Technology Group

E

ENGINEER

Engineer Requirements

Requirement | **Approved by**

Do both of these:

1. Talk to an engineer, surveyor, or architect in your area about the different occupations in engineering. Create a list that tells what they do. ____________
2. Draw a floor plan of your home. Include doors, windows, and stairways. ____________

And do four of these:

3. Visit a construction site. Look at a set of plans used to build the facility or product. Tell your Webelos den leader about these. (Get permission before you visit.) ____________
4. Visit a civil engineer or surveyor to learn how to measure the length of a property line. Explain how property lines are determined. ____________
5. Tell about how electricity is generated and then gets to your home. ____________
6. Construct a simple working electrical circuit using a flashlight battery, a switch, and a light. ____________
7. Make drawings of three kinds of bridges and explain their differences. Construct a model bridge of your choice. ____________
8. Make a simple crane using a block and tackle and explain how the block and tackle is used in everyday life. ____________
9. Build a catapult and show how it works. ____________
10. While you are a Webelos Scout, and if you have not earned it for another activity badge, earn the Cub Scout Academics belt loop for Mathematics. ____________

Engineers designed your school bus, the cars on the road, the road itself, and the bridges you cross. Engineers designed all the different kinds of computers you see at school, in offices, and at home.

Almost anything you use that was manufactured was probably designed by an engineer. Not only that, but engineers designed the machines that workers used to make the product and the factory building where it was made.

Airplanes, space shuttles, space stations—all designed by engineers. Engineers work in many exciting and challenging fields.

While you earn this activity badge, you can work on engineering projects like bridge models, a catapult, and an electrical circuit. When you complete each requirement, ask your Webelos den leader or activity badge counselor to sign it on page 212.

What Engineers Do

Engineering is a specialized profession, which means there are almost as many types of engineers as there are engineering jobs to be done. Here are some of the types of engineers and a few examples of the work they do:

Civil engineers design construction projects like bridges, dams, stadiums, highways, and wastewater treatment plants.

Mechanical engineers design automobiles, engines, refrigeration and heating systems, and machines.

Electrical engineers design computers, motors, television sets, telephones, and communications systems.

There are engineers in aerospace work, industry, agriculture, chemistry, and many other areas.

Engineers write the *specifications* for their designs. Specifications are the rules that the project has to follow. They describe how the project is going to perform, what materials go into it, and exactly how the materials are to be put together.

Engineers also may investigate problems like traffic flow, water and air pollution, and river flooding. Then they work on plans to solve the problems.

Drawing Floor Plans

An architectural engineer draws plans for buildings and houses. He or she designs the plans to make the best use of standard sizes of building materials, like drywall for the interior walls. The engineer includes specifications for materials, including types of doors and windows.

See if you can draw a floor plan of your house or apartment. You don't have to show measurements on your floor plan, but if the living room is twice as big as the kitchen, your floor plan should show it, so you might want to check measurements in each room.

Show doors, windows, and stairways. Use a ruler to make your plan neat.

Visiting a Construction Site

Engineers supervise the work that puts their designs into action. The engineer checks to see that the correct materials are used and the engineering plans—the specifications—are followed.

Good examples are construction jobs like buildings, roads, and dams. With your parent or den, arrange to visit a construction site and talk to an engineer. Ask him or her to show you plans for the job.

