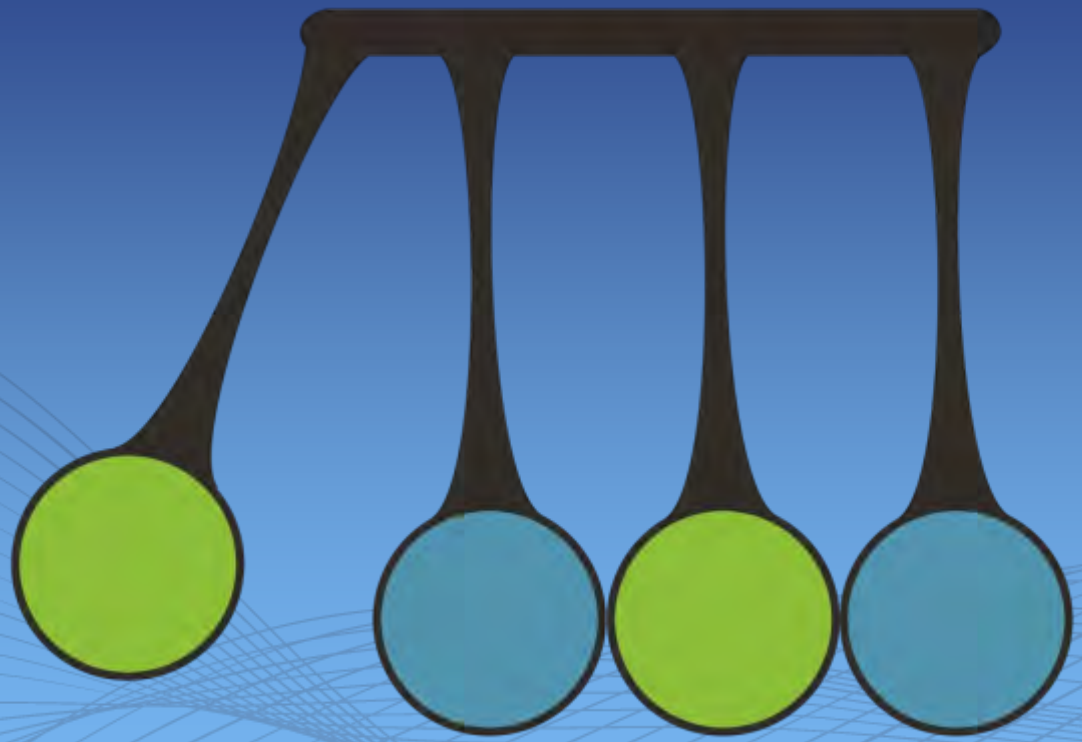
IEB Physics



A:
Kinematics

Displacement, velocity and acceleration

2.6 Acceleration

Acceleration is:

- the rate of change of an object's velocity;
- the change in velocity divided by the time taken;
- a vector with a specific direction.

Definition

Acceleration is the rate of change of velocity of an object.

Displacement, velocity and acceleration

Acceleration gives us an indication of how fast an object's velocity is changing.

Symbol: a

SI-unit: $m \cdot s^{-2}$

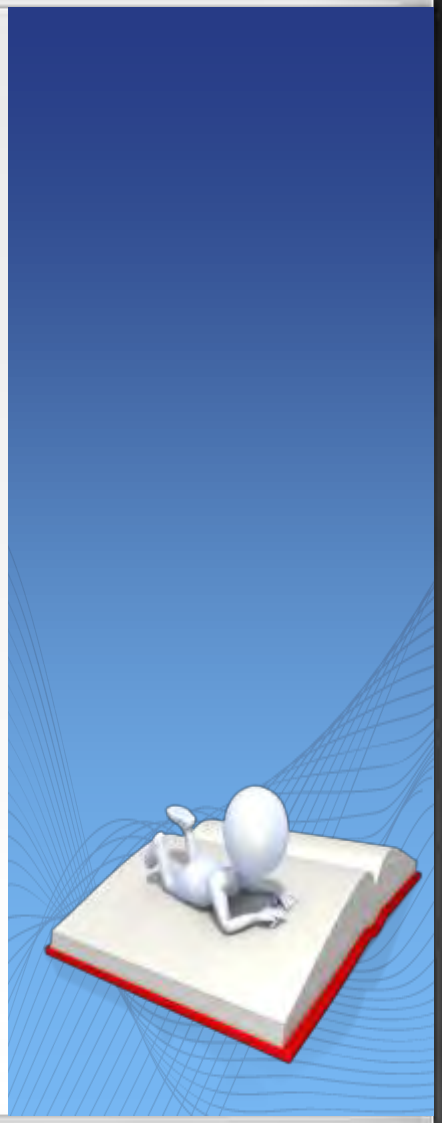
$$a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t}$$

