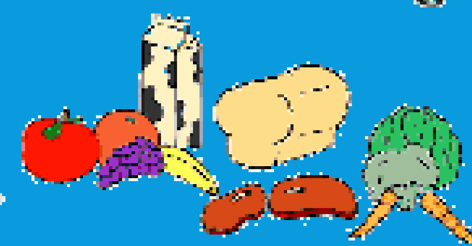
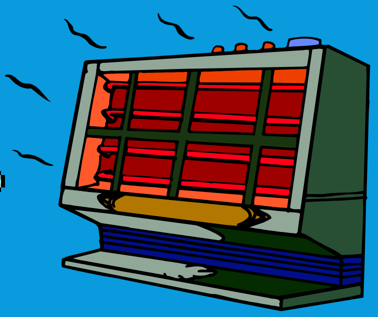
ENERGY



ENERGY

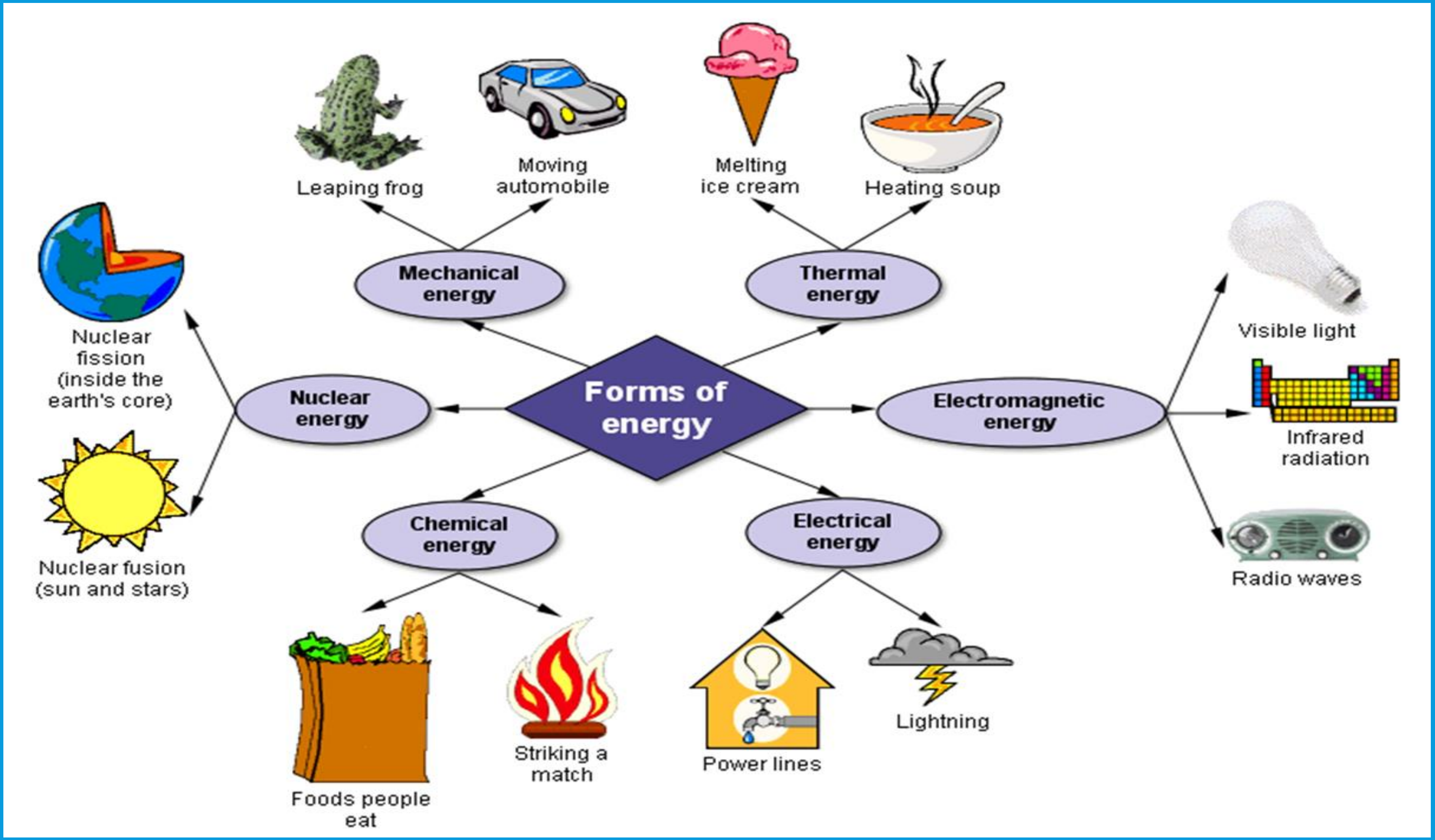
The word *energy* derives from the Ancient Greek: *energeia* "activity, operation", which possibly appears for the first time in the work of Aristotle in the 4th century BC. In 1807, Thomas Young was possibly the first to use the term "energy" in its modern sense. Gustave-Gaspard Coriolis described "kinetic energy" in 1829 in its modern sense, and in 1853, William Rankine coined the term "potential energy".

