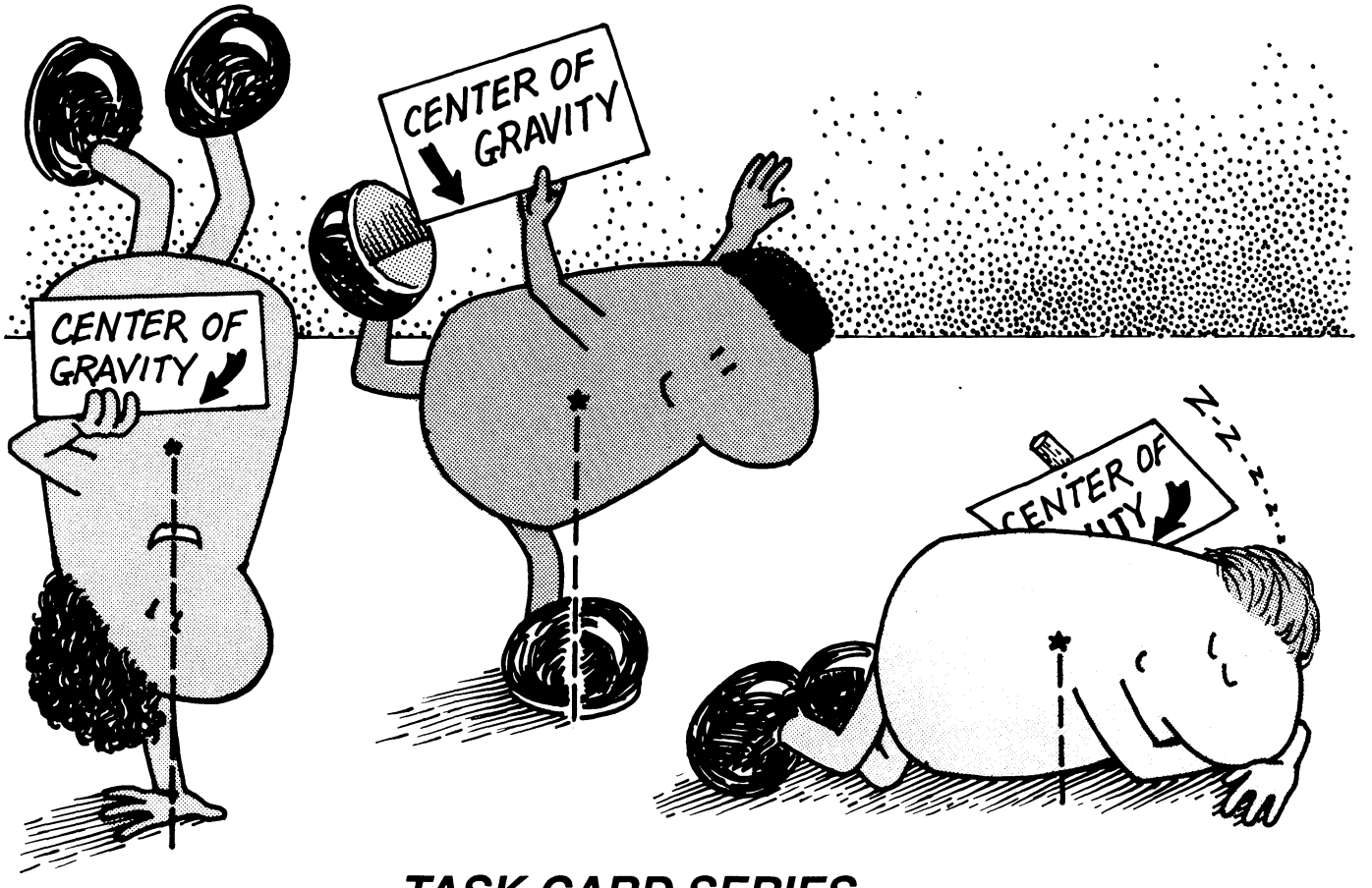
BALANCING



TASK CARD SERIES

Conceived and written by
RON MARSON

Illustrated by
PEG MARSON

TOPS LEARNING SYSTEMS

10970 S Mulino Road
Canby OR 97013
Website: topscience.org
Fax: 1 (503) 266-5200

WHAT CAN YOU COPY?

