KEVICC
Science Department

A-Level Physics

Year 12 Transition task

Name: _____

Introduction to Physics Year 12

Objectives:
- *To give you the skills needed for the successful study of Physics at A level.*
- *To help you to identify areas in which you might need help.*

There are several areas in which students struggle at A level:
- Use of symbols;
- Use of SI units;
- Use of a calculator;
- Use of formulae.

These notes and activities are to help you to become confident with these basic skills, which will help the start of your Physics studies to be more productive and enjoyable.

Using Symbols

An **equation** is a mathematical model that sums up how a system behaves. For example, we know that, if we have a current flowing through a wire and double the voltage, the current will double as well. We know that the quantities of current and voltage are related by the simple rule: $V = IR$

In physics problems we are given certain quantities and use them to find an unknown quantity with an equation.

Symbols

At GCSE you were often given equations in words: $Distance = speed \times time$

At A level you will be with equations that are given in **symbols.** The symbols all mean something; they are abbreviations. The symbols used in exams and most textbooks are those agreed by the Association of Science Education.

Some symbols are easy; *V* stands for voltage. Some are not so easy. *I* for current comes from the French *intensité du courant*, since it was a French physicist who first worked on it. In print you will always find these symbols written in *italics*.

1. What are the meanings for these symbols?
a
v
F
t
Q

You will come across symbols written in Greek letters. The normal (Latin) alphabet has 26 characters. No symbols, with accents are used such as ä (a – umlaut) or ê (e – circumflex). The Greek alphabet adds another 24.

The Greek Alphabet is this:

Greek	*Name*	*Greek*	*Name*
α	alpha	ν	nu
β	beta	π	pi
γ	gamma	ρ	rho
δ (Δ)	delta	σ (Σ)	sigma
ε	epsilon	τ	tau
η	eta	ϕ (Φ)	phi
θ	theta	χ	chi
λ (Λ)	lambda	ψ (Ψ)	psi
μ	mu	ω (Ω)	omega

The ones in grey are the ones you won't generally come across in A-level. You will come across the others in the context of:

- Particles – many particles are given Greek letters, e.g. π meson.
- Physics equations, e.g. $c = f\lambda$

2. The wave equation is $= f\lambda$. What do the symbols refer to?
c
f
λ

The most common uses of Greek letters are:

- α – as in alpha particle;
- β – as in beta particle;
- γ – as in gamma ray;
- Δ – change in (Δt is time interval);
- θ – angle;
- π – 3.1415…;
- Σ – sum of.

When you use an equation, you will need to know exactly what each term means. But don't worry; the terms will be explained when the formula is introduced to you.

Units

Physics formulae use **SI** (Système International) **units** based on seven **base units (Read your Measurement and their Errors notes)**

Many physics formulae will give you the right answer ONLY if you put the quantities in SI units. This means that you have to convert. You will often find units that are prefixed, for example kilometre. The table below shows you the commonest prefixes and what they mean:

Prefix	Symbol	Meaning	Example
pico	p	$\times 10^{-12}$	1 pF
nano	n	$\times 10^{-9}$	1 nF
micro	μ	$\times 10^{-6}$	1 μg
milli	m	$\times 10^{-3}$	1 mm
centi	c	$\times 10^{-2}$	1 cm
kilo	k	$\times 10^{3}$	1 km
Mega	M	$\times 10^{6}$	1 MΩ
Giga	G	$\times 10^{9}$	1 GWh

When converting, it is perfectly acceptable to write the number and the conversion factor. For example:

$$250 \text{ nm} = 250 \times 10^{-9} \text{ m} = 2.5 \times 10^{-7} \text{ m}$$

3. Convert the following quantities to SI units:	
15 cm	
3 km	
35 mV	
220 nF	

When you write out your answer, you must **always** put the correct **unit** at the end. The number 2500 on its own is meaningless; 2500 J gives it a meaning.

Failure to put units in loses 1 mark in the exam, which is 2 %. Repeated across a paper, it can mean the difference of two grades.

Converting areas and volumes causes a lot of problems.

Area:
$$1m^2 \neq 100cm^2$$

$$\mathbf{1m^2 = 100cm \times 100cm = 10,000cm^2 = 10^4 cm^2}$$

Volume:

$$\mathbf{1m^3 = 100cm \times 100cm \times 100cm = 1000,000cm^3 = 10^6 cm^3}$$

4. Convert the following:	
1 m^2 =	mm^2
45 000 mm^2 =	m^2
6 000 000 cm^3 =	m^3

Standard Form

Standard form consists of a number between 1 and 10 multiplied by a **power** of 10. For big numbers and very small numbers standard form is very useful.

You should have found that very small numbers entered into a calculator are read as 0, unless they are entered as standard form. The following number is shown in standard form:

$$\mathbf{3.28 \times 10^5}$$
$$= 3.28 \times 100\ 000 = 328\ 000$$

5. Convert these numbers to standard form:
86
381
45300
1 500 000 000
0.03
0.00045
0.0000000782

There is no hard and fast rule as to when to use standard form in an answer. Basically if your calculator presents an answer in standard form, then use it. Generally use standard form for:
- numbers greater than 100 000
- numbers less than 0.001

When doing a **conversion** from one unit to another, for example from millimetres to metres, consider it perfectly acceptable to write:

$$15 \text{ mm} = 15 \times 10^{-3} \text{ m}$$

Using a Calculator

A **scientific calculator** is an essential tool in Physics, just like a chisel is to a cabinet-maker. All physics exams assume you have a calculator, and you should always bring a calculator to every lesson. They are not expensive, so there is no excuse for not having one.

The calculator should be able to handle:
- **standard form**;
- **trigonometrical** functions;
- **angles** in **degrees** and **radians**;
- **natural logarithms** and **logarithms to the base 10**.

Most scientific calculators have this and much more.

We are assuming that you know the basic functions of your calculator, but we need to draw your attention to a couple of points on the next page.

Misuse of the EXP key:

Suppose we have a number like 2.31×10^7. You key it in like this:

$$\boxed{2} \quad \boxed{.} \quad \boxed{3} \quad \boxed{1} \quad \boxed{\text{EXP}} \quad \boxed{7}$$

This will give you 2.31×10^8. Misuse of the calculator will always cost marks.

Too Many Significant Figures

Consider this calculation:
$$V_{rms} = \frac{13.6}{\sqrt{2}}$$

Your calculator will give the answer as $V_{rms} = 9.6166526$ V

There is no reason at all in A-level Physics to write any answer to any more than 4 significant figures. Four significant figures is claiming accuracy to about one part in 10000. Blindly writing your calculator answer is claiming that you can be accurate to one part in 100 million, which is absurd.

The **examination mark schemes** give answers that are either 2, 3 or 4 significant figures. So our answer above could be written as:

$$V_{rms} = 9.617 \text{ V (4 s.f.)}$$
$$V_{rms} = 9.62 \text{ V (3 s.f.)}$$
$$V_{rms} = 9.6 \text{ V (2 s.f.)}$$

Do any **rounding** up or down at the end of a calculation. If you do any rounding up or down in the middle, you could end up with rounding errors

6. Use your calculator to do the following calculations. Write your answers to **three** significant figures.	
	ANSWER
(a) $\dfrac{3.4\times10^{-3}\times6.0\times10^{23}}{235}$	
(b) $\dfrac{27.3^2-24.8^2}{\sqrt{38}}$	
(c) 1.4509^3	
(d) $\sin 56.4^0$	
(e) Reciprocal of 2.34×10^5	
(f) $45sin10^0$	

Some other tips on use of calculators:
- On most calculators the number is keyed in before the function (sin, cos, log)
- Take one step at a time and write intermediate results.
- It is easy to make a mistake such as pressing the $\times$ key rather than the $\div$ key. It is a good idea to do the calculation again as a check.
- As you get more experienced, you will get a feel for what is a reasonable answer. 1000 N is a reasonable force that a car would use to accelerate; 2×10^{-10} N is most certainly not.

