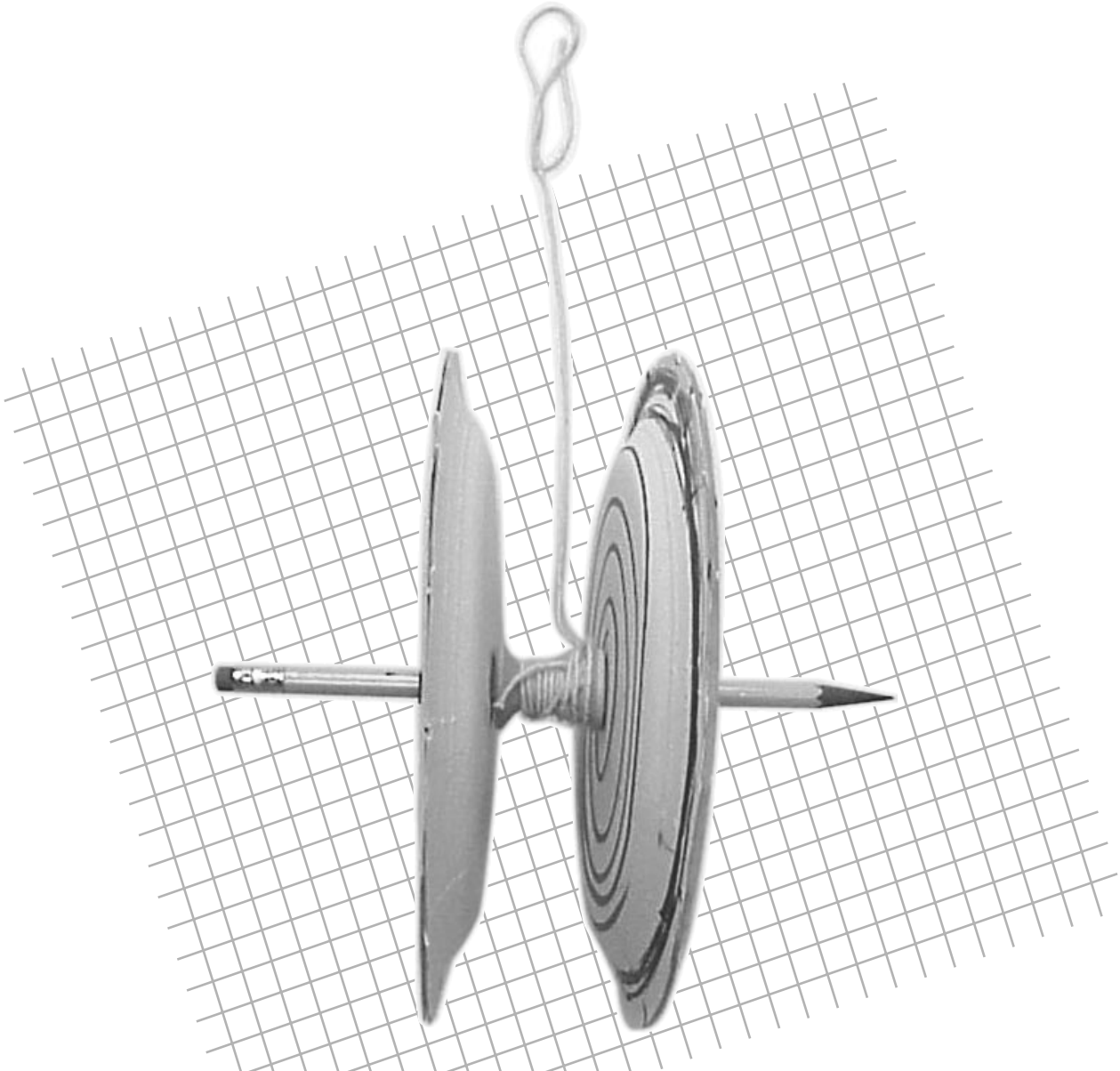


SPINNING TOYS

KELVIN® Stock #651815

DESIGN IT! ENGINEERING IN AFTER SCHOOL PROGRAMS

Education Development Center, Inc.

Table of Contents

Activity 1: Assembling a Top

What Materials Do I Have?

