Today: HW by 5pm

Monday: Cover 3.5

Weds: ....

Law of Inertia

The law of inertia establishes a "default" motion for any object:

> If there is no overall external influence on an object then that object will continue to move with constant speed in a straight line.

The will require:

* description of speed
* combining speed and straight line direction into a single quantity — velocity.

Speed
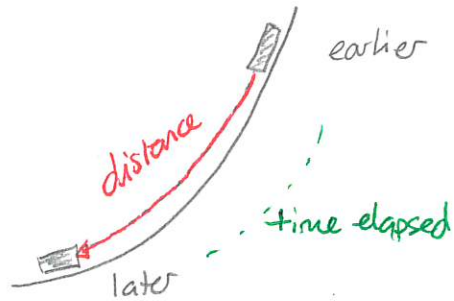
Speed describes the rate at which distance is covered. The conceptual idea is

speed ≈ rate at which object covers distance

A definition of this is:

Observe the motion of the object over some period of time.

1) record the time that passes

2) measure the distance traveled

Then over the entire period of motion

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

earlier

distance

time elapsed

later

We can convert this into a formula using symbols:

$\bar{s} \equiv$ average speed

$d \equiv$ distance

$t \equiv$ time

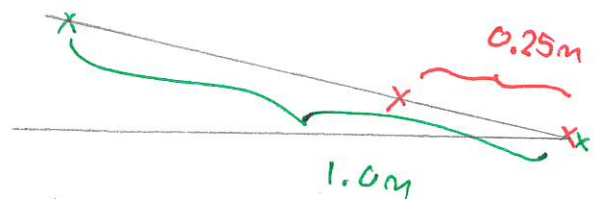$\Rightarrow \quad \bar{s} = d/t$

Units: $\dfrac{\text{meters}}{\text{seconds}}$

$\dfrac{m}{s}$

Quiz1

An example would be to have a cart slide down a track inclined at one particular angle. We can have the cart slide various lengths

Demo: Do this and time

We get

0.25m

1.0m

distance	time	average speed
0.25m		
1.00m		

We can invert the definition to give (exactly true when speed is constant)

$d = \bar{s} \times t \quad$ or $\quad$ distance = speed × time elapsed

1 Soccer players and ball

A soccer player, Lindsey, kicks a soccer ball along the ground to a teammate, Rose, standing stationary 15 m away. It travels in a straight line, taking 0.75 s.

a) Determine the speed of the ball.

b) An opposing player, Marta, initially alongside Lindsey, runs at speed 8.0 m/s towards Rose, starting at the moment when the ball was kicked. Determine how far Marta will travel by the time that the ball reaches Rose. Is it likely that Rose will be able to evade Marta?
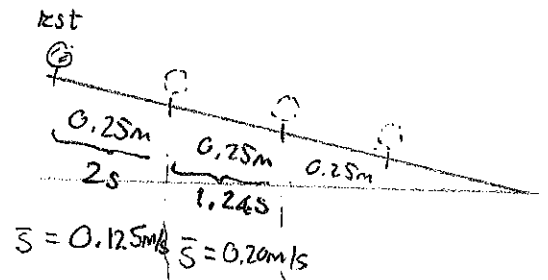
Answer: a) $\text{speed} = \dfrac{\text{distance}}{\text{time}} = \dfrac{15M}{0.75s} = 20m/s$

b) $\text{distance} = \text{speed} \times \text{time} = 8.0m/s \times 0.75s = 6m$

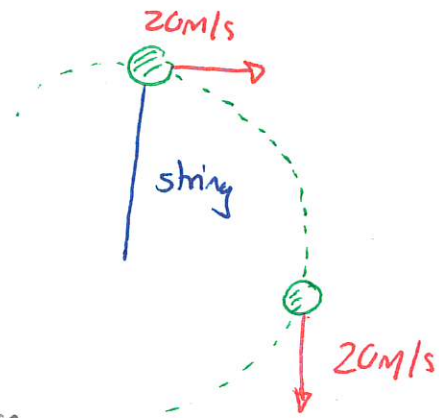Marta will be 9.0m short and Rose should be able to evade

Generally an object's speed will vary during its motion. Then the average speed is a poor representation of the state of motion. This would occur for the object sliding down the incline.

To more accurately captured to state of motion we could use Instantaneous speed which would be the speed calculated over a very small interval of time

rest

0.25m   0.25m   0.25m
2s   1.24s
$\bar{S} = 0.125m/s$ $\bar{S} = 0.20m/s$

Velocity

The law of inertia refers to both speed and direction of motion. We need to account for the direction. The reason for this is that there must be some external influence to change the direction of motion. We can envisage this by considering a ball on the end of a string. Even if the ball travels with constant speed its direction of motion changes. The string causes this change.

So we define.

20m/s

string

20m/s

velocity of an object = speed of the object AND description of direction,	units: m/s

We can then rephrase the law of Inertia

If an object is subjected to no net external influence then its velocity stays constant.

Acceleration

The interesting situations in physics occur when the velocity changes and we need to

* describe how velocity changes ~> acceleration
* why velocity changes.

Consider the example of a skateboarder moving with constant velocity and holding a ball

Quiz 4

Quiz 5

Before launch   After launch

The velocity has changed.

Quiz 6

Demo: Ball launcher.