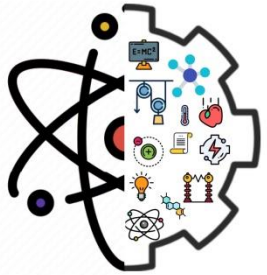

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Chapter 3
Motion In One Dimension:
Motion along a Straight Line

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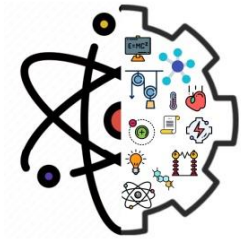
Contents:



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أولا
01

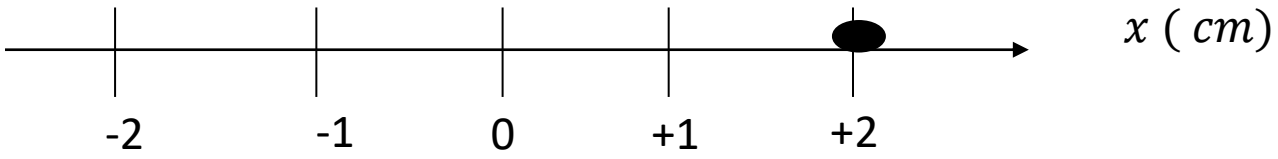
Position and Displacement

Position and Displacement:

Position:

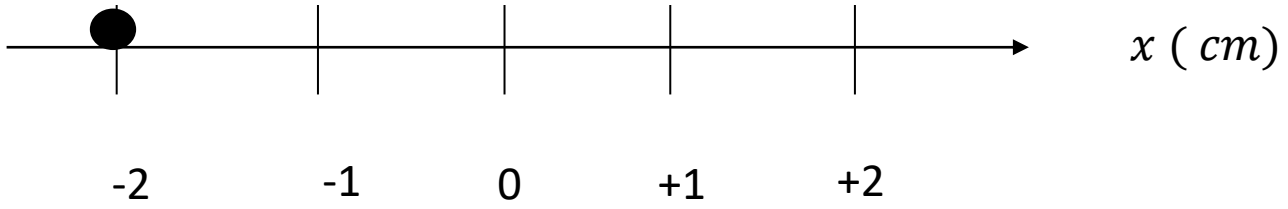
The position (x) of an object describes its location relative to some origin or other reference point.

Example 1:



The position of the ball is $x = +2cm$.
The positive sign indicates the direction is to the right of the origin.

Example 2:



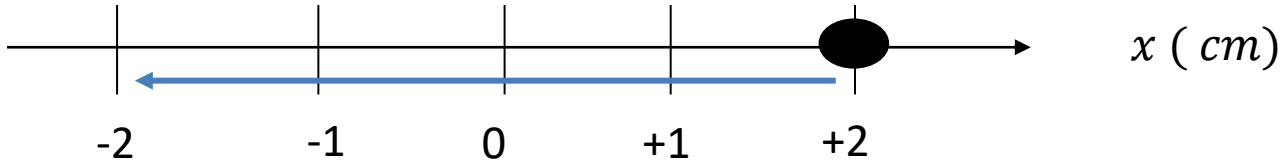
The position of the ball is $x = -2cm$.
The negative sign indicates the direction is to the left of the origin.

Displacement:

The displacement is the change in an object's position. It depends only on the beginning and ending positions.

$$\Delta x = x_f - xi$$

Example 1:



$$\Delta x = x_f - x_i = -2 - (+2) = -4\ cm$$

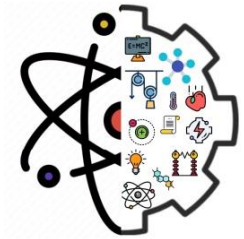
Example 2:

At 3 PM a car is located 20 km south of its starting point. One hour later it is 96 km farther south. After two more hours it is 12 km south of the original starting point.

a- What is the displacement of the car between 3 PM and 6 PM.

b- What is the displacement of the car from the starting point to the location at 4 PM.

c- What is the displacement of the car from 4 PM to 6 PM.



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Velocity (average and Instantaneous velocity)

ثانيا

02

Velocity (average and Instantaneous velocity)

Velocity:

Velocity is a vector that measures how fast and in what direction something moves.

Velocity:

“is the rate of change of the position of an object”.

SI Unit of the velocity : m/s

Speed:

is the magnitude of the velocity.

For example : "5 m/s" is a scalar while "5 m/s east" is vector

Average Velocity :

Is the change in position Δx divided by the time interval Δt.

$$V_{av} = \frac{\Delta x}{\Delta t}$$

$$\Delta x = x_f - xi$$
$$\Delta t = t_2 - t_1$$

Example 1 :

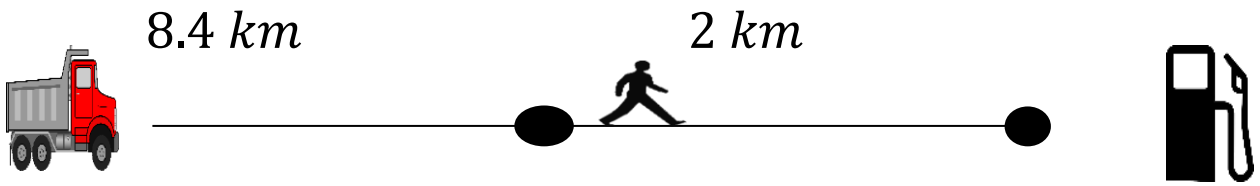
A car moves in a straight line, at a time $1s$ after the start of the movement, the car is at $x_1 = 19m$ to the right of the origin, at $4s$ after the start , it is at $x_2 = 277m$ from the origin find the average velocity for the car ?

Example 2 :

A car moves from $x_1 = 277m$ to $x_2 = 19m$ during time interval 16 sec and 25 sec , find the average velocity for the car?

Example 3 :

One drives a truck along a straight road for $\mathbf{8.4\ km, 70 km/h}$ at this point the truck runs out of gasoline and stops. Over **30** min , he walk another $\mathbf{2\ km}$ to a gasoline station.



a- What is the overall displacement from the beginning of his drive to his arrival at the station?

b- What is the time from beginning to his arrival to the station?

c- What is the average velocity from beginning to his arrival to the station?

Instantaneous Velocity :

Is the average velocity during a very short time interval.

The Mathematical Formula of Instantaneous velocity:

$$v = \frac{dx}{dt}$$

Example 1 :

The position of a particle moving on the x axis is given by

$$x = 5 + 2t^2 - 3t^3$$

(a) What is its instantaneous velocity at $t = 3$ seconds?

(b) Is the velocity constant or is it continuously changing?

(c) Is there ever a time when $v = 0$?

(d) Find the average velocity in the interval between 1 Sec and 5 Sec?

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ثالثا

03

Acceleration (average and instantaneous acceleration)

Acceleration :

Generally, if the velocity of an object is changing with time then the object is undergoing an acceleration.

Acceleration :

“is the rate of change of velocity with respect to time”

SI Unit of the Acceleration : m/s^2

- When the acceleration and velocity are in the same direction, the object is speeding up.
- When the acceleration and velocity are in opposite directions, the object is slowing down.
- Acceleration is a vector quantity.

Average Acceleration :

Is the change in velocity divided by the change in time.

$$a_{av} = \frac{\Delta v}{\Delta t}$$

$$\Delta v = v_f - vi$$
$$\Delta t = t_2 \_ t_1$$

Example1 :

A car accelerates along a straight road from rest to 60 km/h in 5 $seconds$. What is the magnitude of the average acceleration?

Instantaneous Acceleration:

The Mathematical Formula of Instantaneous velocity:

$$a = \frac{dv}{dt}$$

Example 1 :

If the velocity of the object is given as

$v = 10t2 + 2t$

Calculate the instantaneous acceleration after 2 $second$ of motion?

Example 2:

The position of a particle moving on an x axis is given by:

$x = 4 - 27t + t^3$

Find:

a- The particle's velocity function v(t) and acceleration function a(t)?

b- What is the velocity at $t = 3.5\ s$?

c- Is the velocity constant or is it continuously changing?

d- What is the acceleration at t = 2s?

e- Is the acceleration constant or is it continuously changing?

f- Is there ever a time when $v = 0$?

