# A Level Physics Pre-Learning

## Reading watching and listening

To help you develop your inquisitive side you will need to read around the subject. Since the course is very broad you will need to discover how this is linked to your own interests or career goals (and it will be, everything is Physics). Here are some suggestions for papers, books, podcasts and YouTube channels that might help. And if you find any others let me know and I will add them for next year.

Books:

- Stephen Hawking - A Brief History of Time
- JP McEvoy and Oscar Zarate - Stephen Hawking: A graphic Guide
- Brian Greene - The Elegant universe
- Edwin A. Abbot - Flatland
- Chad Orzel - How to Teach Relativity to Your Dog
- Richard P. Feynman - Six Easy Pieces
- Ben Goldacre - Bad Science
- Peter Atkins - Galileo's finger
- Russell Stannard - The Time & Space of Uncle Albert
- Russell Stannard - Black Holes and Uncle Albert
- Russell Stannard - Uncle Albert and the Quantum Quest
- Lee Smolin - Three Roads to Quantum Gravity
- Richard Feynman - Feynman Lectures in Physics (Vol 1-3) [Can also be found on youtube]
- Bill Bryson - A Short History of Nearly Everything

## YouTube suggestions:

Institute of Physics

Feynman Lectures

Veritasium

Smarter Every Day

Lectures by Walter Lewin

Minutephysics

Steve mould

Sixty Symbols

**Articles (grouped by topic areas)**

Gravitational Waves and General Relativity

Einstein's gravity theory passes toughest test yet: Bizarre binary star system pushes study of relativity to new limits: http://phys.org/news/2013-04-einstein-gravity-theory-toughest-bizarre.html

First Direct Evidence of Cosmic Inflation: https://www.cfa.harvard.edu/news/2014-05

Gravitational Waves from Early Universe Remain Elusive:

http://www.jpl.nasa.gov/news/news.php?release=2015-46

Crashing Black Holes http://calteches.library.caltech.edu/4298/1/BlackHoles.pdf

CERN's new Einstein Observatory to explore black holes, Big Bang: http://phys.org/news/2011-05-cerneinstein-observatory-explore-black.html

String Theory

New website dedicated to discussion of string theory: http://phys.org/news/2012-10-websitededicateddiscussion-theory.html

Scientists find a practical test for string theory: http://phys.org/news/2014-01-scientists-theory.html

What is string theory? http://www.physics.org/article-questions.asp?id=47

String theory: it's not dead yet: http://www.newscientist.com/article/dn11882-string-theory-its-notdeadyet.html#.VQa6AqzLcjU

Finally, a MAGIC test for string theory?: http://www.newscientist.com/article/dn12609-finally-amagic-testfor-string-theory.html

Quantum Computers

How Quantum Computers Work: http://computer.howstuffworks.com/quantum-computer.htm

The Father of Quantum Computing:

http://archive.wired.com/science/discoveries/news/2007/02/72734

The Revolutionary Quantum Computer That May Not Be Quantum at All:

http://www.wired.com/2014/05/quantum-computing/

Materials Science

Scientists fabricate defect-free graphene, set record reversible capacity for Co3O4 anode in Li-ion batteries: http://phys.org/news/2014-08-scientists-fabricate-defect-free-graphene-reversible.html

Theoretical physicists design 'holy grail' of materials science: http://phys.org/news/2015-03-theoreticalphysicists-holy-grail-materials.html

Novel crumpling method takes flat graphene from 2D to 3D: http://phys.org/news/2015-02-crumplingmethod-flat-graphene-2d.html

Stanene is ‘100% efficient’, could finally replace copper wires in silicon chips:

http://www.extremetech.com/extreme/171551-stanene-is-100-efficient-could-finally-replacecopper-wiresin-silicon-chips

What is Aerogel? Theory, Properties and Applications:

http://www.azom.com/article.aspx?ArticleID=6499

Particle Physics

Why particle physics matters: http://www.symmetrymagazine.org/article/october-2013/whyparticlephysics-matters

It's a boson! But we need to know if it's the Higgs: http://www.newscientist.com/article/dn22029-

its-aboson-but-we-need-to-know-if-its-the-higgs.html?page=1#.VQfooqzLdVw

Particle chameleon caught in the act of changing http://press.web.cern.ch/pressreleases/2010/05/particlechameleon-caught-act-changing The search for dark matter at the LHC:

http://www.symmetrymagazine.org/article/the-search-for-darkmatter-at-the-lhc Could the Higgs

Nobel Be the End of Particle Physics?: http://www.scientificamerican.com/article/could-thehiggsnobel-be-the-end-of-particle-physics/

Astrophysics

How do we know dark matter exists?: http://phys.org/news/2015-03-dark.html

The corrugated galaxy: Milky Way may be much larger than previously estimated:

http://phys.org/news/2015-03-corrugated-galaxy-milky-larger-previously.html

Solving the riddle of neutron stars:

http://www.sciencedaily.com/releases/2015/03/150310074105.htm

Cosmology: First stars were born much later than thought:

http://www.sciencedaily.com/releases/2015/02/150205131233.htm

**Podcasts**

These are all available via BBC sounds

- In our time
- The life scientific
- Frontiers
- The infinite monkey cage
- BBC inside science

**Turning points in physics**

This option is intended to enable key concepts and developments in physics to be studied in greater depth than in the core content. Students will be able to appreciate, from historical and conceptual viewpoints, the significance of major paradigm shifts for the subject in the perspectives of experimentation and understanding. Many present-day technological industries are the consequence of these key developments and the topics in the option illustrate how unforeseen technologies can develop from new discoveries.  This unit builds on all of the work covered and is a great chance to develop your further reading rather than the quickfire questions you should research the work of the following Physicists;

- JJ Thompson
- Frank Dunnington
- Robert Millikan
- Thomas Young
- Christiaan Huygens
- Isaac Newton
- Heinrich Hertz
- Max Planck
- Louis de Broglie
- Ernst Ruska, Gerd Binnig and Heinrich Rohrer
- Albert Michelson and Edward Morley
- Hendrick Lorentz
- William Bertozzi

## Skills and information

### Greek letters

Greek letters are used often in science. They can be used as symbols for numbers (such as π = 3.14…), as prefixes for units to make them smaller (eg μm = 0.000 000 001 m) or as symbols for particular quantities (such as λ which is used for wavelength).

