AS Physics 2015-16

**TRANSITION WORK**

**for Physics A-level**

Welcome to Physics A-level. We have chosen 4 key areas for you to focus on, in order to develop key skills needed to support the start of your A-level studies.

These are :

1. Using Equations

Being confident at rearranging equations in letter rather than word form.

1. **Using prefixes**

Being confident at converting from kilo (K), mega (M), milli (m), micro(µ) etc into standard form.

1. Significant Figures

Quoting answers to the correct number of significant figures.

1. Vector and Scalar Quantities

Being able to add vector quantities together. This is a vital skill for the first mechanics module.

**Read the introductory notes for each section and then complete the exercise relevant to that section. You will also have a baseline test within the first few weeks which will also test these skill.**

**Please hand the work into your Physics teacher on the first lesson of next term. Thank you. Mr Boddaert**

1. Using Equations

At Physics A-level, you are expected to be able to manipulate formulae correctly and confidently. You must practise rearranging and substituting equations until it becomes second nature. We shall be using quantity symbols, and not words, to make the process easier to rearrange. You will have already done some rearranging in GCSE.

Key points

* Whatever mathematical operation you apply to one side of an equation must be applied to the other.
* Don’t try and tackle too many steps at once.

Simple formulae

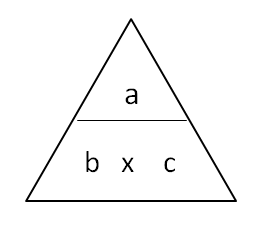
The most straightforward formulae are of the form *a = b x c* (or more correctly *=bc*).

Rearrange to set b as the subject: Divide both sides through by c a = b x c therefore a = b

c c c

Rearrange to set c as the subject: Divide both sides through by b a = b x c therefore a = c

b b b

Alternatively you can use the formula triangle method. From the formula you know put the quantities into the triangle and then cover up the quantity you need to reveal the relationship between the other two quantities. This method only works for simple formulae, it doesn’t work for some of the more complex relationships, so you must learn to rearrange

**A really non mathematical way to think of it is “If you want to move something to the other side of the equation you must do the exact opposite to what it is doing on the other side. For example, if it is multiplying ion one side, then to move it over to the other side, just divide it on the other side. If it is dividing on one side, then just multiplying it on the other side”**

**Also always do addition and subtraction, before multiplication or division.**

**Example:**

**e.g. v2 = u2 + 2as make ( a ) the subject of the equation**

**First do + or -, so need to take u2 to the other side first. It is adding so we need to subtract it on the other side.**

**v2 – u2 = 2as now we need to get 2s over to the other side. It is multiplying with a, so we need to do the opposite which is divide by 2s.**

**a =**

Using Equations - Questions

1. Make t the subject of each of the following equations:
   1. F = t

m

* 1. v = u +at
  2. Y = k

t

* 1. S = ½ at2
  2. A = kb2t
  3. P = va

t2

* 1. Y = 2t1/2
  2. Make s the subject of the equation in v2 = u2 + 2as

1. **Using prefixes**

Often the value of the quantity we are interested in is very big or small. To save space and simplify these numbers, we prefix the units with a set of symbols.

You will have come across a few of these in your GCSE,

e.g. 100km = **100,000 m** or 100 x 103m

20mm = **0.020m** or 20 x 10-3 m

It is vital in Physics not to try and convert into the bold type in the example, but to write it as x10n, depending on what the prefix was. This reduces your chance of error in the conversion.

If the number is greater than 1, then the prefix is a capital letter , and the power to the 10 is positive. If the prefix is less than 1, then it is lower case and the power to the 10 is negative.

Below are all the prefixes you need to now and be able to use.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |

Examples:

1. How much energy in Joules does a 1000GW power station produce in 5 minutes?

Energy (J) = Power (W) x time(s) = 1000 x 109 x (5 x 60) = 3 x 1014J

1. A 9.8kΩ resistor has a current flowing through it of 250µA. What is the voltage across it?

R = so V = I x R = 250x10-6A x 9.8x103Ω = 2.45V

**Exercise:**

For each question, use the equation given and the information. Convert from the prefix as shown in the examples above and calculate the answer. Show all your working.

1. The resistance of 300kΩ has a current flowing through it of 35mA. What is the current flowing through it? Use the equation R =
2. A capacitor of capacitance C = 200nF has a voltage across it of V = 20V. What is the charge stored (Q)? Use the equation C =
3. How far will a photon travel in a time of t = 20µs, if it travels at the speed of light v = 0.3Gms-1? Use the equation v =
4. How much force does a bullet of mass, m = 5g apply if it is stopped in a time t= 25ms, when travelling at a velocity v = 20ms-1? You need to convert mass to kg! and use the equation F =
5. What is the frequency(f) of red light with a wavelength 𝝺 = 350nm, travelling at a speed of v = 300Mms-1? You need to use the v = f𝝺

3. Significant Figures

Number in Physics also show us how certain we are of a value. How sure are you that the width of this page is 210.30145 mm across? Using a ruler you could not be this precise. You would be more correct to state it as being 210 mm across, since a ruler can measure to the nearest millimetre.