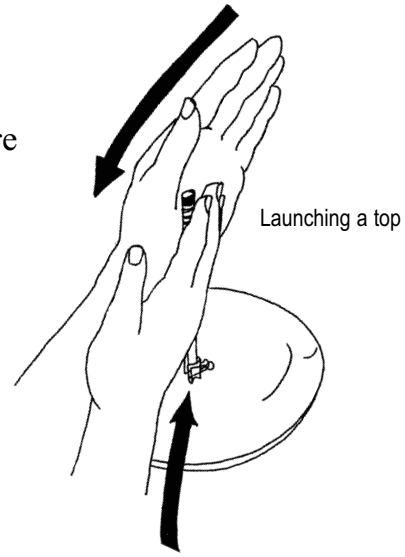
- 2 heavy paper plates (7-inch)
- 1 dowel (3/16-inch diameter, 8 inches long)
- 2 rubber bumpers
- *Data Sheet—Activity 1*

The Challenge

Make a top with the materials available. Make it spin for 20 seconds or more.

What Do I Do?

1. Make a top with the materials provided.
2. Practice "launching" the top in the way shown in the figure at right.
3. Make changes to your top that allow it to spin longer.
4. Time how long your top spins, and record the times on *Data Sheet—Activity 1*.



Launching a top

What to Think About

- Does it matter whether the dowel is exactly in the middle of the plate?
- Why does the dowel need to be fixed tightly to the plate?
- What is the best way to launch the top?
- What is the fairest way to time your top? When should you start and stop the clock?

Data Sheet—Activity 1

Team Members: _____

_____

The timer should use a clock (or stop watch) to time how long the top spins.

Trial #	Time (seconds)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

Activity 1: Assembling a Top

Preparing Ahead

Make a top with the materials listed and discover for yourself what factors affect its performance. This experience will help you be more aware of the difficulties and challenges that the children will face during this activity.

Make one copy of the Challenge Sheet and *Data Sheet—Activity 1* for each team.

Introducing the Activity

Begin by asking if any of the children have ever made a top before. If they have, ask them briefly to describe their experiences. Then ask them what parts they need to make it work and what it will look like when it is working.

Then, bring out the top that you prepared ahead of time. Demonstrate your top to the children, and let them look at how it was made. Explain that for the next few sessions, they will be learning how to make tops, some like the one you made and some that are very different. Their goal is to become experts in what makes different types of tops work best.

The Challenge

Make a top with the materials available. Make it spin for 20 seconds or more.

After this conversation has run its course, hand out the Challenge Sheets, data sheets, and the materials listed above, and let them begin assembling their own tops.

Leading the Activity

Leave the top that you used as a demonstration model in view for the children to copy if they wish. Make sure children understand that it is okay for them to use your model to help them with their own tops. The point here is not to "invent" an original top design so much as it is to figure out how to improve on or refine the design you have given them. The closer children's designs are to one another, the easier it will be to compare small differences in each other's designs to see how significantly they affect the length of time the tops spin.

Materials

FOR EACH TEAM

- 2 heavy paper plates (7-inch)
- 1 dowel (3/16-inch diameter, cut to 8 inches long)
- 2 rubber bumpers
- *Data Sheet—Activity 1*

ALTERNATIVE MATERIALS*

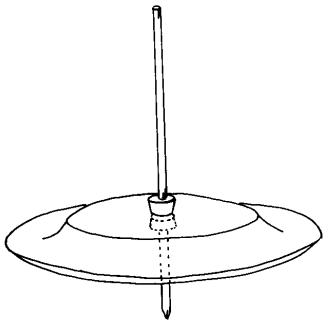
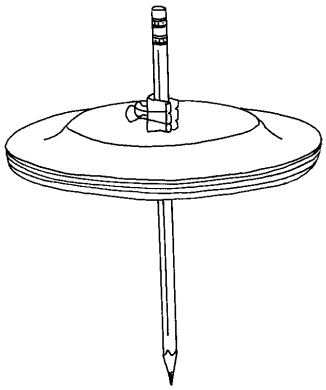
- regular pencils
- binder clips (3/4-inch)

*NOTE: You may wish to make the first tops with these, more available, materials. The only drawback is that some children find the binder clips very painful on their fingers.

