

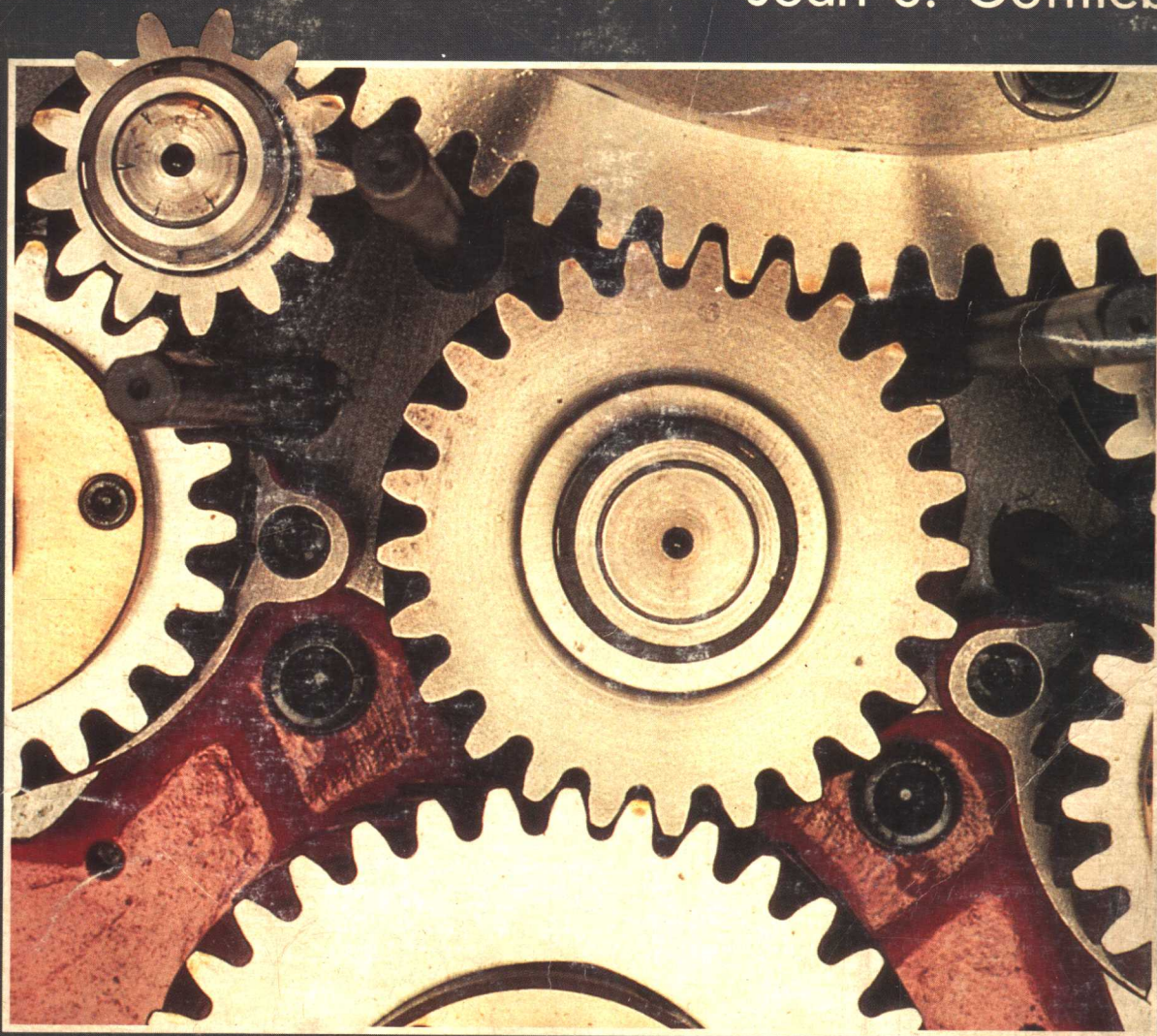


THE WONDERS OF SCIENCE

# MATTER, MOTION, AND MACHINES

Revised Edition

Joan S. Gottlieb







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# **MATTER, MOTION, AND MACHINES**

