AL- Mustaqpal University

Science College

Dep. Medical Biotechnology

Second Stage

Lec 3

The laws of kinetic physics
Interpretation of mechanical motion of bodies

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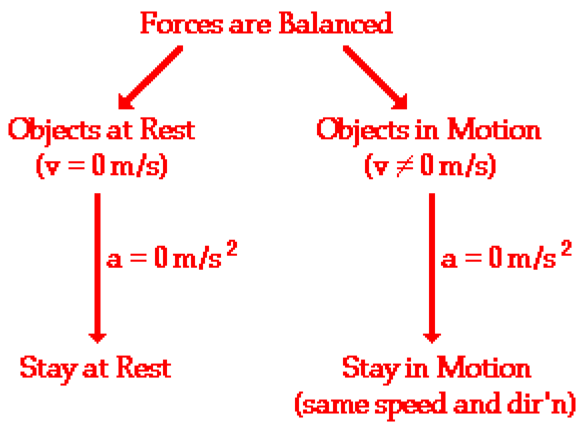
The laws of kinetic physics

Isaac Newton (17th century scientist) put forward a variety of laws that explain why things move (or don't move) when they are in motion. These three laws became known as Newton's three laws of motion. We focus initially on Newton's first law of motion - sometimes referred to as the law of inertia.

Newton's First Law of Motion (Inertia)

An object at rest remains at rest, and an object in motion remains in motion at constant speed and in a straight line unless acted on by an unbalanced force. There are two clauses or parts to this statement - one that predicts the behavior of stationary objects and the other that predicts the behavior of moving objects. The two parts are summarized in the following diagram.



The behavior of all objects can be described by saying that objects tend to "keep on doing what they're doing" (unless acted upon by an unbalanced force).

If at rest, they will continue in this same state of rest. If in motion with an eastward velocity of 5 m/s, they will continue in this same state of motion (5 m/s, East).

If in motion with a leftward velocity of 2 m/s, they will continue in this same state of motion (2 m/s, left).

The state of motion of an object is maintained as long as the object is not acted upon by an unbalanced force. All objects resist changes in their state of motion - they tend to "keep on doing what they're doing."

Here is an important condition that must be met in order for the first law to be applicable to any given motion. The condition is described by the phrase "... unless acted upon by an unbalanced force."

As the long as the forces are not unbalanced - that is, as long as the forces are balanced - the first law of motion applies .

Newton's Second Law of Motion

The acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object.

This verbal statement can be expressed in equation form as follows:

$$a = F_{net} / m$$

The above equation is often rearranged to a more familiar form as shown below. The net force is equated to the product of the mass times the acceleration.

$$F_{net} = m \bullet a$$

Newton's second law of motion states that **$F_{net} = ma$**, or net force is equal to mass times acceleration. A larger net force acting on an object causes a larger acceleration, and objects with larger mass require more force to accelerate .

As stated above, the direction of the net force is in the same direction as the acceleration. Thus, if the direction of the acceleration is known, then the direction of the net force is also known.

Example:

A body with a mass of 20 kg. What acceleration does it gain if it moves under the influence of a pulling force (10 N) ?

$$\mathbf{a = F_{net} / m}$$
$$= \frac{10}{20}$$
$$= 0.5 \ m / s^2$$

Newton's Third Law of Motion

If an object **A** exerts a force on object **B**, then object **B** must exert a force of equal magnitude and opposite direction back on object **A**

(*For every action force, there is a reaction force equal in magnitude and opposite in direction)*

This law signifies a particular symmetry in nature: forces always occur in pairs, and one body cannot exert a force on another without experiencing a force itself .

The above statement means that in every interaction, there is a pair of forces acting on the interacting objects. The magnitude of the forces are equal and the direction of the force on the first object is opposite to the direction of the force on the second object.

A variety of action-reaction pairs are evident in nature. We have listed a few below, and they are as follows:

- Propulsion of fish through water is an example of an action-reaction pair. A fish makes use of its fins to push water backwards. This push serves to accelerate the fish forwards. The size of the force on the water equals the size of the force on the fish; the direction of the force on the water (backwards) is opposite the direction of the force on the fish (forwards).

- The flight of the bird is an example of an action-reaction pair. The wings of the bird push the air downwards. The air pushes the air upwards.
- A swimmer pushes against the water, while the water pushes back on the swimmer.
- Lift is created by helicopters by pushing the air down, thereby creating an upward reaction force.
- Rock climbers pull their vertical rope downwards to push themselves upwards.

Interpretation of mechanical motion of bodies

Kinetic energy, form of energy that an object or a particle has by reason of its motion. If work, which transfers energy, is done on an object by applying a net force, the object speeds up and thereby gains kinetic energy. Kinetic energy is a property of a moving object or particle and depends not only on its motion but also on its mass. The kind of motion may be translation (or motion along a path from one place to another), rotation about an axis, vibration, or any combination of motions.
Translational kinetic energy of a body is equal to one-half the product of its mass, m, and the square of its velocity, v, or $\mathbf{KE = \frac{1}{2} mv^2}$
This formula is valid only for low to relatively high speeds

Mechanics, science concerned with the motion of bodies under the action of forces, including the special case in which a body remains at rest. Of first concern in the problem of motion are the forces that bodies exert on one another. This leads to the study of such topics as gravity, electricity, and magnetism, according to the nature of the forces involved. Given the forces, one can seek the manner in which bodies move under the action of forces; this is the subject matter of mechanics proper.

Mechanics may be divided into two branches: **Statics**, which deals with forces acting on and in a body at rest; **Kinematics**, which describes the possible motions of a body or system of bodies;   and attempts to explain or predict the motion that will occur in a given situation. Alternatively, mechanics may be divided according to the kind of system studied. The simplest mechanical system is the particle, defined as a body so small that its shape and internal structure are of no consequence in the given problem. More complicated is the motion of a system of two or more particles that exert forces on one another and possibly undergo forces exerted by bodies outside of the system.