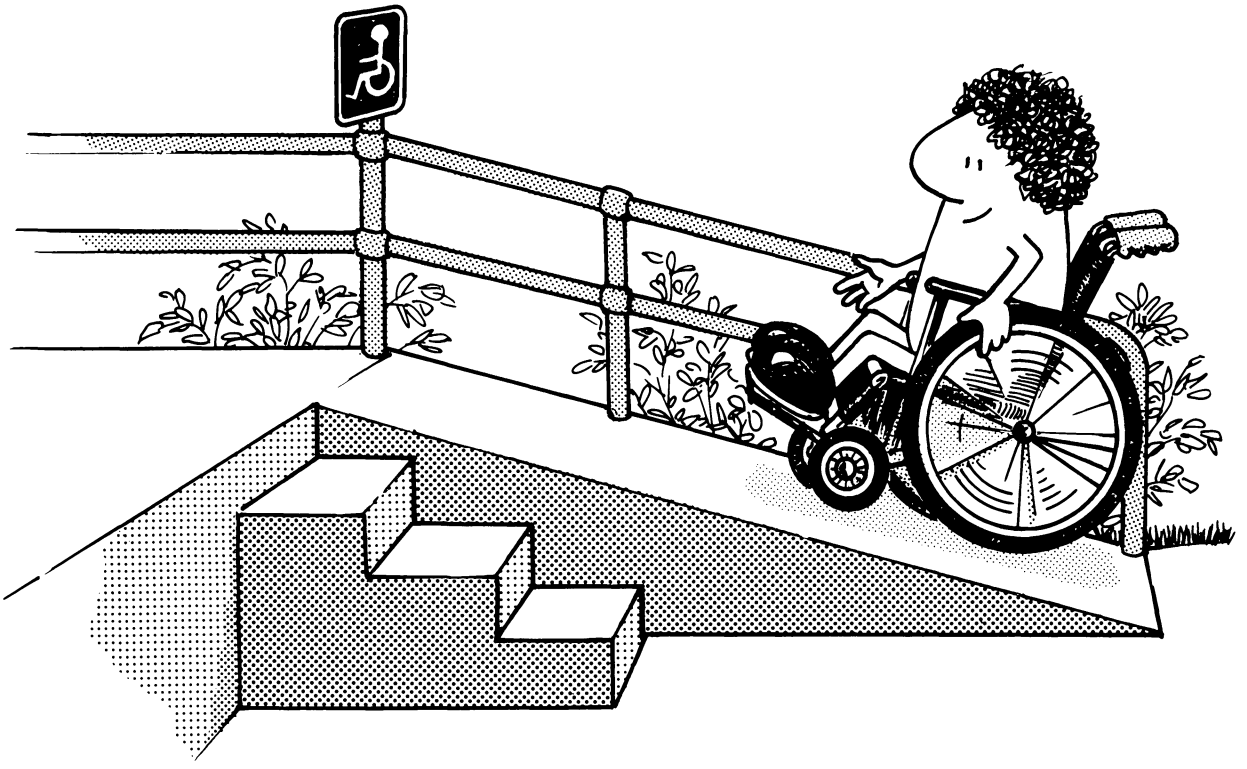
MACHINES



TASK CARD SERIES

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TOPS LEARNING SYSTEMS

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CONTENTS

INTRODUCTION

TEACHING NOTES

REPRODUCIBLE STUDENT TASK CARDS

Gathering Materials

Listed below is everything you'll need to teach this module. You already have many of these items. The rest are available from your supermarket, drugstore and hardware store. Laboratory supplies may be ordered through a science supply catalog.

Keep this classification key in mind as you review what's needed:

special in-a-box materials:	general on-the-shelf materials:
Italic type suggests that these materials are unusual. Keep these specialty items in a separate box. After you finish teaching this module, label the box for storage and put it away, ready to use again the next time you teach this module.	Normal type suggests that these materials are common. Keep these basics on shelves or in drawers that are readily accessible to your students. The next TOPS module you teach will likely utilize many of these same materials.
(substituted materials):	*optional materials:
A parentheses following any item suggests a ready substitute. These alternatives may work just as well as the original, perhaps better. Don't be afraid to improvise, to make do with what you have.	An asterisk sets these items apart. They are nice to have, but you can easily live without them. They are probably not worth the an extra trip, unless you are gathering other materials as well.

