

LEVERS

OBJECTIVE:

You will understand and discover how simple levers are used to magnify effort.

INTRODUCTION:

A lever is a rigid beam that pivots on a fulcrum. An effort applied to one end will cause a load, usually at the other end of the beam, to be raised. Levers are normally used to obtain a mechanical advantage where the effort put in needs to be “magnified” to move a load larger than the effort. Sometimes, however, levers are used to magnify the distance moved by the load, in which case the effort required is larger than the load.

The lever is perhaps the simplest of power machines. It is also one of the oldest, and was probably discovered about 6,000 years ago. Simple levers were used to raise and maneuver stones during the building of the Egyptian pyramids and the raising of standing stones in Stonehenge, both in the third millennium BC. By the time of Archimedes (c.287–212 BC), levers were being used with pulleys in cranes to raise or shift considerable loads. Archimedes first defined the lever principle—a principle on which inclined planes (see 7.03), gears (see 7.09), and pulleys (see 7.06) are also based. Archimedes claimed he could “move the world” given a long enough lever!

Today, levers are the fundamental components of nail clippers and bulldozers, grand pianos and typewriters, cranes and scissors. All machinery operates on the lever principle somewhere in its mechanism. In this investigation, you will explore and demonstrate this basic principle.

TIME NEEDED:

1/2 hour

MATERIALS:

Note: You will need a partner for this investigation.

| | |
|---|------------------|
| meterstick | transparent tape |
| eraser, at least 3 cm x 2 cm x 1 1/2 cm | spring balance |
| X-acto® knife | 1kg weight |
| cutting board | table |
| 2 30cm lengths of string | |

Safety Precautions

Please read and copy the safety precautions at the beginning of this book. Be careful when cutting the eraser.

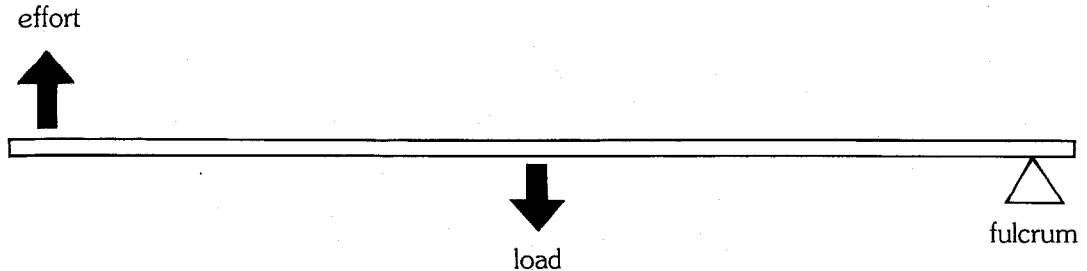
PROCEDURE:

1. Working on the cutting board, use the X-acto® knife to trim the eraser to form a wedge shape on which the meterstick can be balanced. The wedge is the fulcrum and the meterstick is the beam. Place the fulcrum near the corner of the table so that the meterstick extends over the edge (see figure 1).
2. Tie the 1kg weight to a piece of string, and tape the other end of the string to the meterstick at 0 on the scale. Hang the weight over the edge of the table. The weight is the load.
3. Place the fulcrum 20 cm from the load. Tie the spring balance to the other piece of string. Have your partner hold the meterstick steady while you loop this piece of string around the meterstick, on the opposite side of the fulcrum from the weight, and hang the spring balance from this loop (see figure 1). Position the spring balance 20 cm from the fulcrum.

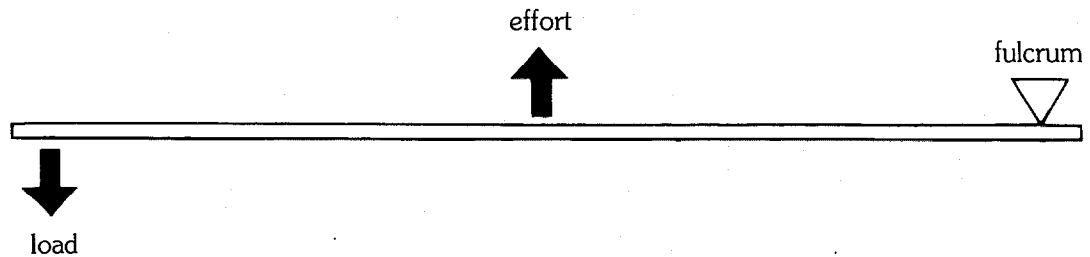
There are two other types of lever, however. They differ from class 1 in the position of the load and effort relative to the fulcrum. In class 2 levers, the load is between the effort and the fulcrum. In class 3 levers, the effort is between the load and the fulcrum (see figures 3a and b).

