples of each.		
Newton's 1st law	Newton's 2nd law	Newton's 3rd law

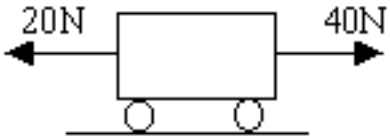
F = ma and resultant force

Calculate the resultant force which acts on each of the trolley in each of these situations. If the trolley has a mass of 1.5kg, calculate the resultant acceleration of the trolley.

(a)



(b)



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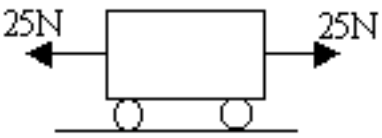
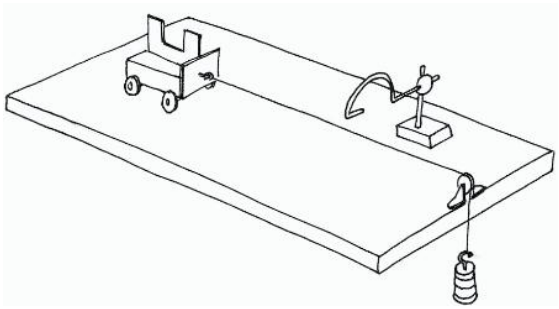
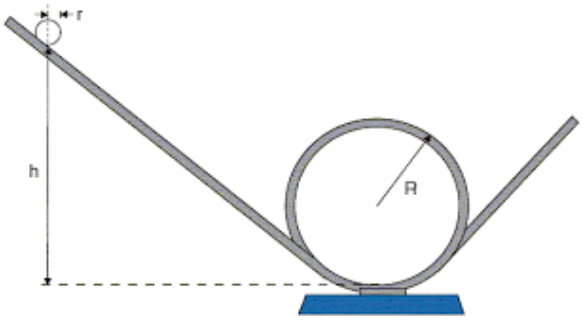


Work, Energy and Power

Energy transfers – describe the energy transfers in each of the situations below





Power and Efficiency

Power equation:

Example Q: A light bulb uses 3600 J of energy in one minute. What is it's power?

Efficiency equation:

Example Q: A light bulb uses 60W of electrical energy, and emits 24J of light every second. What efficiency does it have?

Electricity

Current, voltage and resistance

1. Define…

current:

potential difference:

EMF:

resistance:

power:

2. Calculations…

If the current is 6mA, how long does it take for 12C of charge to flow past a point on the wire.

What is the emf of a cell providing 60J of electrical energy per 24C of charge?

A motor uses 6000 J of energy in 2 minutes. What is the power of the motor?

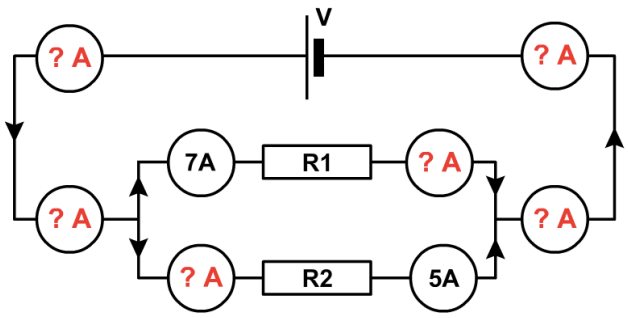
3. Series and parallel circuits…

Describe and explain how current is different between series and parallel circuits:

Describe and explain how potential difference is different between series and parallel circuits:

4. Circuit calculations…

Calculate the current that each ammeter will show.



What can you tell from this circuit about the resistors R1 and R2?

