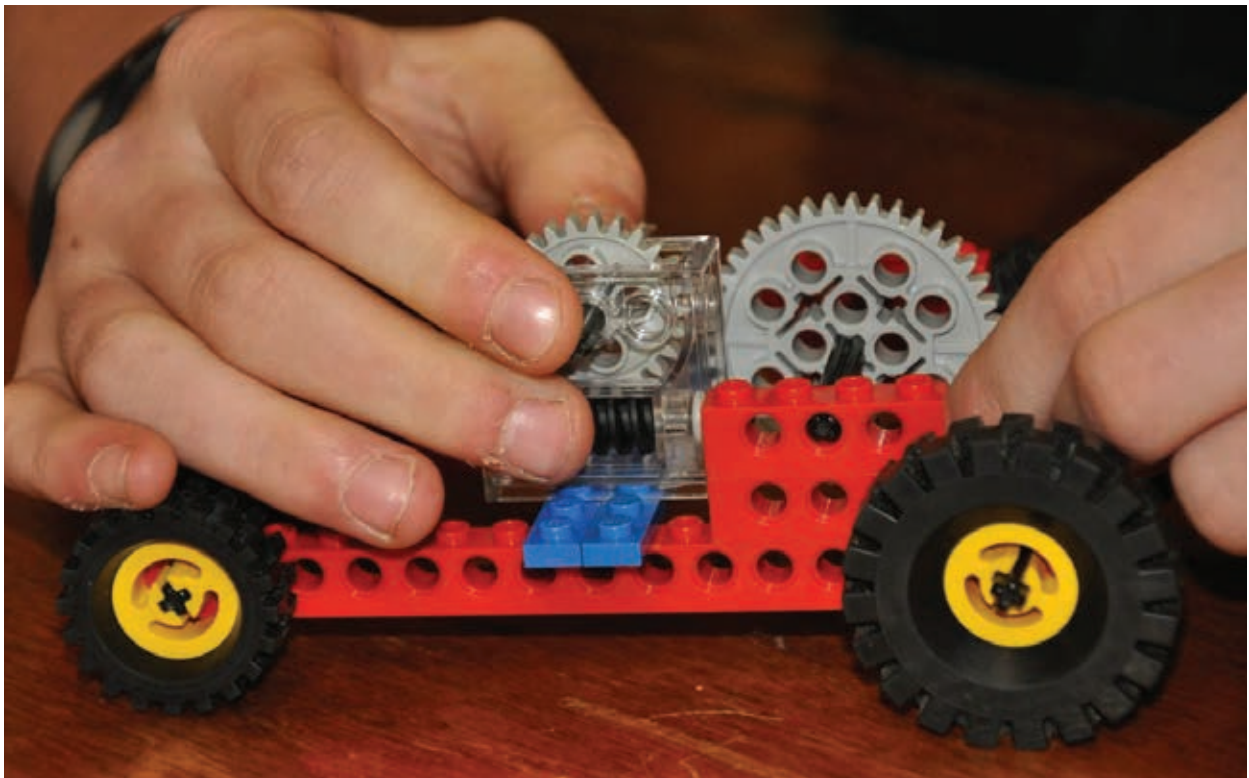




www.4-hontario.ca

4-H ONTARIO PROJECT



Building Blocks Engineering Project

REFERENCE MANUAL



The 4-H Pledge

I pledge my Head to clearer thinking,
my Heart to greater loyalty,
my Hands to larger service and
my Health to better living
for my club, my community and my country.

The 4-H Motto

Learn To Do By Doing

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4-H Ontario grants permission to 4-H Volunteers to photocopy this 4-H project resource for use in their local 4-H program.

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INTRODUCTION

Welcome to 4-H Ontario's 'Building Blocks Engineering Project!'

Build, play and grow! Introduce yourself to the world of building and designing various basic structures and machines. Working in teams or as individuals, test the strength, efficiency and accuracy of the project you build. Apply real-world concepts in physics, engineering and architecture. Challenge yourself to increase the strength, speed, stability and accuracy or efficiency of your project, all while working on your leadership, communication and team building skills. The sky is the limit as to what you can create in this project!

Objectives

1. To exercise creativity.
2. To learn the fundamentals of engineering.
3. To develop spatial reasoning.
4. To learn about structural integrity and design
5. To learn how to communicate ideas.
6. To build team-building skills.
7. To learn in a fun and interactive environment.

How to Use This Manual

4-H Ontario's Lego Engineering Project is made up of 2 parts:

1. The Reference Book:

The reference book is laid out into 6 meetings:

Meeting 1 – On Your Mark, Get Set! Introduction to Design

Meeting 2 – Exploring Forces – Strength and Stability

Meeting 3 - Leverage and Gearing

Meeting 4 – Pulleys

Meeting 5 – Wheels and Axles - Movement

Meeting 6 – Moving on Up!

Each meeting has been broken down into an Introduction with Sample Meeting agendas, References and Resources, Topic Information and Activities.

Sample Meeting Agendas: are at the beginning of each meeting. The agendas give suggestions for topic information, activities, and judging and/or communications activities along with suggested times for each section. These are only suggestions – you will know your group best and will know the skill and attention level of your members. There is more topic information and activities than what can be completed in a two hour meeting. Be creative!

Activities: should be used in combination with the discussion of topic information to teach members in a hands-on, interactive learning environment.

2. The Record Book

This booklet is designed to make it easier for members to record information throughout the club. Members are to record their expectations and goals for the project in addition to contact information, meeting dates and roll calls. Print or photocopy pages from the Reference Book that you think will benefit the members either as a resource or an activity. Answers for the Activity Pages can be found at the back of the Record Book. The Record Book should be given to each member at the beginning of the first meeting. Ask members to keep it in a binder or duotang so they can add to it easily. Go through the Record Book with the members and explain the charts and forms. Encourage them to use their Record Books at every meeting and record as much information as possible. As an added incentive, a prize could be given at the end of the project for the best Record Book.

Planning a Meeting

Plan your meetings well. Review all the information well in advance so you are prepared and ready go!

HINT – this project works better if 4-H members work in pairs for each Challenge project.

Before Each Meeting:

- Read the topic information and activities and photocopy any relevant resources for the members' Record Books.
- Be familiar with the topic information for each meeting. Think of imaginative ways to present the information to the members. Do not rely on just reading the information out loud. Review available resources, plan the meetings and choose activities and themes that complement the ages and interests of your members. The Record Book contains extra activities that can be used if you need to fill in time or if one of the suggested meeting activities does not suit your group of members.
- Gather any equipment and/or resources that will be needed to complete the meeting.
- Each 4-H project must be held over a period of at least 4 separate meetings, totaling a minimum of 12 hours. Typically, 4-H projects consist of 6 meetings and are approximately 120 minutes (2 hours) in length. Before each meeting, create a timeline to ensure that you are providing an adequate amount of instructional time for club completion.

Included on the following page is a Leader's Planning Chart to help with the planning of meetings. In addition to the chart, keep track of what went well and what should be changed next time. That way, each time this project is run, the content of the meetings can be different!

When planning each meeting, a typical 4-H meeting agenda should include the following:

- Welcome & Call to Order
- 4-H Pledge
- Roll Call
- Parliamentary Procedure:
 - Secretary's Report
 - Treasurer's Report (if any)
 - Press Report
 - New Business: local and provincial 4-H activities/opportunities, upcoming club activities
- Meeting content, activities and recipes
- Clean-up
- Social Recreation and/or refreshments
- Adjournment

Judging and Communications:

Each meeting must include either a judging or public speaking activity.

- Judging gives the members an opportunity to use judging techniques as part of the learning process. Through judging, members learn to evaluate, make decisions and communicate with others. They also develop critical thinking skills, confidence and self-esteem. Many examples are used in this reference book but use your imagination! As long as members are setting criteria and critically thinking about where items fit within that set of criteria, they are learning the basic skills of judging!
- A communications activity has been provided for each meeting but can be included in the Roll Call or social recreation time. These activities do not need to involve the topic of milk as the outcome is more about understanding the concepts of effective communication.

Leader's Planning Chart

Mtg.#	Date/Place	Topics Covered	Activities	Materials Needed

As a club volunteer your responsibilities are to:

- Complete the volunteer screening process and to attend a volunteer training session.
- Notify the local Association of the club, arrange a meeting schedule and participate in club meetings, activities and the Achievement program.
- Review the project material in the Reference and Record books to familiarize yourself with the information and adapt it to fit your group. Be well organized and teach the material based on your group's age, interest and experience level.
- Organize the club so members gain parliamentary procedure, judging and communication skills.
- Have membership lists completed and submitted along with fee collected (if applicable) by the end of the second meeting.
- Have members fill out a Participant Agreement Form and identify any health concerns. Ensure that all members, leaders and parent helpers know the appropriate actions during any emergency. Check with members for any food allergies or dietary restrictions and plan snacks accordingly.

As a club member your responsibilities are to:

- Participate in at least 2/3 of his/her own club meeting time. Clubs must have a minimum of 12 hours of meeting time.
- Complete the project requirement to the satisfaction of the club leaders.
- Bring your building blocks kit to each meeting.
- Take part in the project Achievement Program.
- Fill in and complete the Record Book.

**I pledge my Head to clearer thinking,
my Heart to greater loyalty,
my Hands to larger service and
my Health to better living
for my club, my community and my country.**



4-H Ontario

Glossary of Terms

Acceleration - the speed increases over time. Speeding up

Axle - A pin, pole or bar on or with which a wheel revolves

Building Blocks - can include Mega Bloks, Lego, K'Nex, Duplo, etc.

Deceleration - the speed decreases over time. Slowing down

Drive Gear - the gear in a gear train that provides the power to the other gears (usually gets power from a motor); also called the first gear

Engineering - the process of creating solutions to human problems through creativity and the application for math and science knowledge

Fixed Pulley - a pulley that always stays in one place

Follower Gear - the gear that moves last and outputs power in a gear train

Force - a push or pull

Gear Ratio - the ratio of the number of teeth of the driver to the number of teeth of the follower

Gear Train - a set of gears that work together to transmit a force.

Gearing Down - a small gear to a big gear. This results in the follower rotating much slower than the driver

Gearing Up - a large gear to a small gear. This results in the follower rotating much faster than the driver

Gradual - having a gradual or mild slope or incline

Idler - a gear or wheel that transmits motion between two other gears without change of direction or speed

Inclined Plane - a surface that is slanted upward that lowers the effort needed to lift a load

Load - the object being lifted or moved by a machine

Moveable Pulley - a pulley that can move along the rope it connects to

Pitch - a brief presentation/summary of an idea used to convince others that one's solution or idea is best or optimal

Pulley - a wheel with grooved edges for ropes that is used to change the direction of a pull and make it easier to lift a load

Rotation Point - The axis or centre that a wheel or disk spins on.

Screw - inclined planes wrapped around a cylinder that are used to raise and lower objects and hold objects together

Speed - the distance traveled over a certain period of time

Spring Scale - a device for weighing that uses a hanging spring to measure the weight of an object. A spring scale is also called a force meter because it measures force.

Steep - having a very sharp slope or incline

Teeth - the projections on the rim of a gear that fit between the projections on another gear

Wedge - two inclined planes joined back to back to form a sharp edge that are used to change the direction of a force and often result in the splitting of objects

Wheel - a disk or circular frame that revolves on an axle

Work - the use of force to move an object a certain distance

Additional References and Resources

Discovery Education <http://puzzlemakers.discoveryeducation.com>

First Lego League <http://firstlegoleague.org/>

Lego Crazy Action Contraptions www.Klutz.com

Lego Engineering www.legoengineering.com

Massachusetts Institute of Technology School of Engineering www.engineering.mit.edu

Ohio University www.ohio.edu

Play-Well www.play-well.org

Scientists in Schools Program www.scientistsinschool.ca

Spectrum Nasco Canada <http://farm.spectrum-nasco.ca/>

Teach Engineering www.teachengineering.org

Youth Group Games www.youthgroupgames.com.au



Photo Credit: Marianne Fallis

MEETING 1 ON YOUR MARK, GET SET!

Introduction to Design

Objectives:

- Learn the election procedure for establishing an executive.
- Learn what Engineering is and why it's important.
- Learn how to identify the pieces and how to do a building block kit inventory.
- Learn basic design concepts.

Roll Calls

- Have you ever used a building block kit before? If so, what have you created?
- What is your reason for wanting to learn more about building and designing with building blocks?
- When you think of engineering, what is the first thing that comes to mind?

Sample Meeting Agenda – 2 hrs. 20 minutes

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Public Speaking/Judging Activity	Activity #1 – Building Blocks Challenge - Get to Know Each Other Game (instructions can be found at the end of Meeting #1).	15 min
Parliamentary Procedure	Elect executive, hand out Record Books and discuss club requirement. Fill out club and member information in Record Books, and have each member fill out their "Member Expectations and Goals" page.	30 min
Topic Information Discussion	Discuss what Engineering is, the names of Building Block pieces, Inventory Checks and Building Rules and why they are important. Also discuss finding spare parts and replacements.	30 min
Public Speaking/ Judging Activity/ Activity Related to Topic	Activity #2 – Fishing Pole Strength Challenge (instructions can be found at the end of Meeting #1)	20 min
Topic Information Discussion	Evaluation of the Fishing Poles.	20 min
Wrap up, Adjournment & Social Time!		10 min
At Home Challenge	Choose one of the At Home activities to complete.	

Electing Your Executive

Elections can be chaired by a youth leader, senior member or club leader. The person chairing the elections is not eligible for any positions.

Procedure:

1. All positions are declared vacant by the chairperson, who indicates this by saying “I’d like to declare all positions vacant.”
2. The group decides on the method of voting (i.e. show of hands, ballot or standing).
3. The chairperson accepts nomination from members for each position being filled. Nominations do not require a seconder. Nominations are closed by motion or declaration by the chairperson.
4. Each member nominated is asked if he/she will stand for the position. Names of members who decline are crossed off.
5. Voting takes place by selected method and majority rules (i.e. member with most votes).
6. Announce the name of the successful member. Offer congratulations and thank all others that ran for the position.
7. If ballots are used, a motion to destroy the ballots is required and voted on.

Steps in Making a Motion

The motion is a very important key to having good meetings. Motions are a way of introducing topics for discussion and allowing each member to speak and vote. Any member can make a motion.

Steps in Making a Motion:

1. Address the chairperson (i.e. raise your hand).
2. Wait for the chairperson to acknowledge you.
3. Make the motion: “I move that...”
4. Another person seconds the motion: “I second the motion.”
5. Chairperson states the motion.
6. Chairperson calls for discussion of the motion.
7. Chairperson restates the motion.
8. Chairperson calls the vote: “All in favour? Opposed?”
9. Chairperson announces the result of the vote: “Motion carried” or “Motion defeated.”