Figure 3

a Class 2 lever



b Class 3 lever



Consider the following list of devices, all of which operate according to levers: crowbar, spade, tweezers, wheelbarrow, pliers, nutcrackers, scissors, fishing rod, bottle opener, golf club, spanner. Which are class 1, which are class 2, and which are class 3 levers?

4. Levers broadly fulfill one of two functions. Those that have the load closer to the fulcrum than the effort is are "effort-magnifiers"—the effort needed to cause movement is smaller than the load. Levers that have the effort closer to the fulcrum than the load is are "movement-magnifiers"—the distance moved by the load is greater than the distance moved by the effort. Of the three types of lever, which one:

- is an effort-magnifier?
- is a movement-magnifier?
- can be either of the above?

OUR FINDINGS:

Click on above link to see what we found.

SPECIAL SAFETY NOTE TO INVESTIGATORS

Each invention includes any special safety precautions that are relevant to that particular project. These do not include all of the basic safety precautions that are necessary whenever you are working on a scientific investigation. For this reason, it is absolutely necessary that you read, copy, and remain mindful of the General Safety Precautions that follow this note.

Experimental science can be dangerous, and good laboratory procedure always includes carefully following basic safety rules. Things can happen very quickly when you are constructing or demonstrating a model invention. Things can spill, break, even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following basic safety guidelines the *entire* time you are carrying out the project, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual projects. We made this choice for one reason: We want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical to your safety.

One further note: The book assumes that you will read the safety precautions that follow, as well as those in the box within each project you are preparing to perform, and that you will *remember* them. Except in rare instances, these precautions will not be repeated in the procedure itself. It is up to you to use your good judgment and pay attention when performing potentially dangerous parts of the procedure. Just because the book does not say **BE CAREFUL WITH HOT LIQUIDS** or **DON'T CUT YOURSELF WITH THE KNIFE** does not mean that you should be careless when simmering water or stripping an electrical wire. It does mean that when you see a special note to be careful, it is extremely important that you pay attention to it.

If you ever have a question about whether a procedure or material is dangerous, wait to perform it until you find out for sure that it is safe.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking unnecessary risks can be avoided by practicing safety procedures and being alert while carrying out these projects. Be sure to check the individual projects in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone.

PREPARING:

- Clear all surfaces before beginning projects
- Read the instructions before you start
- Know the hazards of the procedures and anticipate dangers

PROTECTING YOURSELF:

- Follow the directions step-by-step; do only one project at a time
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eye wash, and first-aid kit
- Make sure there is adequate ventilation
- Do not horseplay
- Wear an apron and goggles
- Do not wear contact lenses, open shoes, loose clothing, or loose hair
- Keep floor and work space neat, clean, and dry
- Clean up spills immediately
- Never eat, drink, or smoke in laboratory or work space
- Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult

USING EQUIPMENT WITH CARE:

- Set up apparatus far from the edge of the desk or bench
- Use knives and other sharp or pointed instruments with caution
- Pull plugs, not cords, when removing electrical plugs
- Clean glassware before and after use
- Check glassware for scratches, cracks, and sharp edges
- Clean up broken glassware immediately
- Do not touch metal conductors
- Use only low voltage and current materials such as lantern batteries
- Be careful when using stepstools, chairs, and ladders
- Never look directly at the sun with your observation devices

USING CHEMICALS:

- Never taste or inhale chemicals
- Label all bottles and apparatus containing chemicals
- Read labels carefully
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves)
- Do not touch chemical solutions
- Wash hands before and after using solutions
- Wipe up spills thoroughly

HEATING SUBSTANCES:

- Use goggles, apron, and gloves when boiling water
- Keep your face away from test tubes and beakers
- Never leave apparatus unattended
- Use safety tongs and heat-resistant mittens
- Turn off hot plates, bunsen burners, and gas when you are done
- Keep flammable substances away from heat
- Have fire extinguisher on hand

FINISHING UP:

- Thoroughly clean your work area and glassware
- Be careful not to return chemicals or contaminated reagents to the wrong containers
- Don't dispose of materials in the sink unless instructed to do so
- Wash your hands
- Clean up all residue and put in proper containers for disposal
- Dispose of all chemicals according to all local, state, and federal laws

BE SAFETY CONSCIOUS AT ALL TIMES