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VCE Physics Unit 3

Area Of Study 1, Motion In One And Two Dimensions, Study Notes 1

Quantities

A quantity is an **amount** of something. It specifies **how much** of something there is. For example, there are **4** wheels on my car.

Quantities can be found by measurement or calculation, and are expressed with a **number**, and usually a **unit**. The unit specifies what the number means. For example, my ruler is **1 metre** long. The unit, metre, indicates that the number is a quantity of **length**.

Scalar Quantities

There are two main kinds of quantities. One of them is **Scalar** quantities. A scalar quantity is one for which the **magnitude** (the "bigness" or "smallness") is the only thing that matters for it to be accurately described. For example, an egg takes **180 seconds** to boil. No other information is required to accurately state the amount of time needed to boil an egg. Quantities of time, mass, density and energy are all examples of scalar quantities.

Vector Quantities

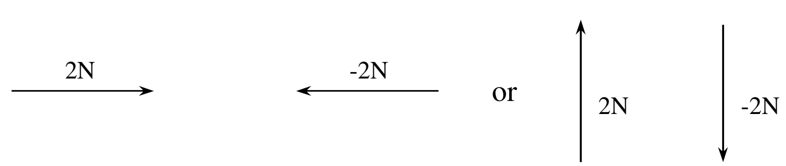
The other main kind of quantities are **Vector** quantities. A vector quantity is one for which **directional information** as well as a magnitude is required for it to be accurately described. For example a car might accelerate at **1.5ms^{-2}**. This magnitude alone is not enough information to fully describe the car's acceleration, because:

- if the car is stationary and if the acceleration is in a **forward** direction, the car will **speed up**,
- if the car is moving forward and the acceleration is in a **backward** direction, the car will **slow down**, or
- If the acceleration is in a **sideways** direction, the car will turn.

Acceleration requires **both** magnitude **and** direction to be accurately described. This makes it a vector quantity. Quantities of acceleration, velocity, displacement, momentum and force are all examples of vector quantities; they all require information about their direction as well as their magnitude.

Representing Vector Quantities

Magnitudes can be specified with numbers and units. Vector quantities can be shown as "**vectors**". A vector is a simple diagram of a straight arrow. The length of an arrow shows a quantity's magnitude (so it must be drawn accurately, to a scale, with a ruler, and graph paper might also be helpful). The direction of the arrow's head shows the quantity's direction. Examples for representing forces, where 1cm=1N:



Directions are all relative to each other, so if to the **right** of the page on which the arrow is drawn means **forward**, to the **top** of the page will mean **left** and to the **bottom** will mean **right**. If to the left means forward, then to the top means right and to the bottom means left.

The magnitude of a vector, or a pronumeral that represents a vector, is often indicated as being a vector by having a "harpoon" symbol ($\rightharpoonup$) above it. For example, "vector A" maybe denoted as "$\vec{A}$".

Adding Vectors

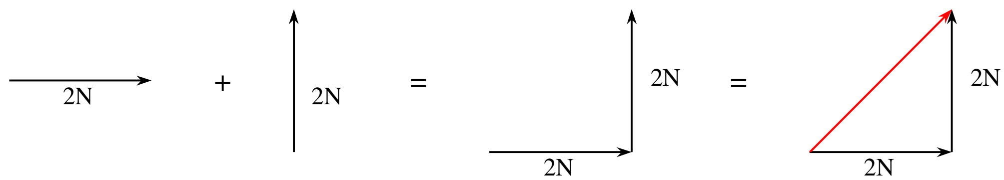
An object's motion (or lack of) will often be the result of more than one vector. For example, a projectile (like a ball thrown through the air), will be moving up and down (vertically), at the same time as it moves across (horizontally), or an object travelling in a circle is moving forward at the same time as sideways. Vectors must be added or subtracted to find a single vector that describes a quantity most simply.

To add vectors, follow these steps:

1. Arrange them so that the "head" of each vector meets the "tail" of the next (without changing their directions, of course).

