Forces!

this may not cover everything in forces, but it should be enough for the test coming up.

Types of forces
Free body diagram
Newton's 3 laws
Friction
Gravity.

Almost all the questions are going to be based on the 3 laws. However, they are very traditional and I don't like the flow.

Here are a few things to keep in mind of, or to remember and understand.

First off, a force acting upon an object will make it accelerate. not the perfect sentence ik, but. them is whats important about it.

$1N = 1kg \cdot m/s^2$ or the famous function, $F_{net} = ma$.
Force = mass · accel

as long as you remember this, the rest is basic geometry.

There are a few more things to keep in mind of though, such as the normal force, or $\vec{F}_N$. Its a weird name, but this force is to offset gravity or whatever. It sources from action-reaction law. as a result, its direction will always be opposite of the surface, but have the same magnitude.

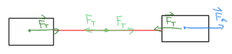
Now, onto ropes, which are $\vec{F}_T$. The string or rope or whatever.

is governed by a few rules.

1. It has no weight and is not affected by gravity
2. It does not stretch

There is also a concept that will help with ropes a lot. It makes the objects act like one whole. for grade 11 purposes the rope won't loosen so do what it. However, if the moving as a whole thing is too hard to understand, draw it out! (pretty sure you are required anyways.)

lets assume no friction.



Now, what I do is get the ratio but thats kinda dumb. However, Im gonna stick with it for now.

Ok apparently we are doing friction now. So, there is kinetic and static friction.

$\vec{F}_s$ is static friction
$\vec{F}_k$ is kinetic friction
μ is coefficient of friction

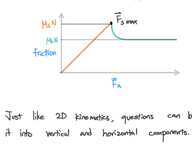
Remember! $\vec{F}_k = \mu_k \vec{F}_N$

For static friction, things are a little different. Static friction changes with the applied force.

Remember! $\vec{F}_{s\,max} = \mu_s \vec{F}_N$

Something important to remember is that any $\vec{F}_a$ under $\vec{F}_{s\,max}$ will result in an equal $\vec{F}_s$ force.

yay I understand now! so... any $\vec{F}_a$ less than $\vec{F}_{s\,max}$ results in an equal F_s. However, kinetic friction is constant. here is a more visual approach:



Just like 2D kinematics, questions can be solved by splitting it into vertical and horizontal components.

For the sake of simplicity, we can go with a problem not at an angle.

I will walk you through the most common question types. However, we shall tackle the knowledge first, specifically, the stuff on the test.

Newton's three laws are relatively easy to understand, so we can go over it briefly

1st law: unless there is a force acting upon an object, it remains stationary, or in constant velocity

2nd law: $\vec{F}_{net} = m\vec{a}$
the object accelerates at $\frac{F_{net}}{m}$

3rd law: action reaction forces. Pushing on an object and stuff like that results in an equal reaction force

Friction we have done already. which is just $F_k = \mu_k F_N$ & $F_s = \mu$

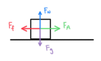
Now, gravity. $F_g = mg$ $F_g = \frac{G m_1 m_2}{d^2}$

G	=	6.61×10^{-11}
mass of earth	=	5.98×10^{24}
radius of earth	=	6.38×10^{6} m

ΔF_N

next, _____

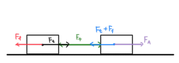
Exemplar

lets start off simple.  for the sake of not dying. we will result to free body diagrams instead of analysing word problems. Now, in this question, $F_g = mg$ and $F_N = F_g$.

mass 9.8

$\vec{F}_{net} = \vec{F}_a + \vec{F}_f + \vec{F}_s + \vec{F}_k$; μ_s and μ_k is usually given. if F_a is unknown, we can get it... Allow me to explain.

$F_{s\,max} = \mu_s F_N$, $F_k = \mu_k F_N$. If F_a is less than $F_{s\,max}$, F_s or F_f is = F_a. However, if F_a is larger than $F_{s\,max}$, F_f is = F_k. Moving on to a slightly more complicated question



This problem is commonly seen as the train issue. to solve it, get the F_a on both parts first, then F_a can be used to find F_{net}. F_{net} for the entire car makes it accelerate at a certain speed, the F_{net} for the individual trains are different tho.

Now, pulleys. The most complicated pulleys Ive seen aren't very, and it is commonly just "atwood's machine" It looks like this. The problem here is the tension, and not the acceleration. The equations to remember are: $a = \frac{(m_2 - m_1)g}{m_2 + m_1}$ and tension = $m_1 g + m_1 a$

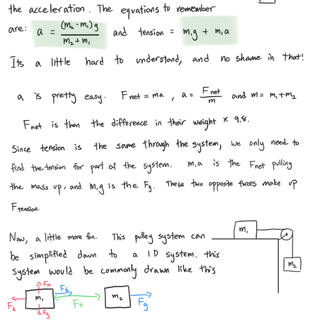
Its a little hard to understand, and no shame in that!

a is pretty easy. $F_{net} = ma$, $a = \frac{F_{net}}{m}$ and $m = m_1 + m_2$

F_{net} is then the difference in their weight x 9.8.

Since tension is the same through the system, we only need to find the tension for part of the system. $m_1 a$ is the F_{net} pulling the mass up, and $m_1 g$ is the F_g. These two opposite forces make up $F_{tension}$.

Now, a little more fun. This pulley system can be simplified down to a 1D system. this system would be commonly drawn like this



the tension in the system can be understood as the pull exerted on the two opposite directions.

For the majority of questions the thing to keep in mind is free body diagrams and the utilization of $F_{net} = ma$ and $F_g = mg$

Just like kinematics, there is a criteria for problem solving procedure. However, the criteria for forces is hidden and not provided. through research, we can get a rough idea.

So, we will resolve to formulas to remember. :

This is actually pretty much it for forces.

Newton's 1st law : the velocity remains constant — Aka Inertia
Newton's 2nd law : $F_{net} = ma$
Newton's 3rd law : action reaction forces

G	=	6.61×10^{-11}
mass of earth	=	5.98×10^{24} ⟷ or 5.97
radius of earth	=	6.38×10^{6} m

$F_{net} = ma$
$F_k = \mu_k F_N$
$F_{s\,max} = \mu_s F_N$
$F_g = \frac{G m_1 m_2}{d^2}$
$a = \frac{G m}{d^2}$
$V^2 = V_0^2 + 2ad$
$X = X_0 + V_0 t + \frac{1}{2} a t^2$
$O = \sin\theta H$
$A = \cos\theta H$

Oh right, keep in mind of sigfigs

To do forces, lets again make a procedure for it. This would be pretty common and apparent on the test when the question is encounter

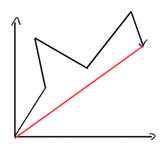
1. define the givens and variables : label it.
2. draw the diagram and or free-body
3. calculations.
4. concluding sentence.

Do not forget $V^2 = V_0^2 + 2ad$, also read the fucking question correctly. Also → and [ ] and sigfigs, and point protectors. Also state "for clarity's sake" and define the particular forces when we define the givens. Remember for tension, F_t is equal through the system, the rest is luck.

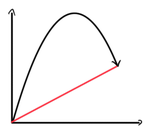
2D kinematics.

typically we would have two sets of problems.

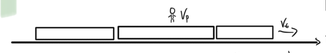
the top-down



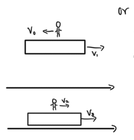
the side-view



Relative motion is probably the most interesting part about 2D kinematics. Though it may feel complicated, there is a technique for relative motion and it is rather simple. On a 1D scale, picture being on a train.

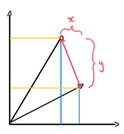


your velocity relative to the ground is $V_0 + V_f$. Quite simple. now, lets make it a little difficult. 2 trains, or a few.



Now, who is faster? well, we are comparing $V_1 - V_0$, $V_2 + V_0$ and V_f. Whoever's value is bigger is faster, its common sense

this exact concept can be applied to 2D relative motion straight away.

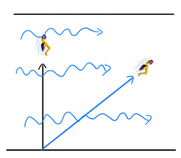


Relative motion with the same origin ↩

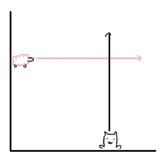
The concepts on the left are rather difficult and likely will not be covered.

However, what may be discussed is the following.

Scenario 1:



Scenario 2:



the more common question is scenario 1. Where a swimmer is crossing a river with the river applying a horizontal force.

this is rather easy, as it is just pythagorean.

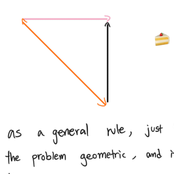
However, the more complicated question is asking the angle you go for it the goal is to end up going in a straight line.

The trick here is to not think about it too literally. Instead, put it in numbers.

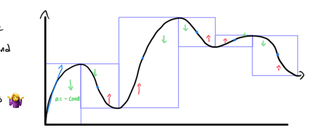
Simply tan it

$\tan\theta = \frac{y}{x}$

Scenario 2 is literally the same question, just disguised differently.



as a general rule, just try to make the problem geometric, and its from there.



Such complicated problems probably will not be encountered, but in reality, this is the same problem as this:

to find the displacement, or anything in particular, we need to split this in the form of x and y seperately

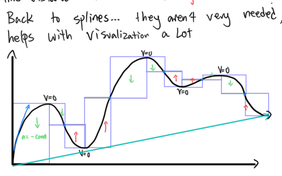
Sample issue will be:

Subject is thrown at a x degree angle at V_i. find displacement in t.

Sampling V_i per second as interval, trig can be used to find its y rise. $y = \sin x \times V_i$
$x = \cos x \times V_i$

after t, the object would move x, y, and we can just use pythagorean theorum to get the straight line distance with Result = $\sqrt{x^2 + y^2}$

Back to splines... they aren't very needed, but! helps with visualization a lot



this basically tells you to seperate the curve into comprehensible shapes, namely squares.

then, just solve the individuals with given V_0, a and t or d.

How about something more exciting eh?

addition of vectors

These problems are challenging because of the english behind it (smth).

In a question like such

first reaction is: ew wtf.
but! when breaking it down its just a hell lot of triangles.
typically, these "nodes" which is this

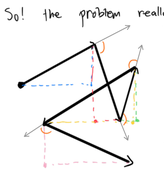
Can be described in 2 ways,

N
W E [N 30° E] or, 30° (right.) (clockwise)
S

[N 30° E] → from N, rotate towards E

So this:

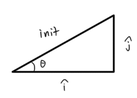
So! the problem really looks like this.



complicated? hell yea. In grade 11, we just measure it... yea... dont forget the point protectors though!

Some trig for both scenarios.

typically, I would put a calculator here but... graphics isn't really my thing. So, here is the math behind the calculator.

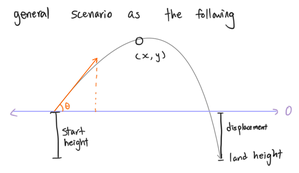


$\hat{j} = \sin\theta \cdot init$
$\hat{i} = \cos\theta \cdot init$
$init = \tan^{-1}(\hat{j} / \hat{i})$

An expansion on 2D kinematics.

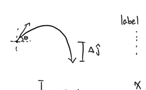
Briefly put, there is only two parts to 2D kinematics. top-down-view, and side view. Side view is rather simple, so thats what Im going to go through first.