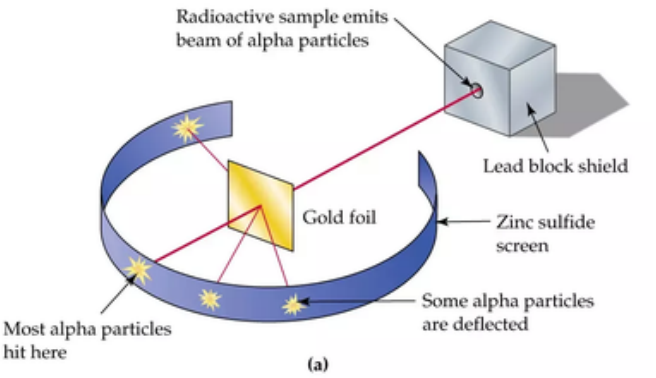
Section 3 – Research project

The first two units of the course will be particles and radiation, followed by waves. Please research and prepare an informative poster or presentation on **one** of the topics below. Some of the course is a recap from GCSE, but you will also need to do some research to extend your understanding. Use the prompt questions in each box to get started, but these are not exclusive, feel free to expand

your research! A great example of an informative poster [can be found here](https://www.pinterest.com/pin/149252175129704783/)
https://www.pinterest.com/pin/149252175129704783/

– detailing the history of the atom.

Atomic structure, nuclide notation, quarks

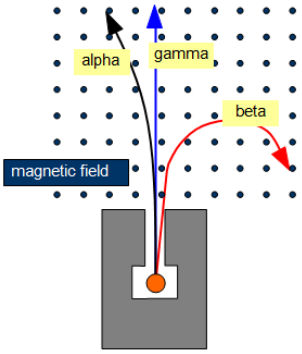


1. What is the structure of the atom? How did Rutherford's gold leaf experiment provide evidence for this?

2. What is 'nuclide notation'? How does it help Physicists to represent nuclear reactions?

3. What are quarks and baryons? How do quarks help to explain the differences between protons and neutrons?

Alpha, β+and β- decay and the neutrino

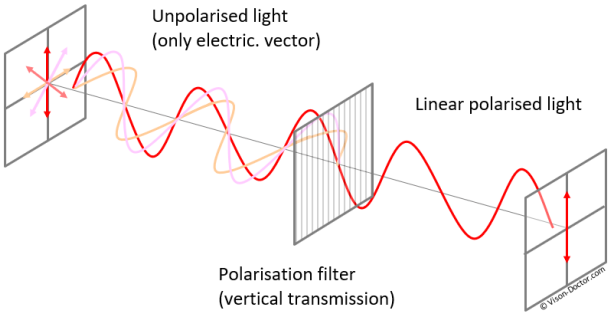


1. What are the properties of alpha and beta radiation? How are they both detected?

2. What are the similarities and differences between β+and β-decay?

3. What is a neutrino? How are they detected? Why are they important in β+and β- decay?

Transverse and longitudinal waves, polarisation

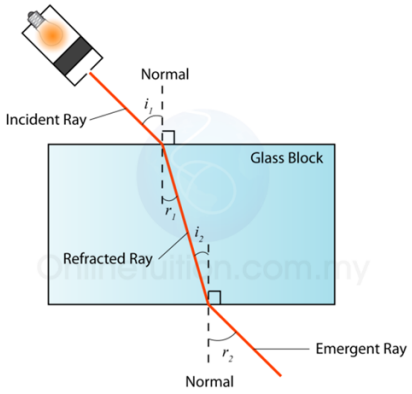


1. What is the difference between a transverse and longitudinal wave? Give examples.

2. Define and use the terms wavelength, frequency, amplitude, time period for both longitudinal and transverse waves.

3. What is meant by polarisation of light? How is polarisation used in an application such as polarised sunglasses, stress detection or polarimetry?

Refraction and diffraction



1. Use diagrams to explain refraction of light when light travels between different materials.

2. What is Snell's law? Explain an example calculation. How does it link to total internal reflection?

3. What happens when white light hits a narrow gap (a slit)? *Hint: not as easy as you think!*

Section 4 – Optional extras

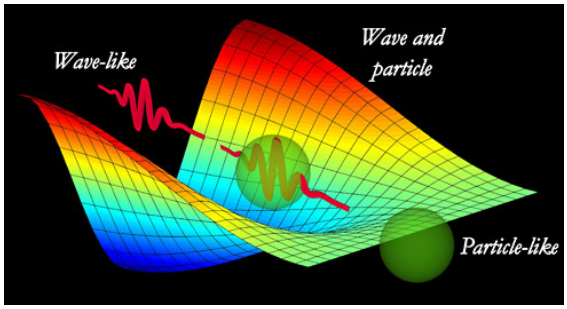
Some of you will be very excited to get started with studying A-Level Physics, and keen to do some extra work to help you prepare. Here are some extension tasks that go beyond the GCSE syllabus and start to tackle the A-level syllabus.