The Greek alphabet is shown below.

| | | |
|---|---|---|
| Α | α | alpha |
| Β | β | beta |
| Γ | γ | gamma |
| Δ | δ | delta |
| Ε | ε | epsilon |
| Ζ | ζ | zeta |
| Η | η | eta |
| Θ | θ | theta |
| Ι | ι | iota |
| Κ | κ | kappa |
| Λ | λ | lambda |
| Μ | μ | mu |

| | | |
|---|---|---|
| Ν | ν | nu |
| Ξ | ξ | ksi |
| Ο | ο | omicron |
| Π | π | pi |
| Ρ | ρ | rho |
| Σ | ς or σ | sigma |
| Τ | τ | tau |
| Υ | υ | upsilon |
| Φ | φ | phi |
| Χ | χ | chi |
| Ψ | ψ | psi |
| Ω | ω | omega |

**Task 1:** list all of the Greek letters you have encountered in Science and Maths so far and what you have used them to represent.

The most common prefixes you will encounter are:

| Prefix | Symbol | Multiplication factor | | |
|---|---|---|---|---|
| Tera | T | $10^{12}$ | 1 000 000 000 000 | |
| Giga | G | $10^{9}$ | 1 000 000 000 | |
| Mega | M | $10^{6}$ | 1 000 000 | |
| kilo | k | $10^{3}$ | 1000 | |
| deci | d | $10^{-1}$ | 0.1 | 1/10 |
| centi | c | $10^{-2}$ | 0.01 | 1/100 |
| milli | m | $10^{-3}$ | 0.001 | 1/1000 |
| micro | μ | $10^{-6}$ | 0.000 001 | 1/1 000 000 |
| nano | n | $10^{-9}$ | 0.000 000 001 | 1/1 000 000 000 |
| pico | p | $10^{-12}$ | 0.000 000 000 001 | 1/1 000 000 000 000 |
| femto | f | $10^{-15}$ | 0.000 000 000 000 001 | 1/1 000 000 000 000 000 |

**Task 2:** Which SI unit and prefix would you use for the following quantities?

1. The length of a finger
2. The temperature of boiling water
3. The time between two heart beats
4. The width of an atom
5. The mass of iron in a bowl of cereal
6. The current in a simple circuit using a 1.5 V battery and bulb

Sometimes, there are units that are used that are not combinations of SI units and prefixes. These are often multiples of units that are helpful to use.

For example, a light year is a distance of 9.46 × 1012 km.

**Task 3:** Re-write the following in SI units.

1. 1 minute
2. 1 hour
3. 1 tonne

At A level quantity will be written in standard form, and it is expected that your answers will be too. This means answers should be written as ....x $10^y$. E.g. for an answer of 1200kg we would write 1.2 x $10^3$kg.

**Task 4:** Solve the following:

1. How many metres in 2.4 km?
2. How many joules in 8.1 MJ?
3. Convert 326 GW into W.
4. Convert 54 600 mm into m.
5. How many grams in 240 kg?
6. Convert 0.18 nm into m.
7. Convert 632 nm into m. Express in standard form.
8. Convert 1002 mV into V. Express in standard form.
9. How many V in 0.511 MeV? Express in standard form.
10. How many m in 11 km? Express in standard form.

## Rearranging formulae

This is something you will have done at GCSE and it is crucial you master it for success at A level. Find out how to do this here:

https://www.youtube.com/watch?v=cbKc_qilgzA

**Task 5:** Rearrange the following:

1. E=m x g x h to find h
2. Q= I x t to find I
3. E = ½ m $v^2$ to find m
4. E = ½ m $v^2$ to find v
5. v = u + at to find u
6. v = u + at to find a
7. $v^2 = u^2 + 2as$ to find s
8. $v^2 = u^2 + 2as$ to find u

## Significant figures

At A level you will be expected to use an appropriate number of significant figures in your answers. The number of significant figures you should use is the same as the number of significant figures in the data you are given.

You can never be more precise than the data you are given so if that is given to 3 significant your answer should be too. E.g. Distance = 8.24m, time = 1.23s therefore speed = 6.75m/s

The website below summarises the rules and how to round correctly.

http://www.purplemath.com/modules/rounding2.htm

**Answers:**

**Task 2:**

1. Cm
2. K
3. S
4. nm
5. µm
6. MA

**Task 3:**

1. 60 s
2. 3600 s
3. 1000 kg

**Task 4:**

1. 2400 m
2. 8 100 000 J
3. 326 000 000 000 W
4. 54.6 m

**Task 4 continued:**

5. 5.240 000 g
6. $1.8 \times 10^{-8}$m
7. $6.32 \times 10^{-7}$m
8. 1.002 V
9. $5.11 \times 10^{-5}$V
10. $1.1 \times 10^{4}$m

**Task 5:**

1. h= E/ (m x g)
2. I = Q/t
3. m = (2 x E)/$v^2$ or E/(0.5 x $v^2$)
4. v= √((2 x E )/m)
5. u = v – at
6. a = (v-u)/t
7. s = ($v^2$ – $u^2$) / 2a
8. u = √($v^2$-2as)