Weds: Read 4.1 → 4.3

Fri: HW by 5pm

Recall that velocity describes speed an direction of motion. Then the Law of Inertia states that velocity remains constant whenever there is no overall external influence on an object. It follows that interesting situations in physics arise when velocity changes.

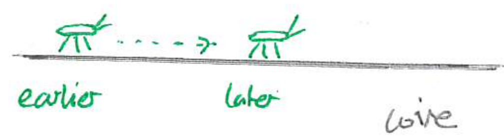
Quiz! (was done previously but redo before ~~desolp~~' demo)

Demo: Cart + Ball launcher.

Acceleration

Acceleration describes the rate at which velocity changes. Note that velocity can change because either or both speed and direction change. We consider the simpler case where the object moves in one direction.

We illustrate this with motion at constant velocity and then with changing velocity.



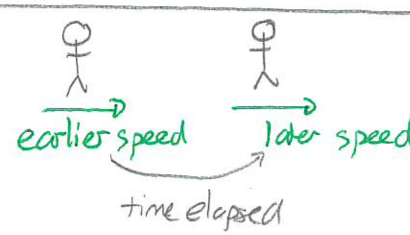
Demo: PhET Moving Man.

1) illustrate constant velocity - start left, move right
2) Illustrate constant acceleration - start left, move right.

We define acceleration for an object moving in one direction via:

Consider an object moving along one direction

1) observe object's speed at two moments
2) record speed at two moments.



Then

change in speed = later speed − earlier speed

$$\text{(average) acceleration} = \frac{\text{change in speed}}{\text{time elapsed}}$$

units: meter/second^2

m/s^2

1 Moving Man Acceleration

The PhET Moving Man simulation depicts a man moving with various possible accelerations. The instructor will set this up and have you determine the acceleration of the man.

The set up is as follows. Run the PhET simulation "The Moving Man" and select the "Charts" tab. Set up the man initially at the -10 m mark with velocity 1.0 m/s. Select an acceleration → 2.5m/s² *and hide the acceleration graph. Run the simulation. Stop the simulation just before the man reaches the wall.*

a) Using the playback feature of the animation, determine the man's velocity at 0.0 s and later at 1.0 s. Determine the man's acceleration during this interval.

b) Using the playback feature of the animation, determine the man's velocity at 2.0 s and later at 3.0 s. Determine the man's acceleration during this interval.

c) Using the playback feature of the animation, determine the man's velocity at 3.0 s and later at 4.0 s. Determine the man's acceleration during this interval.

d) Is the man's velocity constant from 0 s to 4 s?

e) Is the man's acceleration constant from 0 s to 4 s?

Answers: a)

time	velocity
0s	1.0m/s
1s	3.5m/s

change in velocity = 3.5m/s − 1.0m/s = 2.5m/s

acceleration = $\frac{2.5 m/s}{1.0 s}$ = 2.5m/s²

b)

time	velocity
1s	3.5m/s
2s	6.0m/s

change in velocity = 6.0m/s − 3.5m/s = 2.5m/s

acceleration = $\frac{2.5 m/s}{1 s}$ = 2.5m/s²

c)

time	velocity
2s	6.0m/s
3s	8.5m/s

change in velocity = 8.5m/s − 6.0m/s = 2.5m/s

acceleration = $\frac{2.5 m/s}{1 s}$ = 2.5m/s²

d) no, it goes from 1.0m/s → 8.5m/s

e) yes, it appears to be fixed at 2.5m/s².

In each second the man speeds up by 2.5m/s.

Quiz2 60% – 100%

The definition of acceleration can be extended to

1) objects that can move right or left and change direction from right to left and vice-versa
2) objects whose direction of motion changes.

There is mathematical language (vectors) that captures all of these situations. In all case we get

The acceleration of an object is exactly $0 m/s^2$	$\Longleftrightarrow$	speed of the object does not change **AND** direction of motion does not change.

Quiz3 70% – 90%

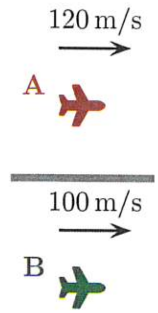
Quiz4 50% – 70%

Velocity from acceleration

Sometimes we know the acceleration of an object on need to determine its speed. We cannot simply determine the speed but we can determine the change in speed.

> If an object * moves in a straight line (to the right) and
> * acceleration is constant
>
> then during a given period
>
> change in speed = acceleration × time elapsed in interval

2 Accelerating aircraft



Two aircraft travel in straight lines directly East. At one initial moment the aircraft have the illustrated speeds. For more than 10 s after this aircraft A has acceleration $5.0\,\text{m/s}^2$ and aircraft B has acceleration $10\,\text{m/s}^2$. Both of these result in increasing speed.

a) After the illustrated initial moment, does it seem that aircraft A will always move faster than aircraft B? Explain your answer.

b) After the illustrated initial moment, does it seem that aircraft B will always move faster than aircraft A? Explain your answer.

c) Determine the speed of each aircraft 2.0s after the initial moment.

d) Determine the speed of each aircraft 4.0s after the initial moment.

e) Determine the speed of each aircraft 6.0s after the initial moment.

f) Based on your calculations, do your answers to the first two questions change?

Answer: a) No, B speeds up more rapidly. It might eventually move faster.

b) No, A is moving faster initially.

c) For A change in speed = accel x time

= $5.0\,\text{m/s}^2 \times 2.0\,\text{s}$ = 10m/s

speed goes from 120m/s → 130m/s.

For B change in speed = accel x time

= $10\,\text{m/s}^2 \times 2.0\,\text{s}$ = 20m/s

speed goes from 100m/s → 120m/s

d) For A change in speed = accel x time = $5.0\,\text{m/s}^2 \times 4.0\,\text{s}$ = 20m/s

speed 120 → 140m/s

For B - - - - - - $10\,\text{m/s}^2 \times 4.0\,\text{s}$ = 40m/s

speed 100 → 140m/s.

e) For A change in speed = accel x time = $5.0\,\text{m/s}^2 \times 6.0\,\text{s}$ = 30m/s

speed → 150m/s

For B " " " = " x time = $10\,\text{m/s}^2 \times 6.0\,\text{s}$ = 60m/s

speed → 160m/s.

f) No B eventually goes faster.