Simple Machines

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1. Introduction

Newtons Laws of Motion

The first law talks about what happens to bodies in the absence of any forces. The second law talks about what happens to bodies in the presence of a force. It is this law that also serves to define what a force is quantitatively. The third law also talks about force.

First Law

Every body continues to be in its state of rest or of uniform motion in a straight line (uniform velocity) unless compelled by an external force.

This tendency of bodies whereby they do not change their state of motion in the absence of a force is called as inertia.

Second Law

Mass may be defined as the measure of a bodies inertia. Thus greater the mass of a body, the greater is its inertia. Thus greater the force needed to change its state of motion or in otherwords to cause acceleration in a body. This is what is contained in the following equation. F = ma.

Everybody has an acceleration when a force acts on it which is dependent upon the mass of the body.

Third Law

Every action has an equal and opposite reaction.

Principles of Friction

Work

In physics, work is said to be done not by a person, but by a force. Work is done by a force when its point of application moves in the direction of force.

When the point of application moves against the direction of force, work is said to be done against the force.

Work done by a force is measured by the product of the force and the displacement of the point of application in the direction of the force. Mathematically this is represented by the dot product.

W = F. d

Energy

Energy is defined as the capacity to do work.

There are different forms of energy. Potential Energy, Kinetic Energy, Heat, Light, Sound etc. Potential energy is stored energy whereas Kinetic energy is the energy of motion. A body might have potential energy stored in it due to its height, such as the energy of a brick which has been raised to a height or the water in a dam. There is also chemical energy stored in the food we eat. This chemical

potential energy is converted into kinetic energy by our muscles and ultimately into heat energy, say when we rub our hands together. The energy in food can also be directly converted into heat and light by adding certain chemicals.

Conservation of Energy

When the total energy change in a physical process was observed it was seen that the total energy remains the same before and after a physical process. Energy can neither be created nor destroyed but can only be transformed from one form to another.

Simple Machines

- A machine is something that helps you use you energy more effectively.
- The different types of simple machines
  - Inclined plane
  - Lever
  - Wheel and axle
  - Pulleys
  - Wedge
- The lever and the inclined plane are the two basic machines. Other simple machines are mostly a modification of the lever and inclined plane.
- In all cases we have the relation , $W_{in} = W_{out}$
- The force that you input is also called the effort (E). This force is applied to overcome a force that is called the load or resistance (R)
- We can then write the above relation as

  $$E \times de = R \times dr$$

  , where de is the distance through which the effort acts and dr is the distance through which the load moves.
- The mechanical advantage of the machine is defined as the ratio of the resistance to the effort.

  $$ME = \frac{R}{E}$$

  which is also equal to

  $$ME = \frac{de}{dr}$$
- The mechanical advantage of a machine has to be greater than 1 in order for it to reduce our effort.

Inclined plane

- It allows you to trade increased distance for decreased effort or force.
- Consider loading a heavy weight onto a truck by lifting it directly versus rolling it on an inclined plane. In the latter case the force acts over a longer distance so that the force required to push it is lesser. The force required changes depending on the steepness of the inclined plane.
- Examples of inclined planes in daily life:

Lever

- It is another kind of simple machine which consits of a bar resting on a fulcrum. It has two arms the effort arm and the resistance arm which balances two forces, the effort and the resitance.
- The principle of the lever was stated first by Archimedes. It states that, "The longer the arm of the lever to which force force is applied, the less that force need be."
- Examples of levers in daily life:
  - Using a hammer to pull a nail out of a plank of wood.
  - A can or soda opener.
- Levers are of three different types. [refer to text.]

Mechanical advantage and friction

- The mechanical advantage of the inclined plane is in most cases less than that of the lever.
- This is because friction is involved to a greater extent when two objects are pushed against each other. In order to overcome the force of friction more effort has to be supplied and this reduces the mechanical advantage offered by the machine.
- With the lever however, the area of contact is greatly reduced and hence the role of friction is reduced to a great extent.

Screw

- A screw is a modified form of an inclined plane.
- It can be considered as an incline plane wrapped around a cylinder.
- Example of screws in daily life are:

Wedge

- A wedge is also a modified form of the inclined plane.
- It consists of two inclined planes joined together.
- Example of the use of wedge in daily life are:

Pulleys

- A pulley consits of a wheel with a grooved rim which can rotate freely around an axle.
- The axle is supported by a framework called the block.
- A string or rope passes around the wheel
- The chief function of the pulley is to equalise the tension in the string on either side of the pulley.
- Pulleys can be classified into two types. Fixed pulleys and movable pulleys.
- Fixed pulleys are attached to a fixed support
- Movable pulleys are attached to the resistance and moves along with the resistance.
- Examples of pulleys in daily life are:

1.0.1 Uniform Circular Motion

Centripetal Force

Centrifugal Force

2. Uses of simple machines in health care and medical practice
3. Different types of levers in the Human body
4. Traction