We use energy to do work in our day to day life. Energy from the sun gives us light during the day. Energy powers our vehicle, trains and airplanes. Energy warms our home, plays our music, cooks our food, and gives us picture on tv. Energy powers machinery in factories and tractors on a farm. Everything we do is connected to energy in one form or another.



Energy is defined as an ability to perform work or act.

Energy is a scalar quantity. Energy can be stored in an object, or it can be transferred from one object to another. Energy is intangible and cannot always be perceived. All form of energy are associated with motion.



TYPES OF MECHANICAL ENERGY

Energy has a number of different forms all of which measure the ability of an object to do work on another object. There are two main types of mechanical energy which are:

- kinetic energy
- potential energy

KINETIC ENERGY

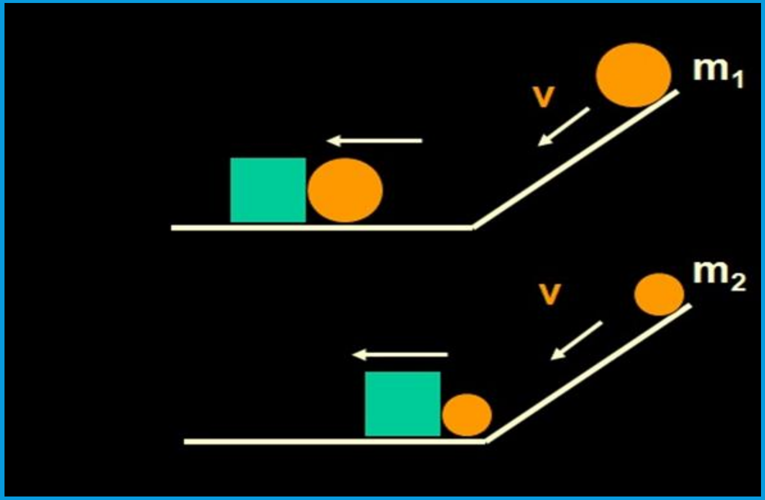
It takes energy to makes things move. You transfer energy to a ball when you throw it or hit it. A car uses energy from its fuel to get it moving So a moving object is a a store of energy. This energy is known as kinetic energy. We often make use of an object's kinetic energy, To do this, we must slow it down. For example, moving air turn a wind turbine. This slows the air, reducing its kinetic energy.

This suggest that the kinetic energy of an object depends on two factor:

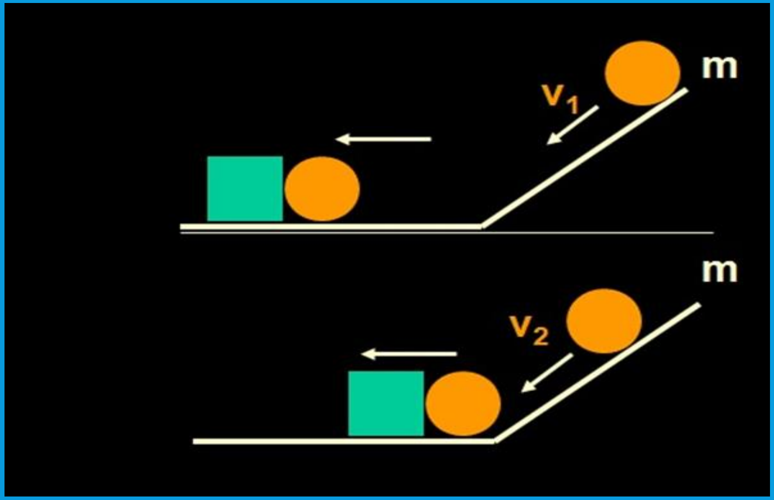
- the object's mass m – the greater the mass, the greater its kinetic energy (picture 1)
- the object's speed v – the greater the speed, the greater its kinetic energy (picture 2)

This are combined in a formula for kinetic energy:

$$kinetic\ energy = \frac{1}{2} x\ mass\ x\ speed^2 \Rightarrow E_K = \frac{1}{2} m v^2$$



picture 1

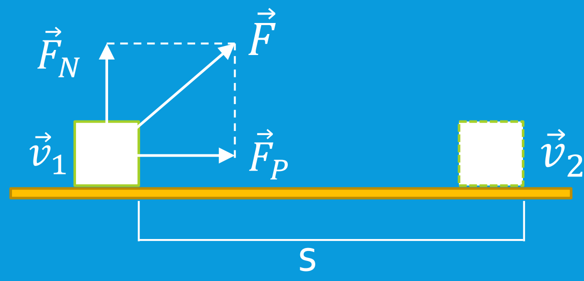


picture 2

Note also that kinetic energy (like all form of energy) is a scalar quantity.

WORK AND KINETIC ENERGY

Let us consider a constant force $\vec{F}$ acting on a body (it can be resultant of several forces). It can be said about the force $\vec{F}$ that, firstly, it imparts an acceleration to the body, due to which its velocity varies and secondly, the force $\vec{F}$ does a work since the body is moving. We can expect that there is a certain relation between the work done by the force and the change in the velocity of the body. Let us establish this relation.



