

Ch. 15 & 16: Forces, Motion and Machines

Ch. 15 & 16 Vocab

- Force: a push or pull
- Friction: the force that resists the movement of one surface past another
- Gravitational Force: the force of attraction between the objects in the universe
- Speed: a measure of how fast an object is moving
- Velocity: the speed of an object in a particular direction

Vocab

- Acceleration: the rate at which velocity changes
- Inertia: the tendency of an object to remain at rest or in constant motion unless a force acts on it
- Momentum: a measure of the force needed to stop a moving object
- Work: to use force in order to move an object a certain distance
- Machine: any device that helps people do work

Vocab

- Simple Machine: a tool made up of one or two parts
- Compound Machine: a machine made up of one or more simple machines
- Fulcrum: a support on which a lever rests while moving or lifting an object
- Load: force of an object on a lever
- Effort Force: a force applied to the end of a lever to lift a load

Ch. 15.1 What happens when forces act on objects?

Forces

- A force has both size and direction
- Some forces act only if objects touch
 - Hands pushing a box
- Other forces act even if objects don't touch
 - Earth's gravity pulls you when you jump
 - Magnets push or pull each other

Measuring Forces

- Forces are measured in units called newtons (N)
- One newton is the force needed to change the speed of a one-kilogram object by one meter per second each second
 - It takes about one newton of force to lift a small apple
- Force can be measured using a spring scale
 - Attach an object to one end of the scale and hold it up
 - The spring inside stretches to show the force needed to support the object

Forces on Objects

- There are more than one force acting on an object at a time
 - Flying a kite
 - Weight of kite pulls it down
 - Force of wind pushes it up
 - You guide the kite by applying force on the string
- The combination of all the forces acting on an object determines the effect of the forces
- Balanced forces cause no change in motion, even if the object is moving
- Unbalanced forces can cause an object at rest to move
- Can also change the speed or direction of a moving object

Forces on Objects

- To find the overall effects of forces acting on an object, you add the forces together
- The resulting force is called the net force
- Net force doesn't always determine the direction that an object moves
- It determines the change in an object's motion
- EX: there is a 5N force pulling an object to the right while a 3N force pulls to the left
- Net force is 2N to the right

Friction

- There are 3 types of friction
- Rolling: resists the motion of a rolling object
 - EX: resists the motion of a skateboards wheels
- Sliding: resists the motion of a sliding object
 - EX: pushing a box across the floor
- Static: resists the motion of an object just as it begins to move
 - EX: first trying to push the box

Friction

- Friction depends on the type of surfaces rubbing against each other and how strongly they are pushed together
- Friction is mainly caused by rough surfaces
- Even surfaces that appear smooth have tiny bumps and holes
- Friction is usually greater for rough surfaces
- If both surfaces are very smooth and flat, the attraction of their particles increases their friction
- A soft or rubbery surface also has more friction because it easily bends

Helpful and Harmful Friction

- Friction is useful for many things
- Walking across a room would be like walking on ice without friction
- Friction of the brake pads on the brake drum helps slow down a car
- Friction can also be harmful
- Heat produced by friction makes engines from less efficiently
- Friction between wind and soil can cause erosion
- Also wears away the rubber on tires and form holes in the soles of shoes

Ch. 15.2 How does gravity affect objects?

Gravitational Force

- Earth's gravity pulls all objects on Earth toward Earth's center
- Gravitational force holds water in the ocean and holds the air near the Earth
- It also affects the way plants grow and the way your bones develop
- Isaac Newton was the first to explain the many details of gravity
- Realized that gravity depends on the masses of the two objects that exert gravitational forces on each other

Gravitational Force

- The greater the mass of an object the stronger its gravitational force
- Astronauts on the Moon experience a lower gravitational force because the Moon has less mass than Earth
- Gravitational force depends on the distance between two objects
- As distance increases, gravitational pull decreases

Gravity and the Universe

- The gravitational forces that impact us on Earth, also occur in the solar system
- We don't feel the Sun's gravitational pull because we are farther away from its center
- The closer to the center of an object you are, the stronger the gravity

Tides

- A tide is a rise or fall in water level near the ocean's shore
- Most coastal areas around the world have two high tides and two low tides a day
- The Moon's gravity pulls on the ocean
- The part of the Earth facing the Moon has a high tide so does the opposite side of the Earth
- The other parts of Earth experience a low tide

Ch. 15.3 How can you describe motion?