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Joan S. Gottlieb

Illustrated by Ben Smith and Jessie Flores



**STECK-VAUGHN COMPANY**

**AUSTIN, TEXAS**

A Division of National Education Corporation



Cover Photo by The Image Bank/Michael Melford

**NOTICE:** Final reviews are bound in the back of the book.

**ISBN 0-8114-1383-7**

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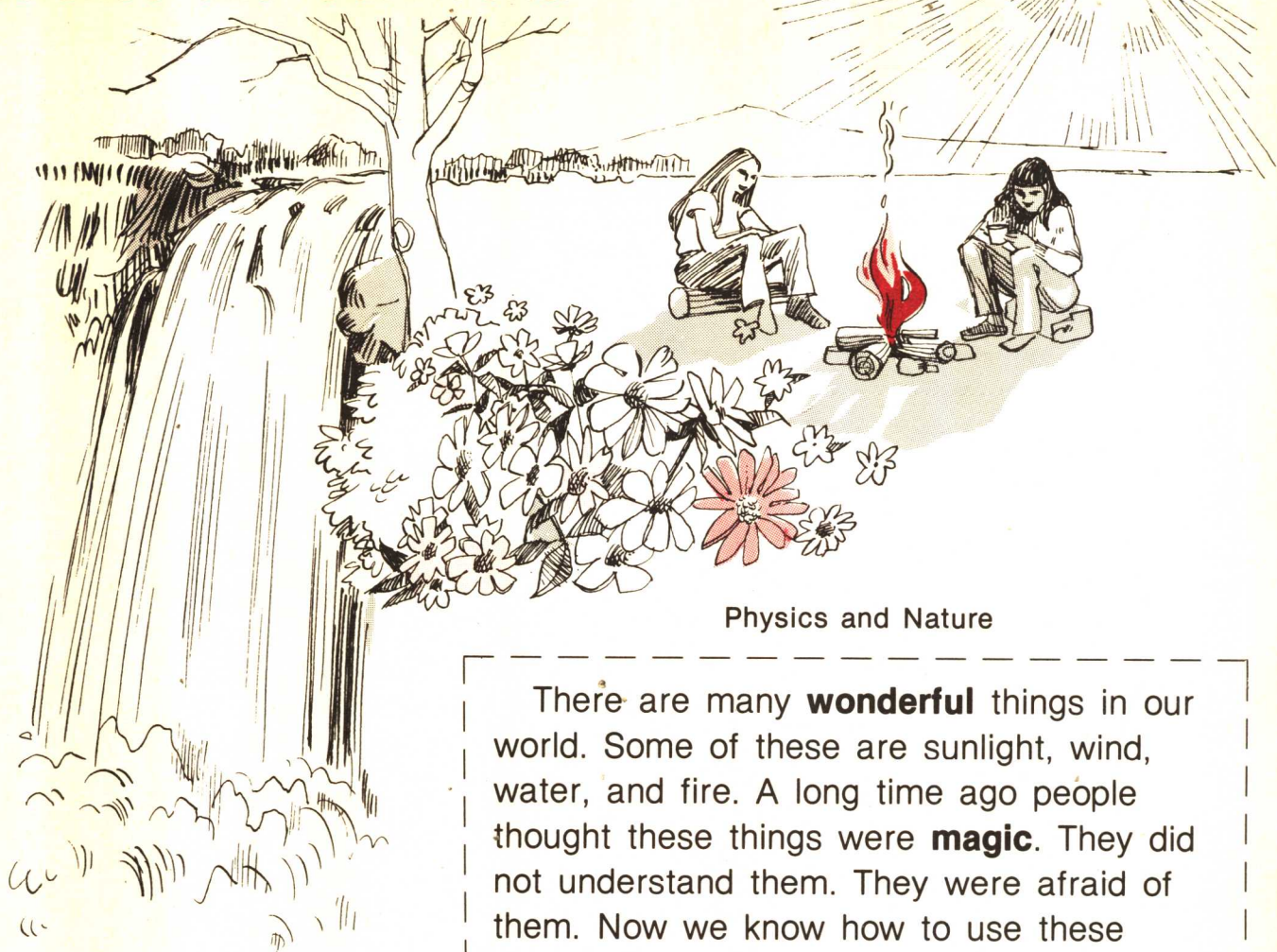
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Printed and bound in the United States of America.

# UNIT 1 Understanding Physics

## Science and Our World



Physics and Nature

There are many **wonderful** things in our world. Some of these are sunlight, wind, water, and fire. A long time ago people thought these things were **magic**. They did not understand them. They were afraid of them. Now we know how to use these things. We understand them. They are no longer magic.

People who study about the **wonders** of the world are called **scientists**. What they find out and write about is called **science**.

There are many kinds of science. Each kind has a different name. The science you will learn about in this book is called **physics**. In physics you learn how people use the wonders of the world in their everyday lives. You learn how the sun, water, wind, and fire can be used to run machines. You learn about work and about machines which make work easier. You learn about heat, light, sound, and electricity. Physics is a very important science. Physics is a very interesting science.

To understand physics, you must understand the words used in this science. In this book, you will learn new words. You will also learn some new meanings for words you already know.

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**A. Find the words in the dictionary. Write the meaning of each word.**

wonderful .....

magic .....

wonder .....

scientist .....

science .....

physics .....

**B. Find a sentence with each word in it. Write all of the sentence.**

sunlight .....

.....

know .....

everyday .....

.....

important .....

**C. Put the words in ABC order.**

magic      water      1. .... 5. ....

physics      sunlight      2. .... 6. ....

science      fire      3. .... 7. ....

wind      wonders      4. .... 8. ....

**D. Answer the questions.**

There are many wonderful things on our earth. What are some of these?

.....

Why do people no longer think these things are magic? .....

What can be used to run machines? .....

Why is physics a very important science? .....



# Matter and Molecules

What is the world made of? Scientists say everything in the world can be called **matter**. Matter is anything which needs space to be in. All **solids, liquids, and gases** are matter. All living things are matter. You are matter. Nonliving things are matter. Air is matter.

[Can you name other kinds of living matter? Can you name other kinds of nonliving matter?]

Matter can be divided into very tiny parts. These parts are called **molecules**. Molecules are too small to be seen, except under a special **microscope**. Molecules move all the time. They do many things for us. Because of them, you can smell. You can smell food cooking. Tiny molecules of the food go into the air. They go into your nose, and you smell them.

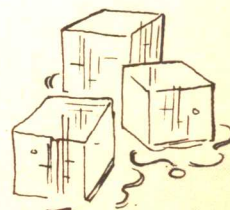
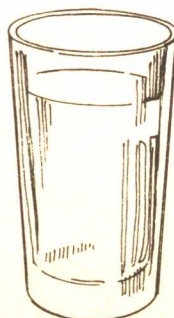
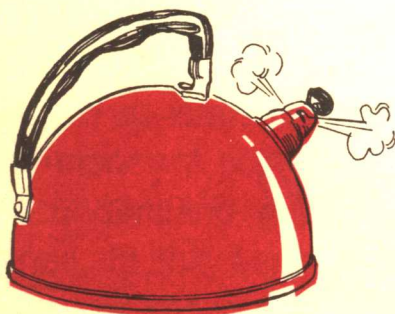


Our Sense of Smell

All solids, liquids, and gases are made of molecules. It is the molecules which make these three things different. In a solid, the molecules are held tightly together. In a liquid, the molecules are close together, but they are loose. They are free to roll around. In a gas, the molecules are far apart.

Some scientists study molecules. They try to change the ways the molecules are put together. This changes the matter. We call these scientists chemists. They study **chemistry**.

Learning about matter and molecules is important in many sciences. In physics it is very important.



Molecules as Gas, Liquid, and Solids



**A. Find the words in the dictionary. Write the meaning of each word.**

\*matter .....

\*solid .....

liquid .....

gas .....

molecule .....

microscope .....

chemistry .....

**B. Finish the sentences.**

- All living .....

Matter can be divided .....

Molecules are too .....

Tiny molecules .....

They go .....

In a solid, .....

In a liquid, .....

In a gas, .....

Learning about .....

**C. Answer the questions.**

What can be called matter? .....

What are the tiny parts matter is made of? .....

What are solids, liquids, and gases made of? .....