Dear Educator,

Please honor our copyright restrictions. We offer liberal options and guidelines below with the intention of balancing your needs with ours. When you buy these labs and use them for your own teaching, you sustain our work. If you "loan" or circulate copies to others without compensating TOPS, you squeeze us financially, and make it harder for our small non-profit to survive. Our well-being rests in your hands. Please help us keep our low-cost, creative lessons available to students everywhere. Thank you!

PURCHASE, ROYALTY and LICENSE OPTIONS

TEACHERS, HOMESCHOOLERS, LIBRARIES:

We do all we can to keep our prices low. Like any business, we have ongoing expenses to meet. We trust our users to observe the terms of our copyright restrictions. While we prefer that all users purchase their own TOPS labs, we accept that real-life situations sometimes call for flexibility.

Reselling, trading, or loaning our materials is prohibited unless one or both parties contribute an Honor System Royalty as fair compensation for value received. We suggest the following amounts – let your conscience be your guide.

HONOR SYSTEM ROYALTIES: If making copies from a library, or sharing copies with colleagues, please calculate their value at 50 cents per lesson, or 25 cents for homeschoolers. This contribution may be made at our website or by mail (addresses at the bottom of this page). Any additional tax-deductible contributions to make our ongoing work possible will be accepted gratefully and used well.

Please follow through promptly on your good intentions. Stay legal, and do the right thing.

SCHOOLS, DISTRICTS, and HOMESCHOOL CO-OPS:

PURCHASE Option: Order a book in quantities equal to the number of target classrooms or homes, and receive quantity discounts. If you order 5 books or downloads, for example, then you have unrestricted use of this curriculum for any 5 classrooms or families per year for the life of your institution or co-op.

2-9 copies of any title: 90% of current catalog price + shipping.

10+ copies of any title: 80% of current catalog price + shipping.

ROYALTY/LICENSE Option: Purchase just one book or download *plus* photocopy or printing rights for a designated number of classrooms or families. If you pay for 5 additional Licenses, for example, then you have purchased reproduction rights for an entire book or download edition for any **6** classrooms or families per year for the life of your institution or co-op.

1-9 Licenses: 70% of current catalog price per designated classroom or home.

10+ Licenses: 60% of current catalog price per designated classroom or home.

WORKSHOPS and TEACHER TRAINING PROGRAMS:

We are grateful to all of you who spread the word about TOPS. Please limit copies to only those lessons you will be using, and collect all copyrighted materials afterward. No take-home copies, please. Copies of copies are strictly prohibited.

Ask us for a ***free shipment*** of as many of our ***TOPS IDEAS Catalogs*** as you need to support your efforts. Every catalog is a rich, attractive resource magazine packed with free sample teaching ideas.

For licensing, honor system royalty payments, or catalog requests, contact: **www.TOPScience.org**; or

TOPS Learning Systems, 10970 S Mulino Rd, Canby OR 97013; or inquire at **tops@canby.com**

ISBN 978-0-941008-74-7

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: 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.	general on-the-shelf materials: 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): Parentheses enclosing 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.	*optional materials: An asterisk sets these items apart. They are nice to have, but you can easily live without them. They are probably not worth an extra trip to the store, 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		
3/25/30	index cards - 4x6 inch	
1/10/10	meter sticks	
2/10/20	straight pins	
3/30/30	medium-sized cans — both ends should be removed for activity 5	
8/80/80	pennies — see notes 7 and 9	
1/5/5	rolls masking tape	
1/3/3	spools thread	
1/10/10	scissors	
1/3/3	boxes paper clips	
1/10/10	full sheets newspaper	
2/20/20	size-D batteries, dead or alive — see note 13	
3/12/30	clothespins — wooden are best	
1/4/10	plastic drinking straws	
6/60/60	rubber bands — half thick and half thin	
1/10/10	medium-sized nails — see note 7	
1/10/10	each of assorted coins: pennies, nickles, dimes, quarters	
1/3/3	rolls clear tape	
1/1/1	roll waxed paper	
1/3/10	small graduated cylinders — 10 ml capacity	
1/10/10	hand calculators	
1/1/1	*wooden see-saw, constructed with saw, hammer and nails - see note 15*	
1/1/1	*bathroom scales	
2/6/20	large plastic milk cartons with handles and lids	
2/6/20	*feet of cord or thin rope*	

