# Physics (Kinematics)

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Hookes law stuff in a gravitational field

1 g

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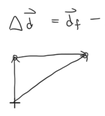
## Recap of Grade 11

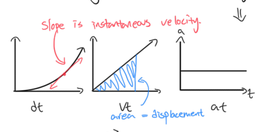
So its been a year since physics, and notes are really important now.

Kinematics

$\Delta\vec{d} = \vec{d}_f - \vec{d}_i$



calculating instantaneous velocity.




$V_{average} = \frac{\Delta\vec{d}}{\Delta t}$

Big 5:

$\Delta d = d_f - d_i = Vt$

$V_f = V_i + at$

$\Delta d = d_i + V_i t + \frac{1}{2}at^2$

$\Delta d = d_f + V_f t - \frac{1}{2}at^2$

$V_f^2 = V_i^2 + 2a(d_f - d_i)$

Remember → vector signs

↑ point protectors

$y = ax^n + bx^m + c$

$y' = anx^{n-1} + bmx^{m-1}$ } polynomials only

$y'$ means [IROC] or instantaneous rate of change.

oh quadratic formula too.

$y = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$y = ax^2 + bx + c$

$\Delta d = \frac{1}{2}at^2 + Vit + d_i$ ← the derivative of this is the Vt graph

a b c

$\dot{d} = V = at + V_i$ omg what!? so cool

Dynamics

Ifr just did this in grade 11 but its fine.

1. motion in one dimension

this is rather simple. everything is developed from a particular Vt graph. Just keep in mind the big 5 formula and the fundamental concepts.

Velocity acceleration displacement speed

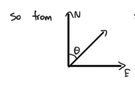
2. Vectors

finally, adding vectors.

lets review normalization from compsci bl. it is turning a vector to the length of one, as following

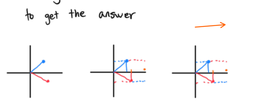
also, screw drawing with adding vectors, thats dumb. It is particularly difficult to add vectors by eye. So, we use a coordinate system.

[N θ E] turns into [x y]

so from  into 

since the teacher does not particularly care on how its done, this is how we do it.

after $(x_1 + x_2)$, $(y_1 + y_2)$, we get the resulting raw coordinates which we can tan to get the answer



now, note, this isn't the best way to do it in circular motion, but we will let it slide for now

now, when you encounter unit vectors, also known as $\hat{i}$, it is normalized, basically,

$\vec{V} = a\hat{i} + b\hat{j}$. ∧ is a normalization

ok thats a terrible explanation. lets use tuples

$\vec{V}$ is the same as $\begin{bmatrix} x \\ y \end{bmatrix}$

in  $\hat{i}$ is $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$

$\hat{j}$ is $\begin{bmatrix} 0 \\ 1 \end{bmatrix}$

thus, $\vec{V} = x\hat{i} + y\hat{j}$ or $a\hat{i} + b\hat{j}$.

now, when adding these unit vectors up, it is even easier!

$\vec{d}_{total} = (a_1 + a_2 + a_3)\hat{i} + (b_1 + b_2 + b_3)\hat{j}$

relative motion is so easy its a joke, moving on...

(just don't forget the reference)

So is projectile motion

## Solving projectile motion

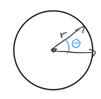
As it gets higher by n times range increases by $n^2$

$t = \frac{2y}{g}$ t is also $\frac{V_f - V_i}{g}$

range $= Xt = \frac{2xy}{g}$ $\cos(\theta) \times \sin(\theta) = \frac{\sin(2\theta)}{2}$

horizontal displacement $= \frac{V_{fy} - V_{fi}}{g} V_x$ $\frac{\sin(2\theta)A^2}{g}$

in the case that there is vertical displacement.

time for the better way, polar notation 

How to add in polar notation?

Oh remember cosp, and how it messes up your angles?

Ignore it, use this:

| 90, 180° | 0, 90° |
|---|---|
| 180, 270° | 270, 360 |

| −90° | θ |
|---|---|
| −180° | −270° |

$x = r\cos(\theta)$

$y = r\sin(\theta)$

Ok so calculator work

a, 2nd F STO, b

Steps: 1. put in a values, x or r

2. put in , (the comma) by 2nd F STO

3. put in b values, y or θ

4. convert to rθ or xy by 2nd F 8 or 9

### A little side note for some 2D kinematics problem tricks

$\vec{V}_{result} = \vec{V}_1 + \vec{V}_2 + \vec{V}_3 \ldots$

The thing is, this applies to almost all of the vector based problems, and probably most of relative motion.

In an example problem:

$\vec{V}_{water}$ is flowing west at $V_w$

What should the swimmer go at to travel in $(V_f, \theta)$?

Well, we craft the formula first.

$\vec{V}_{target} = (V_f, \theta) = V_{fx}, V_{fy}$

$\vec{V}_{swimmer} = (V_i, \Theta) = V_{ix}, V_{iy}$

Now typically this would be super easy. Except thats not always the case.

Think! What if you dont have the angle?

Lets use a textbook question.

A person ... swims ... ng point. ... stream ... your

6. A pilot is flying to a destination 220 km [N] of her present position. An air traffic controller on the ground tells her the wind velocity is 42 km/h [N 36° E]. She knows her plane cruises at a speed of 230 km/h relative to the air.
   (a) Determine the heading of the plane.
   (b) How long will the trip take?

1. state the givens

$V_f \alpha = 90°$

$\vec{V}_w = (42\text{km/h}, 54°)$

$\vec{V}_p = (230\text{ km/h}, b°)$

2. draw the graph / chart

Note!

the x component of the plane's velocity should negate the effect of the wind's x component.

3. Some Vector Math

$\vec{V}_w = 24.69\text{ km/h}_x, 33.98\text{km/h}_y$

This means $\vec{V}_p$'s x component should be $-24.69$ km/h.

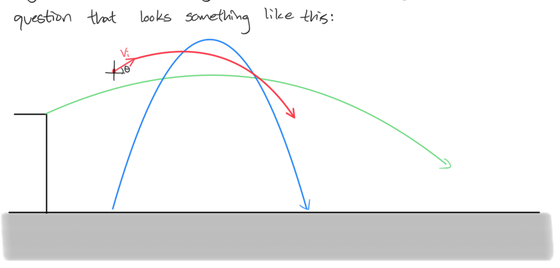
$\theta = \sin^{-1}\left(\frac{24.69}{230}\right)$

$\theta = 6.16°$

A) the heading of the plane is [N 6.2° W]

pretty simple right?! Time to move on

hypothetically speaking you meet a slightly more challenging question that looks something like this:



Looks BS right? It is just simple projectile motion in different pieces + relative motion.

We start with the easy part. Projectile motion!

so, a few things we need and know about projectile motion!

$(\vec{V}_o, \theta)$  $\vec{V}_f$ $t$

displacement, or $\Delta x$, $\Delta y$

given time, you can find the $\Delta x$ and $\Delta y$

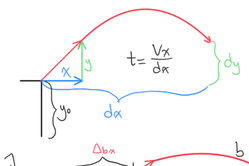
$\Delta x = x_{current} + V_x t$ (present position; velocity in x component)

$\Delta y = y_{current} + V_i t - 4.9t^2$ (present position; stuff; gravity)

If you want to find maximum height btw, use formulas

$V_f^2 = V_o^2 + 2ad$ $V_o^2 = 19.6d$ d is the max height

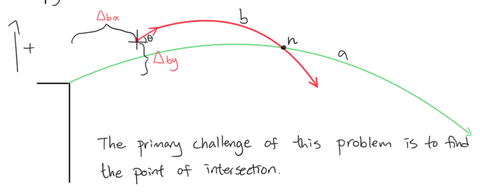
Demonstration:



$t = \frac{V_x}{dx}$

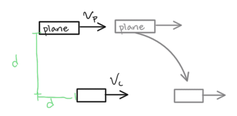
Cool! now we go back to this BS question.

Question is when should the red ball launch to hit the green ball?



The primary challenge of this problem is to find the point of intersection.

Apparently there is an easier question?



at what time does the plane have to drop the object for it to land in the car?

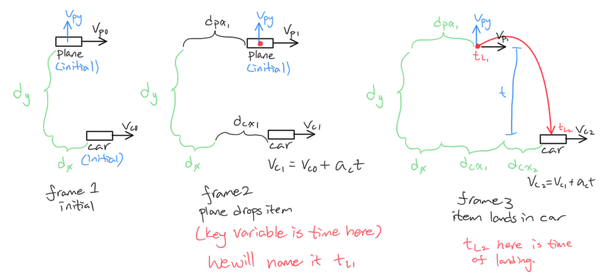
Variables of importance

$V_p$ $d_x$ } where the initial displacement is

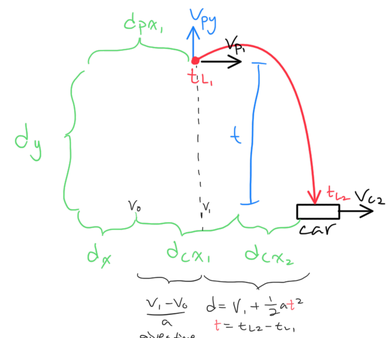
$V_c$ $d_y$

here is a more labelled diagram.

(took out $dp_y$ because of complexity)




Still seems a little complicated? Thats ok, lets look at frame 3 further.



$\frac{V_1 - V_0}{a}$ gives time taken.

$d = V_1 + \frac{1}{2}at^2$

$t = t_{L2} - t_{L1}$

$d = V_{p1}t$

(this gives us $V_1$)

# Class work

instrumental uncertainty. half the smallest increment on the measuring tool is the accepted instrumental uncertainty

Mr. Zeng policy:

4 communication marks per test.

he also likes ↑ N, W, S, e instead of polar form

# Lab Expectations

Passive words and first person is fine. However, this should only be under the premise that it makes the lab more readable.

Page length should be less than 2 pages.

Abstract
- → background info
- → results
- → methods and procedure
- → Major sources of error
- → significance of error

Note: No numbers, and this should cover the entire lab and provide good insight about the rest.

Purpose

The purpose, be concise

Hypothesis

Be concise.

Method

Observations

Discussion

Conclusion

1 Standard relative motion procedure

there are only so many questions possible here.