Al-Mustaqbal University Colleg
Medical Physics Department

General Physics/ lecture 3

First stage

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Lecture 3

Outline

Force and its types

Newton's laws of motion

What is Force?

A force is a push or pull acting upon an object as a result of its interaction with another object that causes it to change its velocity. It has a magnitude and a direction (vector quantity).

القوة هي تأثير السحب او الدفع على الجسم نتيجة تفاعله مع جسم اخر ممايسبب تغير في سرعته. هي كمية متجها اي لها مقدار واتجاه.

What is formula for Force? معادلة القوة

The quantity of force is expressed by the product of mass (m) and acceleration (a). The equation or the formula for force can mathematically be expressed in the form of: القوة تساوي حاصل ضرب الكتلة في التعجيل

$$\vec{F} = m\vec{a}$$

Where: m = mass, a = acceleration

Acceleration a is given by: $a = \Delta v/\Delta t$

Where: v = velocity and t = time taken

So Force can be expressed as:

$$\mathbf{F = m\Delta v/\Delta t}$$

Unit of Force

- In the centimeter gram second system of unit (CGS unit) force is expressed in **dyne.**
- In the standard international system of unit (SI unit) it is expressed in **Newton (N)**

$$\text{Newton(N)} = \text{Kg M/S}^2$$

Types of Force

There are two types of forces based on their applications:

1. Contact Force

   Forces that act on a body either directly or through a medium are called contact forces.

   Examples of contact forces are:

   - Muscular Force
   - Mechanical Force
   - Frictional Force

2. Non-Contact Force

   Forces that act through spaces without making direct contact with the body are called non-contact forces.

   Examples of non-contact forces are:

   - Gravitational Force
   - Electrostatic Force
   - Magnetic Force

The force exerted by a magnet on other magnets is called **magnetic force**. Magnetic force and electrostatic force act on an object from a distance, that's the reason they are non-contact forces. The strength of gravity is an attractive force that is exerted

by the Earth on objects, which make them fall to the land. The weight of a body is the force that is pulled by the earth towards the center.

Solved Force Examples

Q.1) How much net force is required to accelerate a 1000 kg car at 4 m/s^2?

Solution:

Given,

- a = 4.00 m/s^2
- m = 1000 kg

Therefore,

F = ma = 1000 × 4 = 4000 N

Q.3) A hammer having a mass of 1 kg going with a speed of 6 m/s hits a wall and comes to rest in 0.1 sec. Compute the obstacle force that makes the hammer stop.

Solution:

Given,

- Mass of Hammer, m = 1 kg
- Initial Velocity, u = 6 m/s
- Final Velocity, v = 0 m/s
- Time Taken, t = 0.1 s

The acceleration is: **a** = $\Delta v/ \Delta t = (v_f - v_i)/t$

Therefore, a = -60 m/s^2 [-ve sign indicates retardation]

Thus, the retarding Force, F = ma = 1 × 60 = 60 N

Questions on Force

1. Which is the weakest force in nature?

Gravity is the weakest force as its coupling constant is small in value.

2. Which force is strongest?

The strongest force is the strong nuclear force which is 100 times stronger than the electromagnetic force.

3. What are some types of forces?

Basically, there are two types of forces:

- Contact forces
- Non-Contact forces

4. What are some examples of force?

Some examples of force are:

- Gravitational force
- Electric force
- Magnetic force
- Nuclear force
- Frictional force

5. Which force causes a charged balloon to attract another balloon?

Electrostatic force

Newton's laws of motion

❖ **Newton's First Law**

- states that "***an object at rest will remain at rest and an object in motion will remain in motion with a constant velocity unless external force acted on it***".

ينص قانون نيوتن الاول على ان "الجسم الساكن يبقى ساكن والجسم المتحرك بسرعة ثابتة يبقى في حركته مالم تؤثر عليه قوة خارجية تغير حالته".

- The tendency of an object to resist any attempt to change its velocity is called ***inertia***.

القصور الذاتي: هو مقاومة الجسم لمحاولة تغير حالته الحركية.

❖ **Newton's Second Law**

- states that "***the acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass***".

$$\vec{a} \propto \frac{\sum \vec{F}}{m} \rightarrow \sum \vec{F} = m\vec{a}$$

$\sum \vec{F}$ is the net force. May also be called the total force, resultant force

Gravitational Force $\vec{F}_g$ ***:*** is the force that the earth exerts on an object. This force is directed toward the center of the earth.

From Newton's Second Law:

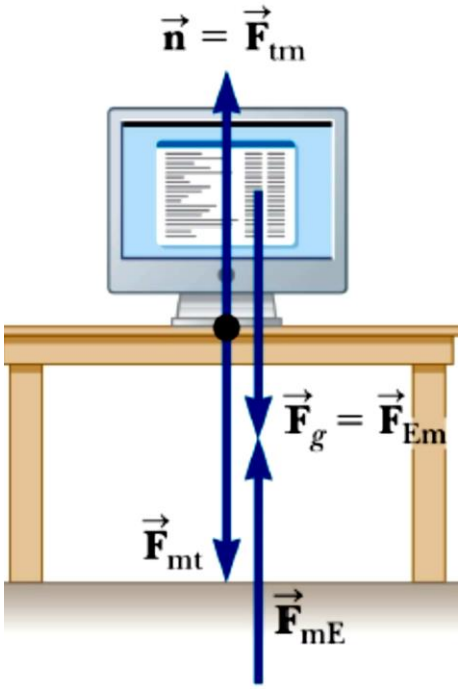
$$\vec{F}_g = m\vec{g}$$

Its magnitude is called the weight of the object

$$\text{Weight} = F_g = mg$$

❖ **Newton's Third Law**

- states that "***if two objects interact, the force*** $\overrightarrow{F_{12}}$ ***exerted by object 1 on object 2 is equal in magnitude and opposite in direction to the force*** $\overrightarrow{F_{21}}$ ***exerted by object 2 on object 1***
- The action force is equal in magnitude to the reaction force and opposite in direction.
- One of the forces is the action force, the other is the reaction force.
- The normal force (table on monitor) is the reaction of the force the monitor exerts on the table. (Figure)



- Normal means perpendicular, in this case The action (Earth on monitor) force is equal in magnitude and opposite in direction to the reaction force, the force the monitor exerts on the Earth.

Q1: A 60 Kg person walking at 1 m/sec bumps into a wall and stops in about 0.05 Sec. what is the force?

Sol: $F = ma = m\Delta v/\Delta t$

$\Delta(mv) = (60\ Kg)\ (1m/sec) - (60\ Kg)\ (0\ m/sec) = 60\ Kg\ m/sec$

the force developed on impact is

$F = \Delta\ (mv)/\Delta t = 60Kg\ m/sec\ /\ 0.05\ sec = 1200\ Kg\ m/sec^2$

F = 1200 Newton