Sequencing Task Cards

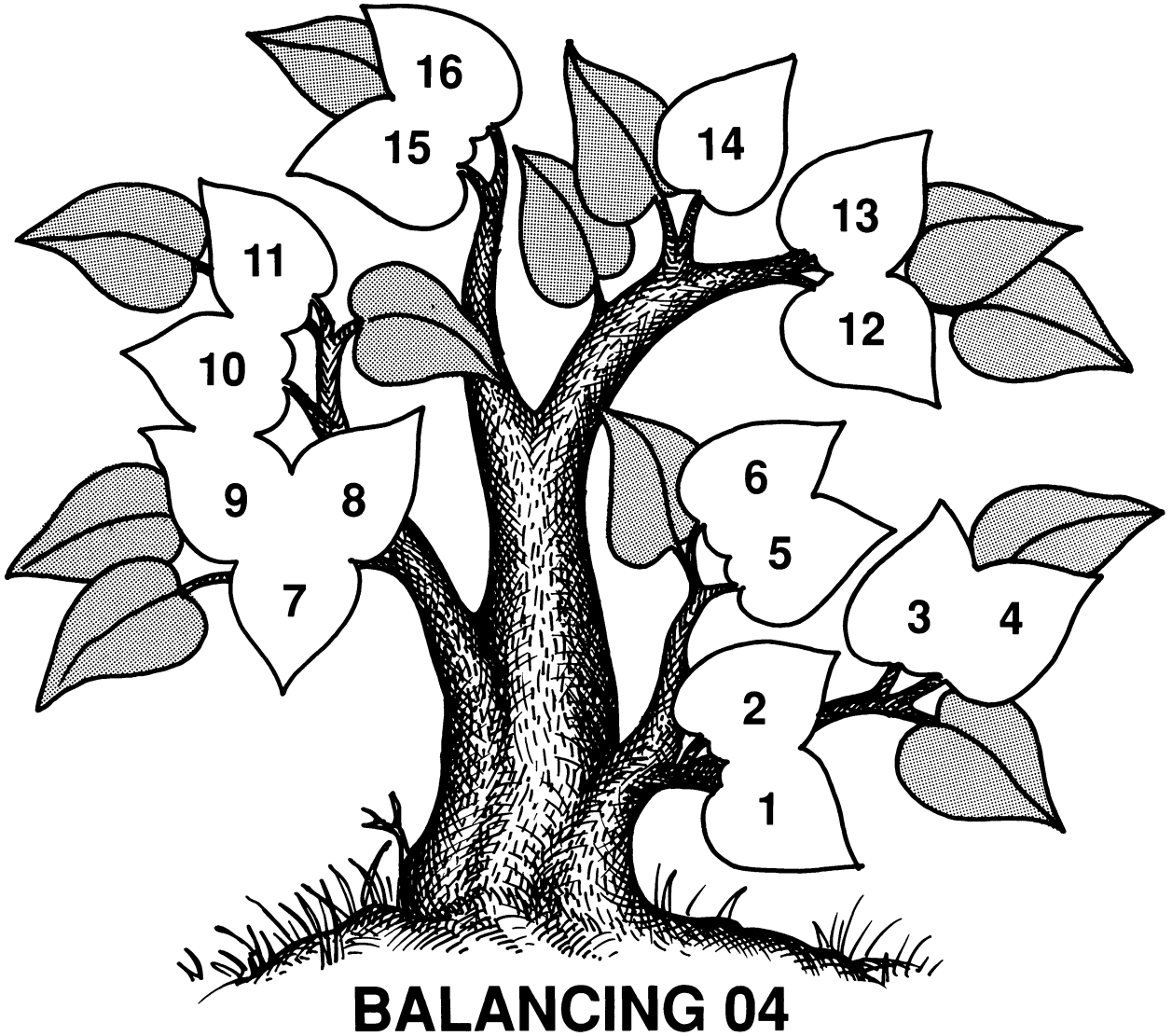
This logic tree shows how all the task cards in this module tie together. In general, students begin at the trunk of the tree and work up through the related branches. As the diagram suggests, the way to upper level activities leads up from lower level activities.

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.



BALANCING 04

Review / Test Questions

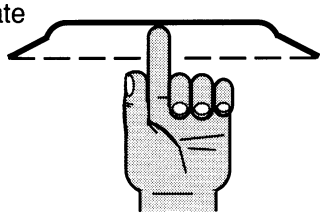
Photocopy the questions below. On a separate sheet of blank paper, cut and paste those boxes you want to use as test questions. Include questions of your own design, as well. Crowd all these questions onto a single page for students to answer on another paper, or leave space for student responses after 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

Mechanics balance car tires by fixing lead weights, as necessary, to the wheel rims. Explain how this affects the CG of a tire and the car's ride.

task 1, 5, 6

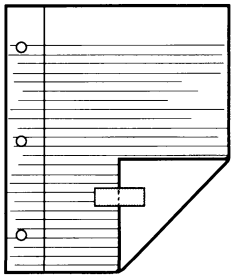
Imagine balancing an upside-down paper plate on one finger.



a. Where is the CG in relation to your finger?
b. Why is it easier to balance this plate with the rim down than with the rim up?

task 2 A

The corner of a sheet of notebook paper is folded and taped like this. Explain how to use a plumb line to find its CG.

