No clickers & yes calculators.

READ the Launch lab on page 257

Get a piece of paper and set-up a table to collect data.

Write the questions you will need to answer.

Apr 26-11:51 AM

Section 10.1: Energy and Work

In this section you will:

- **Describe** the relationship between work and energy.
- **Calculate** work.
- **Calculate** the power used.

Section 10.1-1

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A change in momentum is the result of an impulse, which is the product of the average force exerted on an object and the time of the interaction.

Consider a force exerted on an object while the object moves a certain distance. Because there is a net force, the object will be accelerated, $a = F/m$, and its velocity will increase.

Go to page 68 and point to the formula with velocity^2

In the equation $v_f^2 - v_i^2 = 2ad$

, if you use Newton's second law to replace a with F/m and multiply both sides by $m/2$, you obtain:

$$\frac{\cancel{m}}{\cancel{2}} \cdot \cancel{2}\,\frac{F}{\cancel{m}} \cdot d = (v_f^2 - v_i^2)\,\frac{m}{2}$$

$$F \cdot d = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

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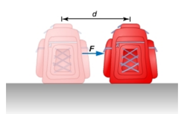
A force, F, was exerted on an object while the object moved a distance, d, as shown in the figure.

If F is a constant force, exerted in the direction in which the object is moving, then **work**, W, is the product of the force and the object's displacement.

Work is equal to a constant force exerted on an object in the direction of motion, times the object's displacement.



$$W = Fd = N \cdot m$$

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Recall that $Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$.

Hence, rewriting the equation $W = Fd$ gives

$$W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

The right side of the equation involves the object's mass and its velocities after and before the force was exerted.

$\frac{1}{2}mv_i^2$ describes a property of the system.

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The ability of an object to produce a change in itself or the world around it is called **energy**.

The energy resulting from motion is called **kinetic energy** and is represented by the symbol *KE*.

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

The kinetic energy of an object is equal to half times the mass of the object multiplied by the velocity of the object squared.

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Substituting *KE* into the equation

$W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ results in $W = KE_f - KE_i$.

The right side is the difference, or change, in kinetic energy.

The **work-energy theorem** states that when work is done on an object, the result is a change in kinetic energy.

Work is equal to the change in kinetic energy.

$$W = \Delta KE$$

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The relationship between work done and the change in energy that results was established by nineteenth-century physicist James Prescott Joule.

To honor his work, a unit of energy is called a **joule** (J).

For example, if a 2-kg object moves at 1 m/s, it has a kinetic energy of

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

$1 \cdot 1^2 =$

1 Joule

1 J

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Through the process of doing work, energy can move between the external world and the system.
The direction of energy transfer can go both ways. If the external world does work on a system, then W is positive and the energy of the system increases.
If, however, a system does work on the external world, then W is negative and the energy of the system decreases.
In summary, work is the transfer of energy by mechanical means.

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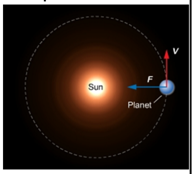
Calculating Work

The equation $W = Fd$ holds true only for constant forces exerted in the direction of motion. An everyday example of a force exerted perpendicular to the direction of motion is the motion of a planet around the Sun, as shown in the figure.

If the orbit is circular, then the force is always perpendicular to the direction of motion.

A perpendicular force does not change the speed of an object, only its direction. Consequently, the speed of the planet does not change.
Therefore, its kinetic energy is also constant.



Using the equation $W = \Delta KE$, you can see that when KE is constant, $\Delta KE = 0$ and thus, $W = 0$.

This means that if F and d are at right angles, then $W = 0$.

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Because the work done on an object equals the change in energy, work also is measured in joules.

One joule of work is done when a force of 1 N acts on an object over a displacement of 1 m.

An apple weighs about 1 N. Thus, when you lift an apple a distance of 1 m, you do __1__ J of work on it.

$W = f \cdot d$

$1N \cdot 1m$

$= 1J$

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Example 1:

A 105-g hockey puck is sliding across the ice. A player exerts a constant 4.20-N force over a distance of 0.140 m. How much work does the player do on the puck? What is the change in the puck's energy?

$m = .105\,Kg$

$F = 4.20\,N$

$d = 0.140\,m$

$\Delta KE = .588\,J$

$W = ?$

$KE = ?$

$W = f \cdot d$

$(4.20)(0.140)$

$W = .588\,J$

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Example 2:

A 105-g hockey puck is sliding across the ice. A player exerts a constant 4.20-N force over a distance of 0.140 m. If the force doubled, how would the puck's change in kinetic energy be affected?

$8.4 \cdot .140 = 1.176 \text{ J}$

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Example 3:

If 3 students exert a force of 725 N pushing a car 20 m, how much work do the students do on the car?

$725 \cdot 20 = 14,500 \text{ J}$

$1.45 \times 10^4 \text{ J}$

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Example 4:

A mountain climber wears a ~~60~~ 6.0 kg backpack while climbing Mt. Everest. After 20 minutes, the climber is 7.4 m above the starting point. How much work does the climber do on the backpack? If the climber weighs 625 N, how much work does she do lifting herself and the backpack?

$W = F \cdot d$

$(6.0)(9.8)7.4$

$W = 435.12 \text{ J}$ $4.35 \times 10^2 \text{ J}$

$W = F \cdot d$

$(625 + 58.8)7.4$

$(683.8)7.4$

$5,060.12 \text{ J}$

$5.06 \times 10^3 \text{ J}$

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Pg. 261

1-3 all

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