Side view questions show up most commonly as projectile motion. This, without a doubt, can be represented as one general scenario as the following



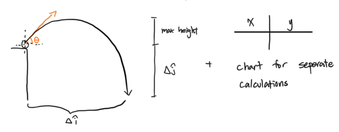
there is a simple way to solve this problem, regardless of whats being asked in the question. the solution is to seperate the problem into two sections. x and y, or $\hat{i}$ and $\hat{j}$. As there is only one destination (typically) in either i or j, we can treat the problem as a 1D motion problem.

the typical test diagram looks like this →



label given

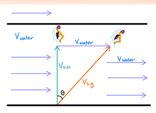
do this →



+ chart for seperate calculations

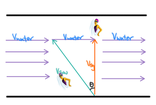
x	y

now, time for scenario 2 which takes slightly more brain



there are several variations to Scenario 2. The simplest one of them is the swimmer. with this diagram, the values can easily be found using trig. To negate this effect, the angle just needs to be flipped.

however, do not just flip the values around, instead, do this.



switching the values and do the same problem

Solving problems, in particular, is not

the best experience, and the english is rather confusing in most problems. here is how to do the question in a standard format.

1 define given variables
ie. $\vec{V}_{sw}$ = x m/s [N θ E]
swimmer, ground, standard unit, from N to E at θ

2 define "formula" used
ie $\vec{V}_{tow} = \vec{V}_{sw} + \vec{V}_{rig}$
swimmer, water, ground

→ typically I don't label it in such a way. but uh... tests yknow so...

$V_{a\,b}$ ← vector symbol; b ↑ relative to (ground typically); a ← subject in question ie (C car, swimmer)

the formula for $\vec{V}_g = \vec{V}_{fg} + \vec{V}_{ff}$ makes sense if you visualize it in $\hat{i}$ $\hat{j}$ format.

so, $V_f = V_{fg}[\,^{\circ}_{0}] + V_{ff}[\,^{\circ}_{?}]$
$V_f = [\,^{?}_{1}]$

yay!

3 draw the diagram or whatever

→ Some noteworthy points
- scale
- title (maybe)
- point protectors
- angle (perhaps)
- label lines
- show angle
- direction

4 show the work & math
some math here

5 the answer
ie $\vec{V}_{sw} = 1.0$ m/s [N θ E]
now
? don't forget sigfigs!

6 final statement (AKA english)
the swimmer .... at 1.0m/s [NθE]

Standard test procedure

1. quickly look through multiple choice
2. if it is a difficult test, browse through the test
3. with extra time, check with a rubric for every question

multiple choice: eh

short answer / word problem:
Read the fucking question.
- state given variables
- state what ur trying to find
- draw a diagram → crosshair angles, arrow signs, compass, scale
- explain method to be used
- math w answer
- concluding statement (sigfigs)

finally, Read the fucking question again

142g = 0.142 kg take right as positive

$F_A = -35000$ N
$F_A = ma$
$a = -246479$ m/s²
$V_f = V_0 + at$
$V_f = 32 + -246479 \times 0.00025$
$= 32 - 61.61$
$= -29.6$ m/s

75 kg crate 150 N 50

75 kg = 735 = F_g
$F_a \downarrow = \sin 50 \times 150 = 114.9$ N
$F_a \rightarrow = \cos 50 \times 150 = 96$ N

$F_k = 0.11 \times (735 + 114) = 93.39$ N
$F_{net} = 96 - 93.39$
$= 2.61$

$F_{net} = ma$
$2.61 = 75a$
$= 0.03$ m/s

b) $F_{net} = 2.61$ N
$F_k = 0.11 \times 735 = 80.85$
$80.85 + 2.61$
$= 83.46$ N [right]

$F_g = 0.15 \times 9.8$

$9.8 \times 3 = 29.4$
$29.4 = V_f$

part 2, $V_f = 0$
$V_i = ?$
$d = 2.5$m
$a = -9.8$
$V_f^2 = V_i^2 + 2a(d)$
$0 = V_i^2 + 2 \cdot -9.8 \cdot 2.5$
$49 = V_i^2$
$V_i = 7$

According to action reaction forces,
$F_{net} = Ma$ $42.1 / 0.15 = 281$ m/s²
$V_f = V_i + at$ $7 = -29.4 + 281t$
$t = 0.129$
$= 0.13$ s