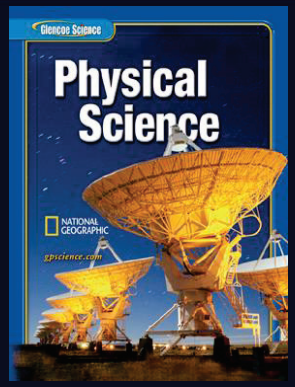
5



5

Unit 1: Energy and Motion

5.1

What is work?

- To many people, the word *work* means something they do to earn money.
- The word *work* also means exerting a force with your muscles.

5.1

Work Makes Something Move

- Remember that a force is a push or a pull. In order for work to be done, a force must make something move.
- **Work** - the transfer of energy that occurs when a force makes an object move.
- If you push against the desk and nothing moves, then you haven't done any work.

5.1

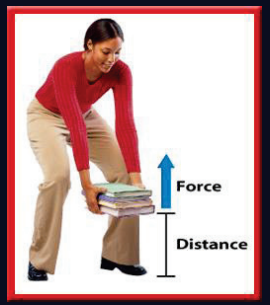
Doing work

- There are two conditions that have to be satisfied for work to be done on an object.
- For work to be done-
- Applied force must make the object move Movement must be in the same direction as the applied force.

5.1

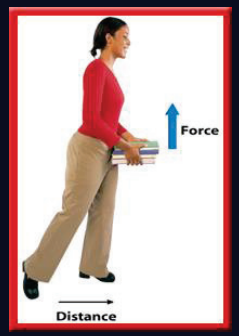
Doing work

- For example, when you lift a stack of books, your arms apply a force upward and the books move upward. Because the force and distance are in the same direction, your arms have done work on the books.



5.1

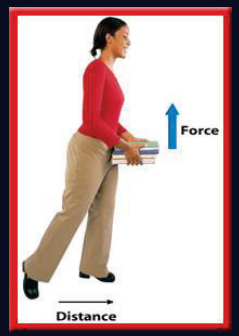
Force and Direction of Motion



- When you carry books while walking, you might think that your arms are doing work.
- However, in this case, the force exerted by your arms does no work on the books.

5.1

Force and Direction of Motion



- The force exerted by your arms on the books is upward, but the books are moving horizontally.
- The force you exert is at right angles to the direction the books are moving.

5.1

Work and Energy

- When work is done, a transfer of energy always occurs.
- This is easy to understand when you think about how you feel after carrying a heavy box up a flight of stairs.
- You transferred energy from your moving muscles to the box and increased its potential energy by increasing its height.

5.1

Work and Energy

- You may recall that energy is the ability to cause change.
- Energy is also the ability to do work.
- If something has energy, it can transfer energy to another object by doing work on that object.

5.1

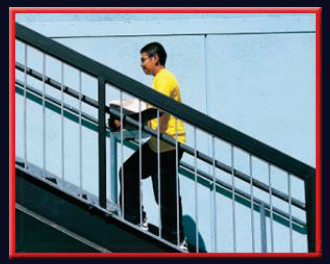
Work and Energy

- When you do work on an object, you increase its energy.
- The student carrying the box transfers chemical energy in his muscles to the box.

5.1

Work and Energy

- Energy is always transferred from the object that is working to the object on which the work is done.



5.1

Calculating Work

- The amount of work done depends on the amount of force exerted and the distance over which the force is applied.

Work Equation

work (in joules) = **applied force** (in newtons) × **distance** (in meters)

$$W = Fd$$

5.1

Power

- Suppose you and another student are pushing boxes of books up a ramp and load them into a truck.
- To make the job more fun, you make a game of it, racing to see who can push a box up the ramp faster.

5.1

Power

- **Power** is the amount of work done in one second.

It is a rate—the rate at which work is done.

5.1

Calculating Power

- To calculate power, divide the work done by the time that is required to do the work.

Power Equation

$$\text{Power (in watts)} = \frac{\text{work (in joules)}}{\text{time (in seconds)}}$$

$$P = \frac{W}{t}$$

- The unit for power is the watt (W).
- 1 watt = 1 joule/second.

5.1

Calculating Power

- Because the watt is a small unit, power often is expressed in kilowatts.
- One kilowatt (kW) equals 1,000 W.

5.1

Power and Energy

- Power rate at which energy is transferred.
- When energy is transferred, the power involved can be calculated by dividing the energy transferred by the time needed for the transfer to occur.

Power Equation for Energy Transfer

$$\text{power (in watts)} = \frac{\text{energy transfered (in joules)}}{\text{time (in seconds)}}$$

$$P = \frac{E}{t}$$

Section Check

5.1

Question 1

_____ is the transfer of energy that occurs when a force makes an object move.

A. Conversion
B. Energization
C. Power
D. Work

CHAPTER RESOURCES

END