Edinburgh Napier UNIVERSITY

Physics-Based Animation (SET09119)

Tutorial 06 - Notes - Energy, Work & Power

1 Energy, Work & Power

1.1 What is Energy, Work & Power?

Energy - is the capacity for doing work. You must have energy to accomplish work - it is like the "currency" for performing work. To do 100 joules of work, you must expend 100 joules of energy.

Work - refers to an activity involving a "force and movement" in the direction of the force. A force of 20 newtons pushing an object 5 meters in the direction of the force does 100 joules of work.

Power - is the rate of doing work or the rate of using energy, which are numerically the same. If you do 100 joules of work in one second (using 100 joules of energy), the power is 100 watts.

- in this tutorial you will work out how to calculate energy, work, and power
- work out the loss of kinetic energy during a collision

2 Work

The work done by a force is defined as:

$$\text{work done} = (force)(distance)$$

The units of work done are joules (J).

$$\begin{aligned} \text{work done} &= \text{gain in K.E.} \\ &= \frac{1}{2}mv^2 - \frac{1}{2}mu^2 \end{aligned} \tag{1}$$

3 Power

Power is the rate at which work is done. It is the work/time ratio. Mathematically, it is computed using the following equation.

$$power = \frac{work}{time}$$

(note - we can substitute the equation for work into the power equation (i.e., $force \times distance$)

$$\begin{aligned} power &= \frac{work}{time} \\ &= \frac{(force)(distance)}{time} \\ &= (force)\frac{distance}{time} \\ &= (force)(velocity) \end{aligned}$$

4 Kinetic Energy (K.E.)

All moving things have kinetic energy. It is energy possessed by an object due to its' motion or movement. These include very large things, like planets, and very small ones, like atoms. The heavier a thing is, and the faster it moves, the more kinetic energy it has.

$$KE = \frac{1}{2}mv^2$$

5 Potential Energy (P.E.)

An object can store energy as the result of its position. For example, the heavy ball of a demolition machine is storing energy when it is held at an elevated position. This stored energy of position is referred to as potential energy. Similarly, a drawn bow is able to store energy as the result of its position. When assuming its usual position (i.e., when not drawn), there is no energy stored in the bow. Yet when its position is altered from its usual equilibrium position, the bow is able to store energy by virtue of its position. This stored energy of position is referred to as potential energy. Potential energy is the stored energy of position possessed by an object.

$$P.E. = m\ g\ h$$

where P.E. represents the potential energy, m the mass, h the height of the object above the ground, and g the gravitational constant (i.e., 9.8 N/kg on Earth).

5.1 Question

Determine the kinetic energy of a 625-kg roller coaster car that is moving with a speed of 18.3 m/s.

Solution:
K.E. = $(0.5)(m)(v^2)$ K.E. = $(0.5)(625)(18.3)^2$ K.E. = $(1.05x10^5)$ Joules

---

6 Summarize

- work done = (force)(distance), where force is constant
- the units of work done are J (joules)
- work done = gain in K.E.
  $Fs = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$
- potential energy is mgh, where h is measured from the ground
- on a smooth surface, there is a conservation of total energy
  $\frac{1}{2}mv_1^2 + mgh_1 = \frac{1}{2}mv_2^2 + mgh_2$
- the units of the P.E. are the J (joules)
- power is the rate of doing work
- the units of power are W (watt)
- power = (force)(velocity), where force is constant