Motion in straight line

If we look at objects around us, we will find objects that some static and some mobile.

Motion:

It is the change in location over time for the body to another body position

Note that:

When the position of the body change over a period of time, the body had moved

If the motion in one direction and take a straight path, movement then named motion in a straight line which represents the simplest kinds of motion

Types of motion:

Motion can be divided into two main types ***(transitional – periodic)***

1-Transitional motion:

It is characterized by a start point and an end point, such as the movement in a straight line, projectile motion and movement of transportation means.

2- Periodic motion:

It is a movement that repeats itself at equal time intervals such as movement in a circle and vibratory movement

Velocity

Moving objects around us, we can say some are ***slow*** and some are ***fast***, but this is ***not accurate*** description of the process

Description of body movement has to be estimated in the amount form through the concept of velocity

To get to know the meaning of the speed study the following motion scheme to calculate the displacement that covered by athletic per second

Time (s)	0	1	2	3	4	5	6
Displacement (m)	0	5	10	15	20	25	30

From the table can reach that person covered displacement 5m every one second, this amount is known as velocity and that calculated from the relationship

$$\text{velocity} = \frac{\text{change in displacement}}{\text{change in time}} \quad \therefore v = \frac{\Delta d}{\Delta t}$$

Applying this relationship to the previous example velocity calculated ***as follow***

$$v = \frac{\Delta d}{\Delta t} = \frac{d_2 - d_1}{t_2 - t_1} = \frac{10 - 5}{2 - 1} = \frac{5}{1} = 5\ m/s$$

Velocity:

It is the displacement that covered by the body per second ***or***

The rate of change in displacement

Velocity measured by a unit ***(m/s)*** or ***(km/h)***

****Representation of the relationship between displacement and time graphically:***

Can be represented by the relationship between the displacement on the vertical axis and time on the horizontal axis ***as follows***

1- Draw a vertical line passing point ***(1s)*** on the time axis

2- Draw a horizontal line passing point ***(5m)*** on the displacement axis

3- Select the points of intersection of the vertical line with the horizontal line.

4- Repeat the above steps with the rest of the points of time and displacement.

5- Draw the best straight line passes dots intersection.

6- Determine the velocity by calculating the slope of straight line

****Types of speed*** (numerical speed and velocity)

When you ride the and notes the existence of a counter in front of the driver its pointer moves right and left.

And this counter determines the amount of car speed (80 km/h for example), does not benefit us in anything in determining the direction of movement and this value called Numerical speed

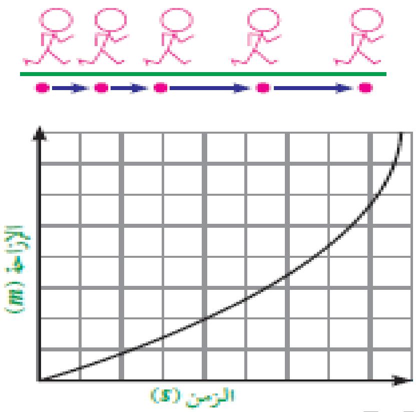
When we say that a car moving at 80 km / h, this is an incomplete description, and even the speed of the car is described, full description must define its direction, we say that the car mentioned traveling at 80 km/h towards the east and called the speed in this case as velocity

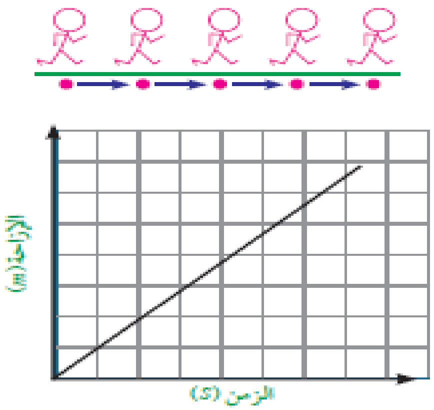
P.O.C	Numerical speed	Velocity
Definition	It is the distance covered by the body per unit time	It is the displacement covered by the body per unit time
Types	Scalar identify by magnitude only	Vector identify by magnitude and direction
Sign	Always be positive	Be positive if the body move in a certain direction and negative if it moves in opposite direction

*Uniform and variable velocity

When the runner moves with ***uniform velocity***, the displacement between the sites be equal in equal times and when he move with ***non-uniform velocity*** the displacement between the sites not be equal in equal times

Uniform velocity	Variable velocity
It the velocity which the body covers equal displacement in equal interval of times. And the body is moving a fixed amount in a straight line	It the velocity which the body covers un equal displacement in equal interval of times And the velocity is variable in magnitude and direction.

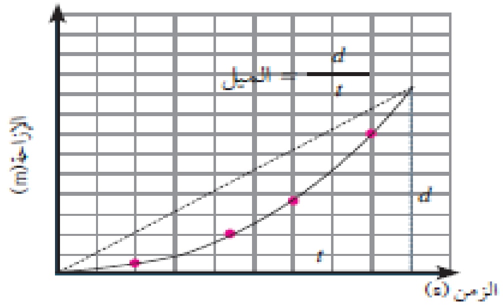


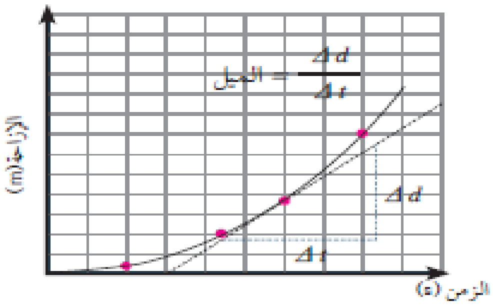


*Instantaneous and average velocity:

If we look at the movement of a car on the road, we note that the velocity is not constant but change according to the road conditions are sometimes increasing and sometimes decreasing not fixed value, and to understand the movement of this car must distinguish between the instantaneous and average velocity.