acceleration ($m \cdot s^{-2}$)

final velocity ($m \cdot s^{-1}$)

initial velocity ($m \cdot s^{-1}$)

change in time (s)



Displacement, velocity and acceleration

THINK:
If both the change in velocity and the direction are negative, the object will be speeding up.
Velocity and acceleration are both vectors in the same frame of reference.
The direction should be inferred from the description (context) of the motion.

Definition

Constant acceleration means a constant increase or decrease in velocity in equal time intervals.

Displacement, velocity and acceleration

Examples

Positive acceleration

A car accelerates constantly at 4 m · s^{-1} every second. The car travels on a long, straight, horizontal road. Its velocity is recorded every second.

Velocity	0	1	2	3	4	5	6
Snelheid ($m \cdot s^{-1}$)	0	4	8	12	16	20	24

Displacement, velocity and acceleration

- Every second the car moves 4 m ▪ s^{-1} faster than during the previous second.
- $\therefore v_f > v_i$
- Acceleration is positive.
- An object that has positive acceleration speeds up, if its **velocity** is in t**he same direction as its acceleration**. If its velocity is negative, that is in the opposite direction to the acceleration, it will slow down.

Displacement, velocity and acceleration

Negative acceleration

Die data vir die motor is ’n rukkie later weer aangeteken.

Velocity	0	1	2	3	4	5	6
Snelheid ($m \cdot s^{-1}$)	20	17	14	11	8	5	2

- Every second the car is moving 3 $m \cdot s^{-1}$ slower than during the previous second.
- $\therefore v_f < v_i$

Displacement, velocity and acceleration

- It accelerates negatively by 3 metres per second squared (-3 m ▪ s^{-2}).
- An object that has a **negative acceleration** slows down, if its **velocity** is in the **opposite direction** to its **acceleration**. If the velocity is negative, that is in the same direction as the acceleration, it will speed up.

Displacement, velocity and acceleration

Voorbeelde

1. A car starts from rest at a stop street. After 5 s the car has a velocity of 7 m ▪ s^{-1}. Calculate the acceleration of the car.

$$a = \frac{v_f - v_i}{\Delta t}$$

$$a = \frac{7 - 0}{5}$$

$$a = 1{,}4\ m{\cdot}s^{-2}$$

$\therefore$ 1,4 $m{\cdot}s^{-2}$ in die rigting van die beweging

$v_i = 0\ m{\cdot}s^{-1}$

$v_f = 7\ m{\cdot}s^{-1}$

$\Delta t = 5\ s$

$a = ?$

Displacement, velocity and acceleration

2. While travelling at a speed of 10 m · s^{-1} on a straight road, the car suddenly has to stop for a red light. It takes the car 6 seconds to come to a stop. Calculate the acceleration.

$$a = \frac{v_f - v_i}{\Delta t}$$

$$a = \frac{0 - 10}{6}$$

$$a = -1{,}67\ m \cdot s^{-2}$$

$v_i = 10\ m \cdot s^{-1}$

$v_f = 0\ m \cdot s^{-1}$

$\Delta t = 6\ s$

$a = ?$

$\therefore$ 1,67 $m \cdot s^{-2}$ in the opposite direction to movement