To show the precision of a value we will quote it to the correct number of significant figures. But how can you tell which figures are significant?

The Rules

1. All non-zero digits are significant.
2. In a number with a decimal point, all zeros to the right of the right-most non-zero digit are significant.
3. In a number without a decimal point, trailing zeros may or may not be significant, you can only tell from the context.

Examples

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Value |  | number of S.F. |  | Hints |  |
|  |  |  |  |
|  |  |  |  |
|  | |  |  |  |  |  |
| 23 | | 2 | |  | There are two digits and both are non-zero, so are both significant |  |
| 123.654 | | 6 | |  | All digits are significant – this number has high precision |  |
| 123.000 | | 6 | |  | Trailing zeros after decimal are significant and claim the same high precision |  |
| 0.000654 | | 3 | |  | Leading zeros are only placeholders |  |
| 100.32 | | 5 | |  | Middle zeros are always significant |  |
| 5400 | |  | 2, 3 or 4 |  | Are the zeros placeholders? You would have to check how the number was obtained |  |



When taking many measurements with the same piece of measuring apparatus, all your data should have the same number of significant figures.

For example, measuring the width of my thumb in three different places with a micrometer:

20.91 x 10-3 m 21.22 x 10-3 m 21.00 x 10-3m **all to 4 s.f**

Significant Figures in Calculations

We must also show that calculated values recognise the precision of the values we put into a formula. We do this by giving our answer to the same number of significant figures **as the least precise piece** of data we use.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | *There is no way we can state the* |  |
| *For example:* A man runs 110 m in 13 s. Calculate his average speed. | | *runners speed this precisely.* |  |
|  |  |
| Speed = Distance / Time = | 110 m / 13 s = 8.461538461538461538461538461538 m/s | |  |
|  | = 8.5 m/s to 2 s.f. |  |  |

*This is the same number of sig figs as the time which is less precise than the distance*

Significant Figures - Questions

1. Write the following lengths to the stated number of significant figures:
   1. 5.0319 m to 3 s.f.
   2. 500.00 m to 2 s.f.
   3. 0.9567892159 m to 2 s.f.
   4. 0.000568 m to 1 s.f.
2. How many significant figures are the following numbers quoted to?
   1. 224.4343
   2. 0.000000000003244654
   3. 344012.34
   4. 456
   5. 4315.0002
   6. 200000 stars in a small galaxy
   7. 4.0

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |
|  |  |

1. Calculate the following and write your answer to the correct number of significant figures:
   1. 2.65 m x 3.015 m
   2. 22.37 cm x 3.10 cm
   3. 0.16 m x 0.02 m
   4. 54.401 m3

4 m

1. Vector and Scalar Quantities

Scalars and vectors

Introduction

You will have met vector and scalar quantities in GCSE Maths and Physics so should know that examples of **scalars**, which have **only magnitude**, are speed, distance, mass, energy, and time. They are always positive.

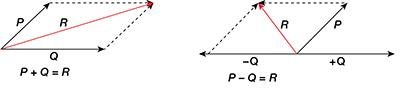
**Vector** quantities have **magnitude and direction**, and examples are velocity (speed in a certain direction), displacement (distance travelled in a certain direction), force, acceleration, and momentum. All of these quantities can be negative or positive (the negative sign indicating the opposite direction).

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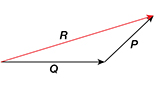
Background

To combine any two vectors you can use any of the following methods.

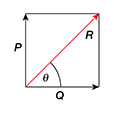
1. You can draw a scale diagram where the lengths of the sides of a parallelogram represent the magnitude of the vectors. The diagonal shows us the magnitude and direction of the resultant force.



1. You can draw a scale diagram of a triangle, and represent the vectors in magnitude and direction by the three sides of a closed triangle taken in order.



1. If vectors are at right angles to each other you can use Pythagoras’ theorem.  
   ***P*** 2  ***Q*** 2  ***R*** 2  
   You can then use tan *θ*  ****** to find *θ* and define the angle



If using Method 1 you can follow these steps:

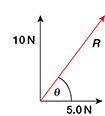
* choose a scale
* draw a horizontal line to represent one vector
* draw a line from the end of the first vector at the correct angle to represent the second vector
* join the beginning of the first vector to the end of second. This will be the resultant vector.

Method 3 is quicker and can be more accurate (depending on your drawing skills) than Methods 1 and 2.

Worked example 1

**Question**

Find the resultant of the forces shown in Figure 1.