2. Create a new vector, from the tail of the first to the head of the last. This vector is the single result of adding the others.

Example:



To find the magnitude of the result, you can:

- Draw the diagram accurately so as to measure it with a ruler and convert using whatever the scale.
- Use the Pythagoras Theorem (if you don't know what this is or how it works, find it in a Maths book).
- Use trigonometry ("**S**OH **C**AH **T**OA"; this can especially useful if you already know the result and need to find what was added, or if angles other than 90° are involved. Again, if you don't understand trigonometry, read a maths book).

The vector that results from the addition or subtraction of others is called a **resultant** vector.

The vectors that have been added to make a resultant vector are called **component** vectors.

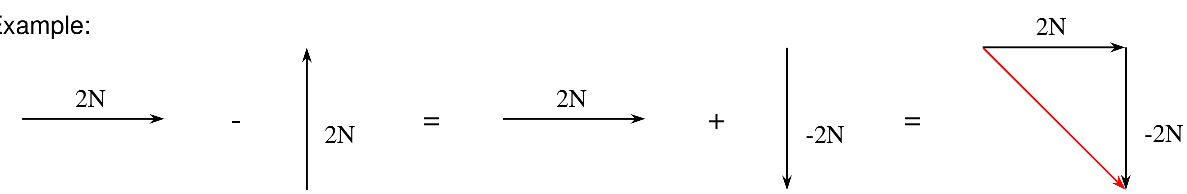
Subtracting Vectors

To subtract one vector from another, follow these steps:

1. Reverse the direction of the second vector. This makes its magnitude negative if it was previously positive, and vice versa.

2. Add the vectors (following the process outlined above, under the heading *Adding Vectors*).

Example:



How to find the magnitude of the result is outlined above, under the heading *Adding Vectors*.

Resolving Vectors

"Resolving" a vector means finding component vectors that add to give it as a resultant. Rather than with adding or subtracting vectors, when multiple vectors are combined to create a single vector, resolving a vector takes one vector and finds multiple vectors from which it's comprised.

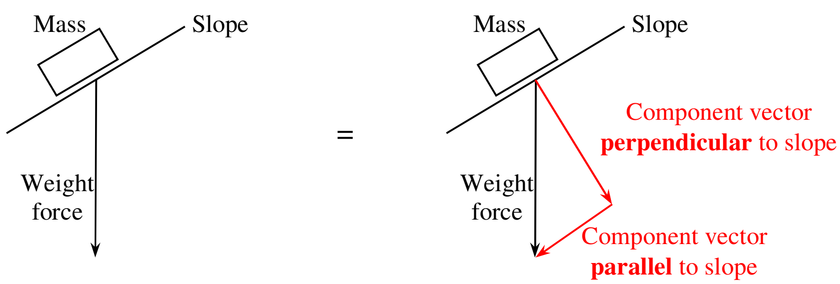
There are infinite combinations of vectors from which any single vector could result, but usually a vector will be resolved into **two components at a right angle to each other**, with **one parallel** to a vector we're required to find, and **the other perpendicular** to it. This makes the already known vector the **hypotenuse** of a right angle triangle.

A common application of this process is when a known weight force acts downwards onto a slope (often referred to as an "inclined plane"). The weight force can be resolved into two forces; one acting parallel to (downwards with) the slope and another acting perpendicular to (directly into) the slope's surface.

To resolve a vector into its components, follow these steps:

1. Draw a diagram of the situation. It helps very much to clearly visualise everything.
2. Make the known vector (the weight force, for example) the hypotenuse of a **right angle** triangle. Note that for the purpose of the below inclined plane example, one of the other two sides is **parallel** to the slope, and the other is **perpendicular** to it, because these are the directions of the forces in which we're interested.
3. Make the other two sides of the triangle (that **aren't** the hypotenuse) vectors joined "head to tail". These are the resolved component vectors.
4. Use trigonometry to find the magnitude of the components.

Example:



The above example could just as easily be shown with the components on the other side of the resultant: