Chapter 5 - The Laws of motion

So far, we have described how objects move, e.g. • the car has $a=0$ and $v=20\ m/s$

• the runner has $v_i=0$ and $a=2.5\ m/s^2$.

Now, we will investigate why objects move.

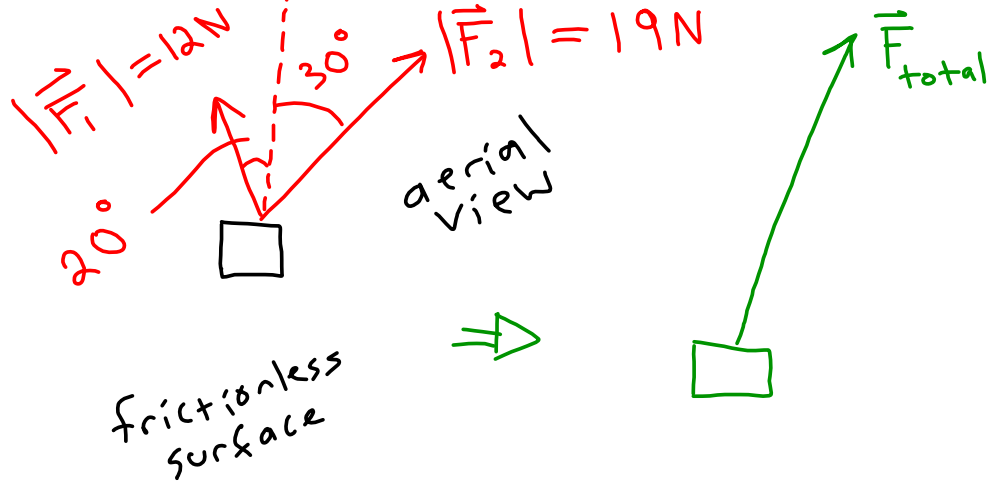
5.1 - the concept of force

Informal definition of force - a push or pull

It has magnitude & direction

vector

e.g. find the net force on the block



$\vec{F}_1 = -(12\ N) * \sin(20\ deg)\,\hat{i} + (12\ N) * \cos(20\ deg)\,\hat{j}$

$\vec{F}_2 = (19\ N) * \sin(30\ deg)\,\hat{i} + (19\ N) * \cos(30\ deg)\,\hat{j}$

$\vec{F}_{total} = [-(12\ N) * \sin(20\ deg) + (19\ N) * \sin(30\ deg)]\,\hat{i} +$

$[(12\ N) * \cos(20\ deg) + (19\ N) * \cos(30\ deg)]\,\hat{j}$

5.2

Definition – Inertial reference frame

$\vec{a} = 0$

https://www.youtube.com/watch?v=umLcFAI5SZg (0:16 → 1:57)

https://www.facebook.com/NOVApbs/videos/1900444973591374

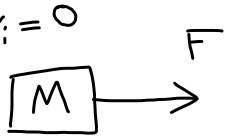
Newton's 1st Law: when observed from an inertial reference frame, objects move with constant velocity (a = 0) unless a force acts on the object.

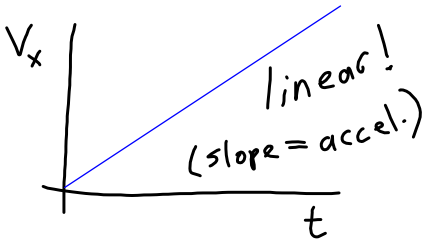
Formal definition of force - that which causes a change in motion (velocity) of an object.

5.3 - Mass - The property of an object that determines how much it resists changes to its motion (velocity). (Note: mass not equal to weight)

5.4 - Newton's 2nd Law

$v_i = 0$





M (kg)	F_x (N)	a (m/s^2)
1	1	1
2	1	0.5
1	2	2
2	2	1

↳ pattern: $a = \frac{F}{m}$

12.4 kg 27.8 N $\frac{27.8}{12.4} = 2.2 \frac{m}{s^2}$ ✓

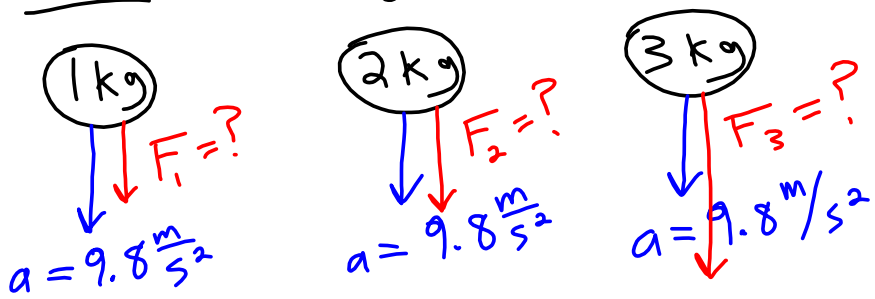
Newton's 2nd Law:

$$\sum \vec{F} = m\vec{a}$$

✳

$$[F] = N = kg \cdot m/s^2$$

5.5 - The gravitational force (a.k.a. weight)



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earth

$F_1 = (1)(9.8)$

$= 9.8\ N$

$F_2 = (2)(9.8)$

$= 19.6\ N$

$F_3 = (3)(9.8)$

$= 29.4\ N$

$$F_{gravity} = mg$$

where $g = 9.8 \frac{m}{s^2}$