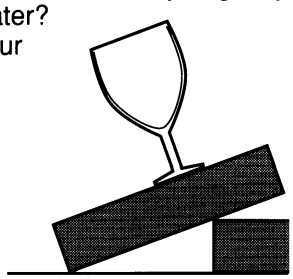


task 2 B

A piece of notebook paper hangs from the tip of a pencil at its corner margin hole. Where is its CG in relation to the pencil point? Explain.

task 3-4 A

A wine glass rests on a slanting book. What happens to it when you gently fill it with water? Illustrate your answer with a labeled drawing.



task 3-4 B

Maria is standing on both feet. Can she stand on 1 foot *without* moving her upper body? Explain.

task 3, 14

How far off the edge of a table can you slide a book before it falls? Illustrate your answer with a drawing.

task 5-6 A

Is a meter stick more stable resting flat on the table, or standing on end? Use a labeled diagram to illustrate your answer.

task 5-6 B

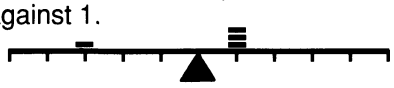
Name a 3-dimensional shape that *always* has neutral equilibrium on a level surface.

task 7

How would you use a centered meter stick balance to determine whether 3 pennies are heavier than 4 dimes?

task 7-9 A

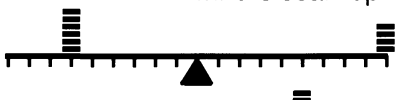
Here is one way to balance 3 coins against 1 coin on a centered balance. Draw two more ways to balance 3 against 1.



task 7-9 B

Use math to predict whether each beam will balance. If not, which way will the beam tip?

a.

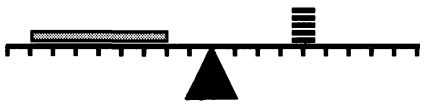


b.

c.

task 7-9, 13

A bar balances on a centered beam opposite 5 coins of equal mass. What is the mass of the bar in terms of these coins? Explain your reasoning.



task 10, 11

An eyedropper dispenses 20 drops of water per milliliter. One ml of water equals one gram.
a. What is the mass of 1 drop of water?
b. Exactly 46 drops of water counterbalance 1 dime when placed on opposite sides of a centered balance, equidistant from the pivot. What is the mass of the dime?
c. Exactly 23 drops of water are placed 20 cm from the pivot. How far from the pivot would you place the dime on the opposite side?

task 10-11, 15-16

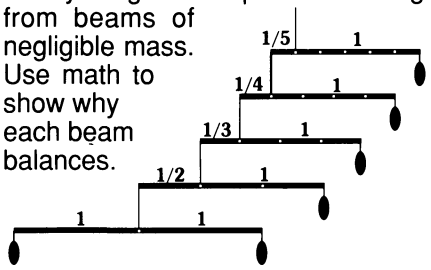
A washer balances at the 10 cm position on a centered meter stick opposite 3.0 ml of water at the 90 cm position.
a. What is the mass of the washer?
b. If this washer is placed at the 45 cm position, it balances a paper clip at the 80 cm position. Calculate the mass of the paper clip.

task 11, 15, 16

A 150 pound adult and a 90 pound child sit on opposite sides of a see-saw. If the adult sits 6 feet from the pivot, where does the child balance?

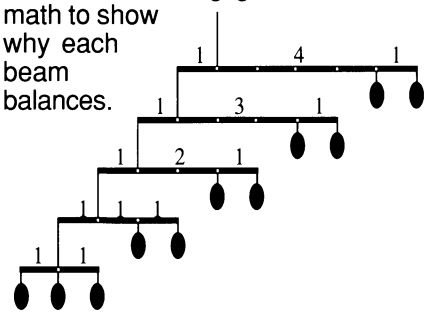
task 8-9, 11-12

Heavy weights of equal mass hang from beams of negligible mass. Use math to show why each beam balances.



