Al-Mustaqbal University College

Medical Physics Department

General Physics/ lecture 2

First stage

DR. Aiyah Sabah Noori

M. Sc. Sara Jaleel Ahmad

2022-2021

Lecture 2

Outline

Linear motion

Vector and scalar

Linear motion in one dimension الحركة الخطية في بعد واحد

If an object changes its position with respect to its surroundings with time, then it is called in motion. It is a change in the position of an object over time. Motion in a straight line is nothing but linear motion. As the name suggests, it's in a particular straight line, thus it can be said that it uses only one dimension.

Types of Linear Motion

The linear motion, also called the Rectilinear Motion can be of two types:

1- Uniform linear motion with constant velocity or zero acceleration.
2- Non-Uniform linear motion with variable velocity or non-zero acceleration.

Linear motion is the most straight forward kind of one-dimensional motion. As Newton's first law of motion suggests, an object will either be in rest or continue to move in a straight line with a uniform velocity unless and until an external force is applied to it.

Vector and scalar

The ideas behind vectors and scalars are used extensively in math and physics .

A **vector** is a quantity which has size (called magnitude) and direction. By quantity we mean something like weight, displacement, velocity, acceleration, force, and momentum, all of which are vectors.

- Therefore have to have a direction connected to them as well as value or size.

Vector هو كمية لها حجم (تسمى المقدار) والاتجاه.

A **scalar** is a quantity which has size or value only. Quantities like mass, speed; energy, power, and length have a value only. For example, a person could have a mass of 60 kg, or an amount of 1000 joules of energy are used up when performing an exercise.

- No directional angle is required when talking about these quantities.

Scalar الكمية التي لها حجم أو قيمة فقط بدون اتجاه.

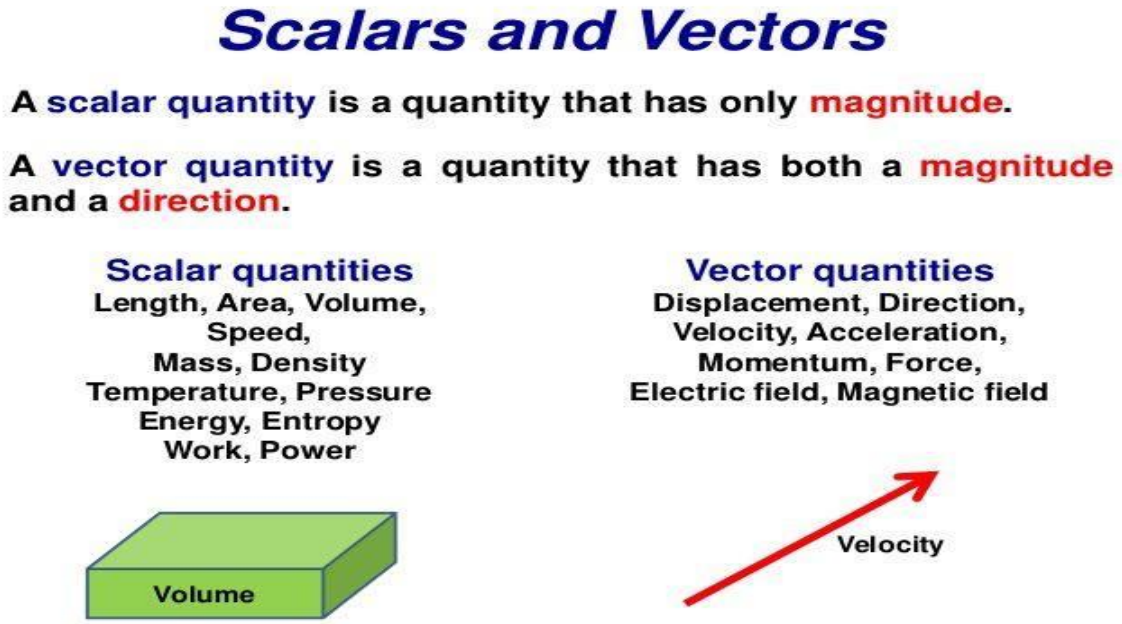


Figure 1 show the definition and examples of scalar and vector.

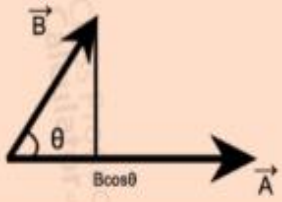
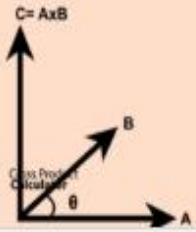
Dot Product	Cross Product
Product of magnitude of vectors and cos of the angle between them.	Product of magnitude of vectors and sine of the angle between them.
In terms of vectors A and B $\mathbf{A \cdot B = |A|\,|B| \cos\theta}$	In terms of vectors A and B $\mathbf{A \cdot B = |A|\,|B| \sin\theta\, n}$
The final product is a scalar quantity.	The final product is a vector quantity.
Follows a commutative law: A.B=B.A	Does not follow a commutative law: AxB is not equal to BxA
If the vectors are perpendicular to each other, their dot result is 0. As in, A.B=0	If the vectors are parallel to each other, their cross result is 0. As in, AxB=0
	

Figure2 show the product properties.