Troubleshooting

Although the standard top model design is very simple, it has a number of aspects that can dramatically affect how well (and how long) the top spins. Walk among the children as they work to help them figure out what these aspects are and how to maximize the efficiency of their designs. When they are stuck, remember that it is always better to ask a question than to give a solution. Table 1.1 gives some clues on what to watch out for and suggestions for how to react.

Table 1.1

Image	Problem	Comments
	Axle (dowel) not pushed through exact center of the plates, making top wobble dramatically.	Although this can be corrected by adding extra weight to the plates on the "short" side, it is very difficult to do. It is better to give the children new plates and help them figure out how to find the center.
NO DIAGRAM	Axle not fixed tightly to the plates. Axle spins, but the plates do not.	The rubber bumpers hold the axle and plates together firmly so they spin as one unit. Push the bumpers tightly against the plates (top and bottom) to make this joint tighter.
	Plates too high on the axle. Top spins fine for a while, but falls over quickly.	Tops spin much longer and are much more stable when the plates are as low as they can be on the axle.

Do not, tell the children what is wrong with their tops or how to fix them. Instead, ask one or more of the following three questions (or something like them):

- What works (and what doesn't)?
- What have you tried (and what happened)?
- What has worked for other teams?

In addition to the general questions listed above, here are some specific questions you could ask children:

- How do the rubber bumpers help your top?
- How did you keep the plate fixed tightly to the axle? Why does it matter?
- How did you spin the top?
- Did your top wobble? What did/could you do to stop the wobble?
- What happened if your axle wasn't exactly in the middle of the plate?
- How did you find the middle of the plate?
- How could you change the design to make it work better?

As in other *Design It!* projects, avoid responding with an opinion of your own. Rather than indicating that you agree or disagree with the child's response, first acknowledge that you have heard the response and then ask a follow-up question that might lead the child to think more deeply or carefully about the issue.

Leading the Discussion

After they have worked on their tops for an ample amount of time, gather the children together away from the area where they have been working to share what they have observed and learned so far. Begin with a brief show-and-tell. Ask a volunteer team to spin their top in front of the whole group and time how long it spins. Make sure there is agreement on how to time the tops "fairly"—when to start and when to stop the clock. Some children may wish to time until the top is completely stationary while others will prefer to stop the clock when the edge of the top first touches the table. The latter is probably a better measure, since it accounts for both spin and stability. But you may consider letting the group make that choice. It is important, though, that all spin times are measured using the same method. If your schedule allows, let each team spin their top twice. Record the results on the *What Works?* chart described below.

Before each team spins its top, ask them to describe any challenges they overcame while making it or any features of their design or discoveries about it they would like to point out to the group.

When all the teams have spun their tops (twice) and the data has been recorded, gather the children around a large two-column *What Works?* chart

with the column heads shown below. Have the children call out any ideas that they believe to be true about making tops with these materials. Below are some ideas they may suggest. Write a very shorthand version of whatever they say in the appropriate column. Do not edit the meaning or offer any opinion on what is correct or incorrect. Even if statements contradict, write them down anyway. The children are taking part in a "brainstorm" session, creating a list of ideas that will be tested and refined during the coming design sessions. Table 1.2 shows an example of what you might hear from the children.

Table 1.2

What Works	What Doesn't
The hole in the middle of the plate	Hole not in middle
Sharp pencil	Plates high on dowel
Bumpers on top of plates	Spin too hard
Plates low on dowel	Bigger plates are worse
Bumpers tight	Sharp point on dowel
Spin really hard	Slow launch
Bigger plates spin better	
Fast launch	

If time still remains in this first session, let the children make another top with the same materials, perfecting the design as best they can based on what they have learned from their own and others' experiences.

Collecting data

On chart paper, make a large version of the chart on page 85 in the Appendix. This chart will help you keep track of the general improvement of top design over the time the children spend on the project. Post this chart on the wall of your room at the beginning of the project. As each team carries out an official test of their top (during the Discussion Circle, in front of the whole group), enter a check mark on the chart in the appropriate gray box. For instance, if a top spins for 33 seconds, place a check mark in the third column [30–59 sec].