Everything is listed in order of first use. Start gathering at the top of this list and work down. Ask students to bring recycled items from home. The teaching notes may occasionally suggest additional student activity under the heading "Extensions." Materials for these optional experiments are listed neither here nor in the teaching notes. Read the extension itself to find out what new materials, if any, are required.

Needed quantities depend on how many students you have, how you organize them into activity groups, and how you teach. Decide which of these 3 estimates best applies to you, then adjust quantities up or down as necessary:

$Q_1 / Q_2 / Q_3$

- **Single Student:** Enough for 1 student to do all the experiments.
- **Individualized Approach:** Enough for 30 students informally working in 10 lab groups, all self-paced.
- **Traditional Approach:** Enough for 30 students, organized into 10 lab groups, all doing the same lesson.

KEY: *special in-a-box materials* (substituted materials) general on-the-shelf materials *optional materials

$Q_1 / Q_2 / Q_3$	
6/60/90	identical textbooks
1/10/10	meter sticks
1/10/10	large rubber stoppers
1/1/1	gallon jug of water
1/1/1	roll of masking tape
1/10/10	rulers – centimeters or inches
1/10/10	baby food jars with tight-fitting lids
1/1/1	roll of thread
1/10/10	*spring scales – 2 Newton capacity (200 grams) is ideal*
1/1/1	roll of plastic wrap
1/5/10	pairs of scissors
1/1/1	box of paper clips
1/10/10	*ring stands
1/5/10	*single wheel pulleys*
2/20/20	flexible plastic drinking straws
1/1/2	*paper punches
1/10/10	*pieces of cardboard cut from boxes – about as long and wide as notebook paper*
2/20/20	index cards – 4x6 inch work best
1/1/2	staplers
1/1/1	*bolts
1/1/1	*can opener
1/1/1	*nut cracker
1/1/1	broom
1/10/10	feet of strong pliable wire, about 14 gauge
1/1/1	strong smooth post, fixed upright
20/20/20	feet of cord or rope
1/10/10	medium-sized cans
4/40/40	rubber bands
1/10/10	small lids from cooking oil bottles, or equivalent
1/10/10	large lids from mayonnaise jars, or equivalent
1/1/1	small nail or thumbtack
1/1/1	hammer
2 /20/20	straight pins
1/1/1	roll of string
1/1/1	flight of stairs
1/1/1	yard stick (foot ruler and string)
1/1/1	stopwatch
1/1/1	*bathroom scale*
1/5/10	*hand calculators

Sequencing Task Cards

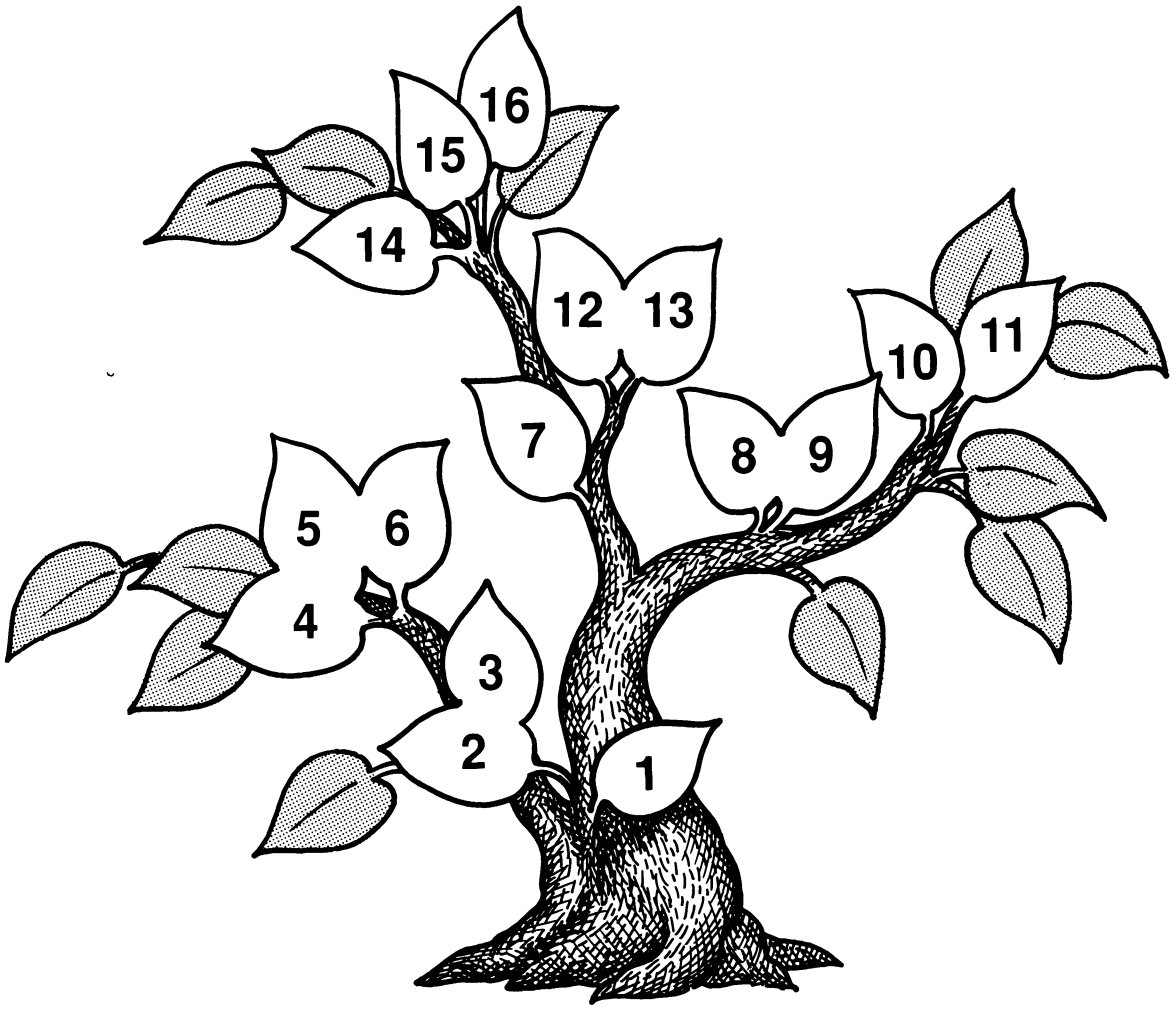
This logic tree shows how all the task cards in this module tie together. In general, students begin at the trunk of the tree and work up through the related branches. As the diagram suggests, the way to upper level activities leads up from lower level activities.

At the teacher's discretion, certain activities can be omitted or sequences changed to meet specific class needs. The only activities that must be completed in sequence are indicated by leaves that open *vertically* into the ones above them. In these cases the lower activity is a prerequisite to the upper.

When possible, students should complete the task cards in the same sequence as numbered. If time is short, however, or certain students need to catch up, you can use the logic tree to identify concept-related *horizontal* activities. Some of these might be omitted since they serve only to reinforce learned concepts rather than introduce new ones.

On the other hand, if students complete all the activities at a certain horizontal concept level, then experience difficulty at the next higher level, you might go back down the logic tree to have students repeat specific key activities for greater reinforcement.

For whatever reason, when you wish to make sequence changes, you'll find this logic tree a valuable reference. Parentheses in the upper right corner of each task card allow you total flexibility. They are left blank so you can pencil in sequence numbers of your own choosing.



Review / Test Questions

Photocopy the questions below. On a separate sheet of blank paper, cut and paste those boxes you want to use as test questions. Include questions of your own design, as well. Crowd all these questions onto a single page for students to answer on another paper, or leave space for student responses after each question, as you wish. Duplicate a class set and your custom-made test is ready to use. Use leftover questions as a review in preparation for the final exam.

task 1

Draw how to move a large rock using a strong wood pole and a brick. Label the effort, fulcrum and resistance.

task 2

Which is more work — lifting 50 lbs of sand 6 feet or 100 lbs of sand 3 feet?

task 3

A 100 lb girl and a 150 lb boy balance each other on a see-saw. The girl raises the boy 2 feet higher.

a. Calculate how much work she did.

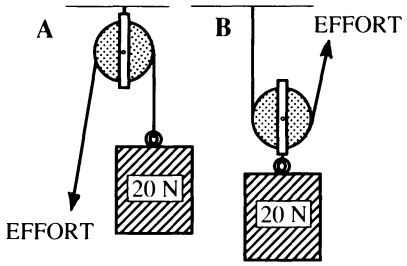
b. Assuming the lever is 100% efficient, how far did the girl move down? Show your math.

tasks 4-5

A 20 Newton weight is attached to each pulley system. Assuming both systems are 100% efficient...

a. How hard must you pull on each rope to lift the resistance?

b. How much work lifts each resistance 3 meters?



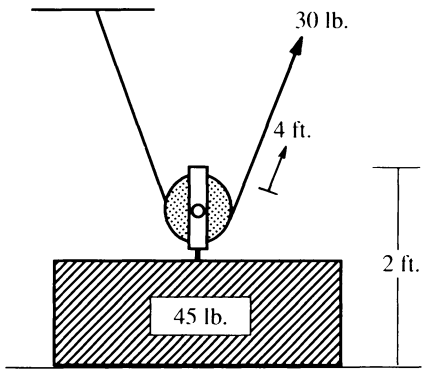
tasks 5-6

In this single movable pulley system, the rope is pulled with a force of 30 lb through 4 feet. The 45 lb resistance is raised 2 feet. Calculate the...

a. work input.

b. work output.

c. efficiency of the pulley.

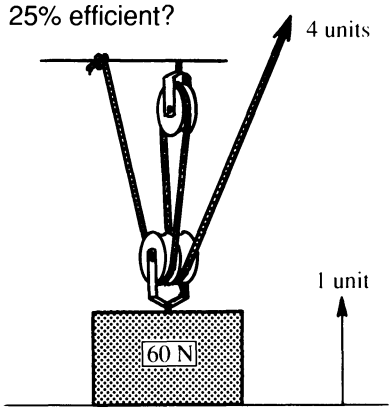


tasks 5-7

In this combination pulley system, the rope moves 4 times as far as the resistance. How much effort is required to lift a 60 N resistance if the machine is...

a. friction free?

b. 25% efficient?



task 6

An engineer is asked to design a single movable pulley that is fully 100% efficient. Why is this an impossible task? Give 2 reasons.

tasks 8-9

An inclined plane measures 12 meters long and 2 meters high.

a. Assuming no friction, what effort is required to push a 420 N cart up this plane?

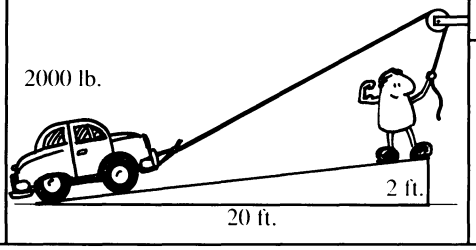
b. How much work is required to do this?

task 3-9

It is said that "machines make less work." Is this statement true in the scientific sense? Support your answer with an example.

tasks 4-9

Can this man pull his 2000 lb car up an incline 20 feet long and 2 feet high? Support your answer with calculations.



task 10

Classify each machine as a lever or inclined plane. Give reasons for your answer.

a. A wheelbarrow.

b. A wedge.

c. A pair of pliers.

d. A steering wheel.

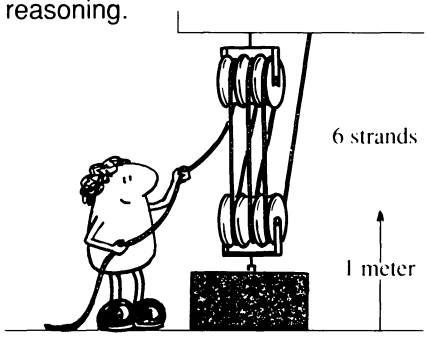
e. A screw

task 11

What class of lever is a fly swatter? Defend your answer.

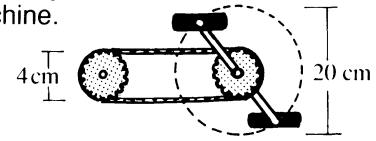
task 12-13

How much rope must this worker pull through the pulley to raise the resistance 1 meter? Explain your reasoning.



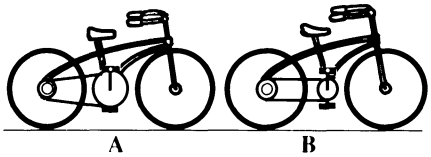
task 14

A bicycle has pedals 20 cm in diameter connected to a sprocket 4 cm in diameter. Calculate the ideal mechanical advantage of this machine.



task 15

Which bicycle is easier to pedal? Which bicycle goes faster? Defend your answer.



task 16

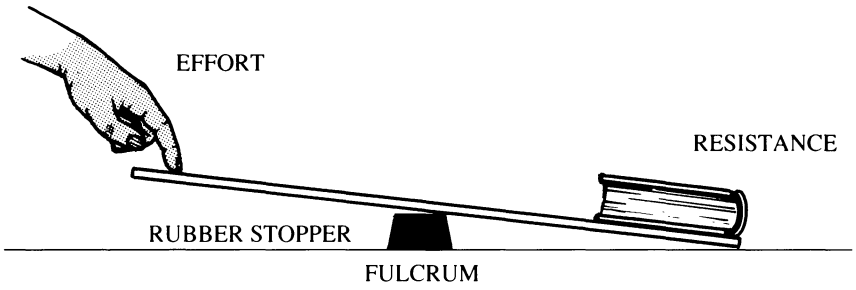
Jack and Jill both climb a hill. Jack runs and Jill walks. If Jack's weight equals Jill's...

a. Who did the most work? Explain.

b. Who used the most power? Explain.

Task Objective (TO) build a simple lever. To experience how this lever either reduces effort, or reduces the distance through which the effort is applied.

LEVERS (1) ○ **Machines ( )**

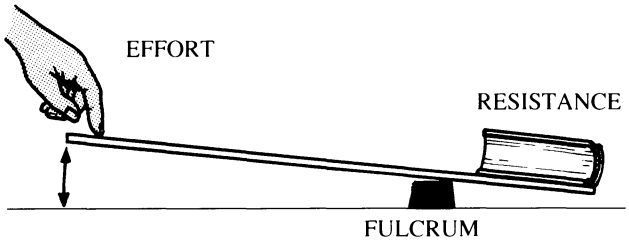


1. Lift a book with a lever: use a meter stick that pivots on a rubber stopper.
   a. Tell how to lift the resistance (the book) using a smaller effort (a smaller push from your hand). Draw a diagram.
   b. Tell how to lift the same resistance using a larger effort. Draw a diagram.

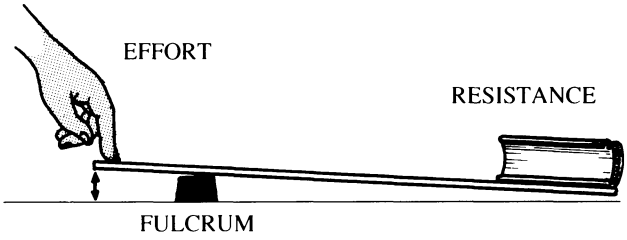
2. Did you apply the smaller effort through the same distance as the larger effort to lift the book? Explain.

Answers / Notes

1a. Slide the fulcrum nearer the resistance to lift it with a smaller effort.



1b. Slide the fulcrum nearer the effort to lift the resistance with a larger effort.



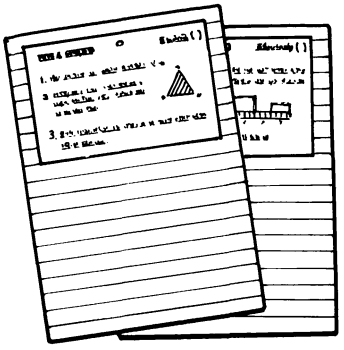
2. No. The smaller effort was applied through a relatively longer distance than the larger effort, as represented by the two arrows above.

Materials

- ☐ A meter stick.
- ☐ A large rubber stopper.
- ☐ A book.

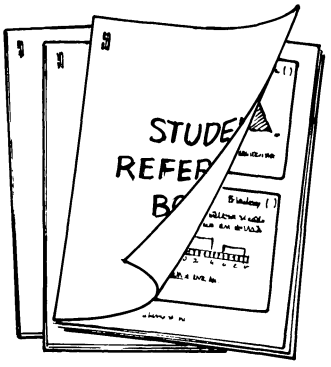
Task Cards Options

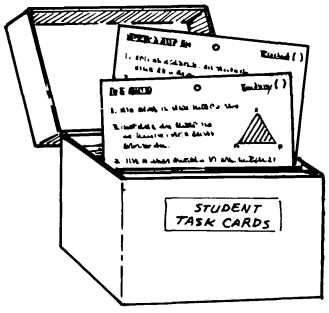
Here are 3 management options to consider before you photocopy:



1. Consumable Worksheets: Copy 1 complete set of task card pages. Cut out each card and fix it to a separate sheet of boldly lined paper. Duplicate a class set of each worksheet master you have made, 1 per student. Direct students to follow the task card instructions at the top of each page, then respond to questions in the lined space underneath.

2. Nonconsumable Reference Booklets: Copy and collate the 2-up task card pages in sequence. Make perhaps half as many sets as the students who will use them. Staple each set in the upper left corner, both front and back to prevent the outside pages from working loose. Tell students that these task card booklets are for reference only. They should use them as they would any textbook, responding to questions on their own papers, returning them unmarked and in good shape at the end of the module.

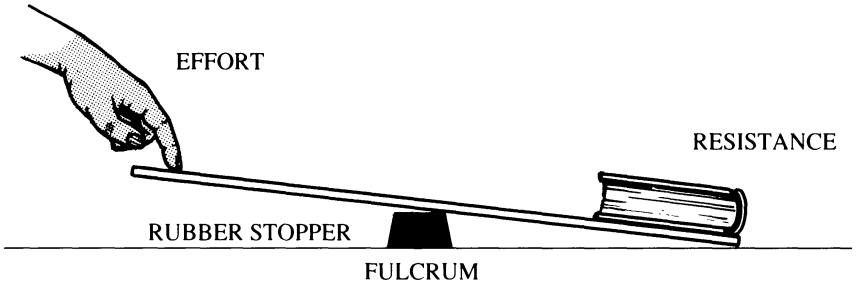




3. Nonconsumable Task Cards: Copy several sets of task card pages. Laminate them, if you wish, for extra durability, then cut out each card to display in your room. You might pin cards to bulletin boards; or punch out the holes and hang them from wall hooks (you can fashion hooks from paper clips and tape these to the wall); or fix cards to cereal boxes with paper fasteners, 4 to a box; or keep cards on designated reference tables. The important thing is to provide enough task card reference points about your classroom to avoid a jam of too many students at any one location. Two or 3 task card sets should accommodate everyone, since different students will use different cards at different times.

LEVERS (1)

Machines ( )



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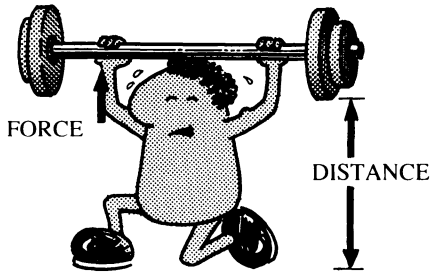
   b. Tell how to lift the same resistance using a larger effort. Draw a diagram.

2. Did you apply the smaller effort through the same distance as the larger effort to lift the book? Explain.

WORK

Machines ( )

1. To do "work" in the scientific sense, you must apply a *force* through a *distance*. In each of the following activities decide if you are doing work. Explain your reasoning.
   a. Lift a book off the table.
   b. Hold a book perfectly still at arm's length for about 1 minute.
   c. Push a book across the table.
   d. Push against a wall as hard as you can.



WORK = Force x Distance

2. Call the force necessary to lift 1 book a "bk." Call the distance of your extended hand 1 "span."
   a. How much work is required to lift 2 books up 3 spans?
   b. How much work is required to lift 6 books up 1 span?
   c. Which requires more work, lifting 3 books up 3 spans or 2 books up 4 spans? Explain.