Instantaneous velocity (v)	Average velocity ($\bar{\vec{v}}$)
It is the velocity of the body at a certain moment It can be determined from the pointer of speedometer of the car at a given moment Can be set by creating slope tangent to the curve at the point corresponding to that moment	It is the displacement from the starting point to the end point on the total time Can be set by creating slope of the line connecting the start point and end point movement





Note that:

Wrong perceptions of the most common confusion between the term average velocity (vector quantity) and term average numerical speed which is a scalar quantity.

$$average\ velcoity = \frac{total\ displacement}{total\ time} \qquad \text{average numerical speed} = \frac{total\ distance}{total\ time}$$

****Example (1):***

Someone drove in a straight line, and covers 8.4 km with a time of 0.12 hours and then fuel is consumed and he left the car walking in the same line to the nearest Gas station covered 2 km in a time of 0.5 hours, ***calculate the average velocity from the beginning of the movement to end.***

****Solution:***

$$\vec{v} = \frac{d}{t} = \frac{8.4+2}{0.12+0.5} = \frac{10.4}{0.62} = 16.8\ \text{km/h}$$

It can reach the same result on finding slope of the line graph connecting between the starting point and end point as drawing.

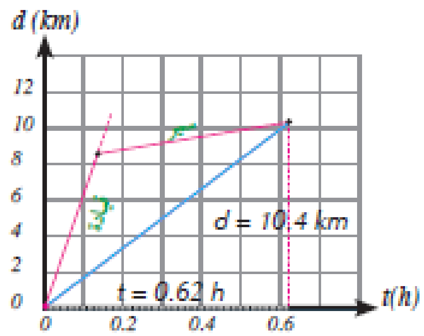
****Example (2):***

If we assume that in the previous example that the person came back again with a time of 0.6 hours, calculate the average speed of the movement since its inception until his return to the car again.

****Solution:***

When the person returns again, displacement becomes the 8.4 km as drawing

$$\vec{v} = \frac{d}{t} = \frac{8.4}{0.12+0.5+0.6} = \frac{8.4}{1.22} = 6.88\ \text{km/h}$$



Acceleration

We discussed the concept of velocity changing in magnitude or direction, or both, the motion in which change occurs in velocity over time is called accelerated motion.

Physical quantity which express the change in velocity according to the time is called ***acceleration (a).***

Through the study of this scheme can be monitored relationship between velocity by the unit (m / s) and time by the unit (sec) in the following table

Time (s)	0	1	2	3	4
Velocity (m/s)	0	5	10	15	20

Of the table can be concluded that the velocity of the car increases at a constant rate, where increasing every second by (5 m/s), this amount express the acceleration , which is calculated from the relationship.

$$a = \frac{change\ in\ velocity}{change\ in\ time} = \frac{final\ velocity - initial\ velocity}{final\ time - initial\ time} \qquad a = \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{t_2 - t_1}$$

Applying this relationship to the previous example $= \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{10-5}{2-1} = 5\ m/s^2$

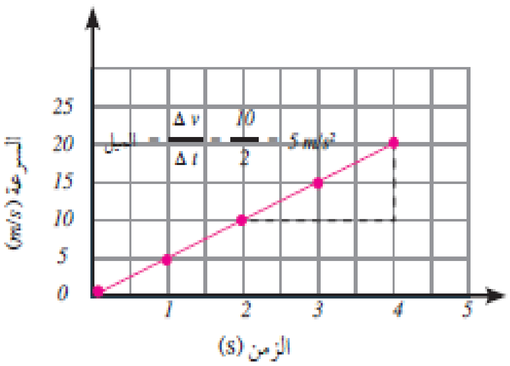
<u>*Acceleration:</u>

It is the change in the velocity per unit time ***<u>or</u>***

It is the rate of change in the velocity ***(measuring unit*** m/s^2 ***or*** km/h^2)

<u>*Representation of the relationship between velocity and time graphically</u>:

Expresses Chart ***(velocity – time)*** the movement of the car in the scheme of the previous motion.



It can be seen that the graph is a straight line and this means that the velocity of the car at a regular rate and increasing the acceleration can be determined ***by calculating the slope of straight line***.

<u>*Types of acceleration:</u>

1- Positive acceleration if we consider that the direction of the speed of the body is the positive direction, the body (incremental velocity)

2- Negative acceleration when decreasing velocity.

3- Acceleration is equal to zero when the body moves with regular velocity.

Note that:

1- When descending the ball the inclined surface, velocity increases over time so the acceleration ***is positive***.

2-When moving the ball on a smooth horizontal plane, the velocity doesn't change, so the acceleration ***equal zero***.

3- When ascending the ball the inclined surface, velocity decreases over time so the acceleration ***is negative***.