Observing Motion

- In order to determine if another object is moving, you must view it in relation to another object that appears to stay in place
- This is called your frame of reference
- How would you describe your motion right now?

Kinds of Motion

- Circular Motion: takes place around a central point
- Straight Line Motion: motion that takes place in a straight line
- Vibrational Motion: a rapid back and forth movement

Calculating Speed

- You can find speed by dividing the distance traveled by the time needed to move that distance
- Often measured in kilometers per hour
- Average speed= distance/time
- An object's speed at any time is its instantaneous speed

Velocity

- When an object changes direction its velocity changes
- Even if the speed stays the same, the velocity is different
- Even going around a curved road at the same speed changes the velocity

Acceleration

- The motion of moving objects usually isn't constant
- The instantaneous speed and direction of motion may change
- Acceleration isn't just an object going faster
 - It can also happen when an object slows down or changes direction
- Velocity can only change if a force acts on the object
- Acceleration is therefore the result of unbalanced forces acting on the object

Ch. 15.4 What are the laws of motion?

First Law of Motion

- Isaac Newton came up with 3 laws of motion
- An object at rest remains at rest and an object in motion remains in motion at constant speed and in a straight line, unless acted on by an unbalanced force
 - If you put a book on a table it won't move until you move it
 - Throw a baseball and it will keep moving
- This first law is sometimes called the law of inertia
- The amount of inertia an object has depends on its mass
- The greater the mass the greater its inertia

Second Law of Motion

- The acceleration of an object depends on the mass of the object and the size of the net force applied

Using an Equation

- The second law of motion can be written as an equation
 - Acceleration= force/mass
 - Force: net force applied to the object
 - Mass: the object's mass
 - Acceleration: object's acceleration
- Not all forces cause a change in motion
- Only unbalanced forces cause an object to accelerate

Third Law of Motion

- When a force is applied to an object, the object exerts an equal force in the opposite direction

Momentum

Ch. 16.1 How do machines help people work?

Measuring Work

- Work in science has a different meaning than what is used in everyday life
- Work means using force, pushing or pulling, in order to move an object a certain distance
- No matter how much force you use, if the object doesn't move you haven't done work
- To find out how much work is done, use this formula
 - $\text{Work} = \text{force} \times \text{distance}$
- Work measured in a unit called the joule(j)
 - $1 \text{ joule (j)} = 1 \text{ newton (N)} \times 1 \text{ meter (m)}$

Work and Machines

- There are many different types of machines
- Some can be as simple as chop sticks
- Others are complicated and can have thousands of parts

How Machines Help

- Every machine makes some kind of tradeoff that helps in some way
- Work is equal to force times distance
- EX: wheelbarrow moving dirt
- Car jack lifting a car

Machines and Friction

- In order for a machine to do its job, work must go into it
- A person using the machine or a battery is providing the work
- The amount of work done by a machine is less than the amount put into it
- This is because of friction
- Heat is often a result of friction
- Ways to reduce friction include using lubricants, wheels, or rollers

Ch. 16.2 What are types of simple machines?

Lever

Inclined Plane

- An incline plane is a slanted surface
- An inclined plane reduces the force needed to move the load, but the load travels farther up the ramp
- You are doing the same amount of work either way

The Wedge

The Screw

- A screw is a type of inclined plane wrapped in a spiral

Wheel and Axle

Pulley

Compound Machines