15/06/25

Resolving Vectors

Physics

Context

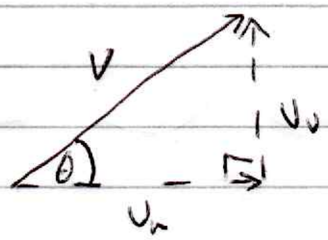
- Vectors can be split up into their respective components. In the case of physics with 2-dimensional vectors this means calculating the horizontal and vertical components of a vector.

Definition

- Vector - a vector is a quantity with both a magnitude and direction

Equation

- Vertical component $v_v = V\sin\theta$
- Horizontal component $v_h = V\cos\theta$



Why?

By right-angled trig,

$\sin\theta = \frac{OPP}{HYP} = \frac{V_v}{V}$

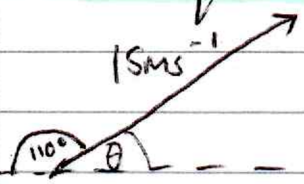
$\Rightarrow V_v = V\sin\theta$

Similarly,

$\cos\theta = \frac{ADJ}{HYP} = \frac{V_h}{V}$

$\Rightarrow V_h = V\cos\theta$

Technique & Other Knowledge



- Find angle θ (70°)
- Sub in to find v_v

$v_v = 15\sin 70 = 14.1ms^{-1}$

- Repeat for v_h

$v_h = 15\cos 70 = 5.2ms^{-1}$

Thing to Remember

- If in doubt, draw the triangle

Resultant Vectors

15/06/25 Physics

Context

- At Nat 5 physics all vector diagram questions were right-angled trig which could, theoretically, be calculated through scale diagrams. At Higher Physics, right-angled trig is calculation only and sine and cosine rule questions are common (but can be solved through scale diagrams).

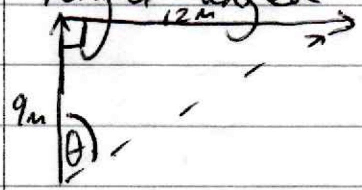
Equations

Right angled trig
- Pythagoras : $a^2 + b^2 = c^2$
- Sohcahtoa : $\text{sine} = \frac{OPP}{HYP}$, $\text{cosine} = \frac{ADJ}{HYP}$, $\text{tangent} = \frac{OPP}{ADJ}$

Non-right angled trig
- Sine rule : $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$
- Cosine rule : $a^2 = b^2 + c^2 - 2bc \cos A$

Technique

- Right-angled trig:



Find resultant vector (tip to tail)

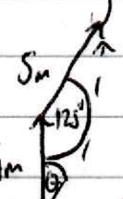
Calculate distance using Pythagoras

$s = \sqrt{9^2 + 12^2} = \sqrt{225} = 15m$

Use Sohcahtoa to find angle

$\theta = \tan^{-1}(12/9) = 53.1°$ East of North

Non-right angled trig:



Find resultant vector

Calculate distance using cosine

$s = \sqrt{4^2 + 5^2 - 2 \times 4 \times 5 \times \cos 125} = 8.00m$

Find angle using sine

$\frac{8}{\sin 125} = \frac{5}{\sin\theta}$

$\sin\theta = \frac{5 \sin 125}{8}$

$\theta = \sin^{-1}(0.511\ldots) = 30.8°$

(East of North)

Thing to Remember

- Vectors <u>always</u> go tip to tail!

Equations of Motion

07/11/25 Physics

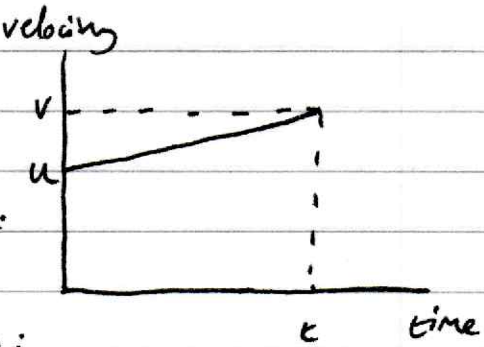
Context

- Using the equations of motion we can calculate the motion of projectiles.
- All of the equations will include four of the five variables: s - displacement, u - initial velocity, v - final velocity, a - acceleration, t - time.

Definitions

- Displacement - the change between an object's initial and final position
- Velocity - rate of change of displacement
- Acceleration - rate of change of velocity

Equations



- From the v-t graph:
  $a = m \Rightarrow a = \frac{v - u}{t}$
- Displacement is the area under the graph:
  $s = ut + \frac{1}{2}(v-u)t \Rightarrow s = ut + \frac{1}{2}at^2$
- Rearranging ① and squaring both times:
  $v^2 = (u + at^2) \Rightarrow v^2 = u^2 + 2uat + a^2t^2$
  $\Rightarrow v^2 = u^2 + 2a(ut + \frac{1}{2}at^2) \Rightarrow v^2 = u^2 + 2as$
- And the simplest:
  $s = \bar{v}t \Rightarrow s = \frac{1}{2}(v+u)t$

Technique

- A rugby player kicks a conversion at $30\,ms^{-1}$ at $60°$ to the horizontal. If the ball is in the air for 2.3 s before it crosses the posts, what height does it reach the posts at?

- Identifying the information we have and which equation we need:

  $u_v = u\sin\theta = 30\sin 60^\circ = 25.9807\ldots\ ms^{-1}$

  $a = -9.8ms^{-2}$ (due to gravity) $\quad t = 2.3s \quad s = s$

  $\therefore$ we need $\quad s = ut + \frac{1}{2}at^2$

- Substitute in:

  $s = 25.9807\ldots \times 2.3 + \frac{1}{2} \times (-9.8) \times 2.3^2 = 33.9m$

- An incredibly high kick going twice the height of the highest rugby gols?!

Thing to Remember

- Make sure your sign convention is consistent - if someone is kicking something up, acceleration due to gravity should act down.

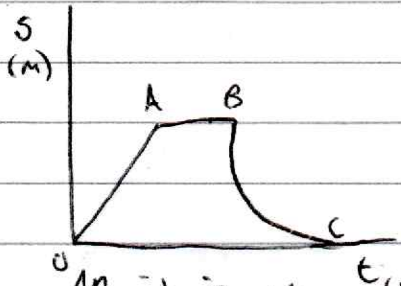
Motion Graphs

08/11/25 Physics

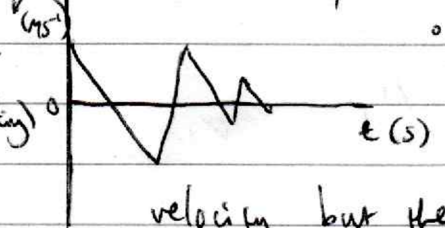
Context

- There are three graphs that describe motion in different ways
- These all feature time on the ~~y~~ x-axis and one of displacement, velocity, and acceleration on the y-axis

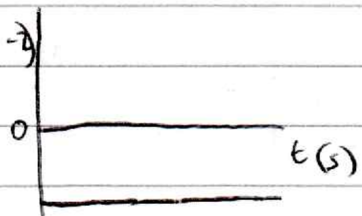
Technique



- Displacement - time graphs show how the displacement of an object varies with time.
- Between 0A this object is moving at a constant velocity. Between AB it is at rest and between ~~0A~~ BC it is moving but at a non-constant velocity (e.g. accelerating)
- NB! As velocity is <u>rate of change</u> of ~~an~~ displacement it is the derivative of this graph - e.g. the gradient.



- Velocity - time graphs show how velocity changes with time.
- In this graph the ball starts with a positive velocity but the gradient slopes down, showing that it is accelerating downwards. When the line crosses the x-axis, the ball has 0 velocity and hence is at the highest point in its bounce before it starts falling (negative velocity)
- Acceleration - time graphs are usually much less common as they measure a constant acceleration normally (e.g. $-9.8ms^{-2}$ due to gravity)



- An exception would be a car travelling, speeding up and slowing down.
- When the line is at 0, the object is travelling at constant <u>velocity</u>.

Things to Remember

- Each of displacement, velocity and acceleration are the successive derivatives of each other. This means that they can be found as the gradient of the graph 'above'.
- Similarly, when a value on a v-t or a-t graph is 0, the value of the graph 'above' is constant.