Transposition of Formulae

The **transposition** (or **rearrangement**) of formulae is a skill that is essential for successful study of Physics. A wrong transposition of a formula will lead to a **physics error** in the exam and you will lose all the marks available in that part of the question. (However, if you use your incorrect answer correctly in subsequent parts, your error will be carried forward and you will gain the credit.)

Get into the habit of rearranging formulae from the start. The best thing to do is to practise.

Key Points:
- What you do on one side you have to do on the other side. It applies whether you are working with numbers, symbols, or both.
- Don't try to do too many stages at once.

Transposing Simple Formulae

Simple formulae are those that consist of three quantities, taking the form $A = BC$. A typical example is $V = IR$

Suppose we are using the equation $V = IR$ and wanted to know I.

We want to get rid of the R on the RHS so that I is left on its own. So we divide both sides by R which gives us:

$$\frac{V}{R} = \frac{IR}{R}$$

The Rs on the RHS cancel out because $R/R = 1$. So we are left with:

$$\frac{V}{R} = I$$

It does not matter which way the equation ends up, as long as it is rearranged properly.

7. Rearrange these equations:

Equation	Subject	Answer
$V = IR$	R	
$p = mv$	v	
$\rho = \dfrac{m}{V}$	m	
$Q = CV$	C	

Formulae with Four Terms

8. Rearrange these equations:

Equation	Subject	Answer
$pV = nRT$	V	
$E_p = mg\Delta h$	Δh (Δh is a single term)	
$V = \dfrac{-Gm}{r}$	G	
$\lambda = \dfrac{ws}{D}$	D	

Equations with + or -

If there are terms which are added or subtracted, we need to progress like this:

$$Ek = hf - \Phi$$

We want to find *h*.

To get rid of the Φ term we need to add it to both sides of the equation:

$$Ek + \Phi = hf - \Phi + \Phi$$
$$Ek + \Phi = hf$$

Now we can get rid of the *f* on the RHS by dividing the whole equation by *f*:

$$\frac{(Ek + \Phi)}{f} = \frac{hf}{f}$$

Which gives us our final result of:

$$h = \frac{(Ek + \Phi)}{f}$$

9. Rearrange these equations:		
Equation	*Subject*	*Answer*
$v = u + at$	*t*	
$E = V + Ir$	*r*	

<u>*Dealing with Squares and Square Roots*</u>
If we have a square root, we get rid of it by squaring. If there is a square, we get rid of it by taking the square root.

Consider this formula:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

Suppose we want to find *g*.

Get rid of the square root by squaring the whole equation:

$$T^2 = 4\pi^2 \frac{l}{g}$$

Now bring *g* upstairs by multiplying the equation on both sides and cancelling:

$$gT^2 = 4\pi^2 l$$

Now get rid of the T^2 by dividing the whole equation by T^2 and cancelling.

$$g = \frac{4\pi^2 l}{T^2}$$

14. Rearrange these equations: (6)

Equation	Subject	Answer
$Ek = \frac{1}{2} mv^2$	v	
$T = 2\pi \sqrt{\dfrac{m}{k}}$	k	
$f = \dfrac{1}{2\pi \sqrt{(LC)}}$	C	

Harder (for a bonus of 5):

$$V = V_0 e^{-t/RC}$$

Make t the subject.

Now Mark your work. Ensure that it is ticked and that you have written up your corrections.

Reflection on this task and the
AS Physics course you are about to undertake.

Which exercises I found the easiest and why?
Which exercises I found the hardest and why?
Concerns I have about the AS Physics course in Year 12: