OL Academy

# PHYCS101

**Chapter 2**

# Motion in One Dimension

Displacement (m) — meter

إزاحة

Distance (m) — meter

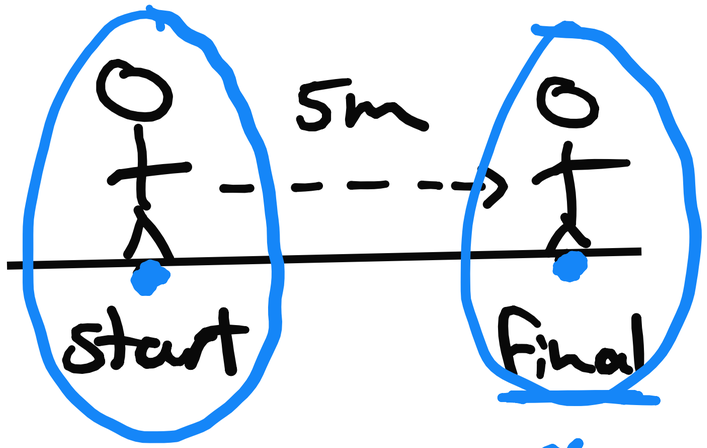
مسافة

Vector Quantity

كمية اتجاه

+

كمية عددية




Scalar Quantity

كمية عددية

X negative

rule:

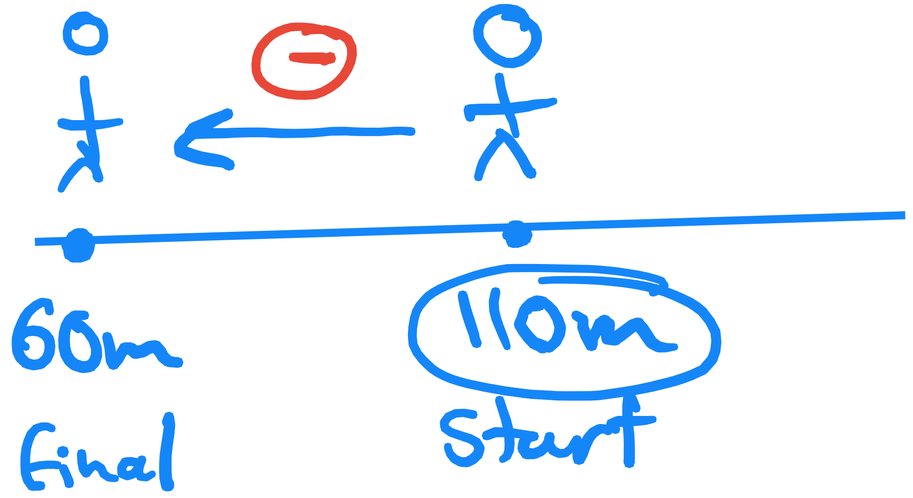
$$\Delta x = x_{(F)} - x_{(i)}$$

$$d = x_1 - x_2$$

$$x_1 > x_2$$

**Examples:**

$x_i$ = 110 m and ending at $x_f$ = 60 m




the displacement is:

$$\Delta x = x_f - x_i$$

$$\Delta x = 60 - 110 = -50 \text{ m}$$

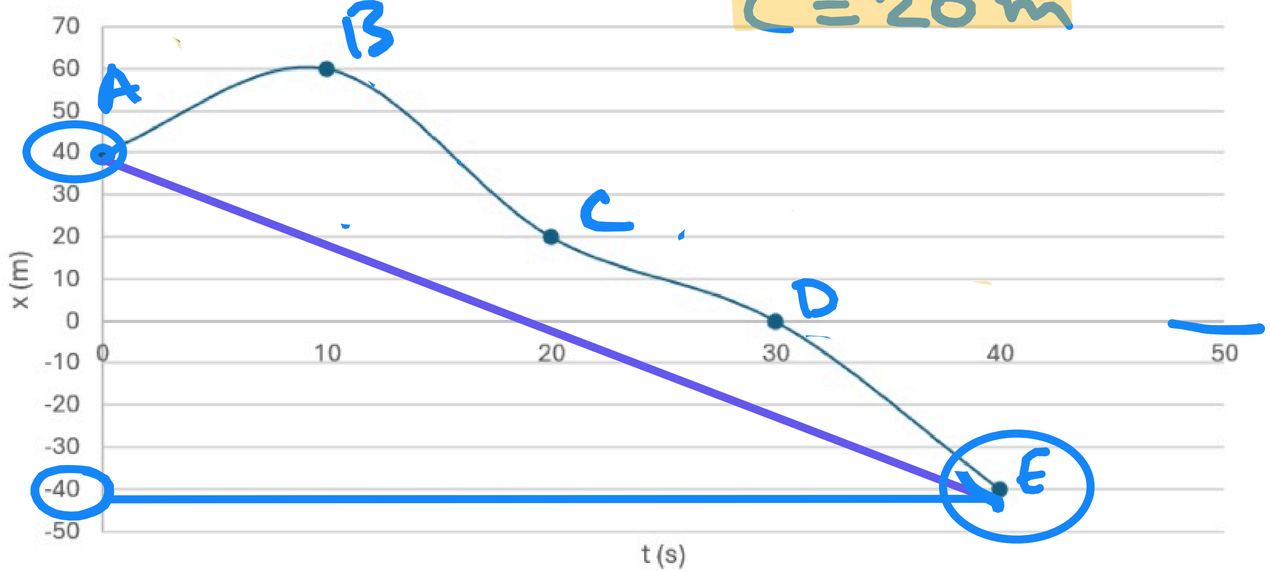
The distance is:

$$d = 110 - 60 = +50 \text{ m}$$

## Exercises

**The position - time graph**

x – t plot is considered for the distance and the displacement




A = 40m

B = 60m

C = 20 m

① What is the displacement between A & B?

$\Delta x = x_f - x_i = 60 - 40$

$= 20\,m$

② What is the distance between B & C?

$d = 60 - 20 = 40\,m$

What is the total distance?

$20 + 40 + 20 + 40 = 120m$

What is the total displacement?

$\Delta x = x_f - x_i$

$= -40 - 40 = -80m$

## Average Velocity (m/s)

- Vector Quantity
- positive or neg.

rule

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

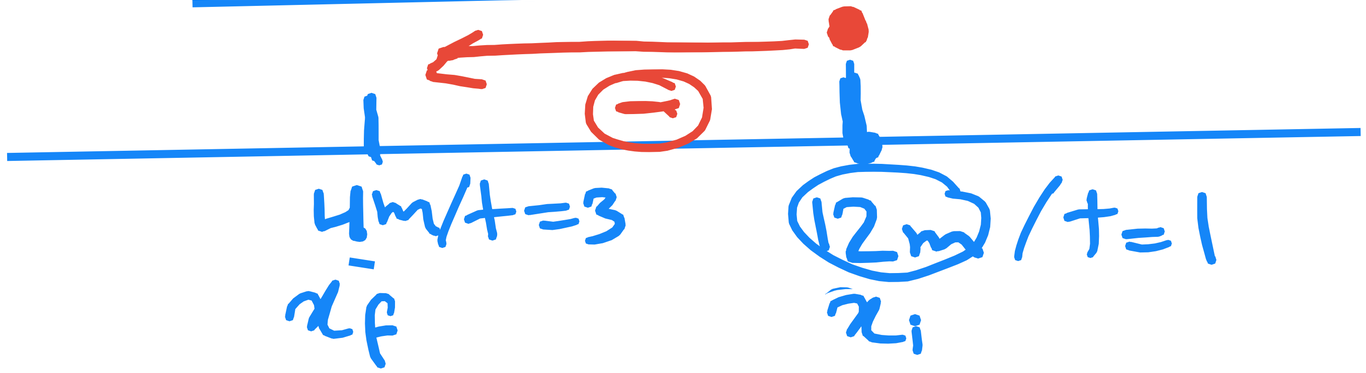
## Average Speed (m/s)

- Scalar Quantity
- positive

$$\text{average speed} = \frac{\text{total distance}}{\text{total time}}$$

## Examples

1- A particle moving along x-axis is located at $x_i = 12m$ at $t_i = 1\,s$ and at $x_f = 4m$ at $t_f = 3s$. Find its displacement, average velocity and average speed.




displacement:

$\Delta x = x_f - x_i$

$= 4 - 12$

$= -8\ m$

average velocity

$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{-8}{3-1} = \frac{-8}{2}$

$= -4\ m/s$

average speed

$= \frac{\text{total distance}}{\text{total time}}$

$= \frac{12-4}{3-1} = \frac{8}{2}$

$= 4\ m/s$

$\Delta x$ $\Delta t$

2- If a truck travels 16 m in 2 s. then its average velocity is:

$$\bar{V} = \frac{\Delta x}{\Delta t} = \frac{16}{2} = 8\ m/s$$

m/s

3- If a car travels 40 km in 4 h then its average speed is:

$$\frac{40\ Km}{4\ h}$$

$$\text{average speed} = \frac{40\ Km}{4\ h} = 10\ km/h$$

3- If a car travels 40 km in 4 h, then its average speed is:

Convert your answer to m/s

$$\text{average speed} = \frac{\text{total distance}}{\text{total time}} = \frac{40\ \text{km}}{4\ \text{h}}$$

معامل التحويل Km

$$\frac{40\ \text{km}}{4\ \text{h}} \cdot \frac{1000\ \text{m}}{1\ \text{km}} \cdot \frac{1\ \text{h}}{3600\ \text{s}} = 2.78\ \text{m/s}$$

معامل التحويل h

# Instantaneous Velocity (السرعة اللحظية)

Exercise: A particle moves along the x-axis. its position varies with time according to the expression $x = -4t + 2t^2$. Calculate

① displacement
$t = 1 \rightarrow t = 3$

② average velocity
$t = 1 \rightarrow t = 3$

③ Instantaneous velocity

① $t=1$ to $t=3$

$x = -4t + 2t^2$

$x_i = -4(1) + 2(1)^2 = -2$

$x_f = -4(3) + 2(3)^2 = 6$

$\Delta x = x_f - x_i$

$= 6 - (-2)$

$= 8\,m$

displacement

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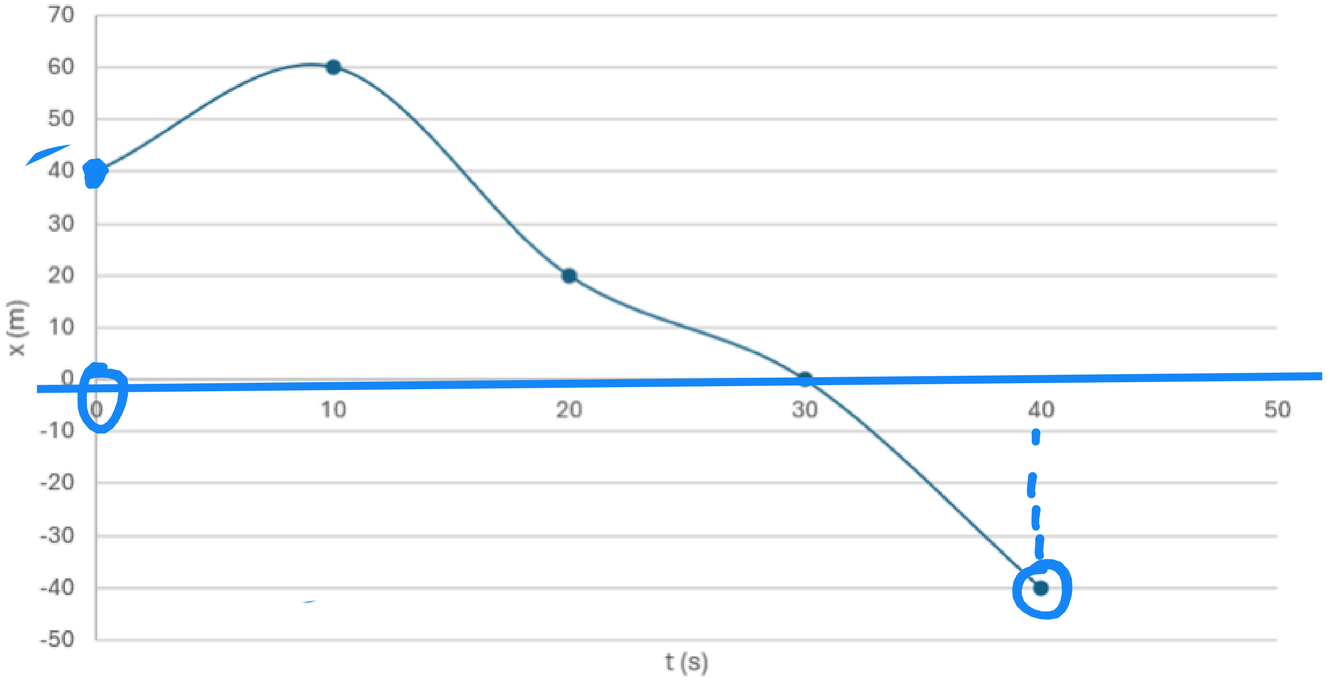
② $t=1$ to $t=3$ average velocity

$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{8}{3-1} = 4\,m/s$

## ③ Instant. Velocity at (2.5) s

$$x = -4t + 2t^2$$

$$= -4 + 4t = -4 + 4(2.5) = 6\,m/s$$




What is the average velocity?

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

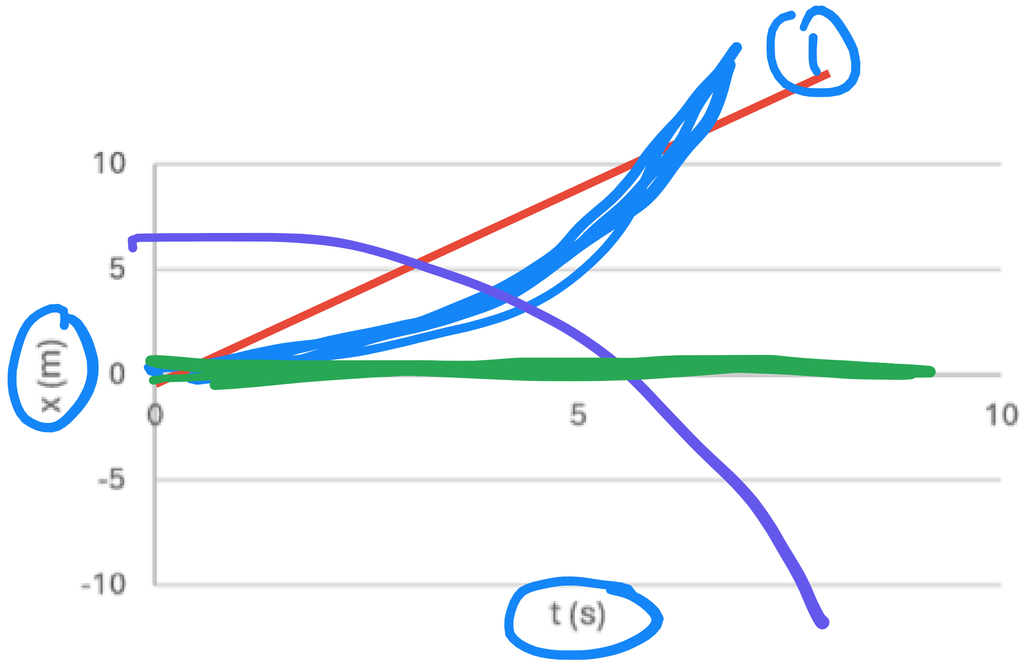
$$= \frac{-40 - 40}{40 - 0} = -2\ m/s$$

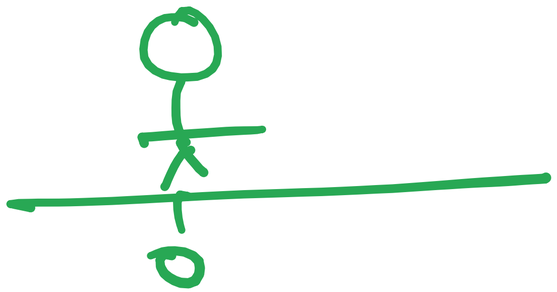
What is the average speed?