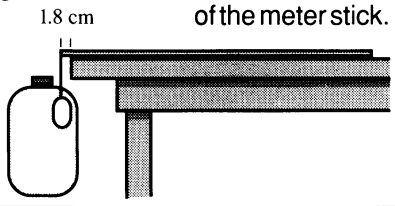
task 8-9, 11-12

Heavy weights of equal mass hang from beams of negligible mass. Use math to show why each beam balances.



task 13, 16

A gallon of water (3.78 liters) hung at the end of a meter stick just begins to tip when it hangs 1.8 cm beyond the edge of the table. Calculate the mass of the meter stick.

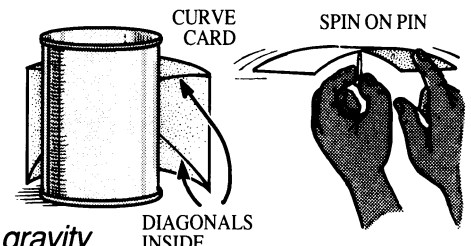


task 14

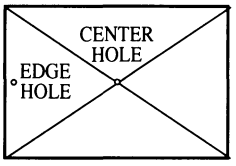
How far beyond a table edge can you cantilever 2 bricks? Draw a labelled diagram as your answer.

Task Objective (TO) find the center of gravity of an index card. To understand why it shifts as mass is added to the card.

CENTER OF GRAVITY ○ Balancing ( )

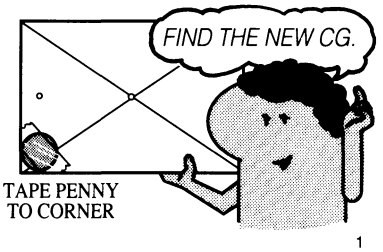


1. On an index card, draw diagonal lines that touch each corner. Use a can to give the card a curve, keeping its diagonals to the inside.
2. Lightly rest your card on a pinpoint where the diagonals cross. Rotate it *horizontally.*
   a. This balance point is called the *center of gravity* (CG). Where is the CG on your index card?
   b. Poke two pinholes through this card: one at its CG, the other near any edge away from the corners. Compare how the card spins *vertically* around a pin through each hole.



3. Tape a penny to a corner of your card. Spin the card on a pin point to locate its new CG, then make a pinhole at this point.
   a. Label this new CG. Compare spinning motions around this point with the other two holes.
   b. Is the CG still centered in the middle of the card? In the middle of its total mass? Explain.

(Write your name on the card and save it.)



Answers / Notes

2. *The pinpoint supports the spinning card; it must not poke through. If the card slides off, it is too flat. Increase its downward curve by pressing it again (diagonals to the inside) around the side of the can.*

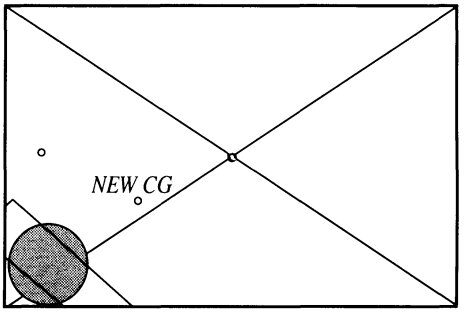
2a. The center of gravity (CG) on the index card is located where the diagonals cross, in the center of the card.

2b. The card rotates smoothly and evenly around its CG, but with variable speed around the outside hole. *(The card also comes to rest at no preferred orientation when the pin is at the CG. It always stops with the CG directly below the pin when spun around the outside hole.)*

3. *To find the new CG students should test various points on the card until they find its unique balance point.*

a. The card spins smoothly and evenly only around this new CG, while spinning at variable speed around the other 2 holes. *(As before, the new CG comes to rest directly below the pin when the other holes are used.)*

b. The CG is no longer located in the middle of the card. It still is, however, located in the middle of its total mass, comprised of the card and penny and tape.

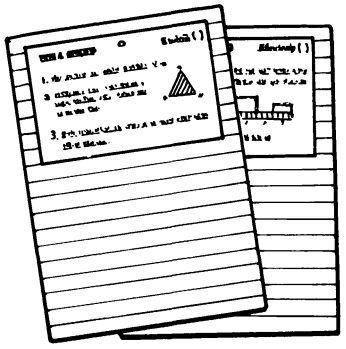


Materials

- ☐ A 4x6 index card.
- ☐ A ruler or other straightedge. Folded scratch paper is suitable.
- ☐ A sharp straight pin.
- ☐ A medium-sized can.
- ☐ A penny.
- ☐ Masking tape.