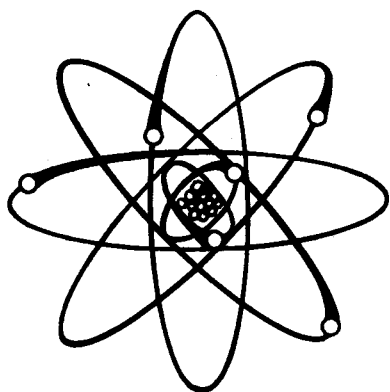
# Atoms

## Key

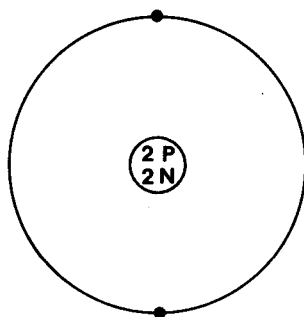
P proton

N neutron

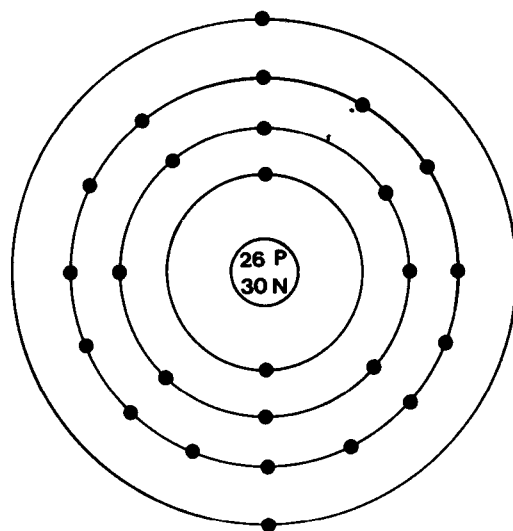
● electron



An Atom and Its Electrons



An Atom of Helium



An Atom of Iron

Molecules are made of even smaller parts. These parts are called **atoms**. A molecule is really a **group** of atoms.

Atoms also have parts. Their parts are called protons, neutrons, and electrons. All protons are alike. All neutrons are alike. All electrons are alike. Then why isn't all matter alike? It is not alike because not all atoms have the same number of parts.

**Helium** is a gas. An atom of helium has only 2 protons, 2 neutrons, and 2 electrons. Because helium has so few parts in each atom, it does not weigh much. That is why helium is used in balloons.

Iron is a heavy kind of matter. An atom of iron has 26 protons, 30 neutrons, and 26 electrons.

The neutrons and protons are in the center of the atom. The electrons move around them. Their motion is something like the planets going around the sun. Atoms move in the molecules. Molecules move in matter.

There are millions of different kinds of molecules. There are only about 100 different kinds of atoms. Each kind of atom is called an **element**. Helium, oxygen, gold, and iron are a few of the elements.

Each element has its own number of protons, neutrons, and electrons. Elements can be put together to make other kinds of matter. Water is not an element. It is 2 kinds of elements put together. Water is made of the elements **oxygen** and **hydrogen**. The study of atoms and elements is important in physics.



**A. Find the words in the dictionary. Write the meaning of each word.**

atom.....

group .....

helium .....

\*element .....

oxygen.....

hydrogen.....

**B. Put the words in ABC order.**

proton      element      1. .... 5. ....

- motion      physics      2. .... 6. ....

electron      molecule      3. .... 7. ....

neutron      balloon      4. .... 8. ....

**C. Underline the right answers.**

The smaller parts of molecules are (helium, iron, atoms).

Each kind of atom is called an (element, electron, iron).

Oxygen and gold are (molecules, protons, electrons, elements).

**D. Write all of the paragraph which begins with the words below.**

The neutrons and protons .....

.....

.....

.....

**E. Answer the questions.**

What is a molecule? .....