Particle Physics	
What is the structure of a proton:	What is the structure of a neutron:
What are: 1. Hadrons 2. Baryons 3. Mesons 4. Leptons 5. Quarks	What are the forces acting on the inside of an atom?

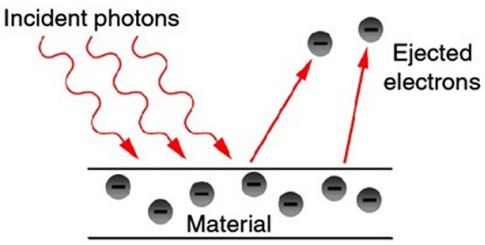
Quantum Physics

<u>Nature of light</u>

Light is described as a wave. It can also be described as a particle. Investigate the particle nature of light.



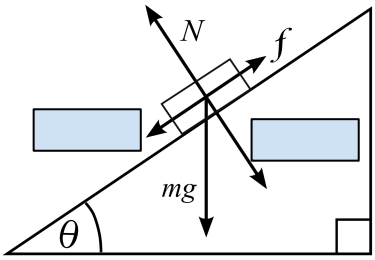
Einstein was awarded a Nobel Prize for Physics for describing light as having a quantised nature.	A piece of experimental evidence for the particle nature of light is the photoelectric effect.



Use the [pHET Photoelectric Effect simulation] to investigate this further.

Forces and motion

Forces on a slope



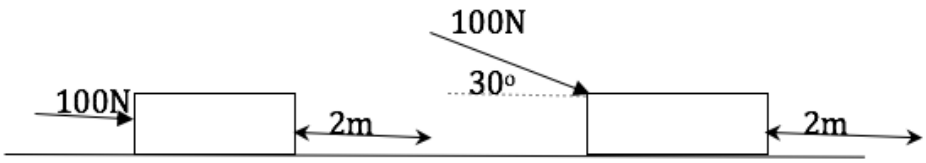
We can split the weight (W=mg) into its x and y coordinates.

Fill in the blanks on the diagram across.

What is the normal force equal to?

The block moves down the ramp at a constant speed. What is the equation of the frictional force?

Work, energy and power



$$W = F\cos\theta$$

Find out what this equation means and calculate the work done in each of the two examples above.

Electricity

The resistance of a wire is directly proportional to length and inversely proportional to cross-sectional area. It also depends on the material of the wire.	What is resistivity? What is the resistivity of copper?
What is the equation that links resistance, resistivity, cross sectional area and length of wire? Give the units	Taking the resistivity of platinoid as 3.3×10^{-7} Ωm, find the resistance of 7.0 m of platinoid wire of average diameter 0.14 cm.

Isaac Physics Problems:

Please find below links to gameboards which have been created on Isaac Physics. Each gameboard consists of up to ten questions for you to work on. If you would like your progress to be saved then you can register with Isaac Physics – it's free – or you can work on the problems without registering.