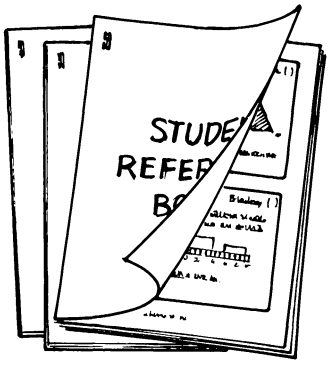
Task Cards Options

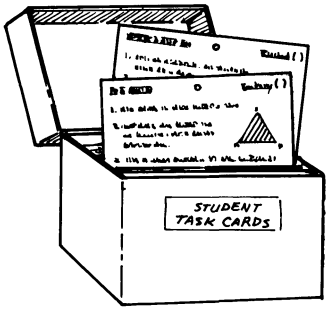
Here are 3 management options to consider before you photocopy:



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.

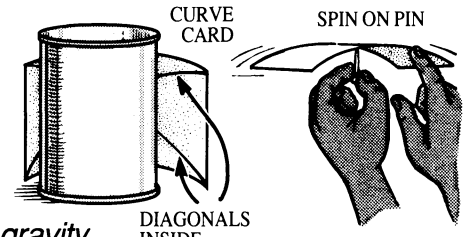




3. Nonconsumable Task Cards: Copy several sets of task card pages. Laminate them, if you wish, for extra durability, then cut out each card to display in your room. You might pin cards to bulletin boards; or punch out the holes and hang them from wall hooks (you can fashion hooks from paper clips and 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.

CENTER OF GRAVITY

Balancing ( )

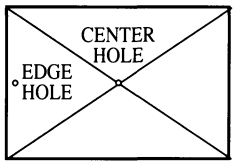


1. On an index card, draw diagonal lines that touch each corner. Use a can to give the card a curve, keeping its diagonals to the inside.

2. Lightly rest your card on a pinpoint where the diagonals cross. Rotate it *horizontally*.

   a. This balance point is called the *center of gravity* (CG). Where is the CG on your index card?

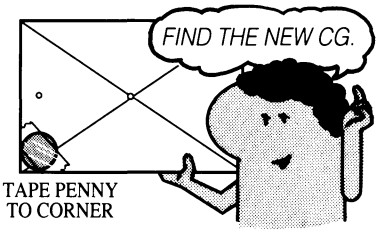
   b. Poke two pinholes through this card: one at its CG, the other near any edge away from the corners. Compare how the card spins *vertically* around a pin through each hole.



3. Tape a penny to a corner of your card. Spin the card on a pin point to locate its new CG, then make a pinhole at this point.

   a. Label this new CG. Compare spinning motions around this point with the other two holes.

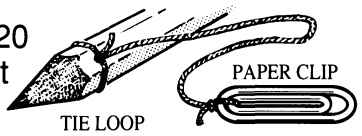
   b. Is the CG still centered in the middle of the card? In the middle of its total mass? Explain.



(Write your name on the card and save it.)

PLUMB LINE

Balancing ( )



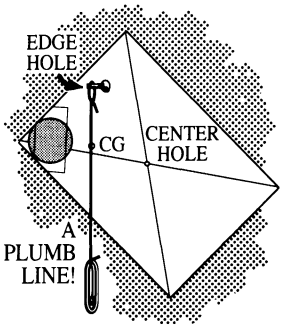
1. Tie a loop at one end of about 20 cm of thread. Tie a paper clip at the other end, and trim.

2. Insert a pin through the thread's loop *and* the edge hole in your weighted index card, so all hangs freely.

   a. Where is the CG in relation to the thread?

   b. Now hang everything from the center hole. Does the plumb line still cross the CG?

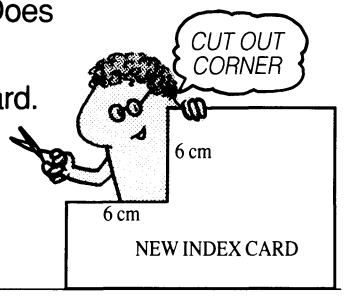
   c. Poke a 4th hole in the card, away from the others. Does the plumb line still cross the CG from this new hole?



3. Cut a 6 cm square from the corner of a *new* index card.

   a. Use your plumb line to experimentally locate and label the card's CG. Explain how you did this.

   b. Confirm that its CG is accurately placed. Explain how you did this.



(Write your name on this card and save it for the next activity.)