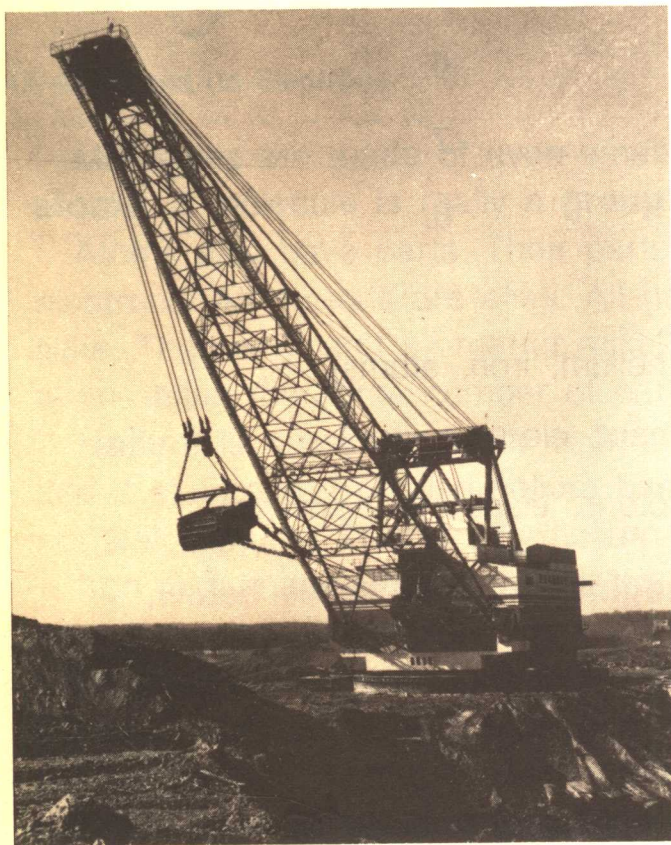
Why isn't all matter alike? .....

Why doesn't helium weigh much? .....

# Work and Force

The word **work** is important in physics. We know that people, animals, and machines can work. But what is work? Scientists say that work is done only if something is moved. In science, playing ball is work. That is because you move a ball and your body. Standing still holding a heavy box would not be work. It would be work when you picked up the box. And it would be work when you put the box down.

Hard work is done if a heavy thing (matter) is moved. Even harder work is done if the heavy matter is moved far. A strong person might carry 6 boxes at a time. A weak person might have to make 6 trips to carry the same 6 boxes. Both people will do the same amount of work.



*Courtesy National Coal Association*

Machine Doing Work

**Force** is another word used in physics. Force is the pulling and pushing done during work. A force can start an object moving. (A child pushing a wagon). A force can stop a moving object. (The brakes stopping a car). A force can change the **direction** of a motion. (Hitting a pitched baseball).

Forces can be different in size. A big force can move more matter than a small force. (A large dog can pull harder on a rope than a puppy). Or, 2 forces can be like a tug-of-war. If the force on both sides is the same, neither side will move. Then no work is done.

**A. Find the words in the dictionary. Write the meaning of each word.**

\*work .....

\*force .....

direction .....



**B. Write in the missing words.**

Scientists ..... that ..... is done ..... if  
..... is ..... In ....., playing  
..... is ..... That is ..... you ..... a  
..... and your .....

Hard ..... is done if a ..... (matter)  
is ..... A ..... might ..... 6  
..... at a time. A ..... might have to  
..... 6 ..... to ..... the same .....

**C. Answer true or false.**

..... Playing ball is work.

..... Standing still is work.

..... Work is not done  
unless something is  
moved.

..... Force is the pushing  
and pulling during  
work.

..... All forces are the same  
size.

..... Forces always keep  
things moving the same  
direction.

**D. From paragraph 3, write the 3 different things which a force can do.**

1. ....
2. ....
3. ....

**E. Answer the questions.**

When do scientists say that work is done? .....

What can move more matter than a small force? .....

What happens if the force on both sides is the same? .....

# Energy and Fuel

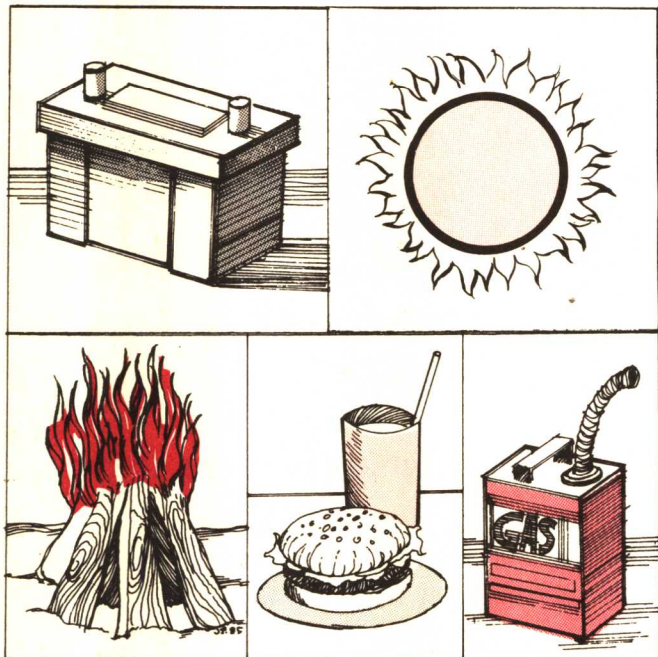
**Energy** is being able to do work. **Healthy** people have energy in their **muscles**. This energy is there waiting to be used. In people, the brain turns on the energy in our muscles when it wants work done. A **battery** also has energy. The energy in the battery is used when a flashlight is turned on.