- **Weight and mass**

Mass is a **scalar** and represents the total quantity of matter in an object. **Weight** is the force due to gravity on a mass (with a direction towards the center of the Earth) and can be calculated from the fact that the gravitational field strength at the Earth's surface is approximately 10 newton's for each kilogram of mass

- **Distance and displacement**

Distance is a change in position relative to a reference (or zero) point. It is a **scalar** quantity, measured in metre[3] (m) and as such, it can only be positive.

Displacement is a change in position relative to a reference (or zero) point in a particular direction. It is a **vector** quantity and also measured in meter (m). Displacement, being a vector, can be **positive or negative**.

- **Average Speed**

Average Speedمتوسط السرعه: is the rate of change of المسافةdistance. It is a **scalar** quantity, measured in metre per second (m/s or ms-1). Since speed is likely to change over the course of motion, it is often useful to give the average speed, which can be obtained using: متوسط السرعة: هو معدل تغير المسافة

$$Average\ speed, v_{avg} = \frac{total\ distance\ covered}{total\ time\ taken}$$

$$= \frac{\Delta d}{\Delta t}$$

$$= \frac{d_2 - d_1}{t_2 - t_1}$$

Where

d : distance t : time Δ : The change

- **Average Velocity**

Average Velocity: is the rate of change of الازاحةdisplacement and is also measured in metre per second (m/s or ms-1). Unlike speed, it is a **vector** quantity, which is expressed as

$$\text{Average velocity, } v_{avg} = \frac{\text{total displacement}}{\text{total time taken}}$$

$$= \frac{\Delta s}{\Delta t}$$

$$= \frac{s_2 - s_1}{t_2 - t_1}$$

S : displacement

- **Average Acceleration**

Average Acceleration: is the rate of change of velocity and is measured in metre per second squared (m/s2 or ms-2). It is also a **vector** quantity and can be evaluated using:

$$\text{Average acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

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

$$= \frac{v_2 - v_1}{t_2 - t_1}$$

Acceleration occurs due to a change in the: التعجيل يحدث نتيجة الى احدى الحالات

1- Magnitude of the velocity only.

2- Direction of the velocity only.

3- Magnitude and direction of the velocity.

✓ If the velocity increases, then the sign of both velocity and acceleration must be the same (**positive or negative**)

✓ If the velocity decreases, then the sign of velocity and acceleration must be **opposite**, i.e. if one is positive the other must be negative.

Quantity Unit	Unit	Scalar / Vector
distance	**metre (m)**	**scalar**
Displacement	**metre (m)**	**Vector**
speed	**metre per second (m/s)**	**Scalar**
velocity	**metre per second (m/s)**	**vector**
acceleration	**metre per second squared (m/s^2)**	**vector**
time	**seconds**	**scalar**

Q1/

A plane flies from London Heathrow Airport to Dubai International Airport, a distance of approximately 5500 km at an average speed of 1200 km/h. The return trip was made at an average speed of 1050 km/h. Find the average speed for the whole journey.

Solution

Step 1. Write out the given values.

$$s = 5500\ km$$
$$u_1 = 1200\ km/h$$
$$u_2 = 1050\ km/h$$
$$u = ?$$
$$\therefore t = 5.24\ hours$$

Step 2. Trip time from London to Dubai.

$$t = \frac{distance}{average\ speed}$$
$$= \frac{5500}{1200} = \frac{55}{12}$$
$$\therefore t = 4.58\ hours$$

Step 3. Trip time from Dubai to London.

$$t = \frac{distance}{average\ speed}$$
$$= \frac{5500}{1050} = \frac{110}{21}$$

Step 4. The average speed for the whole journey.

$$Average\ speed = \frac{total\ distance}{total\ time}$$
$$= \frac{5500 + 5500}{\left(\frac{55}{12}\right) + \left(\frac{110}{21}\right)}$$
$$= \frac{11000}{\left(\frac{275}{28}\right)}$$
$$\therefore Average\ speed = 1120\ km/h$$

Some question about the lecture

Q1/ define scalar and vector?

Q2/ what is the type of acceleration? is a scalar or vector?

Q3/ the solved problem

Q4/ what is the type of linear motion?