Topic Information

Introduction to the Building Blocks Engineering Project!

Engineering is the process of creating solutions to human problems through creativity and the application of math and science knowledge. There are six steps in the engineering design process:

1. Identifying a problem
2. Researching possible solutions
3. Picking the best solution
4. Building a prototype
5. Testing the prototype
6. Repeating any steps needed to improve the design

Engineering solutions help humans by either:

- i. Decreasing the force needed and increasing the resulting distance
- ii. Increasing the required force and decreasing the distance needed to do work

Engineering solutions require the following 'simple machines' to help humans in the design process:

- a. Levers – stiff bars that rotate around fixed points. They make it easier to lift a load or apply a force. E.g. pliers, scissors, crowbar
- b. Wheel and axles – are two different-sized wheels attached to the same axis. They are used to make circular motion easier. E.g. doorknob, fan, wheel on a chair
- c. Inclined Planes – are surfaces that are slanted upwards. They lower the effort needed to lift a load. E.g. disabled ramp, highway ramp
- d. Wedges – are two inclined planes joined back to back to form a sharp edge. They are used to change the direction of a force and often result in the splitting of objects. E.g. door jam, axe, nail
- e. Screws – are inclined planes wrapped around a cylinder. They are used to raise and lower objects and hold objects together. E.g. screw, light bulb base, drill bit
- f. Pulleys – are wheels with grooved edges for ropes. They are used to change the direction of a pull and make it easier to lift a load. E.g. tape dispenser, clothes line, bicycle chain, garage door
- g. Gears – are wheels with teeth around the edge. They are used to turn other gears and change the direction, speed and force of circular motion. E.g. hand drill gear, inside of a clock, bicycle gear

This project will focus on all of the above simple machines.

Math and physics concepts are built into every project. Building Block projects are a good introduction to communicating ideas with physical objects.

Inventory Checks

Before getting started at building anything with building blocks, it is essential to check the inventory in your building block kit. Without checking your inventory before starting a project, once you've started building, you won't know if a piece was missing from the beginning or if you've dropped a piece on the floor.

And, it is just as essential to do an inventory check when you are finished and putting your building block kit away. It's much easier to find a missing piece if you realize its missing while you're still in the same spot you've been working. Trying to look for it days later may be extremely difficult – especially if you were working on your building block project in a public place!

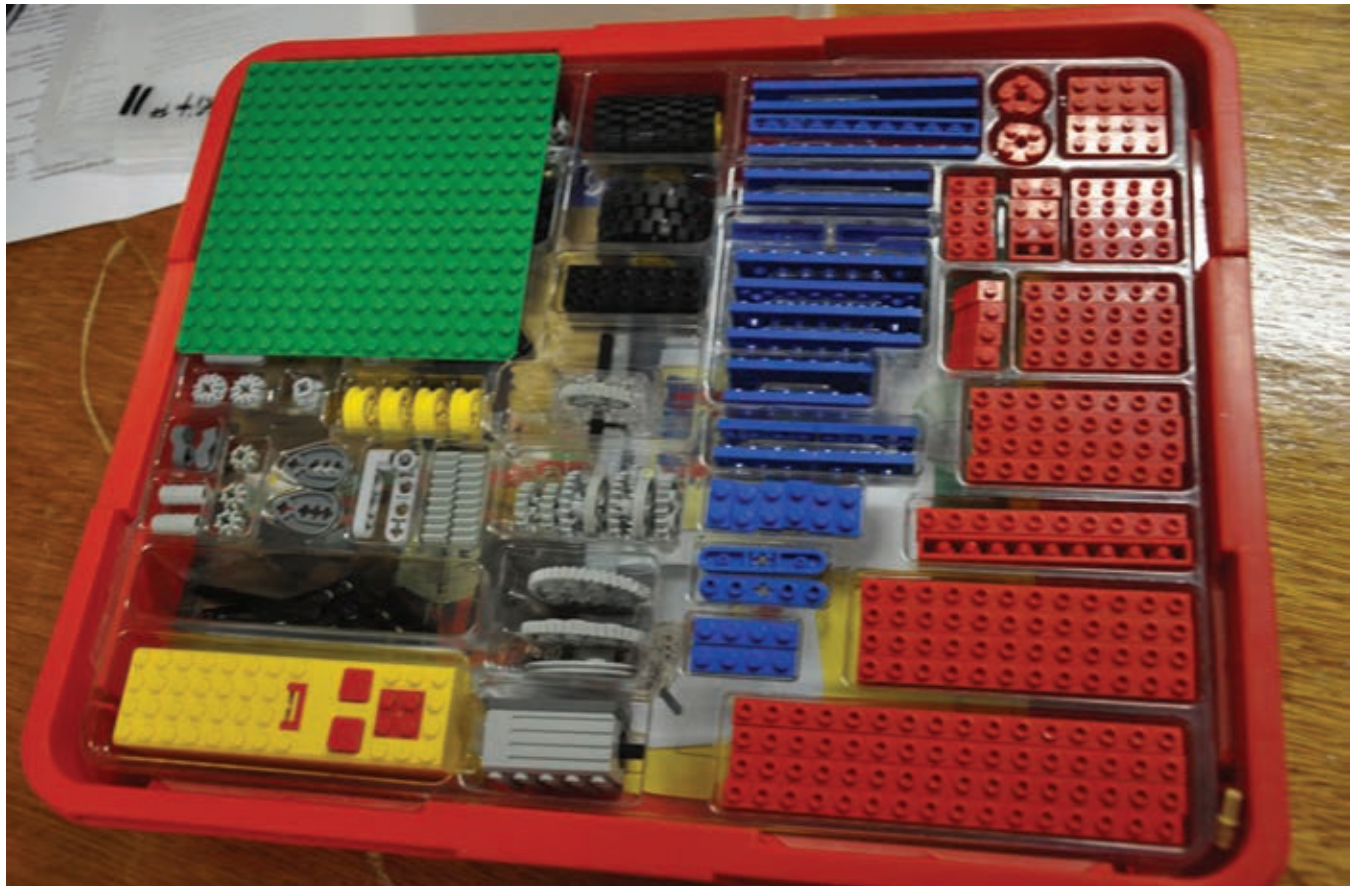


Photo Credit: Marianne Fallis

Building Block Identification

Bricks – are identified with the number of dots on the top (e.g. 2x4)

Beams – have holes along the side and are identified by the number of indented dots on the top (e.g. 1X8)

Plates – are flat with dots on top and may be called stud plates. They contain holes for axle placement

Axles – are identified by the length of a corresponding size beam or brick (e.g. 6 point or 10 point)

Gears – are identified by the number of teeth on the circumference (e.g. 8 point, 24 point, 40 point)

Pulleys – are identified by the groove around the circumference and the diameter

Connectors – can be stabilizing or moveable and can be half axle or half connector combinations

Bushings – are small pulleys that can also act as spacers on axles

Belts – are elastic-like but are usually round and come in various sizes

Building Rules

Before you get started, there are two rules you should know to make everything go smoothly.

1. No parts on the table at any time. Parts are to either stay in the kit, in your hands or on the model.
2. No motorization of models until all parts are moving freely by hand. Adding motorization to parts that don't move freely will most likely break those parts.

BEFORE THE NEXT MEETING

Try one of these activities at home.

1. Research what different kinds of building block kits are available and the price of each kit. Record your findings in your Record Book.

OR

2. Research what types of projects can be built/created using various building block kits. What is the ultimate project that you want to be able to create by the end of this project? Record your findings in your Record Book.

DIGGING DEEPER

The History of Building Blocks

Starting in a small carpenter's workshop, one of the first building block toy sets on the market was Automatic Binding Bricks. These were a precursor to what is known today as Lego.

The Lego Company was founded by Ole Kirk Kristiansen from Denmark in 1932 although the Lego brick in its present form wasn't launched until 1958. The name Lego is an abbreviation of two Danish words, "leg" and "godt", meaning "play well." In Latin the word Lego means "I put together." When the company started it had 6-7 employees.

The Automatic Binding Bricks, made of wood, were sold in Denmark exclusively for a number of years in the 1930's and 1940's. They were sold in one colour until 1949 when four colours of bricks were introduced to the market place.

In 1946 the Lego Group purchased a plastic-injection moulding machine for toy production. In 1953 the name of the Automatic Binding Blocks was changed to Lego and the Lego Company started making the block out of plastic in the 1950's.

By 1958, the current Lego stud and tube coupling system was patented. The new coupling system made the blocks much more stable. The Lego Company also started establishing companies in other countries such as Sweden, France, Belgium and Great Britain. In 1961 sales of Lego began in the United States and Canada and by 1966, Lego was being sold in 42 countries.

In 1964, model sets, complete with building instructions were launched. In 1969 the Duplo series for children under 5 years old was launched and the first Legoland film was produced. By 1987 Lego products were being sold in 115 different countries. Lego Canada was established in 1988.

In 1992, a Guinness World Record was set when a railway line was constructed measuring 545 metres of Lego rails with 3 locomotives. That same year the world's largest Lego castle was built in Sweden. Over 400,000 Lego bricks were used to create the castle which measured 4.45m X 5.22M to also set a Guinness World Record.

The 1990's saw the launch of Lego Mindstorms. As well, Lego also released a CD-ROM containing building instructions with their model sets.

The world's largest Legoland Park opened in Florida in 2011.

The company has been passed down from father to son and is now owned by the grandson of Ole Kirk Kristiansen. Today the Lego Company employs almost 5000 employees. Not bad for a company that started in a carpenter's small workshop!

DIGGING DEEPER #2

Challenge – Build a Deck Chair

The Challenge – to build a deck chair that has a backrest that can be repositioned.

Build a deck chair for a Barbie-type doll or a stuffed animal that has a backrest that can be repositioned. The chair must be able to support the doll or stuffed animal from the front, sides and back. Ultimately the chair must keep the doll or stuffed animal in a sitting position without it falling out of the chair.

Evaluation – who has the best functional deck chair?

Bring the Chair to the next meeting and demonstrate how the chair operates. If there are more than two 4-H Members that designed a chair, have the group judge the chairs based on both design and functionality of the chairs.

Activity #1 – Lego Challenge – Get to know each other

Have a bag filled with Building Block pieces. Explain that in the Building Block Engineering Project that many different structures are going to be built and they won't know how many pieces they are going to need. Have each 4-H member reach into the bag and take as many pieces as they wish. Once everyone has an ample supply, explain to the group that for every building block piece in their possession, they must share something about themselves.

NOTE: If anyone knows the activity, ask them not to give away the secret under any circumstances.

Designing for Strength and Performance

Activity #2 - Introductory Strength Challenge – Fishing Pole

The Challenge – to build the longest fishing pole using only pieces from your building block kit.

The fishing pole must have at least one pulley and a hook for catching and reeling in the fish. Once the fish is caught it must be able to reel in the fish and place it in a basket using only hands on the handle.

Evaluation – who has the longest fishing pole that can reel in a fish and place it in a basket?

The fish (the weight of a weighted brick or whatever is desired for a fair test) will be placed on the hook. The Member must reel in the fish at least 12 cm. Then they must move the fish and lower it into the basket. Measurements of the length of the pole will be taken from where the operator's hands are holding the pole. The longest fishing pole that completes the fish in the basket task will be considered the ultimate design!

MEETING 2 - EXPLORING FORCES: STRENGTH AND STABILITY

Objectives

- Learn what the five acting forces are.
- Learn about structural strength and frame structures
- Learn about stability and braces.

Roll Calls

- Name a tall tower found anywhere in the world.
- Give an example of an item that is under tension (eg. a clothes line)
- Name a group of items in the room that could be used for judging.

Sample Meeting Agenda – 2 hrs. 15 minutes

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes & Business	10 min
Topic Information Discussion	Review the Five Different ways a structural part can react to a force.	20 min
Public Speaking/Judging Activity/ Activity Related to Topic	Activity #3 - Team Architect (instructions can be found at the end of Meeting #2).	30 min
Topic Information Discussion	Discuss Shapes, Forces and Structures.	20 min
Public Speaking/Judging Activity/ Activity Relating to Topic	Activity #4 - Tallest Tower Challenge (instructions can be found at the end of Meeting #2).	30 min
Wrap up, Adjournment & Social Time!		10 min
At Home Challenge	Choose one of the At Home activities to complete.	

Topic Information

Structural strength and stability are affected by forces. When forces are applied to a structure, the structural parts will react in a number of different ways. There are five different ways in which a structural part can react to a force:

1. **Compression** - is the result of two forces pushing in opposite directions. The forces act to compress or shorten the thing they are acting on. These are the forces required to compress depending on the compressibility of the material. Forces that try to squash a structural part are called compression forces. A part that is under compression is called a strut. The legs of a chair are under compression. This compressive force will increase when someone sits on it.



Photo credit: Elizabeth Johnston

Snow on a roof is a compressive force. The weight of the snow causes the compressive force to increase on the roof.

2. **Bending** – A force applied to the centre of a part that is supported at both ends would try to bend the part. This would be a BENDING force. A bookshelf is subjected to bending forces. The bending forces will increase as the number of books increases.
3. **Torsion** – Forces that try to twist a part are called TORSIONAL forces. A screwdriver putting in a screw is under torsion.
4. **Tension** – Tension is the result of two forces pulling in opposite directions. The forces act to expand or lengthen the thing they are acting on. These are the forces required to stretch or elongate depending on the elasticity of the material. Forces that try to 'stretch' a part are called TENSILE forces. A part that is under tension is called a TIE. A clothes line is under tension. This tensive force will increase when clothes are on the line.



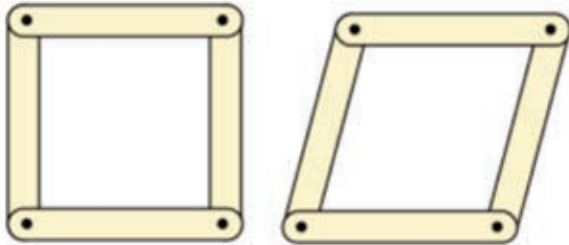
Source: www.vectorart.com

5. **Shear** – Forces that try to cut a structure in two are called SHEAR forces. Shear forces normally occur where two parts join. A nut and bolt holding two pieces of metal together would be under a SHEAR force if the two pieces of metal were pulled apart.

Shapes and Forces

A shape is rigid if it does not change shape when it is pushed or pulled. You can find rigid shapes in bridges, roller coasters, chairs, houses and other structures.

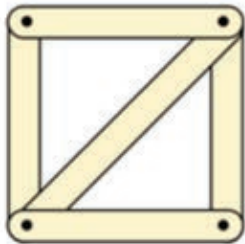
Under a heavy load, a square distorts easily. It ends up looking like a parallelogram.