There are other kinds of energy. The energy of the sun is the most important. All living things need it. Plants take in the sun's energy through their **leaves**. Animals get their energy by eating the plants. The energy of the sun, then, is changed into muscle energy. Heat and electricity are 2 more kinds of energy.

Energy is always changing. The energy of **electricity** can be changed into heat energy. This happens when you turn on an electric heater.

**Fuel** is burned to make energy. Gasoline, oil, coal, wood, and food are all fuels. Gasoline is fuel for cars. Food is fuel for people. Our bodies "burn" the food. This gives us energy for thinking and moving. Our muscles need food-fuel to be able to do work.

Remember: energy can be changed. When we use our leg muscles for running, we get hot. The muscle energy is being turned back into heat energy.



Forms of Energy

## A. Find the words in the dictionary. Write the meaning of each word.

- \*energy .....
- health .....
- muscle .....
- \*battery .....



leaf .....

electricity .....

fuel .....

**B. Find a sentence with each word in it. Write all of the sentence.**

healthy .....

waiting .....

important .....

leaves .....

eating .....

burned .....

coal .....

cars .....

thinking .....

**C. Answer true or false.**

..... Plants get the sun's  
energy through their  
roots.

..... Heat and electricity are  
not forms of energy.

..... Energy can be  
changed.

..... Food is fuel for cars.

**D. Put the words in ABC order.**

fuel 1. ....

energy 2. ....

muscles 3. ....

battery 4. ....

heat 5. ....

**E. Answer the questions.**

What is energy? .....

What energy is the most important? .....

What are two more kinds of energy? .....

# Power

**Power** is how much and how fast work can be done. If something has a lot of power, we say it is powerful. To be powerful, it must have energy. Remember, energy is being able to do work.

Power can be **measured**. A scientist named James Watt found a way to measure power. He used a horse pulling a weight. He measured how much work the horse could do in 1 minute. He called that amount of work 1 **horsepower**. We still use the word *horsepower* to tell the power of engines. Most lawnmowers have 3 or 3½ horsepower engines. Some cars have 300 horsepower engines.

## A. Find the words in the dictionary. Write the meaning of each word.

\*power .....

\*measure .....

horsepower .....

## B. Put the words in ABC order.

energy 1. ....

amount 2. ....

minute 3. ....

engine 4. ....

power 5. ....

## C. On this page, find a word **opposite** in meaning to each word below.

slow .....

weak .....

pushing .....

## D. Answer the questions.

What is power? .....

Who found a way to measure power? .....

What did he use? .....

How long did he measure how much work the horse could do? .....

What did he call that amount of work? .....

What word do we still use to tell the power of engines? .....



# Motion

You know that it is easy to start a marble rolling across a **smooth** table. It is not so easy to push a car. You have to use much more force on the car than on the marble.

To put any object in motion, you have to use force. Force makes things move. The bigger the thing to be moved, the more force you must use. You use force in this way every day.

Another way to put something in motion is by using electrical **switches**. A switch sends power to a machine so it can do its work. Every time we turn on the light switch, we put energy in motion. Switches send the power to a machine so it can do its work. Switches can be **dials**, **levers**, or buttons.

## A. Find the words in the dictionary. Write the meaning of each word.

smooth .....

\*switch .....

dial .....

lever .....

## B. Find a sentence with each word in it. Write all of the sentence.

object .....

move .....

electrical .....

dials .....

## C. Answer the questions.

Force makes things do what? .....

Why do switches send the power to a machine? .....

What do switches put in motion? .....