# Toys Through Time – Physics & Toys
## Optional 4th quarter project

**Purpose:** To investigate the physics principles behind a traditional cultural toy and to design a lab activity for high school physics students using that toy.


Children from Dansville Elementary School try using the climbing bear and the chicken feeder toy in the Rural Michigan Gallery.

In all societies and all times, people have played with toys and games. In hunting and gathering societies children often chased bugs and small reptiles with miniature spears. Thousands of years ago, people played with a board game resembling chess and checkers in Babylon, stone marbles in Egypt, stone yo-yos in Greece and kites in China.

Pioneers in the 19th century made farming toys that helped children learn how to work with animals. The chicken feeder toy taught children the rounded sweeping gesture necessary for casting grain to the chickens. The climbing bear toy taught children that the bear only climbs the rope when the child masters the firm, rhythmic downward pulls necessary for milking a cow successfully.

**The project has four parts:**

- Selecting a toy - ask your parents or grandparents for ideas!
- Library research on the scientific principles behind the toy & a written page on your findings with bibliography.
- Designing & writing a lab to be done with your toy. Donation of your toy would be greatly appreciated – I'd like to put together a kit for use by future classes!
- Carrying out the lab, analysis and conclusions as designed.

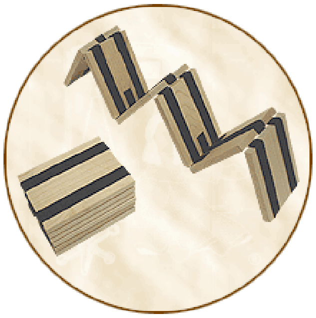
To get ideas for your project, do a web search for traditional folk toys of different cultures. A few examples:

**Russian Folk Toys:**
http://www.rustoys.com/russian_folk_toys.html

*Example: The Climber*

Hold loop of the strings in the hands, repeatedly pull the end of the string with the other and watch the clown go up the rope. When it reaches the top and bump it head, loosen the tension in the rope and down it'll slide and it is ready to start again.

**Historical Folk Toys:**
http://www.historicalfolktoys.com/catalog/toys1.html



*Example: Jacob's Ladder*

Jacob's Ladder is one of the oldest toys in the world, rivaled only, perhaps by the spinning top. Nobody knows where it was invented - as examples have been found all over the world - or how old the idea is, one having been discovered in Tutankhamun's burial chamber in Egypt! Wooden squares make a magical cascading motion.

**ELEMENTS OF THE LAB DESIGN (see example on last page)**

There is an art to communicating scientific ideas and findings. Besides being prepared in a concise, neat, grammatically correct and organized manner, a lab you design must contain certain specific information. The goal is to communicate what you want the experimenter to set out to do, why they set out to do it, and how they should do it, what they found out and what conclusions they reached. A Designed lab SHOULD NOT BE WORDY-- it should be concise and to the point. But be sure that all the required information is included. The audience for your lab design consists of your fellow physics and advanced physics students.

a) TITLE

b) PURPOSE & INTRODUCTION (ABSTRACT)

In no more than 75 words, you should give a brief description of what you intend to have accomplished in the experiment and what results you want the experimenter to present in the body of a report. The purpose of an abstract is to allow a reader to know at a glance what the report is expecting of him/her. The abstract may include some of the theory behind the experiment, some elements of the objectives and of the experimental procedures, but should be concisely written.

c) PROCEDURE

The procedure should be organized, sequential, and complete, identify and name all experimental variables and constants, and describe how the independent variables are controlled. Include a "materials" section including all equipment necessary to do the lab. Make sure you explain in your procedure which tools to use to make measurements. A labeled DIAGRAM of the experimental setup is frequently useful to help the reader understand your procedure.

d) DATA

All data should normally be collected together in one section. You will want data to be displayed in clearly labeled tables. Units should be included. The importance of organization and neatness cannot be overemphasized. Someone reading your designed lab should not have to search to find your data table, or to understand what they mean.