Source: www.leancrew.com

In fact, the triangle is the only shape that cannot be deformed without changing the length of one of its sides. Because it's not easily deformed, the triangle is an extremely popular building shape. Look for triangles in bridges, railway trestles, hydro towers and skyscrapers.

If you put a brace diagonally across the middle of the square you create two triangles and a much stronger shape.



Source: www.leancrew.com

Forces and Structures

The primary force that affects your structure is the vertical force of gravity. The pull of gravity creates a downward force on the structure. This downward force consists of the weight on the structure itself (the dead load) plus the weight of whatever sits, hangs or walks on your structure (the live load).

Think of your building as being divided into layers. As you move down the structure, each layer must support a little more weight than the one above it. As such, the lower layers must be stronger than the upper layers.

According to Newton's Laws, in order for objects at rest to stay at rest, the forces acting on them must balance out. The two forces (Gravity pulling down and the strength of the structure pushing up) balance themselves at zero and then there is no movement. If the structure is not strong enough to exert a force upward, gravity will prevail and the structure will collapse.

The forces that act on structures are all pushes and pulls tending to pull pieces apart or push pieces together. Through pushing and pulling (tension and compression), a building must retain its stability.

Reference material is from the Scientists in Schools program. For more information on forces and engineering concepts for young people visit: www.scientistsinschool.ca

BEFORE THE NEXT MEETING

Try one of the following activities:

1. Using the Internet, research what the largest structure ever made out of Building Blocks of any kind is. How tall or long was it? How many blocks were needed to build it? Where was it built? Record your findings and possibly a picture in your Record Book.

AND

2. Create a Building Blocks Journal. Record the names of the structures you have built using Building Blocks and include pictures if possible. Keep adding to your journal as you create more structures during this project.

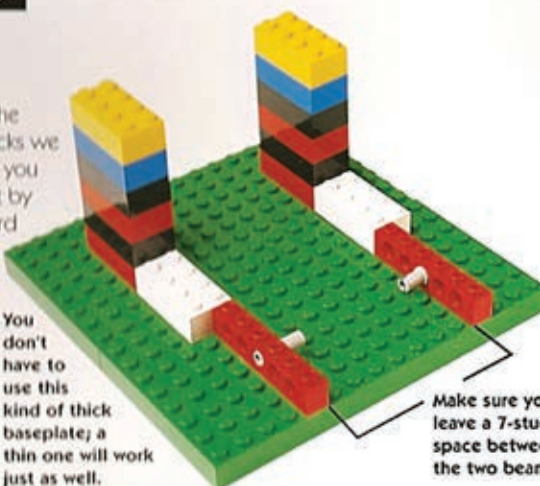
DIGGING DEEPER

Create a Football Launcher!

Using the following instructions, construct a Football Launcher. Once it's completed measure the distance that your field goal kicker will kick the football. Keep track of the number of goals kicked and record all of your information in your Record Book in your Building Blocks Journal.

The Base

1 Build **The Base**. Follow the photo. If you don't have the exact standard bricks we used, don't worry, you can usually build it by using other standard bricks. *






You don't have to use this kind of thick baseplate; a thin one will work just as well.




Make sure you leave a 7-stud space between the two beams.

***CAN I BUILD IT IF I DON'T HAVE THE RIGHT PIECES?**

You bet! There are probably ten different ways to build a standard LEGO 2-stud x 4-stud brick. Here is one:

 +  = 


There are probably eight different ways to make a 2-stud x 3-stud LEGO brick. Here's just one:

 +  = 

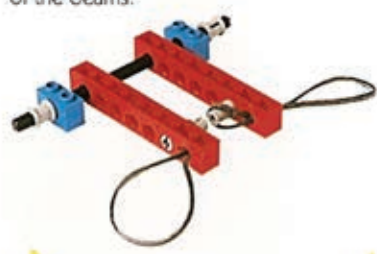
If you need a bigger base plate than you have, just put it together out of smaller base plate pieces. In the same shortcut kind of way, you can make one long beam out of two short ones. 29

The Swing Arm


2 Take the 12-stud axle and add the beams and bushings. (Don't forget to add the gray connector pegs to the long beams.)




Thread the rubber bands around the gray connector pegs and through the holes of the beams.



Then add a standard 2 x 4 LEGO brick to the ends of the beams.



World Record Field Goal set at Klutz Galactic Headquarters



10 FEET!

The Football Launcher

3 Stick The Swing Arm on top of the two towers.

Wrap the ends of the rubber bands around the gray connector pegs.

Add two towers to hold the football. We made them like this, but they're easy to make with other pieces if you can't find the bricks we used.

How to Fold a Paper Football:

Start with a regular sheet of paper. (Notebook paper works great.)

Fold in thirds.

It should look like this.

Fold on the dotted lines...

...fold to a point...

...and tuck.

Round the points of your football so it's not so pointy.

The Official Rules to Table Top Football

1. Sit down at a table. Your opponent should sit down opposite you. Shake hands.
2. Set the football down on the table between you. Thump it so it spins flat across the table. If it overhangs the other end, with out falling off, you've just scored a touchdown. If it goes short (or long) the turn goes over.
3. After touchdowns, kick your extra points with your automatic field goal kicker through the goalpost arms. See page 27 if you're not sure how to use your automatic field goal kicker.

You can build the goal post any way you want. This is how we built ours.

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Activity #3 – Team Architect

The Challenge – to have each team build an item with just a few amounts of supplied materials.

Divide 4-H Members into team of 2 to 4 people. Give each team an assortment of items to work with. For example, each team could be given a packet of popsicle sticks and a roll of sticky tape and asked to build a bridge which will support a heavy book.

Once the items are built, have each team, one by one, demonstrate in front of the rest of the group the strength of their invention. If the invention doesn't work, discuss ideas and suggestions of ways to improve the design to make it work.

Designing for Strength and Stability

Activity #4 - Challenge – Tallest Tower

The Challenge – to build the tallest tower that is able support weight under stress conditions

Build the tallest tower using only pieces from your building blocks kit. It must be able to support the weight of the challenge object under various stress tests.

Evaluation – who has the tallest tower that passes the weight stress test?

Towers will be tested with the weight. The tallest tower that is able to support the weight under stress conditions will be declared the winning tower. Measurements will be taken from the table base to the top of the supporting platform.

Challenge Object: This could be any number of things including a book, a shoe or boot, a soup can. Use your imagination! Make sure that the item won't break if it falls.

MEETING 3 - LEVERAGE AND GEARING

Objectives:

- Learn what a lever is.
- Learn what a gear is.
- Learn why these two items are important in building and engineering.

Roll Calls

- Have you ever used a building block kit before? If so, what have you created?
- Name an every day item that uses a lever.
- Name an item that uses gears.
- Name something you want to building using building blocks, gears and levers.

Sample Meeting Agenda – 2 hrs. 5 minutes

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes & Business	10 min
Public Speaking/Judging Activity/ Activity Related to Topic	Activity #5 – Sturdy Walls (instructions can be found at the end of Meeting #3)	30 min
Topic Information Discussion	Discuss levers and gears and their uses.	20 min
Public Speaking/Judging Activity/ Activity Related to Topic	Activity #6 – Snail Car Race (instructions can be found at the end of Meeting #3)	40 min
Wrap up, Adjournment & Social Time!		10 min
At Home Challenge	Choose one of the At Home activities to complete.	

Topic Information

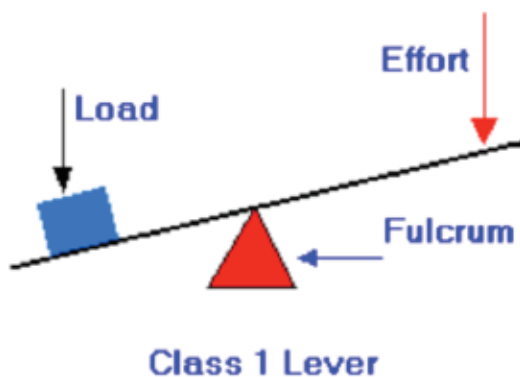
Levers

Levers are straight bars that rotate around fixed points. Levers make it easier to lift a load or apply a force.

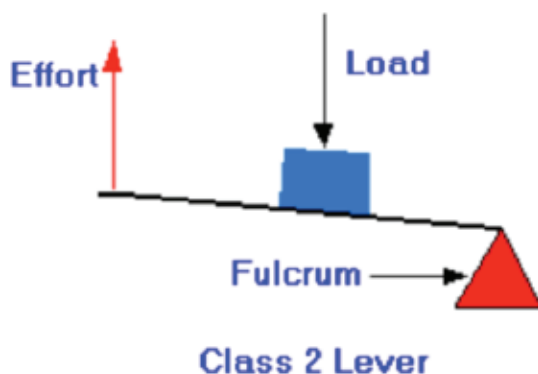
A lever is a bar that turns about a point when it is pushed or pulled. The point is called a fulcrum. The pushing or pulling is called effort. A seesaw is an example of a lever that you might see every day. Levers are often used for lifting heavy loads.

The lever is one of the simplest mechanical devices. A lever consists of a beam or stick or rod. However, a lever by itself is not effective. It must have something on which to pivot. This pivot is called a fulcrum. A lever helps to lift weights with less effort. Children on opposite ends of a seesaw lift each other's weight up and down easily. Anyone who has ever pried something loose with a crowbar or a board has used a lever.

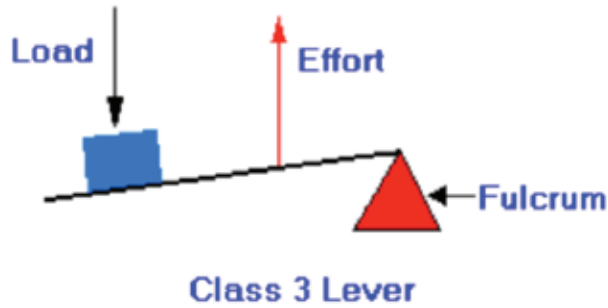
Classes of Levers



First-class levers have the fulcrum placed between the load and the effort, just like a seesaw. If the two arms of the lever are of equal length, as with the balance scale, the effort must be equal to the load. If the effort arm is longer than the load arm, as in the crowbar, the effort travels farther than the load and is less than the load.



Second-class levers have the load between the effort and the fulcrum. A wheelbarrow is a second-class lever. The wheel's axle is the fulcrum, the handles take the effort, and the load is placed between them. The effort always travels a greater distance and is less than the load.



Source: Ohio University

Third-class levers have the effort placed between the load and the fulcrum. The effort always travels a shorter distance and must be greater than the load. A hammer acts as a third-class lever when it is used to drive in a nail: the fulcrum is the wrist, the effort is applied through the hand, and the load is the resistance of the wood. Other examples of third-class levers include:

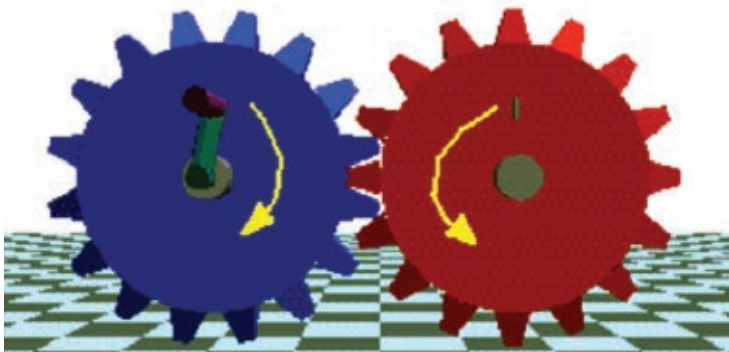
- fishing pole
- the human forearm (the fulcrum is the elbow, the effort is applied by the biceps muscle, and the load is in the hand) and a fishing pole.

There are two ways that levers make work easier for humans. All levers either reduce the force you must exert to get a job done (but require more distance) or reduce the distance you have to put in to get a job done (but require more force).

Gears

A gear is a wheel with teeth (also called cogs) around its edge. The teeth on one gear push against the teeth of another gear to make it turn. Gears are found in many everyday things such as clocks, cars, some farm machinery, elevators and bicycles.

Gears are used to transfer energy in the form of motion from one place to another. By itself a gear can't do much. But in combination with other gears, gear pairs can change the direction, speed, and torque (rotational force) of rotation.



One gear will turn in one direction and the other gear in the opposite direction.

Source: Ohio University

A gear train is a series of two or more gears meshed together. Every gear train has a driver and a follower. The driver is the gear to which the force is initially applied or the first that is spun. The follower, or driven gear, is the final gear in the train.

If a gear train has 3 or more gears, the middle gears are called idlers.

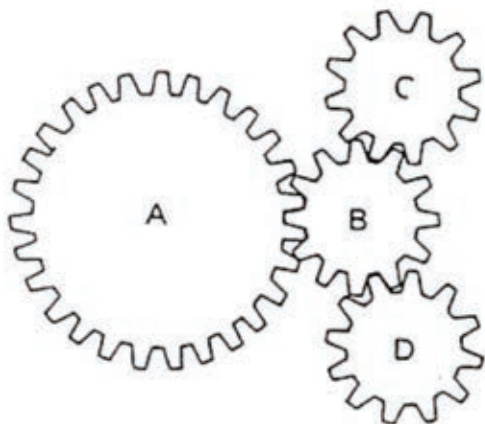
Neighbouring gears always spin in opposite directions, while gears with another gear in between them spin in the same direction.



Photo Credit: Marianne Fallis

If gears are the same size, they spin at the same speed. If they are different sizes, the smaller gear spins faster than the bigger gear.

Smaller gears take less force and more distance to spin a load, while large gears take more force and less distance to spin a load.



Fun Fact

When the gears are set in motion, which one will move in a direction different from the rest? A, B, C or D?

The Answer – B! If A, C and D are all moving clockwise, B will be moving counter-clockwise.

Source: www.oldschool.com

BEFORE THE NEXT MEETING

Try one of the following activities at home.

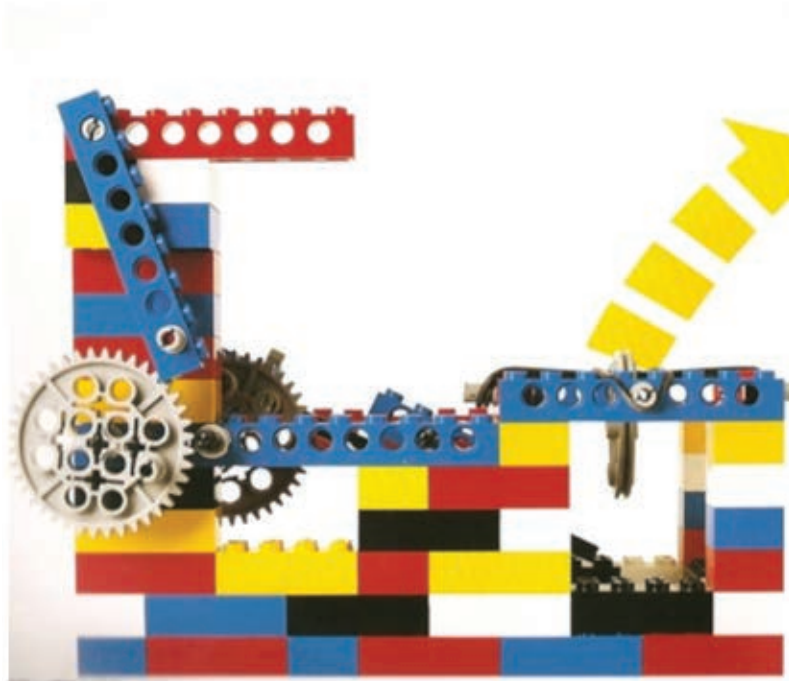
1. Take a walk around your home (or in your shop or barn if you have one) and list 5 items that use gears and 5 items that use levers. Record your findings in your Record Book.

OR

2. Find a small triangular object (or make one out of heavy cardboard, etc.) and build a mini lever using the triangular object and a ruler. Test to see how much weight you can lift. Experiment by moving the ruler so the fulcrum is not centred on your lever. Record what items you were able to lift with your lever.

DIGGING DEEPER

Build a Ping Pong Launcher



This machine uses 63 LEGO bricks that are not in the pouch. But many of them can be built with smaller bricks if you have them. All the rest of the pieces are in your pouch. Except the Ping-Pong ball. (If you don't have one, wad up a piece of paper and make do.)

Ping-Pong Popper

What does the Popper do? Turn the crank and the machine winds up and gets ready. Pull the trigger and **BOING!** the Ping-Pong ball is launched skyward.

54

INGREDIENTS NOT IN THE POUCH:

- a Ping-Pong ball
- 20 of these
- eight of these
- 38 of these

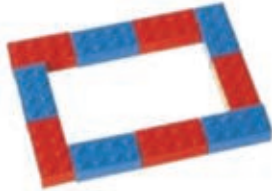
INGREDIENTS IN THE POUCH:

- one 12-stud axle
- one 10-stud axle
- two 8-stud axles
- one 6-stud axle
- two 40-tooth gear wheels
- one 24-tooth gear wheel
- one 8-tooth gear wheel
- one large pulley wheel
- three large rubber bands
- seven gray connector pegs
- seven bushings
- two 12-stud beams
- two 6-stud beams
- two 4-stud beams
- two 2-stud beams
- six 8-stud beams

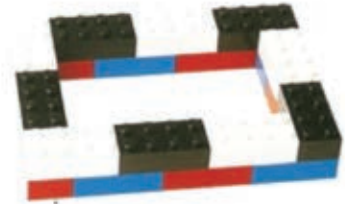
57

The Base

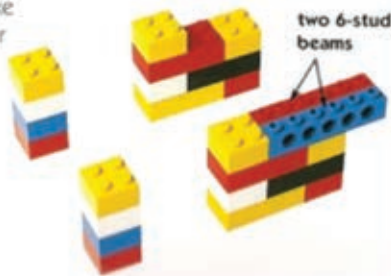
1 Build this frame out of ten LEGO bricks. (14 studs long x 10 studs wide x 2 studs thick)



2 Add a second story the same size.



3 Now make these four towers.



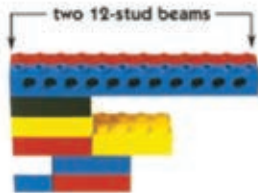
4 Stick the towers on the base as shown here:



Now you're finished with the Base. Put it aside for a minute.

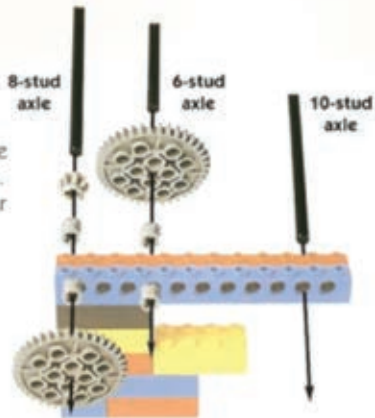
5

Make a diving board out of six 2 x 4 LEGO bricks, two 2 x 2 LEGO bricks and two 12-stud beams.



6

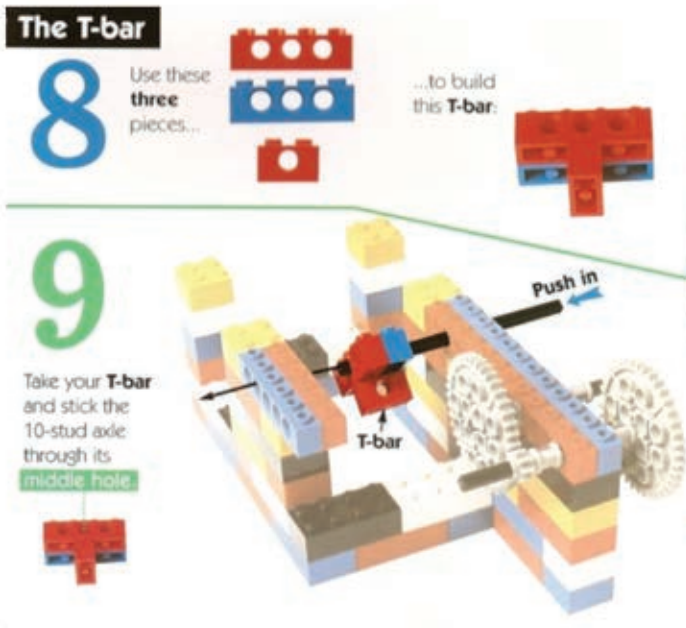
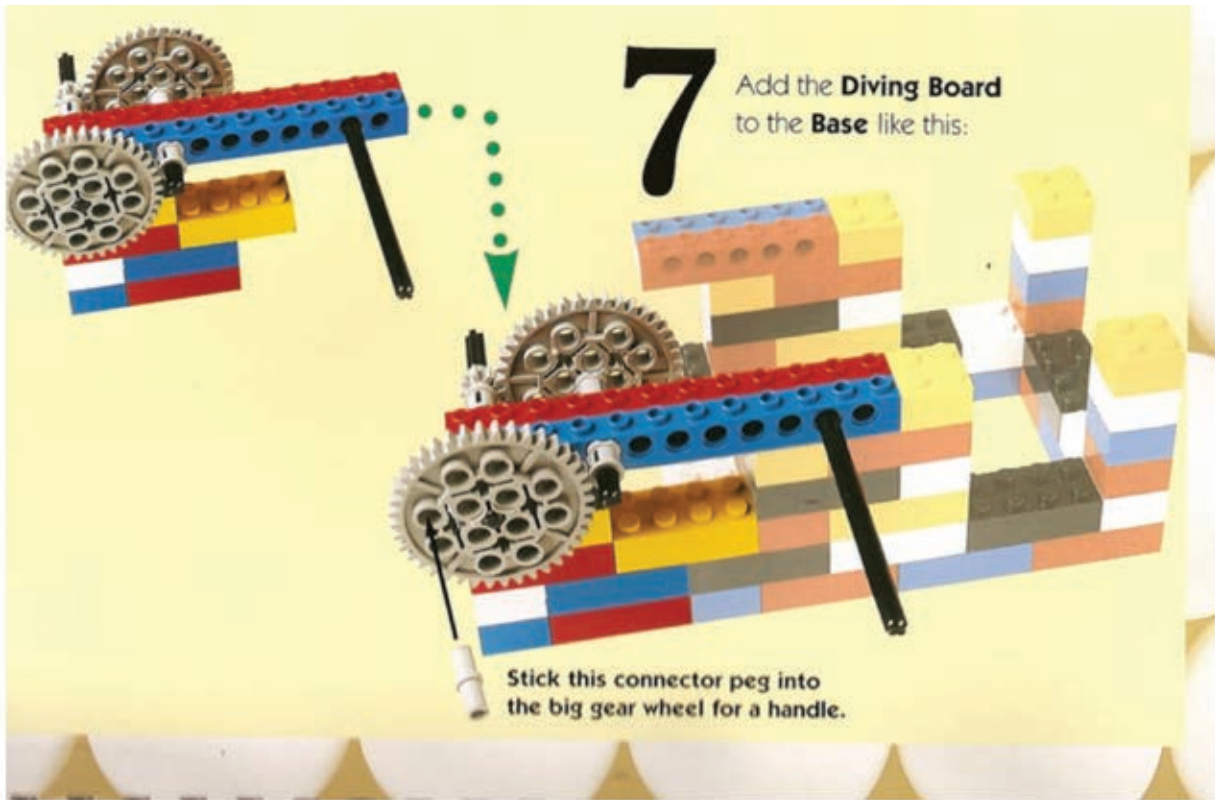
Stick these three axles in like this. Add all the gear wheels and bushings as shown.



END
UP
LINE
THIS

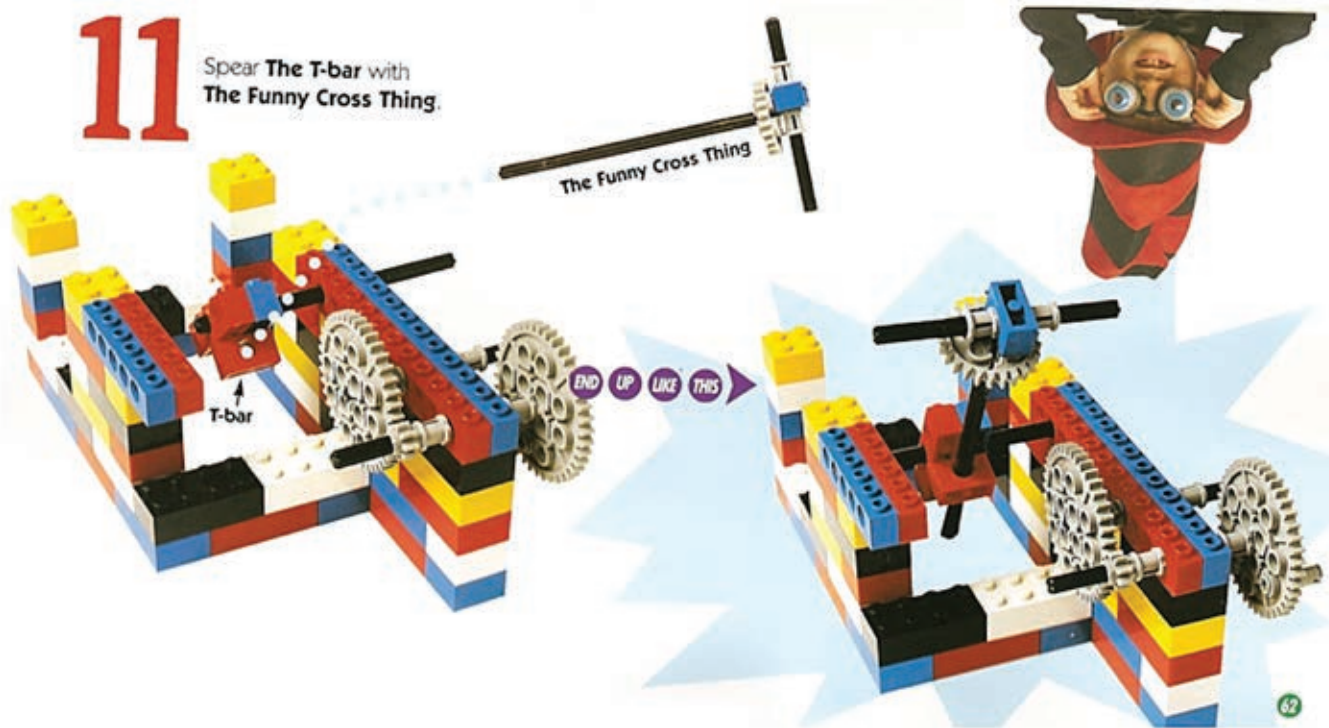
The Diving Board





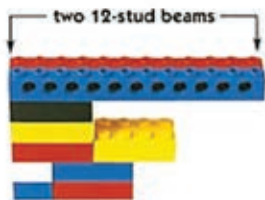
11

Spear **The T-bar** with **The Funny Cross Thing**.



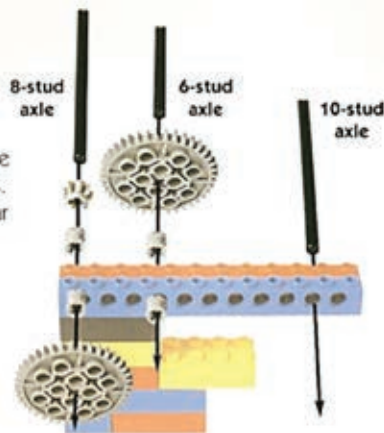
5

Make a diving board out of six 2 x 4 LEGO bricks, two 2 x 2 LEGO bricks and two 12-stud beams.



6

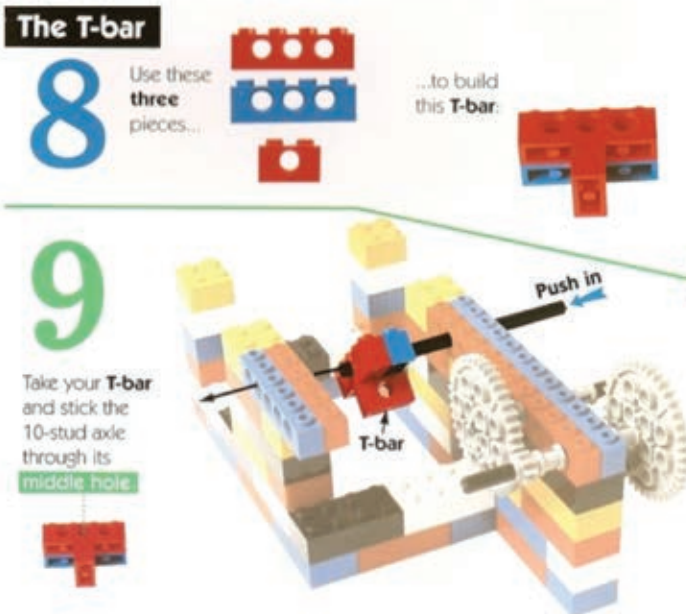
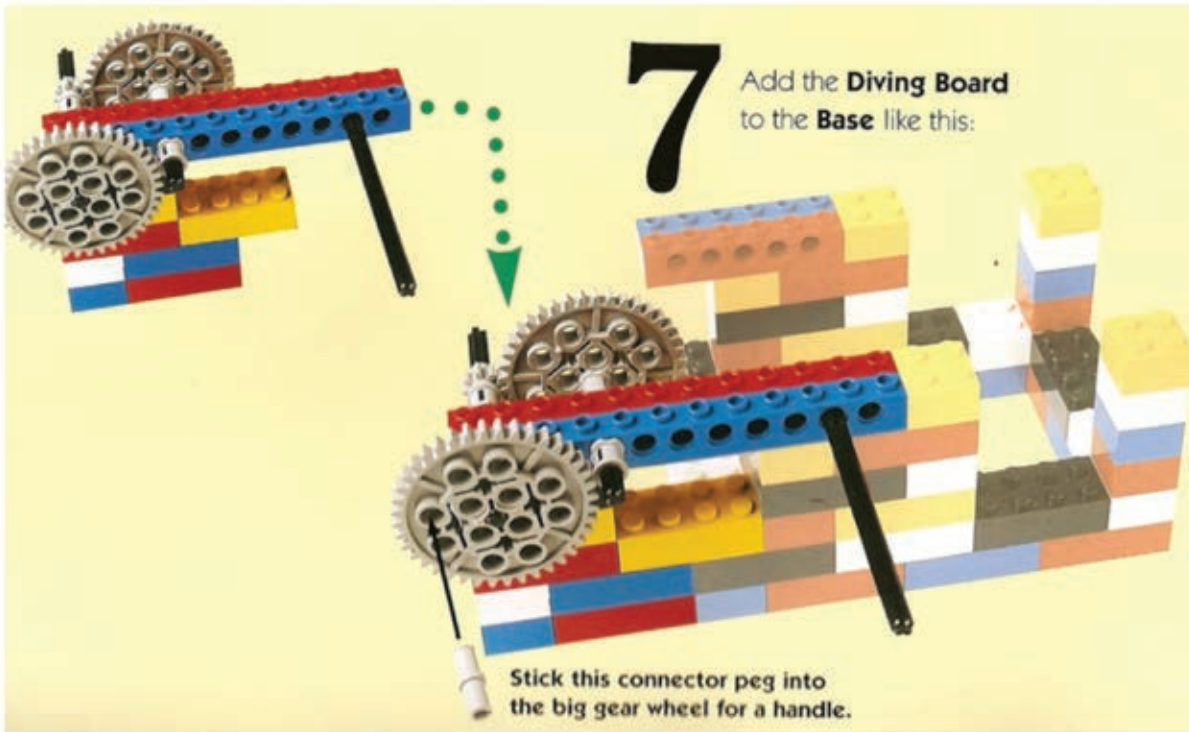
Stick these three axles in like this. Add all the gear wheels and bushings as shown.



The Diving Board

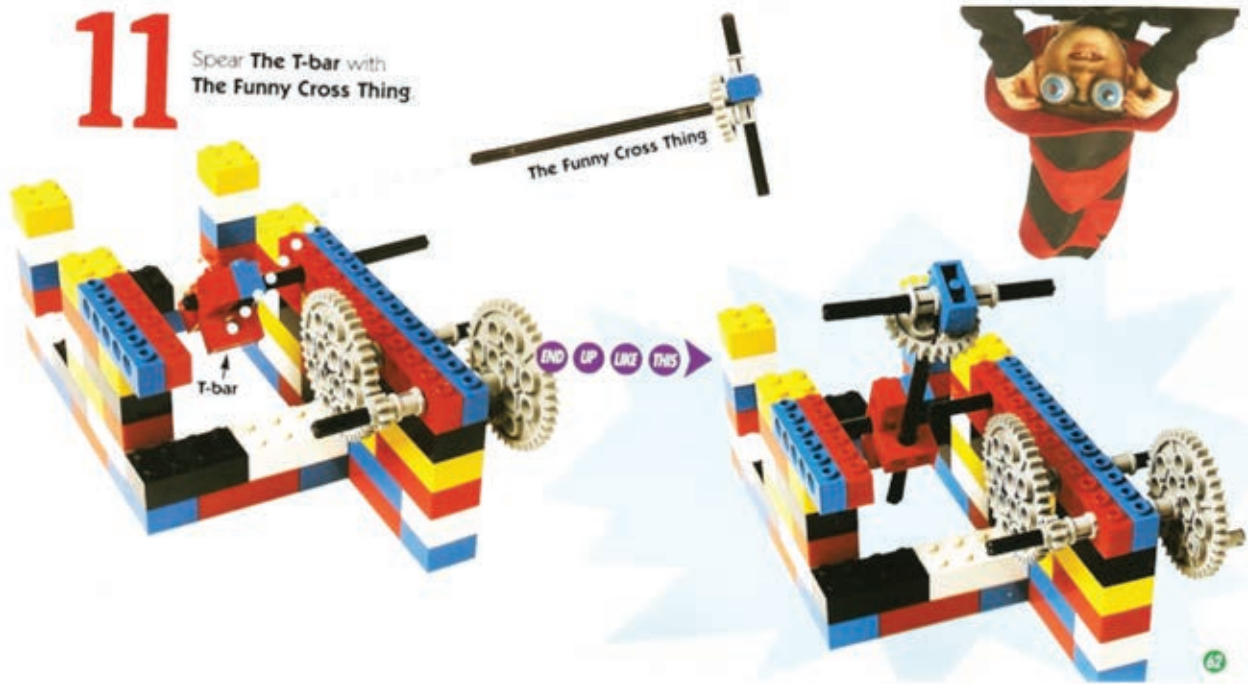


59



11

Spear **The T-bar** with **The Funny Cross Thing**



12

To put **The Funny Cross Thing** in its final working position, take the 8-stud axle and use it to spear the big gear wheel and a bushing. Follow the photo.



The Spring Board



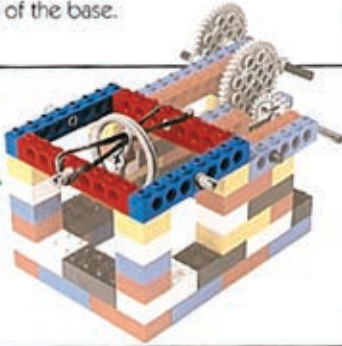
Make a frame out of four 8-stud beams. Spear the middle holes with connectors. Snap it down onto the four towers of the base.

END UP LIKE THIS



Thread TWO of your large rubber bands through a large pulley wheel. Put it onto the gray connector peg.

END UP LIKE THIS

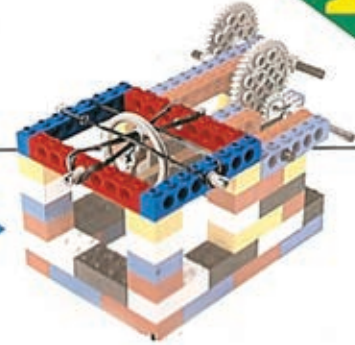


13



Put another of your large rubber bands around the other two gray connector pegs on the frame (the pulley wheel will be in the middle).

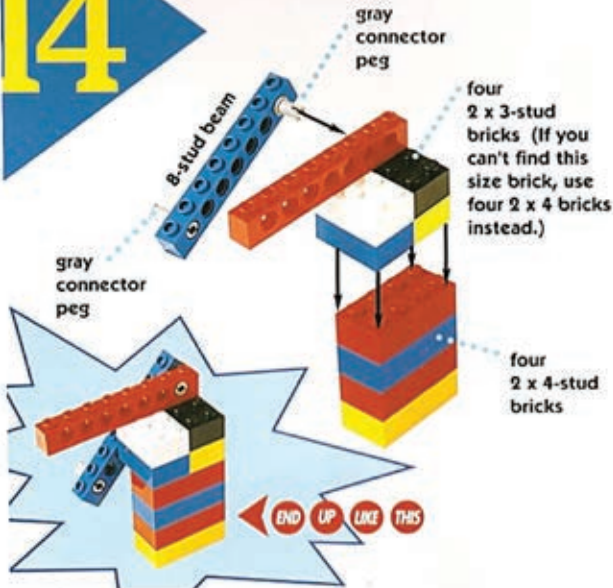
END UP LIKE THIS



14

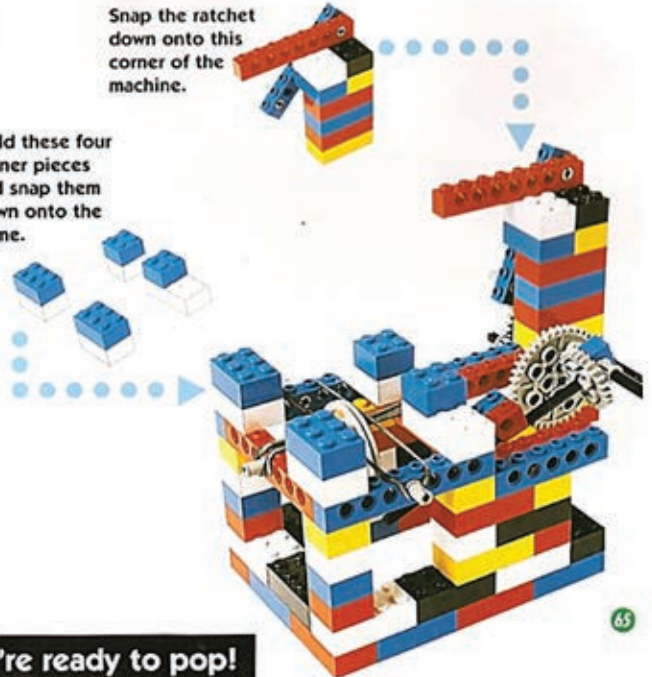
The Ratchet

Build this. Follow the photo carefully.



Snap the ratchet down onto this corner of the machine.

Build these four corner pieces and snap them down onto the frame.



You're ready to pop!

How to Work Your Ping-Pong Popper

Place your Ping-Pong on top of the pulley wheel. Then crank the gray gear wheel handle forward. If you're lucky, the black axle will stick into the wheel under the Ping-Pong ball and start pulling on it. Keep cranking and suddenly, **BOING!** The ball will pop into the air. Dig it out from under the couch and try again. Sometimes the axle will miss the wheel under the ball. If that happens, just fool with it. Happy Popping!



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Activity #5 - Challenge – Sturdy Walls

The Challenge – to build a wall that will hold the weight of a 4-H member standing on it

Build the longest or tallest tower using only pieces from a building blocks kit. It must be able to support the weight of a 4-H Member. The wall must be a minimum of 6 bricks high and at least 6 bricks long.

Evaluation – who has the tallest wall that passes the weight stress test? Who has the longest wall that passes the weight test?

Once each 4-H Member has built their wall, gather Members together to discuss each wall and why each Member built it the way they did. Walls will then be tested with the weight. The tallest and longest walls that are able to support the weight of a 4-H member will be declared the winning walls.

After each 4-H Member has tested their wall, use the walls as a judging class to practice their skills. Help 4-H Members to list criteria for judging the walls. Then have 4-H Members judge the class and give their reasons. The People's Choice Award could go to the wall with the most first place rankings.

Activity #6 - Challenge – Snail Car Race

The Challenge – to build a car that uses gears to travel as slowly as possible.

Begin by reviewing how to make something gear down. Divide 4-H Members into pairs and have them construct their cars.

Evaluation – who has the slowest car?

Once all teams have their car finished, place the starting line on the floor with tape. In consulting with 4-H Members, determine what is an appropriate length for the race and place a second piece of tape for a finish line. If the cars are successful, the finish line shouldn't be too far from the starting line.

MEETING 4 - PULLEYS

Objectives:

- Learn what a pulley is and how it works using either ropes or belts.
- Learn the difference between rope and belt pulleys.
- Discover how to make work easier by requiring less effort.

Roll Calls

- Name a piece of machinery that uses pulleys.
- What building block item do you want to build that incorporates pulleys?
- Have you ever used a pulley system? If so, what for?

Sample Meeting Agenda – 2 hrs. 10 minutes

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes & Business	10 min
Public Speaking/Judging Activity/ Activity Relating to Topic	Activity #7 – Parachute Aerial Car (instructions can be found at the end of Meeting #4)	30 min
Topic Information Discussion	Discuss pulleys with ropes and belts and how they work.	20 min
Public Speaking/Judging Activity/ Activity Relating to Topic	Activity #8 - Rubber Band Racer (instructions can be found at the end of Meeting #4)	45 min
Wrap up, Adjournment & Social Time!		10 min
At Home Challenge	Choose one of the At Home activities to complete.	

Topic Information

Pulleys

A pulley is a grooved wheel that turns on an axle. The groove in the wheel causes the rope, cable or belt to ride on the wheel without slipping off. Pulleys are used in a variety of ways to lift loads, apply forces, and to transmit power.

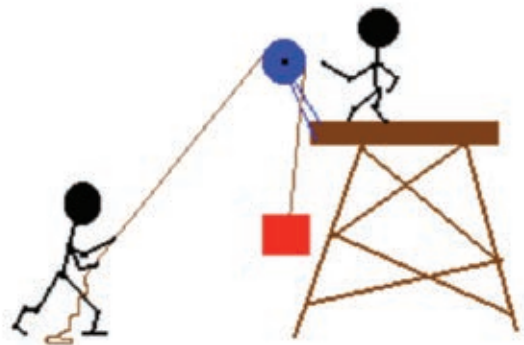
Pulleys with belts can change turning speed and turning direction. Pulleys with ropes can lift things. Pulleys can be found in many everyday things, including cars, some farm machinery and construction equipment.



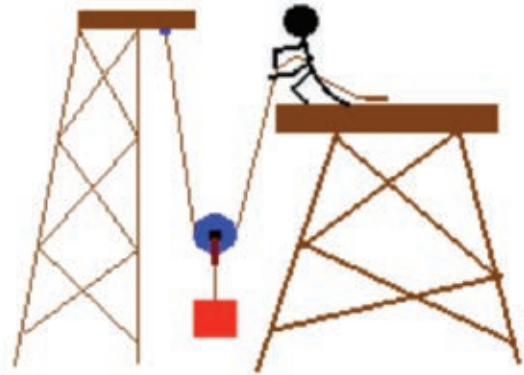
Photo Credit: Marianne Fallis

1. The pulley can change the direction of a pull. In this case, pulling down on the rope will lift the weight up. With just one pulley as shown below there is no saving of effort, but it provides a way to maneuver the weight more conveniently. This pulley is called a fixed pulley.

For lifting with a fixed pulley, you pull down (or any direction) with force equal to the load and with the distance the same as the distance moved by the load. The pulley helps us because we can pull the string down (or sideways or any direction) instead of pushing the load up.



2. With the pulley arrangement shown below, less effort is required. Half the weight is supported by the overhead beam, and half is supported by the person holding the other end of the rope. The weight is shared so the human effort is less. However, now the rope will have to be pulled twice the distance. You would have to use half as much force to lift the weight, but you would have to pull the rope twice as far, as compared to the first example shown above. This pulley is called a moveable pulley.



Source: Ohio University

For lifting with one moveable pulley, you pull down (or any direction) with force equal to half of the load and with distance double the distance moved by the load. The pulley helps because you can pull the rope down (or sideways or any direction) instead of pushing the load up and you only need to put in half the force.

Pulleys with Belts

A belt and pulley system is characterized by two or more pulleys in common to a belt. This allows for mechanical power, torque, and speed to be transmitted across axles. If the pulleys are of differing diameters, a mechanical advantage is realized.



Source: <http://en.wikipedia.org/wiki/Pulley>

BEFORE THE NEXT MEETING

Try one of the following activities.

1. Using the Internet, or by looking around home, research and list 10 items that use a pulley system to either lift, move or power an item or piece of machinery. Record your findings in your Record Book.

OR

2. Create your own pulley system using a small pulley (possibly from your Building Blocks kit) and a heavy string. Practice lifting a small item a distance of at least 30cm.

DIGGING DEEPER

In addition to electrical motorized power, many Building Block projects can incorporate Renewable Energy as a source of power. Energy from solar, wind and water can be collected and stored and used to power many different designs. Renewable energy can affect the power, force, speed and efficiency at which a project can work. There are many possible benefits of solar, wind and water assisted projects.

Using the concepts learned thus far in the Building Blocks Engineering Project, construct the following projects incorporating Renewable Energy.

Digging Deeper Activity #1 – Rotating Carousel

The Challenge – Build a Rotating Carousel that is powered by a solar panel, water wheel or windmill.

Working either as an individual or in pairs, create a moving carousel. This carousel should have the speed, consistency and mechanics of a fair ride carousel. Be creative and have fun!

Evaluation – Who has the most original design? Who has the design that moves the smoothest and most consistently? Does the design look sturdy? Is the design appealing?

Once the rotating carousels are complete, have 4-H Members explain and demonstrate what they have built, why they built it the way they did and any modifications they made along the way.

Digging Deeper Activity #2 – Carnival Ride

The Challenge – Build a Carnival Ride (or rides) that are powered by a solar panel, water wheel or windmill or a combination of these.

Working either as an individual or in pairs, create a carnival ride(s). These rides should have the speed, consistency and mechanics of fair rides. Be creative and have fun!

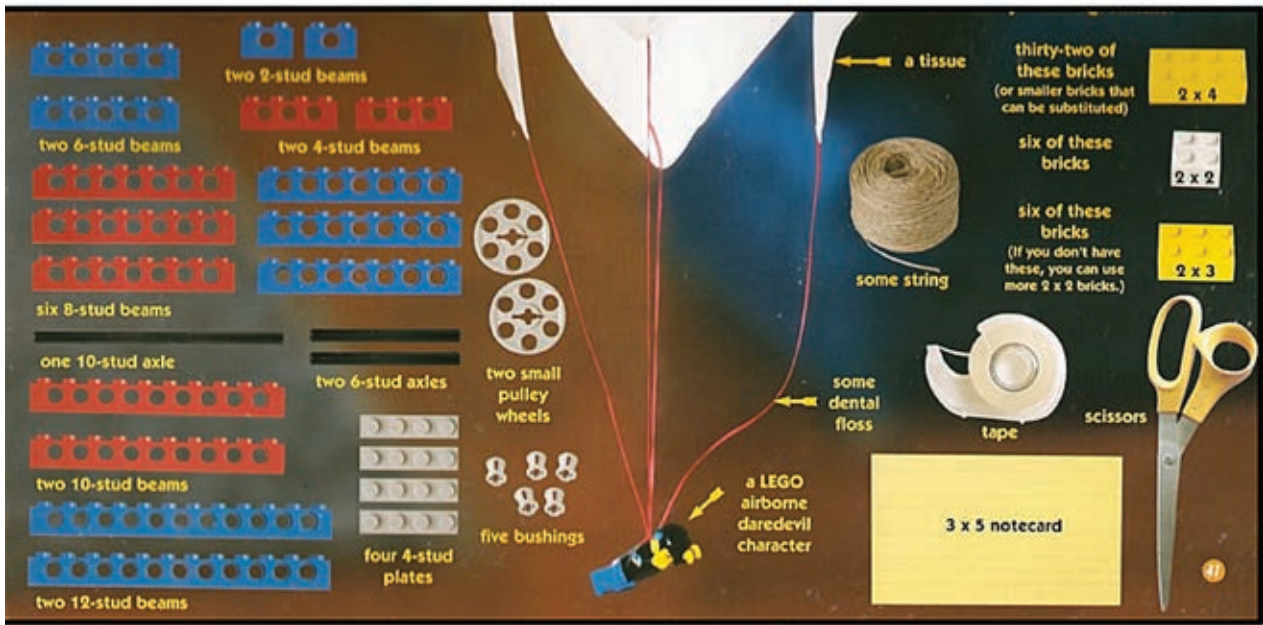
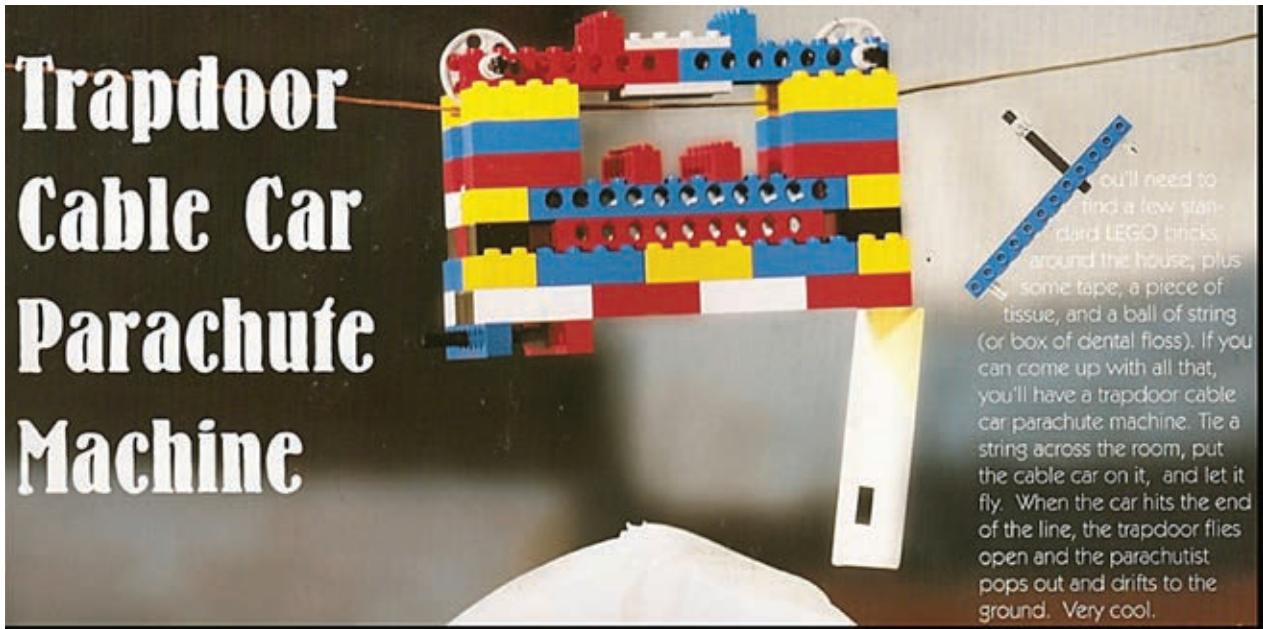
Evaluation – Who has the ride that runs at the most consistent speed and is reflective or an actual ride found at a fair? Is the use of solar, wind or water power appropriate for the ride's design? Is the design appealing? Does the design look sturdy?

Once the carnival ride(s) are built, have 4-H Members explain and demonstrate what they have built, why they built it the way they did and any challenges they had while constructing their project.

Activity #7 – Parachute Aerial Car

Build a Parachute Aerial Car using the following instructions.


Using your Building Blocks Journal in your Record Book, record the distance that your Aerial Car was able to travel. As well, record how many times your parachutist was released and how many times it hit the target.



The Base

1


Build **The Base** of the cable car with two levels of LEGO bricks.



NO
UP
LIKE
THIS

2

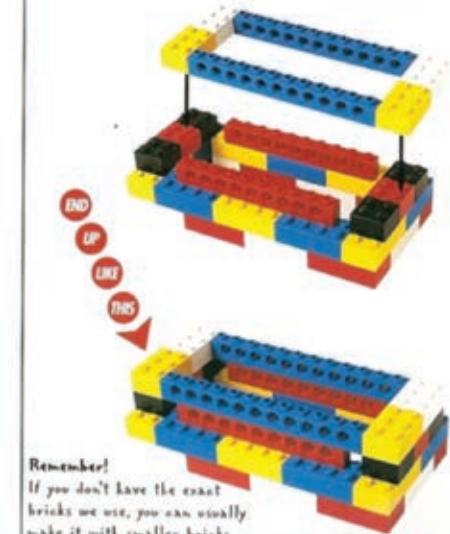
Add the next layer made up of two 10-stud beams and six 2 x 2 LEGO bricks.



END
UP
LIKE
THIS

3

On top of all that, add a third layer of two 12-stud beams and four 2 x 3 LEGO bricks.



END
UP
LIKE
THIS

*Remember!
If you don't have the exact bricks we use, you can usually make it with smaller bricks.*

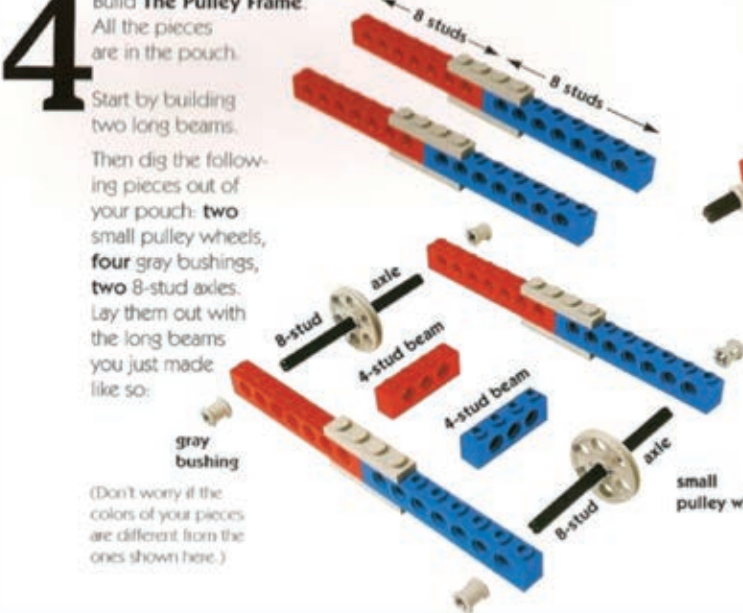
4

Build The Pulley Frame.
All the pieces are in the pouch.

Start by building two long beams.

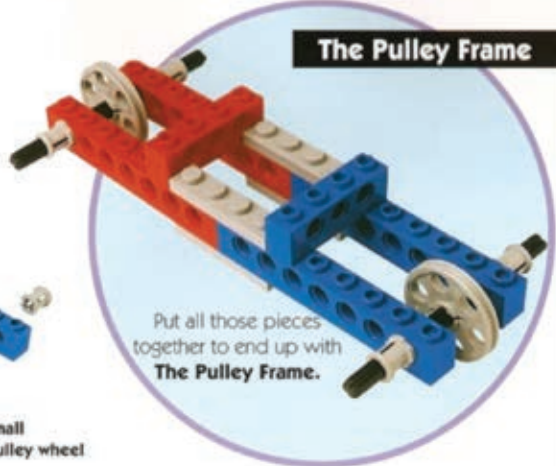
Then dig the following pieces out of your pouch: **two** small pulley wheels, **four** gray bushings, **two** 8-stud axes.

Lay them out with the long beams you just made like so:



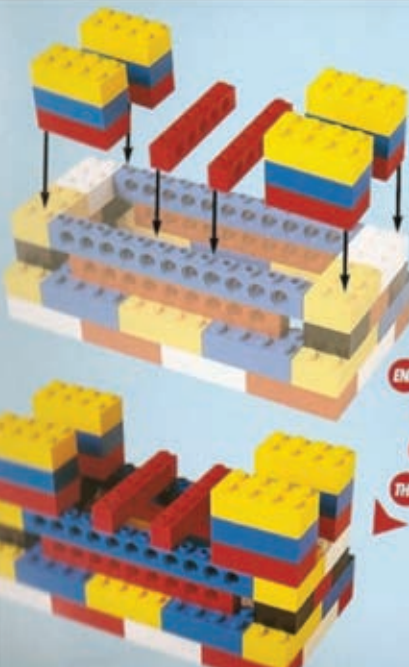
(Don't worry if the colors of your pieces are different from the ones shown here.)

The Pulley Frame



Put all those pieces together to end up with **The Pulley Frame.**


5



Build these four towers. Stick the towers and two 6-stud beams onto **The Base**.

END
UP
LIKE
THIS

6



Now add **The Pulley Frame** to **The Base**.

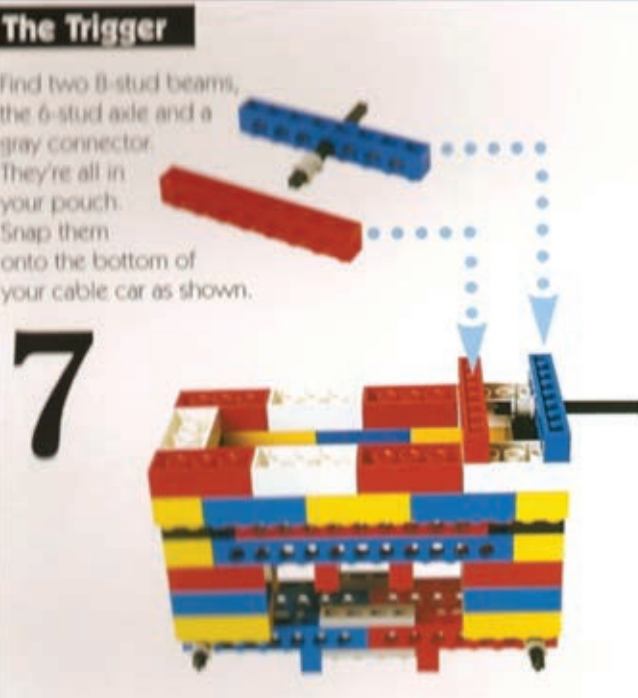
END
UP
LIKE
THIS



The Trigger

Find two 8-stud beams, the 6-stud axle and a gray connector. They're all in your pouch. Snap them onto the bottom of your cable car as shown.

7



The Trapdoor

Make your trapdoor out of a notecard. Shorten it by an inch and a half, put two slits in it and stick in your 10-stud axle. Then tape it onto the bottom of your cable car.

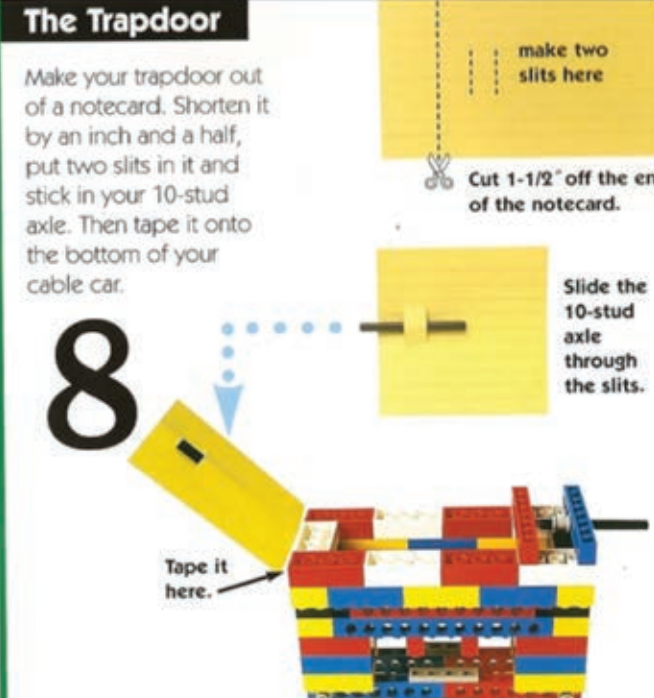
make two slits here

Cut 1-1/2" off the end of the notecard.

Slide the 10-stud axle through the slits.

8

Tape it here.



The Parachute

9

Cut one sheet of a tissue into a square. Tape a few inches of dental floss onto each corner. Tie up the bottoms and tape the knot to your parachute person.

We used a LEGO mini-figure. You can use any small person with a yen for flight.

10

Stuff your parachute person into the cable car. Don't stuff it in too tightly or your parachutist won't drop out. Swing the trapdoor shut. To keep it in place, push the latch into the hole. You're done.

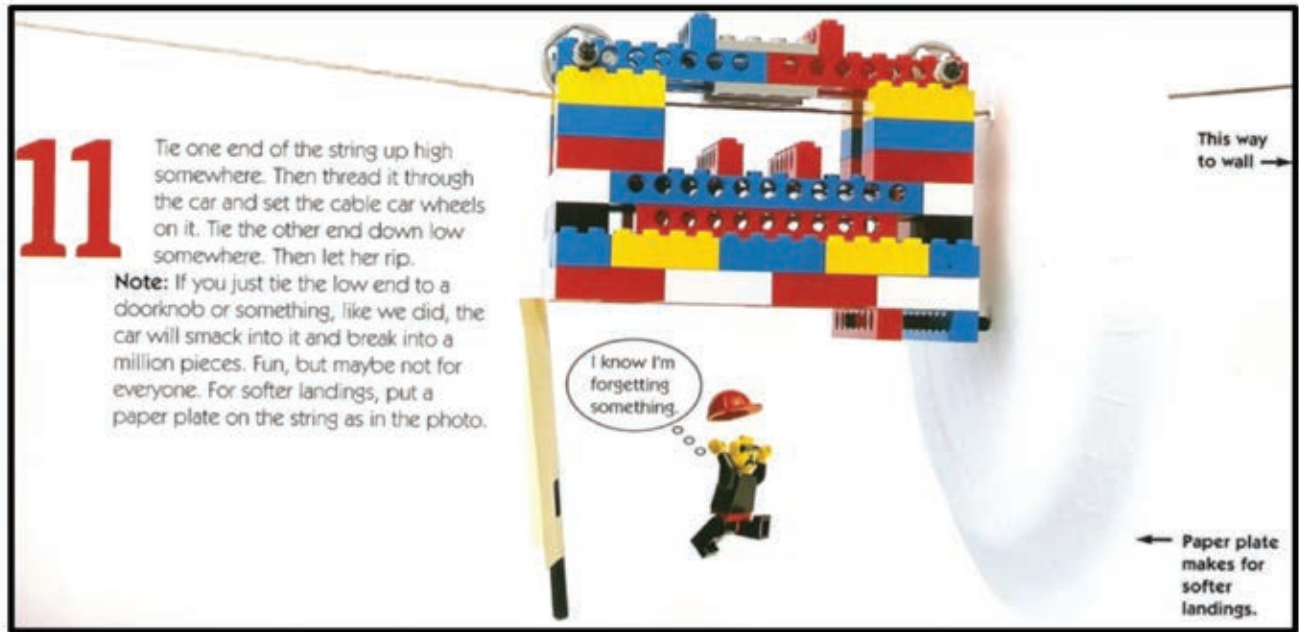
• Let just a bit of this axle show.

Trapdoor OPEN

Trapdoor CLOSED

Axle LATCHED

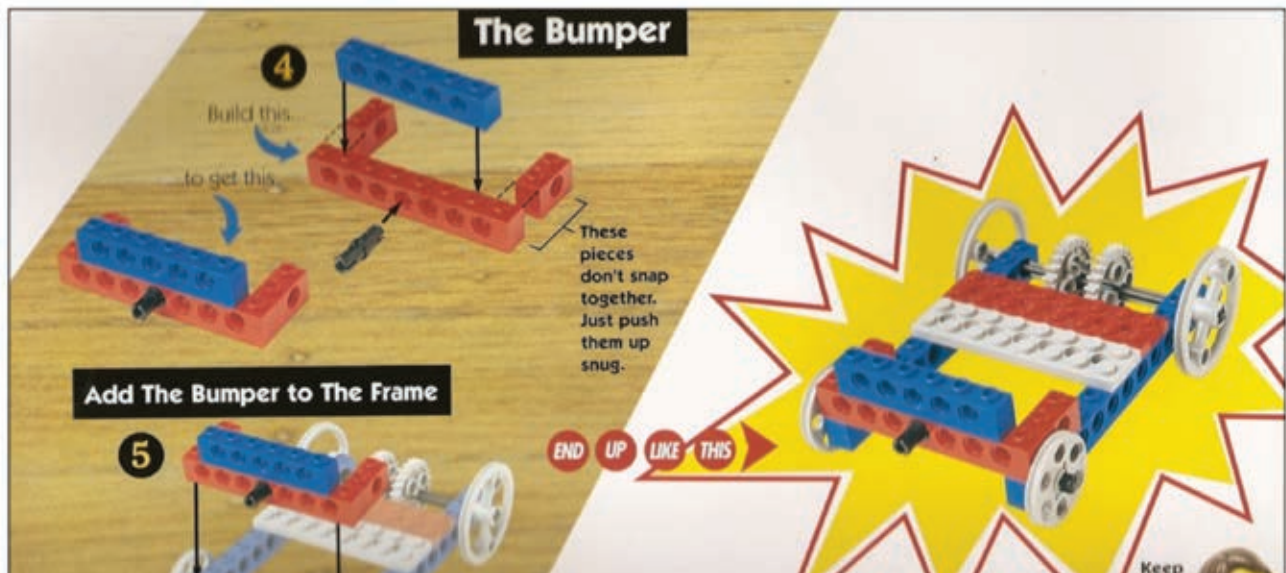
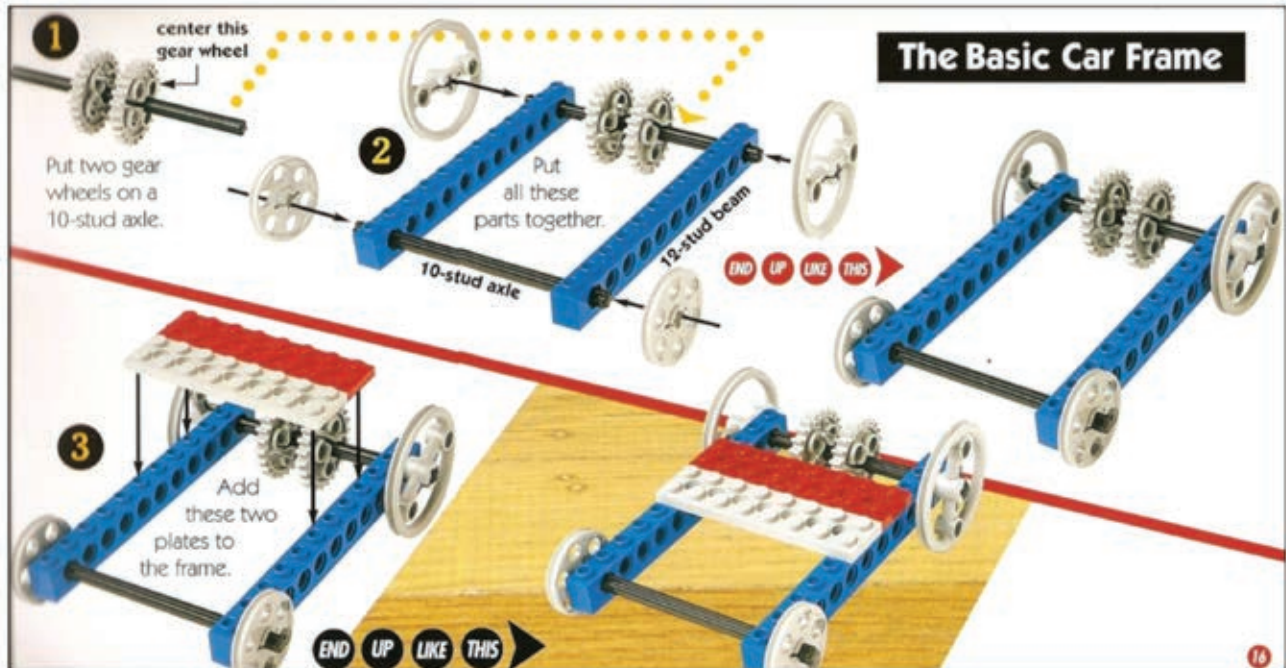
The trapdoor is latched when this axle is pushed in to this hole.

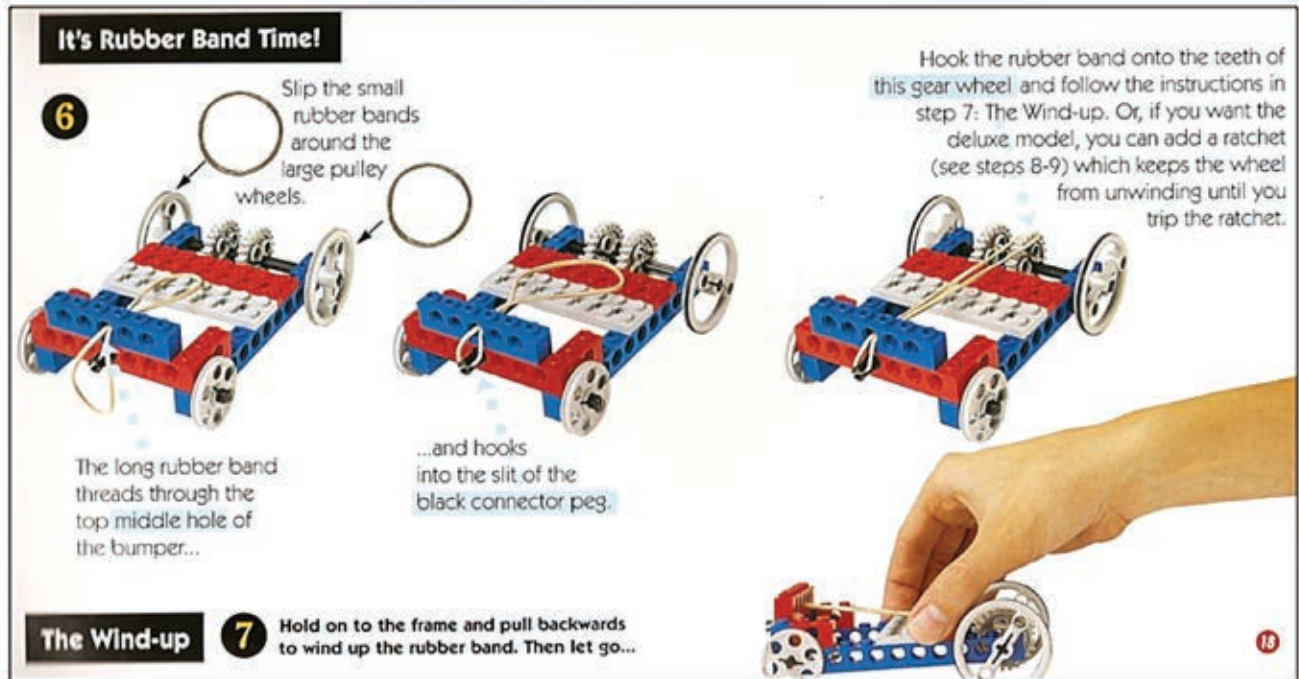


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Activity #8 – Rubber Band Racer

Build a Rubber Band Racer using the following instructions. Record the longest distance your Racer travelled in your Record Book using your Building Blocks Journal.





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MEETING 5 - WHEELS AND AXLES MOVEMENT

Objectives:

- Learn the definition of a wheel and axle.
- Learn the difference between a rolling system and a wheel and axle system.
- Understand the trade-offs between long and short wheel and axle systems.

Roll Calls

- Name one example of an object that uses a rolling wheels system.
- Name a project you would like to build using a wheel and axle system.
- What Building Block project have you built at home since starting this project?

Sample Meeting Agenda – 2 hrs. 5 minutes

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes & Business	10 min
Public Speaking/Judging Activity	Activity #9 – Sturdy Car – The Drop Test (instructions can be found at the end of Meeting #5)	30 min
Topic Information Discussion	Discuss wheels and axles systems and their application to Building Block projects.	15 min
Activity Related to Topic	Activity #10 – Tractor Pull (instructions can be found at the end of Meeting #5)	45 min
Wrap up, Adjournment & Social Time!		10 min
At Home Challenge	Choose one of the At Home activities to complete.	

Topic Information

Wheels and Axles

Wheels are circulating rotating objects that make moving other objects easier. Axles are linear bars that connect together with wheels to move other objects more easily.

Rolling Wheels

By reducing friction, wheels help us move objects along. Objects that use rolling wheels for easier movement include skateboards, wheelbarrows, wagons, scooters, toy cars, equipment carts and desk chairs. On most of these objects, the wheels turn freely on fixed axles (thin rods). The purpose of these axles is to hold the wheels in line. The axles are not used to make the wheels turn. Instead, the wheels turn because you push or pull somewhere else on the object. You don't need to put effort (either a push or a pull) directly into the wheels.

Wheel and Axle System

This system is different from rolling wheels. In a wheel and axle system, the purpose of the wheel and axle is to make each other turn. Objects that use a wheel and axle system include egg beaters and steering wheels. When you use an object with a wheel-and-axle system, you apply effort (a push or a pull) directly to the wheel or axle, rather than to somewhere else on the object. If you apply effort to the wheel, the axle turns.



Photo Credit: Marianne Fallis

A bicycle is a great example of both a Rolling Wheel system and a Wheel and Axle system.

The back wheel of a bicycle is a wheel and axle system. The back wheel of the bike only turns when you put effort into the back axle by pedaling. The bicycle's gears and chain move your pedaling effort from the pedals to the back axle.

The front wheel of a bicycle is not a wheel and axle system. It is just a rolling wheel that turns freely on the fixed front axle. You don't need to put effort into the front axle to make the front wheel turn. Instead, the front wheel turns by itself whenever the bike is moving.

Wheel and Axle Trade-offs

A long wheel and axle system requires less force to turn but more distance. A short wheel and axle requires more force, but less distance.

Before the Next Meeting

Try one of the following activities.

1. Challenge yourself! Using 20 pieces or less out of your Building Blocks set, design a vehicle that can roll across the floor. Record your results in your Building Blocks Journal found in your Record Book.

OR

2. Using water-based stamp pads, construction paper and random pieces of Building Block pieces, create either a structural design of a building, a vehicle or something else of your choosing on the construction paper using the building blocks as your stamps. A piece of foam could be substituted for the construction paper. Include your artwork in your Record Book.

DIGGING DEEPER

Create a Balloon-Powered Rocket Car. Using your Building Blocks Journal in your Record Book, record how far your Balloon Racer travelled.



The Car Frame

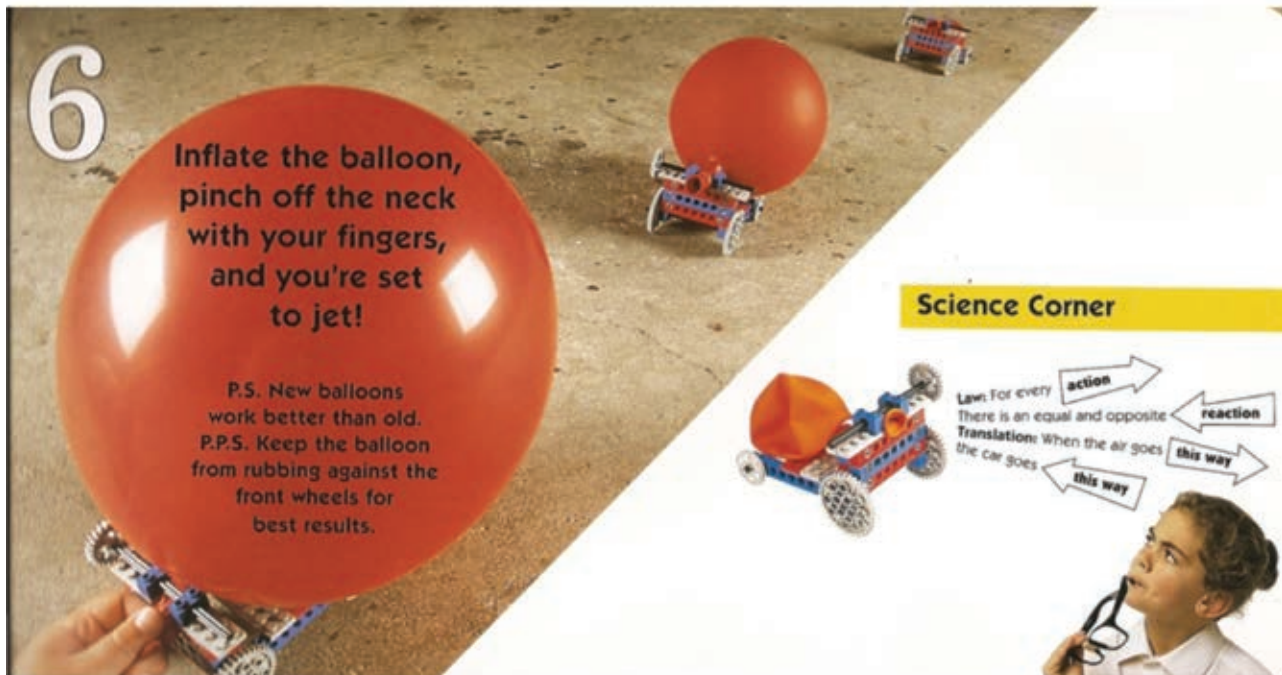
1

The Rocket Car is a basic car frame with something we call our own special Blocky Thing snapped onto it. **The Blocky Thing** just holds the balloon in place. Build the car frame with these ten pouch pieces. (Don't worry if the colors of your pieces are different. It won't affect how your car runs.)

The Blocky Thing

2

Put six beams together using six gray connector pegs.



Activity #9 – Sturdy Car – The Drop Test

The Challenge – Build a car that is sturdy and does not fall apart when dropped.

Begin by discussing how cars are made. All cars have wheels, axles and a frame. The goal of this project is to build a structurally sound car. The car does not have to have a motor but it must be able to roll using wheels. Working either in pairs or as individuals, have 4-H Members design their sturdy cars.

Once cars have been constructed, conduct the Drop Test. Have 4-H Members (or a Youth Leader) do the Drop Test by dropping the car from a height of 10cm (or from ankle height). If the car is unsuccessful, have 4-H Members re-design their car as necessary. Review and discuss the different building methods that 4-H Member used.

Evaluation – Who has the car that was able to withstand being dropped and still be able to function normally?

Have 4-H Members judge the cars based on the criteria of sturdiness and ability to withstand a drop from a height of 10cm (or higher). Discuss any problems that 4-H Members encountered during the building process and how they modified their design. Judging Card can be found in the Record Book

Activity #10 – Tractor Pull

The Challenge – Build a tractor that is capable of pulling a heavy load across the floor.

Begin by discussing how 4-H Members might construct a tractor using a motor(s), gear train, wheel assembly and frame. The goal of this project is to build a tractor that is strong enough to pull a dead-weight object across a flat surface. Working either in pairs or as individuals, have 4-H Members design their Tractor Pull tractors.

Using tape on the floor as a starting line, have each Member test out their tractor one by one. If possible, try to increase the weight the tractor is pulling at certain measured intervals to increase the friction that the tractor is pulling. Once the tractor has spun out and is no longer able to pull the load, measure where the tractor stopped. Have a 2ndd piece of tape for a finish line to see who can have a “full pull.”

Evaluation – Who has the tractor that was able to pull the weight across the floor and have a “full pull”? If there was no full pull, which tractor pulled the farthest?

Discuss why the tractor that had the full pull, or the tractor that pulled the farthest distance, was able to pull that far.

MEETING 6 - MOVING ON UP!

Objectives:

- Introduce Members to the uses of inclined planes, screws and wedges.
- Understand how planes, screws and wedges can help a design.
- Make preparations for the Achievement Program.

Roll Calls

- Name one new thing you learned in this project.
- Name one thing you've built that required screws.
- Name an object that uses a ramp to make work easier.

Sample Meeting Agenda – 2 hrs. 25 minutes

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes & Business	10 min
Topic Information Discussion	Discuss inclined planes, wedges and screws and their uses.	20 min
Public Speaking/ Judging Activity/ Activity Related to Topic	Activity #11 - Mountain Rescue	60 min
Topic Information Discussion	Discuss plans for the Achievement Program.	30 min
Wrap up, Adjournment & Social Time!		10 min
At Home Challenge	Get ready for the Achievement Program!	

Topic Information

Inclined planes, which are surfaces slanted upward, lower the effort needed to lift a load.

Which would be easier to walk up: a steep ramp or a gentle ramp? There is a trade-off in designing ramps or any other inclined planes. To reach a certain height, a steep ramp requires a short distance but it takes a lot of force to get up the ramp. To reach the same height using a gentle ramp, it requires a longer distance but it takes less force to reach the top of the ramp.

Wedges, which are two inclined planes joined back to back to form a sharp edge, are used to change the direction of a force and often result in the splitting of objects. Wedges are often used for cutting or for doing work within very small spaces. For example, the wedge on a screwdriver fits into the notch on a screw.

Screws are inclined planes wrapped around a cylinder. Screws make work easier for humans by connecting objects together and by raising or lowering objects by spiraling. Examples of screws include jar lids, light bulbs, gas caps, spiral staircases, clamps and swirly stools.

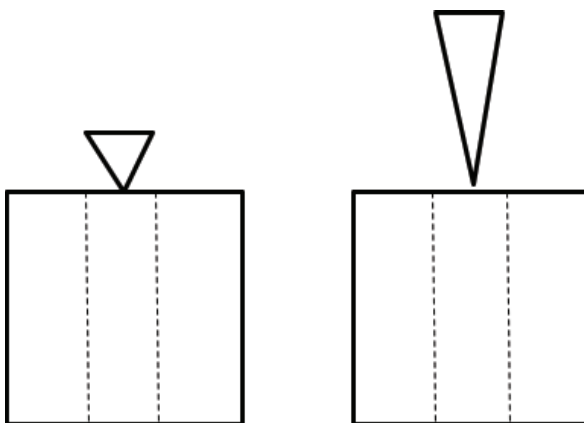
How do inclined planes, screws and wedges work?

The more wraps of an inclined plane around a cylinder to create a screw, the further the distance is to go around it but less force is required.

The fewer wraps of an inclined plane around a cylinder to create a screw, the shorter the distance is to go around it but more force is required.

Consider a plow making a cut through the soil (as shown in the image below). Less force is needed for the longer, steeper plow (wedge) but the plow needs to be pushed a farther distance to make the whole cut be as wide as the widest part of the wedge.

More force is needed for the shorter, gentler plow (wedge) but the plow doesn't have to be pushed as far to make the whole cut as wide as the widest part of the wedge.



Activity #11 - Mountain Rescue

The Scenario: There are people trapped up in the mountains that need to be rescued. But, there has been a rock slide and rocks are blocking the road to get up the mountain. A vehicle needs to be built that will push the rocks out of the way so rescue vehicles can get up the mountain to rescue the victims.

Materials Needed: small board or piece of plywood (approx. 30cm wide X 75-100cm long) to be used as a ramp (the road leading up the side of the mountain), large aquarium stones, boards to go under one end of the 30X70 board to make an incline

Working in pairs, 4-H Members will build a vehicle that could use a combination of gears, pulleys and a motor to make their vehicle travel up an incline. Members will explore the use of gears to give their vehicle more power as well as increase the amount of friction between the wheels and the incline. Vehicles will need to have some type of plow on the front to move the stones.

4-H Members will be given approximately 45 minutes to an hour to create their vehicle. Have each Member take a turn at trying out their vehicle. Give the Members 60 seconds to try and clear all of the stones. If a vehicle was able to move all the stones within the 60 second time frame, discuss what features on the vehicle allowed it to work and be efficient to get the task done.

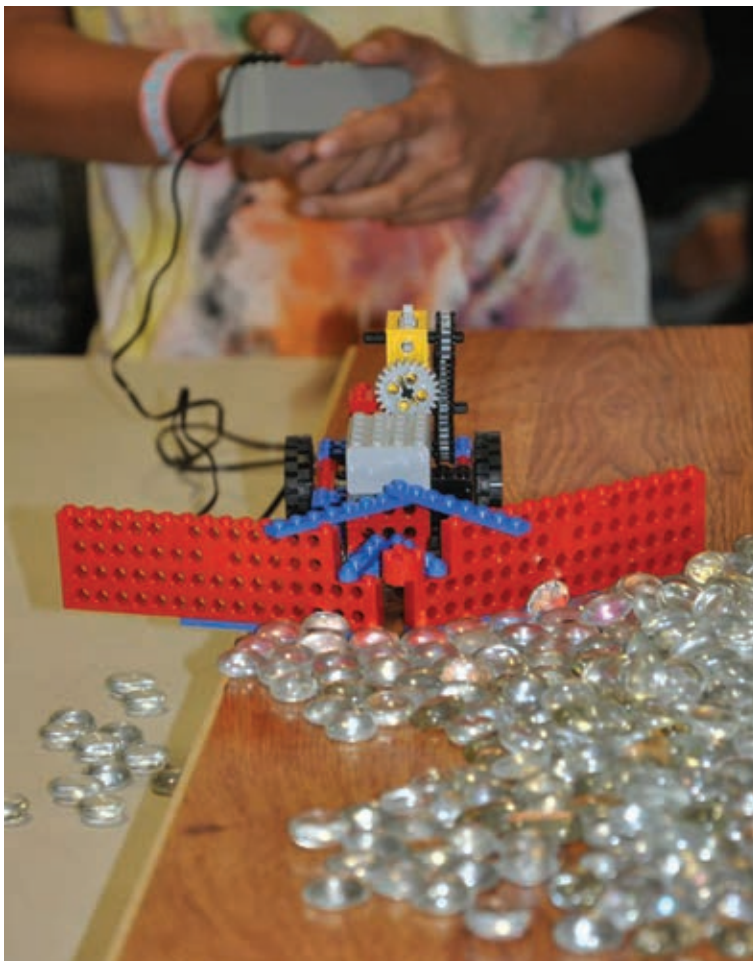


Photo Credit: Marianne Fallis

Achievement Program Ideas/Suggestions

- Hold a Building Blocks competition night and invite family members to participate.
- Visit a senior's centre and participate in a Building Blocks competition with teams consisting of 4-H Members and seniors.
- Do a demonstration at an Agricultural Fair, at a school or community event showcasing some of the projects that 4-H Members have designed in the Building Blocks project.
- Have members make a presentation at school about what they've learned from working with Lego.
- Create a skit about something they can build with Lego.

Special Projects

These projects are done outside of meeting time and are for members interested in doing more – often senior members. It's up to you as the leader to decide if you will require members to complete a Special Project for club completion. Some ideas include:

- Write a press release about the benefits of the skills learned in the Building Blocks Engineering project.
- Interview an architect or an engineer to find out why they chose their profession and write a press release for the newspaper.
- Create a display about the career choices that can stem from the basic concepts learned in the Building Blocks Engineering project.
- Create a display for an Agricultural Fair, local store or school.
- Create a cost comparison chart of the various Building Block kits available on the market.
- Create a video demonstrating something that members have built using Building Blocks and post on YouTube.
-

Tour Ideas

- Have guest speakers attend meetings to supplement the material in the Reference Manual. Speakers could include a structural engineer, a mechanic, an architect, a physics teacher or someone who conducts Building Blocks competitions (such as the First Lego League International competition).
- If there is a local Building Blocks enthusiasts group, attend a meeting to see what types of projects they construct.
- Visit a store that sells Building Block kits.