Also, make a simple list of actual times on a chalkboard or another piece of paper. At the end of the day, add up the check marks in each box and write the number in the white space below. Enter the best spin of the day in the extreme right hand column.

This chart emphasizes that the group is working together to design the best possible tops. If all goes well, it should be possible to see a gradual improvement in spin times as the days go by. Hopefully each team will have a chance to be the best spinner of the day.

Activity 1: Assembling a Top

Rationale

Modern children, saturated with electronic toys and images, still find simple spinning tops irresistible. But in addition to being fun, tops offer a great learning experience in how to design and construct a working machine. The details involved in making a top work well and in measuring its behavior and speed can demand a lot of patience, persistence, and insight. All of these aspects make it an ideal challenge for elementary-aged children.

Introducing the Activity

In all design and science activities, it is very helpful to spend a little time right at the beginning setting the context for what the children are about to do. If you know a good story that involves tops, or if you have a collection of real tops, share these with the group at the beginning of the project; it may spark their imagination. By asking the children what experiences they have already had with tops, and what they know about how tops work, you begin to develop in them the habit of using words and ideas to describe and explain the world. Learning to talk about what they are doing is just as important to the children's learning as solving the problem itself.

Leading the Activity

Troubleshooting

THE AXLE JOINT

The main engineering challenge in the design of a top is to get the axle to attach firmly to the disk (plates). If this joint is not firm, it will be very difficult (next to impossible) to launch the top fast by spinning the axle. Children do not always realize early on how important it is that the axle-plate joint be tight. As with all the other design details in this project, they should be allowed to discover this for themselves, if possible. They may solve it on their own, or they may ask for help. But once the issue is addressed, it is almost certain that their tops will function better.

Children often want to use tape or glue to keep the axle-plate joint together, but this has two disadvantages: (1) The joint often does not hold up well when the top is spun hard, and (2) the user will be unable to adjust the joint when trying out different top arrangements to see which works best. The children can use binder clips to hold this joint tight, but the clips can be difficult and uncomfortable for children to use when pressing them firmly onto the axle. If this is a problem for your children, have them use cardboard, tissues, or some other soft materials to give their fingers extra protection as they push the binder clips tight. Be as creative as you can to come up with a system that the children can and will use to keep the top tightly joined.

OTHER DETAILS OF CONSTRUCTION

How well the top works can be affected by other details, such as:

- the axle not being centered,
- the weight being uneven around the plate(s),
- the axle not being set perpendicular to the plate, and/or
- a poor launch technique.

During this first activity, you should not expect that children correct, or even notice, all of the above issues. If they end this session having had some success assembling and launching a top, they will be well prepared to undertake the second challenge, which is to refine the design for maximum spin time.

Collecting data

Children may not initially be convinced that adjusting the features of the top itself will make a difference in how long it spins. Many children believe that it is all about luck or skill. Some luck and skill is involved, of course, but a great deal also depends on very concrete factors, such as the weight, size, and stability of the top. One way to show how the top is affected by these factors is to keep records of spin times week after week, and to watch how they change over time. Of course, the children may still conclude that the reason spin times have improved is because they have become better at spinning. They would be right; their techniques will have improved over time. But try to draw attention, also, to how the designs of the tops have improved over the course of the project. Later in the project, you can demonstrate the importance of the top's design by having a child skilled at launching tops spin two tops of different designs—one primitive and the other refined. Even though the same child is spinning them, the refined top will probably spin longer. The difference is in the top, not the spinner.

LEADING THE DISCUSSION

It can be difficult to keep the children's attention for a discussion when they would much rather be playing with their tops. However, it is essential to the success of this program that you get into a routine of having a few minutes of reflection at some point during each hands-on session. It is better to make a clear break between the hands-on experimenting and this discussion. Have the children sit in a circle away from their tops and the materials while they talk about what they have done and discovered.

In all the Discussion Circles for this project, you should have the *What Works?* chart on hand. Ask the children at every discussion to review the list and see if they still agree with their earlier thinking. Add new items as they come up, and cross out items when there is consensus that they are not true. If the list gets messy, make a new copy, but hang on to the old one so that you can look back at the progress of ideas as the project goes on.