Checking Property Lines

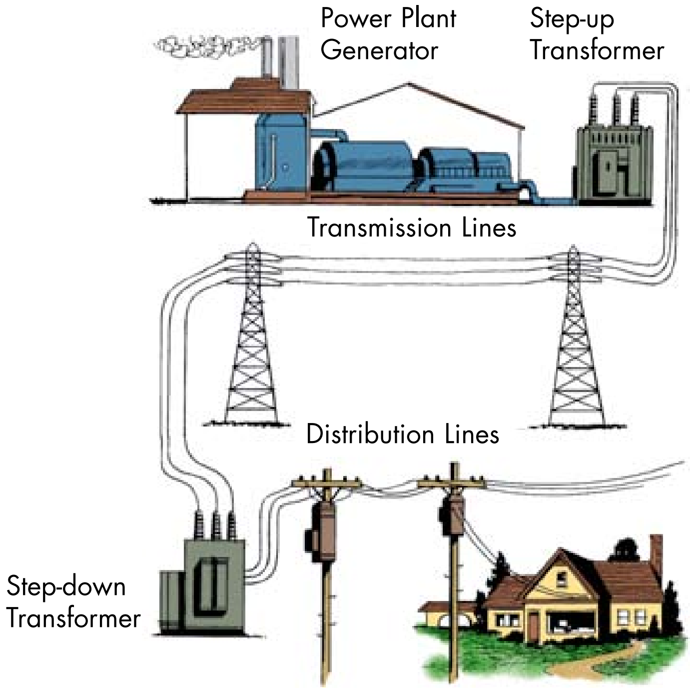
In any construction job, whether it's a building, a highway, or an electrical power line, civil engineers have to know where construction will take place in relation to the property lines around it.

Highways and utility projects are constructed on pathways across property that are called *easements*. Engineers have to know where the boundaries of the easements are.

Surveyors use laser equipment to determine the location of the property and easement lines, how long they are, and where corners are. Once the lines are determined, a civil engineer can use the information to draw plans and supervise construction. If you talk with a civil engineer for requirement 4, you'll learn more about this.

Property lines are important to anyone who owns a home, a building, farmland, or a vacant lot. A homeowner who wants to put up a fence around a backyard may have the lot surveyed to find out exactly where the boundary lines are located.

You can use a tape measure or yardstick to measure one of the lot lines around your house or apartment building.



Electric Power

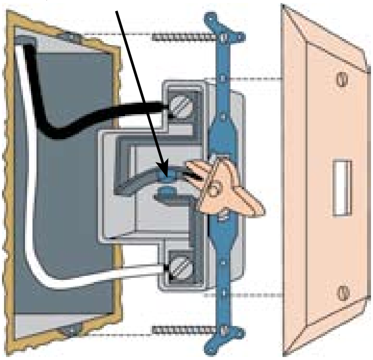
An electric current is created when a magnet is spun rapidly inside a coil of wire. The huge generators in a power plant work on that principle. The turbines that spin the magnet are powered by water, steam, or wind power.

Electricity moves along wires like water running through a pipe. The electricity generated by a power plant moves over wires to a nearby *step-up transformer.* There, the voltage is raised so that the electricity can go efficiently over long distances.

A high-voltage line carries electricity to your town. But the voltage must be reduced by a *step-down transformer* before you can use the electricity in your home.

Electrical Circuits

An electrical circuit is the route by which electricity moves from an electrical source to the point where it is used and back again. In the house or building where you live, electrical circuits



Electric Switch

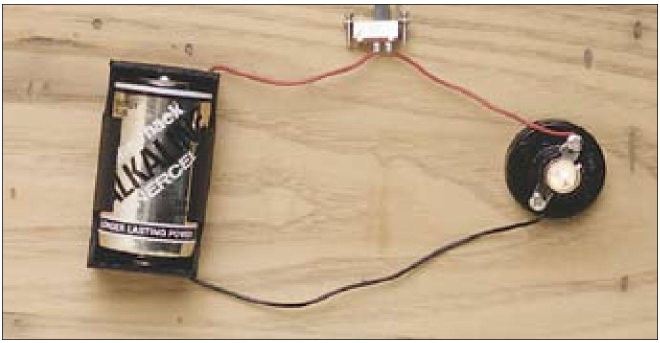
This switch is in the "off" position. There is a gap in the path for electricity. When the switch is turned on, the metal contacts come together so the electricity can flow.

supply electricity to different parts of the building. In lamps and appliances, when a switch is turned to the "on" position, it closes (completes) the circuit and allows electricity to flow to, for instance, the light bulb or the toaster.

You can make a simple electric circuit. You will need

- A "D" size flashlight battery
- A holder for a small light bulb
- A light bulb that fits the holder
- An on/off switch
- Wire to connect it all together

When the switch is off, the circuit is open, which means there is a gap in the circuit. Electricity cannot flow to the light bulb. When the switch is on, it closes the circuit. The circuit is complete, and electricity reaches the bulb.



Be Safe With Electricity

Even low-voltage electricity is strong enough to kill you. It can give you a hard shock or a bad burn. For your safety's sake:

- Don't touch a switch with wet hands or while standing on a damp floor.
- Don't touch anything electrical while taking a bath.
- Plug only one cord into each electrical outlet. Overloading causes fires.
- Don't put electric wires under rugs and carpets. Walking on wires wears off the insulation. This causes short circuits.
- Newer homes have circuit breakers. But if your home has a fuse box, use the correct size fuse in it.
- Don't get under a tree during a thunderstorm. Lightning could hit the tree.
- Get out of the swimming pool or lake when you see a storm or lightning, even in the distance.

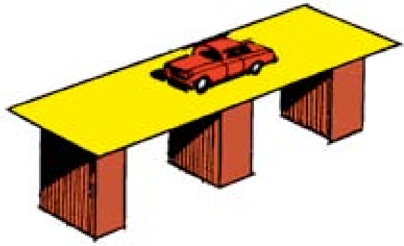
Bridges

The best way to learn about bridges is to study the way they are made. Then you can build model bridges, the way civil engineers do. You can use bricks, wooden blocks, and heavy paper.

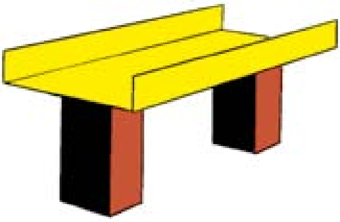
Start with a *plank bridge.* Set up two bricks. Lay a heavy piece of paper on them to go over "the river" beneath. What happens when you put a toy car on the bridge?

Plank Bridge

What would you do to hold the middle? Putting a wooden block under it helps. This is called a *pier bridge.*



Pier Bridge

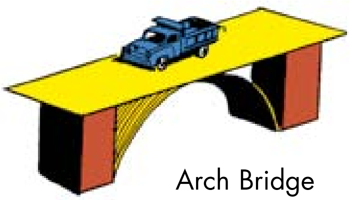


Beam Bridge

Take another piece of paper and fold the sides up 1 inch. Set this on the bricks. How much weight does this hold? More than the flat piece of paper? This is called a *beam bridge.*

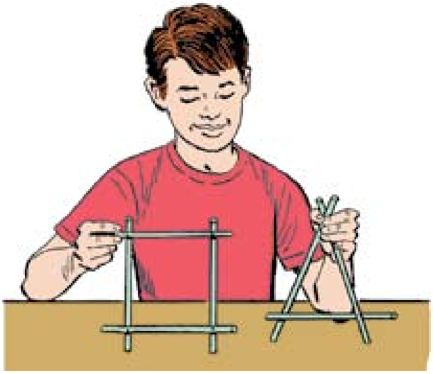
You may have seen beam bridges on railroads. They hold up a heavy weight over a short distance.

Curve a piece of heavy paper to form an arch. Slip it between two bricks. Set a piece of heavy paper on top of it and the bricks. This is called an *arch bridge.* Does it hold more weight than the others?



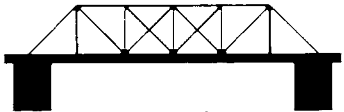
Arch Bridge

Engineers know about shapes and how much weight each one will hold. Make a square out of four drinking straws, fastening the corners with straight pins. Stand it up. Is it rigid? Does it want to fold up? The square will move.



Now make a triangle out of three straws. Does it move out of shape?

In building very long bridges, engineers use a whole row of triangles. These are called *truss bridges*. Railroad bridges over rivers are truss bridges.



Truss Bridge

Suspension cable bridges are the largest. The Golden Gate Bridge in San Francisco, California, is a suspension bridge.

The Golden Gate Bridge is a suspension bridge.

Block and Tackle

A block and tackle is used to lift heavy objects easily. A crane is a huge block and tackle.

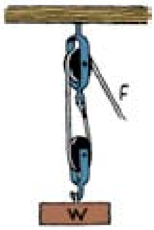
If you have ever watched the end of a crane while it was picking something up, or if you have ever used an engine hoist or a come-along, or if you have ever watched the rigging on a sailboat when the sails are being hoisted or lowered, then you have seen a block and tackle at work.

In a block and tackle, a rope or cable runs over a pulley, which is a small wheel with a grooved rim. The block and tackle is attached to something that must be lifted. A power source pulls the rope and lifts the object. It takes less force to lift this way than it would to try to lift the object without the block and tackle.

Some block and tackles have more than one pulley. Some of the ways a block and tackle can be rigged are shown here.

Runner

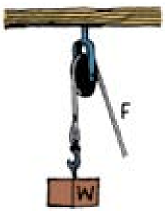
Luff



Gun Tackle

Spanish Burton

Twofold

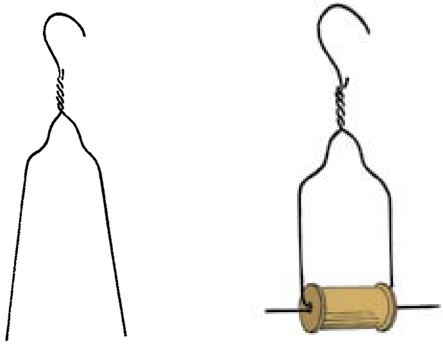


Single Whip

F = Force W = Weight

Making a Single Whip Block and Tackle

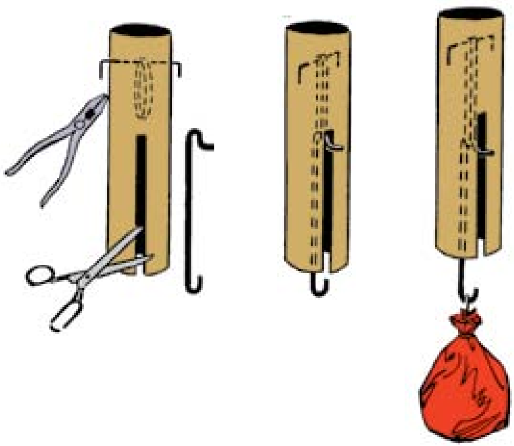
To make a pulley, you need a large spool and a coat hanger. Cut the hanger as shown and bend the ends at right angles through the spool. Then bend down the ends so the hanger won't spread apart. Make sure the spool turns easily.



Testing the Block and Tackle

Use a spring scale to see how much force is needed to lift a weight with and without a block and tackle. If you don't have a spring scale, you can make one as shown.

A cardboard tube from a roll of paper towels or something similar will make a good scale. Suspend rubber band and wire as shown.



This *runner* block and tackle is lifting several pieces of wood. The boys at either side support the rod to which one end of the block and tackle's rope is attached. The rope goes around the pulley. The other end of the rope is attached to the spring scale, and the boy in the center is holding the scale and lifting, providing the force. The scale measures the force required to lift the object. By attaching the same object directly to the scale, the boys can then measure the force required without a block and tackle.

Catapult

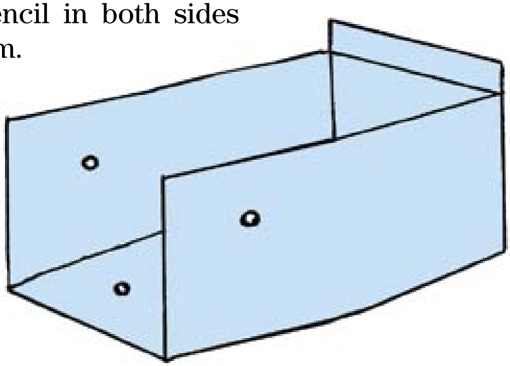
Catapults were once war machines used to throw huge rocks over castle walls. Today, a type of catapult is used to launch planes from aircraft carriers. A slingshot is also a kind of catapult.

Here's a simple catapult you can make. When using it, be sure everyone is out of the way, behind you.

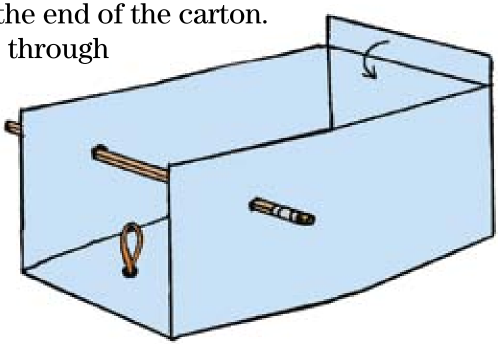
Marshmallow Catapult

To make this marshmallow-throwing catapult, you will need a clean, empty half-gallon milk carton, a 1-inch and a 3-inch rubber band, two pencils, a toothpick, a plastic spoon, tape, and some small marshmallows, or you can use cotton balls or small pieces of dry sponge.

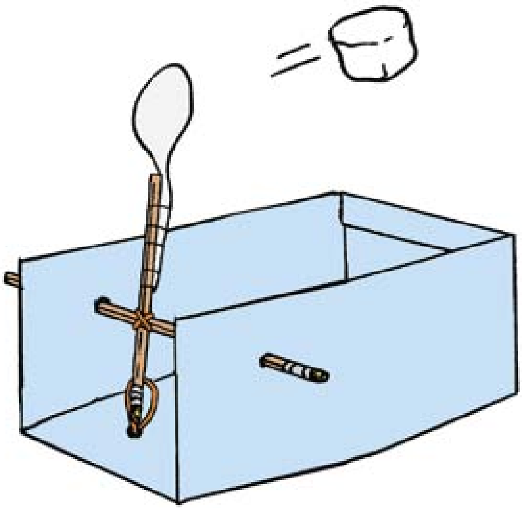
1. Lay a paper milk carton on its side. Cut off one side and the top of the milk carton so it looks like the diagram. Cut holes the size of a pencil in both sides and in the bottom.



2. Fold down and tape the end of the carton. Push a rubber band through the bottom hole. Put the toothpick through it on the bottom, and tape it to hold the rubber band in place. Push a pencil through the side holes.



3. Tape the plastic spoon onto one end of the second pencil. Put the small rubber band on the spoon pencil, lay it across the top of the first pencil, and use the small rubber band to securely attach (lash) the two pencils together. Attach the bottom rubber band to the other end of the spoon pencil.



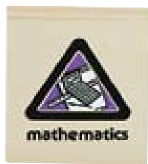
4. Test your catapult to be sure it works properly: Place a marshmallow in the spoon, pull back the pencil, and release it. Adjust and modify your catapult as needed to make it work better.

Computers in Engineering

Engineers use computers in many ways:

- To make calculations. Many advanced technological problems require a huge number of calculations to be solved. Hundreds of people working on the problem by hand might not be able to do them fast enough.
- To design and draw plans using a computer-aided design (CAD) program. CAD is especially useful to architectural and civil engineers in designing and building complicated bridges and other structures. During the design stage, computers can produce models of the structure that even look three-dimensional on a computer screen. These models can be changed and tested before building ever begins. The computer can analyze things such as the strength and weight of each part of the structure, as well as its cost and availability. For a building, the computer can determine whether there will be enough vertical braces, such as walls and columns, to keep a roof up.
- To calculate and store cost estimates and plan budgets for projects.
- To schedule work.
- To write business letters.

Cub Scout Academics Belt Loop for Mathematics



If you earned the Mathematics belt loop earlier in Cub Scouting, great! But that won't count for requirement 10 of this Engineer activity badge. You must earn the Mathematics belt loop again while you are a Webelos Scout for it to count toward this activity badge. (And if you already earned it for another activity badge, that cannot count for Engineer; you should choose another requirement, instead.)