e) ANALYSIS AND RESULTS

You should include a section for analysis and results in your lab design. Any manipulations of the data and any results should be placed in this section. This includes any calculations and graphical analysis. Include formulas needed for major calculations and describe which graphs need to be made. Include a spot for students to write mathematical models derived from graphs.

f) CONCLUSION

In general, specific questions should be asked to guide the experimenter to a discussion of their results. In this section, they should be sure to comment on the following even if these questions are not specifically asked:

i) If the experiment was designed to test a theory, do the results agree with the theoretical predictions?

ii) If the experiment was designed to measure a physical quantity, does your result agree with previous results?

iii) If the answer to (i) or (ii) is no, can you explain why? Whenever possible this should be answered quantitatively. You should look for additional sources of uncertainty or error in your data, describe them and estimate their sizes if possible. Then you should calculate and/or describe what effects these would have on your final results. Do these sources of uncertainty or error explain the discrepancies in your results?

iv) Did the experiment fulfill the stated purpose?

v) Was the experiment worthwhile? Did it help to elucidate the physical principles?

vi) Can you suggest any ways to improve the experiment so that it would better fulfill the purpose? Once again, a good report should include all of the above, and should be neat and CONCISE.

**GRADING**

*Choice of toy & explanation of physics involved* **(30 points)** - Toy chosen is valuable for explaining physics concepts (i.e., centripetal force, Newton's 3rd law (action/reaction), conservation of momentum, conservation of energy, center of gravity, friction, rotational dynamics, torque, etc.). Paper is at least a page and includes a discussion of how the toy works in terms of physics concepts. Where appropriate, equations are included. Paper includes a bibliography.

*Lab Design & Lab Worksheet* **(35 points)** - See explanation on previous pages, lab should be useful and appropriate for high school physics students.

*Carrying out lab* **(35 points)** - You will be filling out the worksheet you wrote for your lab design. Attach calculations and graphs, answers to conclusions questions, etc. Pay attention to normal lab report guidelines for sig figs, graphs, etc.

# Chinese Chicken Feeder

NAME______________________________ PARTNER _____________________ DATE _______

### PURPOSE

To study the nature of centripetal force.

### MATERIALS

Chicken feeder toy (Chinese Cultural toy), Weight 100g X 2, stopwatch, ruler

### INTRODUCTION

When an object is moving in a circle there will be a center-directed force that causes an object to follow a curved or circular path. This force is called the centripetal force. This lab is to find out the relationship of centripetal force, mass, and velocity. The equation which shows the relationship of centripetal force, mass, and velocity is Fc = mv2/r. Fc represents the centripetal force, m is the mass of the moving object, and v is the speed of the mass moving in circular motion, and r is the radius of the orbit of the object.

### PROCEDURE

1. Make the length of the string attached on the toy 40cm long.
2. Tie a 100g mass on the end of the string. *Tie it firmly so the mass won't fly away.
3. Slowly swirl the toy and try to make it so the mass will move in circular motion with radius of 40cm.
4. When the mass moves in perfect circular motion use a stop watch and measure the time it took to make 30 revolutions.
5. Add another 100g weight on the end of the string.
6. Repeat the procedure from 3 and 4.
7. Change the length of the string to 20cm long.
8. Repeat the procedure 2, 3, and 4.
9. Change the length of the string to 60cm long.
10. Repeat the procedure 2, 3, and 4.

### DATA Data

| Mass of the Weight (g) | Revolutions | Time (s) | Radius (cm) | Speed (m/s) | Centripetal Force (mv2/r) |
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# ANALYSIS / CONCLUSION

1. After calculating all of the values in the chart, find the relationship between the centripetal force, mass of the object, velocity of the motion, and the length of the radius.
2. Draw a graph comparing mass of the weight and radius of the circular motion.
3. Draw a graph comparing speed of the motion and mass of the weight.