Electricity:

Level 1 Gameboard: https://isaacphysics.org/gameboards#020465a5-ba73-4ebc-a0c2-21c56daed1a1

Level 2 Gameboard: https://isaacphysics.org/gameboards#9a5fbb69-dd14-463f-95e4-11fab6885ac6

Mechanics:

Level 1 Gameboard: https://isaacphysics.org/gameboards#26a4d8d7-ba77-430a-a0ba-bbd8b06f3c4a

Level 2 Gameboard: https://isaacphysics.org/gameboards#7f567d6e-bc2d-4983-a363-3a393c8dec36

Waves and Optics:

Level 1 Gameboard: https://isaacphysics.org/gameboards#52949353-eb05-4b5d-be8a-f30839593db6

Level 2 Gameboard: https://isaacphysics.org/gameboards#241623b7-6b9f-4f04-87fb-463d613094b7

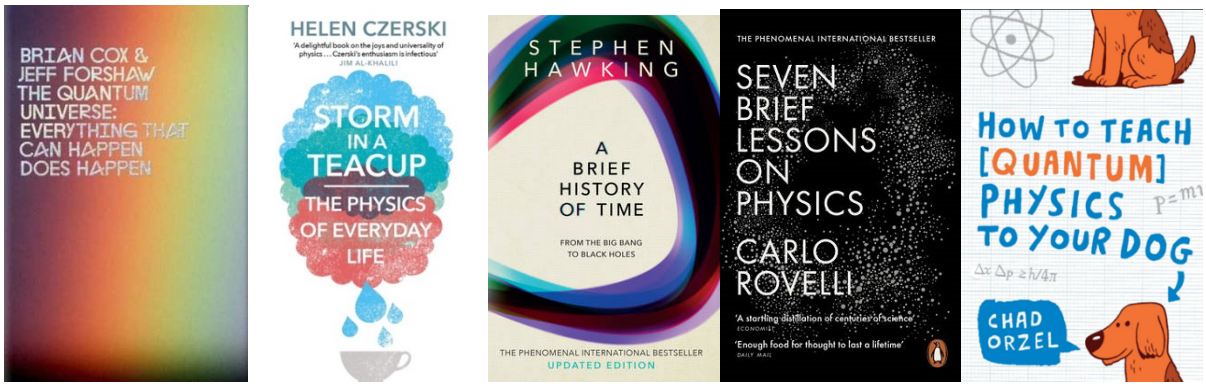
Particle Physics:

Atomic Numbers and Nomenclature:
https://isaacphysics.org/gameboards#phys_book_gcse_ch_6_51

Radioactive Decay: https://isaacphysics.org/gameboards#phys_book_gcse_ch_6_52

Reading list

Book recommendations



Podcasts

Podcasts are a brilliant way of engaging with a scientific topic, beyond the curriculum. Awesome for University interviews! Take a look at this list below.

Podcast series	Some good episodes
Guardian Science Weekly https://www.theguardian.com/science/series/science	Why is the scientific revolution still controversial? Steven Weinberg on the history of science Could a new force of nature reveal the universe's dark side? The quest for a theory of everything What is Dark Matter? How did life begin? Is our universe infinite? Is time an illusion? Are we on course to find the solution to Earth's energy crisis? The truth about radiation The search for planet Earth's twin Smashing Physics - how we discovered the Higgs boson
The Infinite Monkey Cage with Brian Cox https://www.bbc.co.uk/programmes/b00snr0w/episodes/downloads	How we measure the universe Are humans still evolving? GCHQ Microbes: Secret rulers of the world? Immune System Invasion Big Data Teenage Brain The Secret Life of Birds The Mind v the brain The Human Voice
Science VS by Gimlet Media https://gimletmedia.com/shows/science-vs/episodes	How To Stop A Killer Asteroid 5G: Welcome To The Revolution? Ancient Aliens: Who Really Built The Pyramids Scott Kelly: How A Year In Space Changes You Nuclear War...Total Annihilation?

	The Bee-Pocalypse 100% Renewable Energy – Can We Do It?
13 Minutes To The Moon https://www.bbc.co.uk/programmes/w13xttx2	You need to listen to every episode in order to really appreciate this.
The Curious Cases of Rutherford and Fry https://www.bbc.co.uk/programmes/b07dx75g/episodes/downloads	The Flying Clock and The Stopped Watch The Martian Mission The Hamster Power Hypothesis The Space Burrito The End of Everything The Seeded Cloud The Exotic Wormhole The Heart of the Antimatter Jurassic Squawk An Instrumental Case