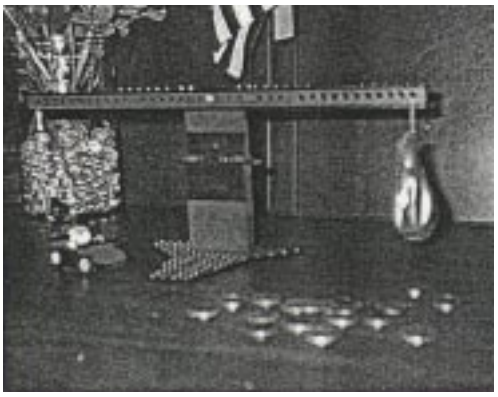
by Kathleen Julicher

Connecting to Science With LEGO®

Lego systems are common finds in the houses of many homeschooling families. Sometimes, LEGO bricks are used as an important part of school time, but usually they are relegated to the toy box. Most homeschoolers think that the LEGO they invest in are for education, but usually feel a little guilty about calling them tools instead of toys. Well, let us put your minds at rest. LEGO really are useful for science training. In this article, you will find some hints for making more use of LEGO (or other building blocks) for science studies.

Physics is one area of study in which LEGO can be useful. You can build the car used in the inclined plane experiments in the November/December 1995 issue of Homeschooling Today. LEGO can be used to build levers of different types for experimenting with work and force. Below are some suggestions for making and using a balance scale for your science laboratory at home. Using the scale requires quarters, nickels, dimes, and pennies.

Here's how to experiment with a LEGO scale: Using a scale built of LEGO Technic parts, measure the masses of these objects. Insert a hooked paperclip into the holes of the LEGO pieces at either end of the scale. Tie a piece of dental floss to each of the objects to be measured. On the other end of the floss, tie a loop. Use this loop to hang the object from the paper clip hook on one end of the balance. Make a little cloth bag to hold the coins. Punch the end hook of one of the paperclips through the cloth, making a way to hang the bag from the end of the balance. You will have an unknown mass hanging from one end of the balance, and from the other end you will have a bag with your coins. Add or subtract coins until the balance is level. Hint: If your LEGO balance does not move freely enough, powder or soap the axle part. Answer the questions in your science notebook.



Kathleen Julicher, a zoologist, and Mark Julicher, an aerospace engineer, have been homeschooling for many years. One of their four children is still at home, one is in engineering school, and two have graduated from college as engineers.

QUESTIONS

Arrange the items in order of increasing mass.

1. Which chocolate kiss had the most mass in it? Why are they not the same? Hypothesize as to why they are not the same.
2. What is the definition of mass?
   Hint: Use your dictionary.
3. What is the mass of the sand alone?
   Hint: Weigh the film box empty and subtract the masses.
4. Why do you think that the copper pennies have a different mass than the copperclad pennies?

ADVANCED QUESTIONS

1. Would the mass of the pencil be the same in space? Explain.
2. How could you measure the mass of an object in space?
3. Are mass and weight the same thing? Explain.
4. The plastic film box is full of sand, but is it full? Try measuring the mass of the film box filled with sand and then topped off with water. The water fills the spaces inbetween the sand grains. How much did this change the mass measurement? What is the amount of mass of the water?
5. Invent a way to compare the masses of the sand and the water.

OBJECT	MASS
1. A set of keys	
2. A toothbrush	
3. A pencil	
4. 50 paperclips	
5. A plastic film box full of sand	
6. A Hershey's kiss	
7. A Hershey's kiss with almonds	

Values for money to be used as standardized masses in your homebuilt balance:

Quarter: 6.1 grams Dime: 2.7 grams
Nickel: 5.3 grams Penny: 3.6 grams (copper)
3.0 grams (copperclad)

Concepts to Remember:

Stable structures do not change easily when acted upon by an outside force. An unstable structure will change even when there are small changes in the forces acting on it.

Machines need stable structures for support. When machines operate, forces push and pull on the supporting structure. Unstable structures would collapse or break.

The triangle is a shape that creates a very stable structure. A group of triangles is called a truss. Tresses are used to build stable structures to cover a large distance.

Stability, Trusses, and Machines

adapted from *Understanding Machines* by Richard A. Myers

1. Fill in the blanks from the concepts above:

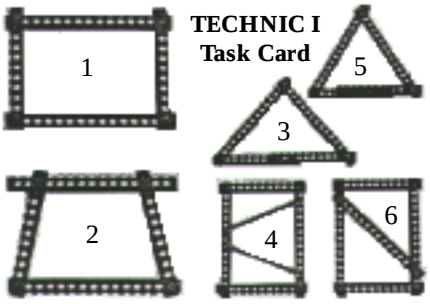
Stable structures do _____ change easily from changing _____. An _____ structure will change when there are _____ changes in the _____ acting on it.

Machines need _____ structures for _____. When machines _____ forces _____ and _____ on the _____ structure. _____ structures would _____ or _____.

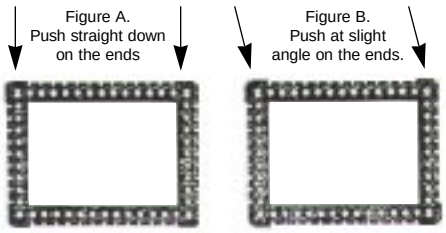
Try giving a little push to someone who is standing on two legs, then on one leg. Which is more unstable?

2. What happens to the supporting structure when a machine operates? ***Hint:*** Look at the washing machine when it is spinning and unbalanced.

3. What do unstable structures do when forces change?



4. Build structure 1 from the above card.

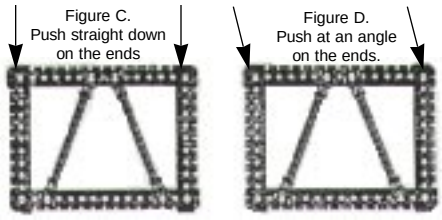


5. Put the structure on a firm surface and press straight down like in Figure A. If you do this correctly, the structure should not move. Now change from pushing straight down and push slightly to the side as shown by arrows in figure B.

6. Describe what happens in the above problem.

7. Build structure 4 from the card.

8. Like the last time, put the structure on a firm surface and press straight down, similar to figure C. Now change from pushing stright down and push slightly to the side as shown by the arrow in figure D.



9. What happens to this structure when you press sideways?

10. Use what you have learned and look at the other structures on the card. Predict which ones will be stable or unstable.

11. Fill in the blanks from the concepts above:

The _____ is the _____ that _____ a very _____ structure. A group of triangles in called a _____. Trusses are used to build _____ structures to cover a _____ distance.

REVIEW QUESTIONS

1. Define truss.
2. What type of structures will not fall
   or break easily?
3. What type of structure will fall or break easily.
4. Why do machines need stable structures?
5. What is the shape of a truss?
6. Name a structure that uses trusses.

RESOURCES

While many children are well into the block stage of building, other building blocks are quickly introduced. I remember our firstborn received his first set of building blocks at 24 months. These DUPLO® blocks (LEGO for the younger set) were used by all our boys, their friends, and were still passed on to another friend. They seem indestructible to endure that much creativity.

As the children grew older, we moved to the more advanced sets. However, it wasn't until our other two boys entered the building stage that we discovered these blocks could be used as educational tools. A few homeschooling catalogs piqued our interest in exploring their value in the areas of math and science. We browsed at the usual shops, but failed to find the more advanced educational sets.

The following list will help you get a better idea of what is available for your educational enhancement. Many other types, styles, and brands are available. We chose the LEGO brand as they are reasonably priced and frequently used by many homeschooling families. Sets are available ranging from pre-school to high school levels.

When evaluating such a purchase, you must consider both the educational investment and the pleasure of learning through hands-on activities. Call LEGO for a complete catalog of products. LEGO Dacta 1-800-527-8339.

TECHNIC I, Simple Machines (Set

#1030) – Our twelve-year-old enjoys this set as he builds levers, pulleys, wheels, axles, etc. By constructing the basic parts, he converted them into windmills, a belt-driven motor, and a simple merry-go-round. A more complicated set, *TECHNIC II, Motorized Machines* (Set #1032) is equipped with a 4.5 volt motor. You can create a balance beam (similar to the one in this article), a lawn mower, a drill, and a helicopter. These sets are recommended for grades 4-6 and are between $60-$75.

Pneumatic Set (Set #9604) – Learning about air power is not only educational but great fun as students make hand pumps, switches, tubing, beams, etc. Students can make a chair that can be raised and lowered and an air powered crane that is capable of picking up objects. Ages 11 and up. Around $35.

Manufacturing Systems (Set #9607) – This set enables you to build a motor block, a transmission module, an oscillating fan, a forklift, stamping press, and a food mixer. Recommended for grades 7-9. Around $85.

Understanding Machines I With LEGO Dacta: TECHNIC I, by Richard Meyers. The father of five home-schooled children, Richard Meyers has designed lesson plans to go along with the TECHNIC I kit and the TECHNIC I cards. You can do all the experiments in the manual if you have TECHNIC II instead of TECHNIC I, but you will have to purchase the cards and a couple of extra pieces separately. You may purchase these parts directly from LEGO or from Innovative Education. The experiments follow the cards, but elaborate upon them and ask questions such as: What is the amount of work done by this machine? Which gear provides the rotational energy for the other gears? The drawings of the machines you are instructed to build are clear and easy to understand. In the back of the book are hints for the teacher as well as answers, explanations and more activities. Book I is designed for 3rd to 6th grade students. Book II is not published yet, but will be designed for the 7th to 10th grade student. The entire course comes in a three-ring binder. Follow-up courses are being developed. Cost is around $26. The previous exercises have been condensed from Book I of *Understanding Machines I with LEGO Dacta: TECHNIC I* for your enjoyment and learning pleasure. For more information on this course, write: Innovative Education, Rte. 1, Box 46, May, TX 76857, 817-259-3311.