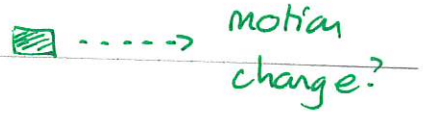
Weds: Read 3.5 - 3.6

Fri: HW 3 by 5pm

This class: * Law of Inertia
* Speed, velocity, accel.

Law of Inertia

An example of relatively simple motion in physics would be an object sliding along a perfectly frictionless horizontal surface. Thought experiments involving ramps allow one to reason about this.



DEMO: Inertia Thought Experiment Video

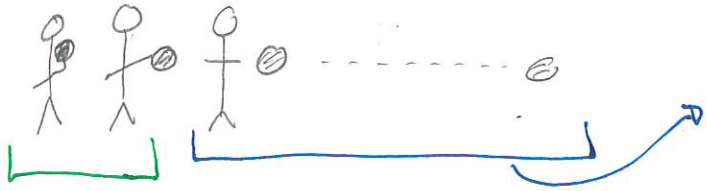
This is an example of the Law of Inertia

> If there is no overall external influence (force, interaction) on an object, then that object will move in a straight line with constant speed.

According to the Law of Inertia, if an object moves, there is not necessarily a force acting on it.

Quiz!

Note that there are two stages to this



Astronaut launches ball using hand
⇒ hand interacts with ball (Law of Inertia says nothing)

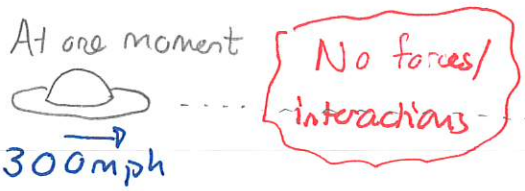
Ball leaves astronaut
⇒ no overall external influence
⇒ straight line const speed

Law of Inertia Applies

Notes:

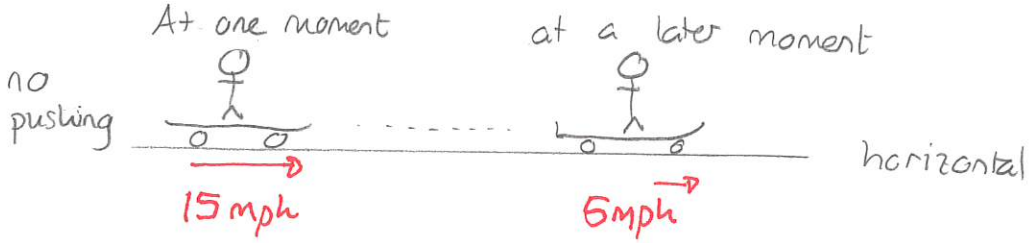
1) the Law of Inertia describes the "prefered" or "inherent" state of motion in classical physics.

"Preferred"
"Inherent"
"Natural"



same speed
same direction

2) In many everyday situations there are hidden forces and interactions. These result in deviation from same speed / same direction



The explanation is that air and friction produce effects that tend to slow the object.

Quiz 2

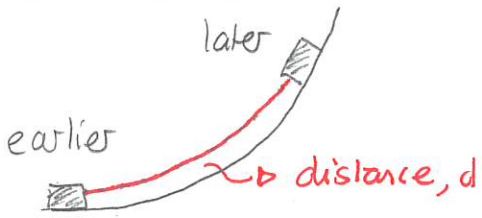
Speed

We now develop measurable quantities that help to describe motion. The law of Inertia refered to speed. An intuitive notion is

Speed ≈ rate at which object covers distance

We need to convert this into a mathematical definition

One possibility is:



1) observe the object at two instants
2) record the time elapsed between the instants
3) measure the distance traveled between the two instants.

Then, over the entire interval the

$$\text{average speed} = \frac{\text{distance traveled}}{\text{time elapsed}}$$

This can be written as a formula

$\bar{s} \equiv$ average speed
$t \equiv$ time elapsed
$d \equiv$ distance traveled

$$\Rightarrow \quad \bar{s} = \frac{d}{t}.$$

Unit m/s

$\frac{\text{meter}}{\text{second}} = \frac{m}{s}$

Quiz 80% – 95%

We can use speed and time to determine distance. Reversing the previous equation gives

$$d = \bar{s} \times t$$

distance traveled = speed × time elapsed

This is exactly true if the speed is constant. When it is not, the formula must be modified.

1 Hockey sliding with constant speed

A hockey puck will slide on an ice rink with nearly constant speed. A puck is hit from one goal and travels 50 m toward the other goal in 1.25 s.

a) Determine the speed of the puck.

b) Suppose that instead of reaching the other goal, the puck is intercepted by another player 0.80 s after it has been hit. Determine how far the puck traveled in this case.

Answer: a) $\text{speed} = \dfrac{\text{distance traveled}}{\text{time elapsed}}$

$= \dfrac{50\text{m}}{1.25\text{s}} = 40\text{m/s}$

b) Distance traveled = speed × time

$= 40\text{m/s} \times 0.80\text{s}$

$= 32\text{m}$

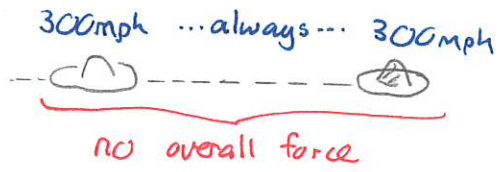
In general the speed of an object might vary while it moves. We can capture the idea of speed at one particular instant by observing over a very small interval of time, starting at that instant and then calculating average speed. The end result is instantaneous speed

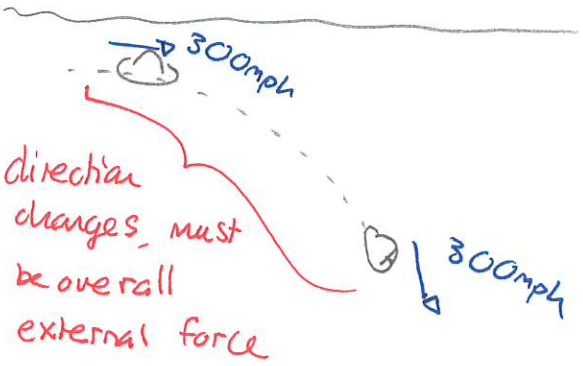
Velocity

The Law of Inertia refers to speed and direction of travel

It is possible that the speed can be constant but the direction changes.

We therefore need a quantity that describes speed and direction of motion. Thus





> Velocity = speed AND description of direction of motion units m/s

Quiz 4 70%

This allows us to restate the Law of Inertia

> If an object is subjected to no overall external influence then its velocity stays constant (same at all times)

Acceleration

The interesting types of motion in physics occur when velocity changes. The way in which velocity changes is described by

> acceleration ≈ rate of change of velocity