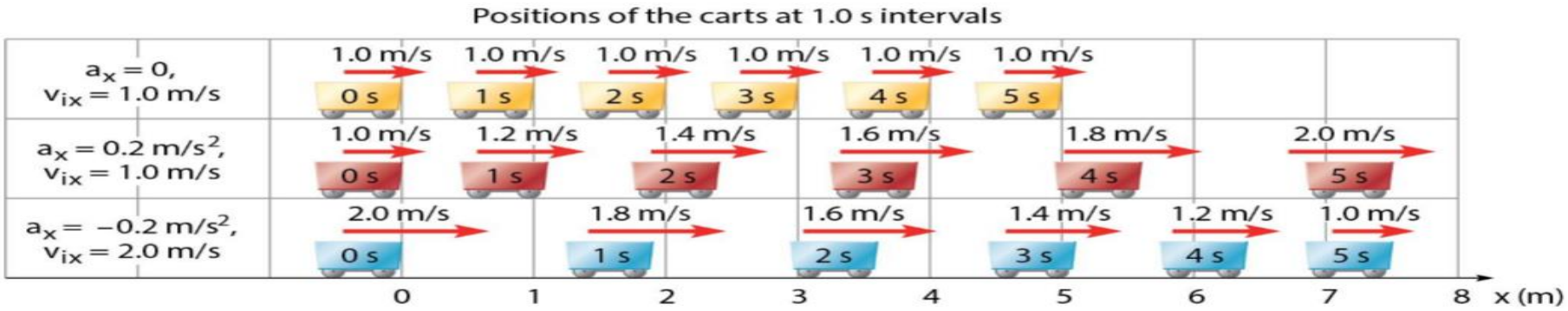
رابعا

04

Motion with constant acceleration

Motion along a Line with Constant Acceleration:

Motion diagrams for three carts. Each cart is shown at 1.0 *s* time intervals, and each has a (different) constant acceleration.



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خامسا

05

Kinematic equations for Motion with constant acceleration

Kinematic equations for Motion with constant acceleration

1) $v_f = v_i + at$

2) $\Delta x = v_i t + \frac{1}{2} a t^2$

3) $v_f^2 = v_i^2 + 2a\Delta x$

$\boldsymbol{t}$: $time$
$\boldsymbol{V_i}$: $initial\ velocity$
$\boldsymbol{v_f}$: $final\ velocity$
$\boldsymbol{a}$: $acceleration$
$\mathbf{x_f}$: $final\ position$
$\boldsymbol{x_0}$: $initial\ position$

Example 1 :

A car initially traveling along a straight stretch of highway at $15\ m/s$ accelerates with a constant acceleration of $2\ m/s^2$

a- What is the velocity of the car after $5s$?

B- What distance does the car travel during its $5s$ of acceleration ?

Example 2 :

If a car moves with initial velocity $40\ m/s$ and constant acceleration $12\ m/s^2$ for a total time of $10s$, what total distance does it travel?

Example 3 :

An object move, starts motion from rest with constant acceleration $10\ m/s^2$ calculate the velocity of the object after it travels $20\ meter$?

Example 4 :

A train is traveling along a straight line at $26.8\ m/s$. Suddenly the driver sees a truck stalled on the tracks $184\ m$ ahead. If the maximum possible braking has magnitude $1.52\ m/s^2$

Can the train be stopped in time?

سادسا

06

Free Fall

Free fall

- If no forces act on an object other than the gravitational force, we say the object is in free fall.
- For example, a stone dropped from the edge of a cliff—if air resistance can be ignored, the stone is in free fall.
- Or a ball thrown upward—if air resistance is ignored, the ball is in free fall.
- An object in free fall has constant downward acceleration, denoted by the symbol (g).

1) $v_f = v_i \pm gt$

2) $\Delta x = v_i t \pm \frac{1}{2} g t^2$

3) $v_f^2 = v_i^2 \pm 2g\Delta x$

$a = -g = -9.8\, m/s^2$

$a = g = 9.8\, m/s^2$

Example 1:

A pitcher tosses a baseball up along a $y\ axis,\ with$ an initial speed of $12\ m/s$.

a- How long does the ball take to reach its maximum height?

b- What is the ball's maximum height?

Example 2:

A ball thrown vertically upward by initial speed of **3m⁄s**. What distance it will take to stop?

Example 3:

A stone dropped from $\boldsymbol{19.6m}$.

Find:

a- Speed of stone before hit the earth?

b- How long does it take to reach the earth?

Example 4:

A child throw a stone upward to reach maximum height at $\boldsymbol{3s}$. Find:

a- Initial speed of stone?

b- Maximum height?

Thank you