The work done by the force in this case is:

$$W = F_P \cdot s \ldots (1)$$

Acording to Newton's second law, we have:

$$F_P = m \cdot a \ldots (2)$$

It was shown in earlier lesson that in a uniformly accelerated rectilinear motion, the velocity and distance are connected through the following relation:

$$s = \frac{v_2^2 - v_1^2}{2 \cdot a}$$

Where v_1 and v_2 are the magnitudes of the initial and final velocity vectors on the segment of the path under consideration.

substituting into formula (1) expressions (2) and (3) for F and s we obtain:

$$W = m \cdot a \cdot \frac{v_2^2 - v_1^2}{2 \cdot a} \Rightarrow W = \frac{m \cdot v_2^2}{2} - \frac{m \cdot v_1^2}{2}$$

We obtained the formula relating the work done by the force $\vec{F}$ to the change in the velocity of the body (to be more precise, the square of its velocity)

WORK–ENERGY THEOREM

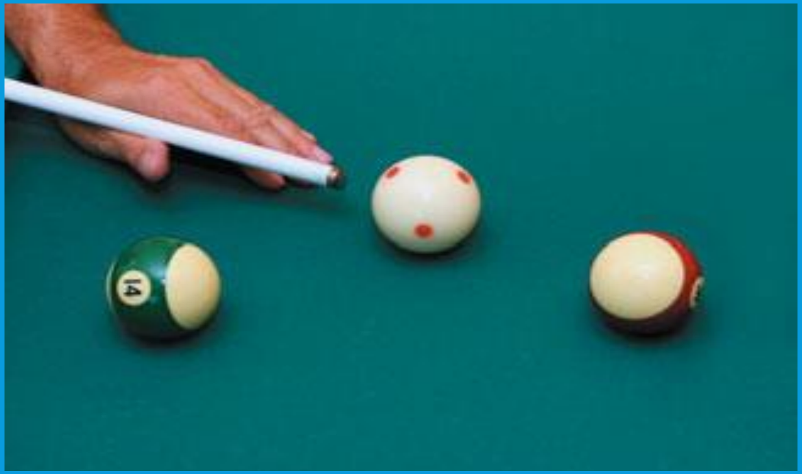
The work done by the resultant of force applied to the body is equal to the change in its kinetic energy. This statement is called the work-energy theorem.

$$W = E_{K2} - E_{K1}$$

- When a force on a body is directed along its trajectory of motion, and hence does a positive work, then $mv_2^2/2 - mv_1^2/2 > 0$. This means that $mv_2^2/2 > mv_1^2/2$,so the kinetic energy of the body increases. This is what should be expected, since the force directed along the displacement of the body increases the magnitude of its velocity.
- It can be easily seen that when the force is directed against the displacement, and hence does a negative work, the kinetic energy of the body decreases.

It fallows that kinetic energy is expressed in the same units as work in joules.

When a billiards player hits a cue ball at rest, the ball's kinetic energy after being hit is equal to the work that was done on it by the cue. The greater the force exerted by the cue and the greater the distance the ball moves while in contact with it, the greater the ball's kinetic energy.



PROBLEMS

1. Which of the following has greater kinetic energy:
   a) A 20-tonne truck travelling at a speed of $30\,\frac{m}{s}$
   b) A 1,2 g dust particle travelling at $150\,\frac{km}{s}$ throught space

2. A 50 g ball is thrown upward from the ground with initial velocity $20\,\frac{m}{s}$. Find kinetic energy of the ball:
   a) after 1 s
   b) after distance of 5 m

3. A car of mass 2 t starts from rest accelerates uniformly with $0{,}8\,\frac{m}{s^2}$. Find kinetic energy of a car
   a) after 10 s
   b) after distance of 20 m

4. A body of 4 kg is raised vertically to a height of 10 m by a force of 50 N. Find the final kinetic energy of the body using two methods:
   Newton's secont law and the work-energy theorem. The initial velocity is zero.

5. A body of 1kg falls from a large height with zero initial velocity. Find the increment in the kinetic energy during the sixth second of its motion?

6. What is the work that must be done to increase the velocity of a train from $v_1 = 72\,\frac{km}{h}$ to $v_2 = 108\,\frac{km}{h}$, if the mass of the train is 1000 t ? What force must be applied to the train to attain this increase in velocity over a distance 2000 m ?Use work-energy theorem to solve problem.

7. A 10 g bullet moving at $600\frac{m}{s}$ strikes a tree and penetrates a distance of 8,34 mm before stopping.Find the magnitude of average resistance force that stops bullet ?Use work-energy theorem to solve problem.

8. A stone pushes over on ice surface with the velocity $v_0 = 2\frac{m}{s}$ slides over a distance of $s = 20{,}4$ metres before it stops. Find the coefficient between the stone and the ice ?Use work-energy theorem to solve problem.

9. A block of mass m=10 kg is pushed to the right by a horizontal force F=30 N. Under the influence horizontal force F, velocity of a block increase from $2\frac{m}{s}$ to $6\frac{m}{s}$ over a distance of 6 meteres. Find the friction force over that distance ? Use work-energy theorem to solve problem.