$$\frac{\text{total distance}}{\text{total time}} = \frac{120\ m}{40\ s}$$

$$= 3\ m/s$$

## Velocity cases in position – time graph



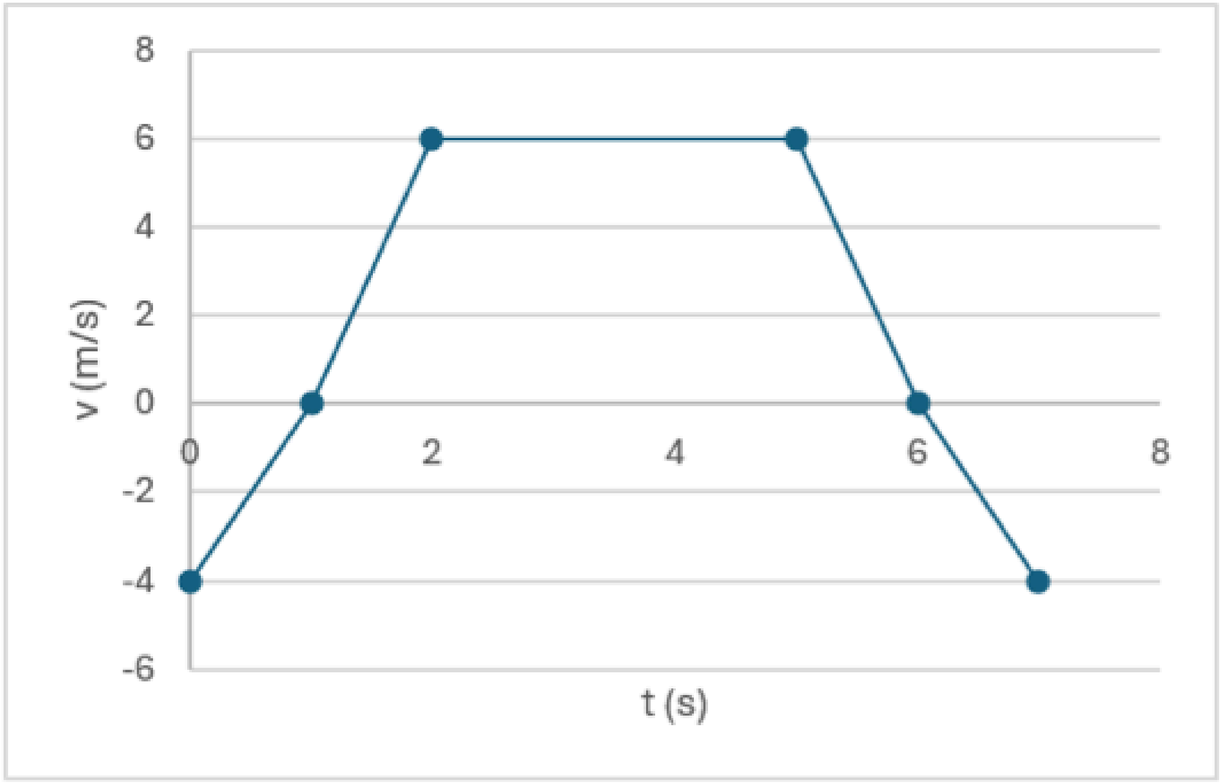
① velocity increase

② velocity decrease

③ Velocity = zero

④ Velocity = constant

# Acceleration cases in position – time graph

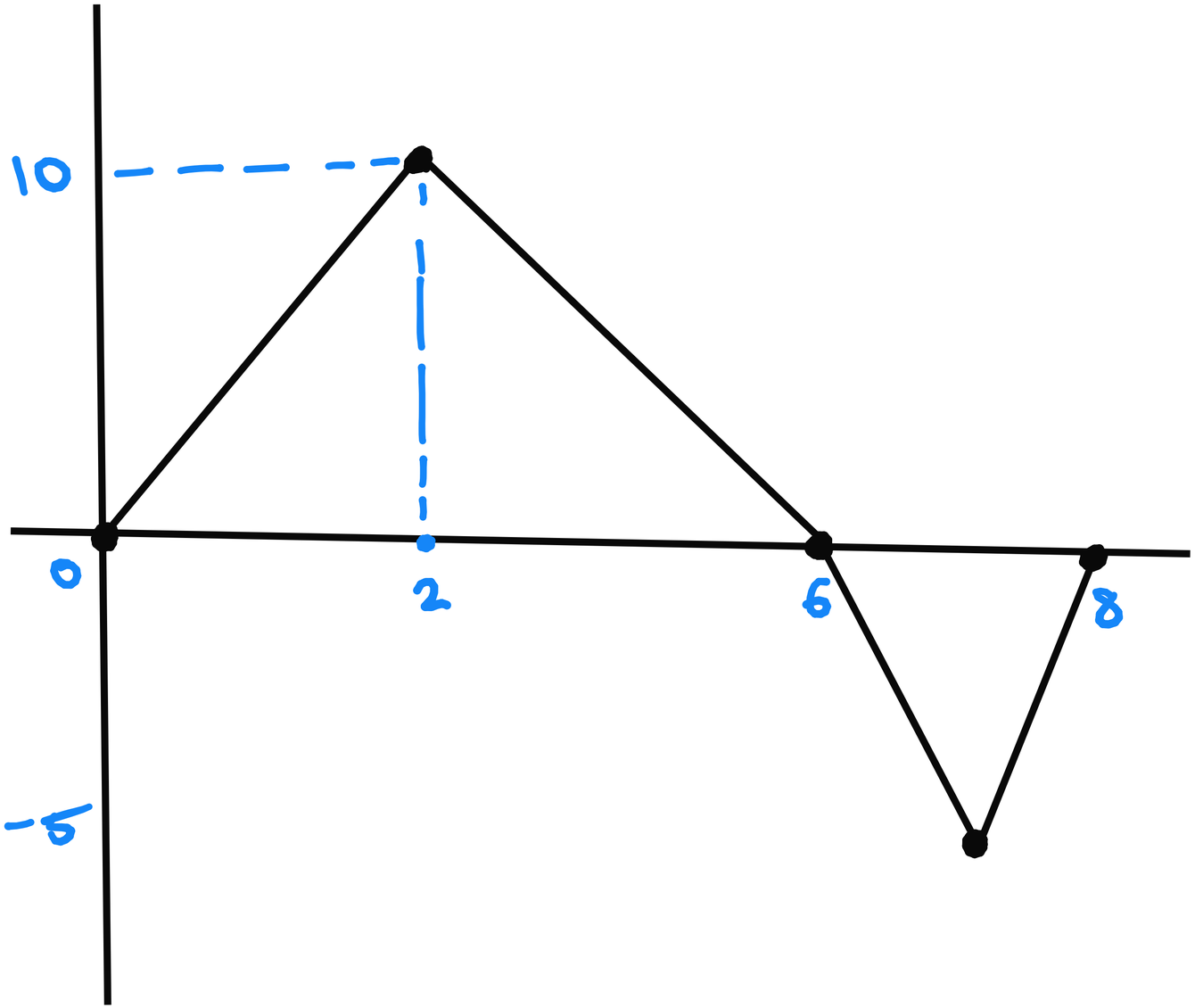


**Example:**

Find the acceleration:

From 0 – 2s?

From 2 – 6s?



# What is Instantaneous acceleration?

**Examples:**

1- A motorcycle starts to move from rest with constant acceleration of $2\frac{m}{s^2}$

a. Find the velocity in t=2s

b. At what time the position be 200m?

c. What is the position at t=6s?

d. What is the velocity after travelling distance of 50 m?

2- A car has an initial speed of 15 m/s and an acceleration of 2 $m/s^2$. How long will it take the car to come to stop?

3- A train starts from rest with constant acceleration 0.5 $m/s^2$. Find the final velocity $V_f$ of the train after 60s, the calculate the distance of this train during this time

4- An airplane must reach a velocity of 27.8 m/s before taking off and its acceleration is $2m/s^2$ from the rest.

a. If the runway is 150 m long, can the plane reach the proper velocity?

b. If not, what is the minimum length must the runway have?

5- A van moves at constant velocity 15 m/s at school crossing it overtook an officer who started his motion from the rest with constant acceleration of $m/s^2$. When and where he will overtake the van?