**Figure 1**

**Answer**

*Step 1*

The forces are at right angles so we can use Pythagoras’ theorem.   
*Don’t forget to take the square root in the calculation.*

*R*2  52  102

*R*2  25  100

*R*2  125

*R*  

*R*  11 N

*Step 2*

Calculate the angle, *θ*, using the formula for its sin, cos, or tan.   
*It may be best to use the formula for its tan since it uses the vector values you’ve already been given but assuming that the resultant has been calculated correctly, any of the three can be used.*

tan *θ*  

tan *θ*  2

*θ*  63°

Worked example 2

**Question**

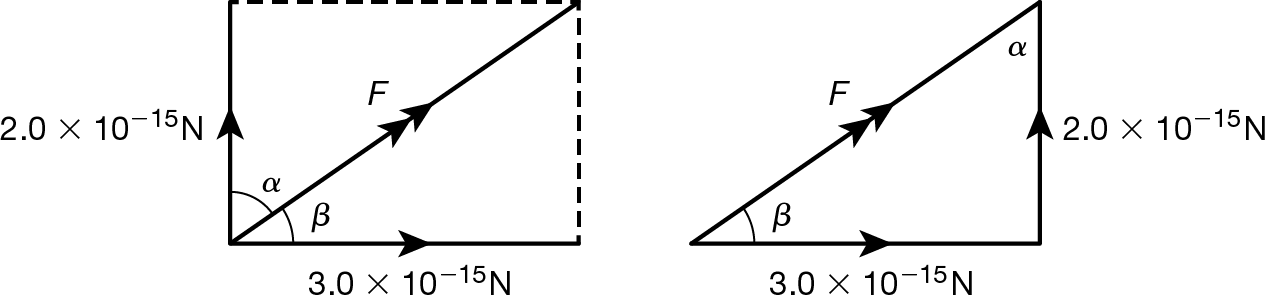
A sub-atomic particle experiences two forces at right angles, one of 2.0 × 10–15 N the other 3.0 × 10–15 N. Calculate the resultant force on the particle and the angle to the horizontal.

**Answer**

*Step 1*

Draw a diagram showing the two forces on the particle.

You can either draw the two forces acting on the particle at the same point, with the resultant as the diagonal of the rectangle formed, or consider the forces acting one after the other with the resultant as the third side of the triangle. Figure 2 shows both of these diagrams. In each the resultant is represented by *F*.



**Figure 2**

*Step 2*

Use Pythagoras’ theorem to calculate the magnitude of the resultant, *F*.

*F*2  (2.0 × 10–15 N)2  (3.0 × 10–15 N)2

 (4.0 × 10–30  9.0 × 10–30)  N2

*Step 3*

Don’t forget to take the square root of your answer.

*F* 

*Step 4*

Write your answer to the same number of significant figures as the question and with the correct units.

*F* 3.6 × 10–15 N

*Step 5*

calculate the angle to the horizontal using tan *β.*

*β*    0.67

Use your calculator to find *β*.

*β*  tan–1 0.6734°

Questions

1. Give four examples of vector quantities and four examples of scalar quantities, including their units. (*4 marks*)
2. A car’s engines generate a forward driving force of 52.7 N against which an opposite, frictional force of 36.5 N is acting. Calculate the magnitude and direction of the resultant force on the car. (*1 mark*)
3. Find the magnitude and direction of the resultant force formed by a 3.0 N and a 4.0 N force acting at right angles to each other using

**a** Pythagoras’ theorem

**b** a triangle of forces (*3 marks*)

1. **a** Sketch a vector triangle showing a force of 3.0 N and a force of 4.0 N acting at right angles, and the resultant of the two vectors. (*2 marks*)

**b** Determine the magnitude and direction of the resultant force. (*2 marks*)

1. Find the resultant force of a 5.0 N and 12.0 N force acting at right angles. (*2 marks*)
2. A river is flowing at 9.5 m s−1. A child tries to swim across at 3.0 m s−1 at right angles to the direction of the flow of the river. Calculate the magnitude and direction of their resultant velocity. (*2 marks*)
3. An aircraft flies south at a velocity of 55 m s−1,the wind is blowing from the west at a constant velocity of 15 m s−1. Calculate the magnitude and direction of the resultant velocity of the aircraft. (*2 marks*)
4. Find the magnitude and direction of the resultant force formed by a horizontal force of 2.0 N, and a 10 N force at an angle of 60° to the horizontal using a scale diagram. *You will need a protractor to do this.* (*2 marks*)
5. Two tugboats are towing a ship in a straight line. Tug A is pulling with a force of 50 kN at 60°to the direction in which the ship is moving. Tug B is pulling at 30° to the direction in which the ship is moving. Draw a sketch and then calculate the magnitude of:
   1. the resultant force on the ship (*1 mark*)
   2. the force from tug B. (*1 mark*)