

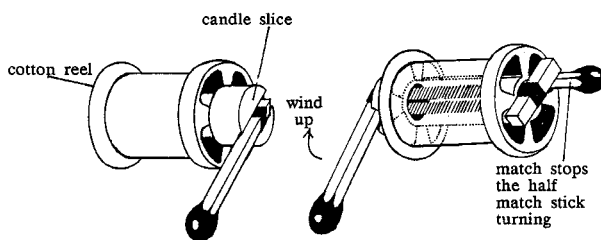
Machines that move (for example, toys) need a source of energy. The main purpose of this mini-project is to design ways of using this energy efficiently to provide controlled movement. In doing it, you will find out a lot about storing energy, energy transfers and factors which affect efficiency.

To make things work in a controlled way, it is often not just how much energy that is important, but also the rate at which it is transferred – that is, the power, or rate of working.

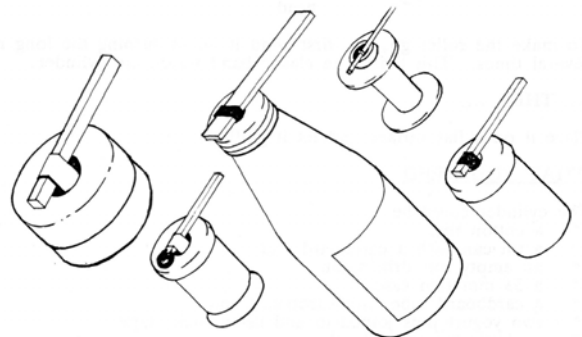
There are two projects to choose from. One is to make 'roller tanks'. You can explore speed (which design can go fastest?), power (how steep a slope can it climb up?) or endurance (how far will it travel?). The second project is a challenge – can you design a machine that can throw a table-tennis ball into a waste-paper basket?

Rollers:

You can use the energy stored in a twisted elastic band to drive a moving toy. A 'roller tank' can be made using a cotton reel.



You can make rollers in many sizes:



The body of the roller can be made from, for example, a cotton reel, plastic bottle, film can or drinks can. The power is supplied by an elastic band. You may need to make a hole in the bottom of the can or bottle to let through the fixed end of the band – how will you fix it so that it cannot turn?

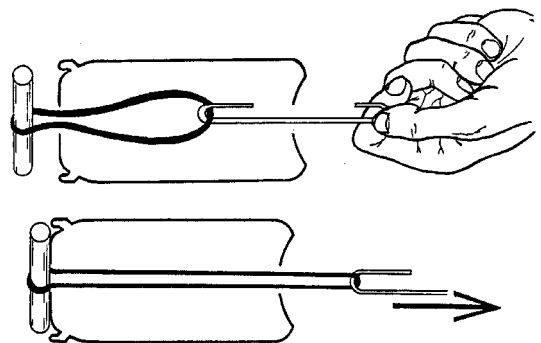
The drive is provided by a stick or rod through the other end of the elastic band. Turn this rod to wind up the band, put down your roller and watch it go!

How long/ thick/strong should the drive rod be?

Do heavy or light rollers go best?

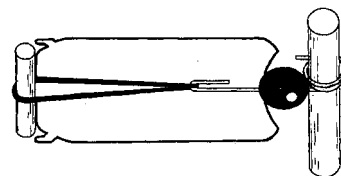
Do you have trouble with skidding, or twisting sideways if you wind up the band too far? How can you cure this – a heavier roller? Or elastic bands or felt strips stretched round the roller to give a better grip?

A partly unfolded paper clip is useful for pulling the band through a hole in the bottom of your can or bottle.



How can you make the drive stick turn more easily? A thin slice of candle wax (look at the cotton-reel tank above) can help to reduce friction.

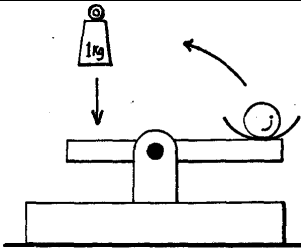
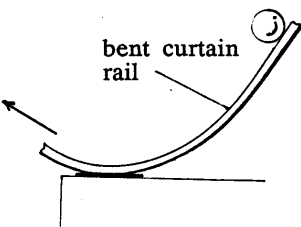
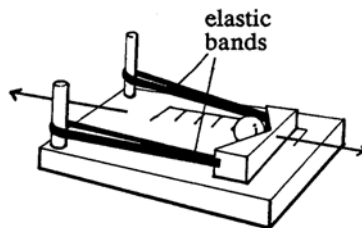
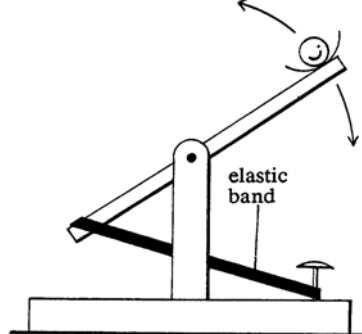
Another way is to use a bent paper clip to attach the drive stick, with a smooth bead to act as a bearing.



Explore the link between the number of turns winding up the elastic band and how far the roller goes. Develop your best design and race-test it against others. You can have 'sprint' races – who is fastest over a short distance, or 'endurance' races – whose roller can go furthest on one wind-up?

In modern warfare, armies use explosives in artillery to fire shells at their enemies, while they keep a safe distance. Before modern artillery and reliable explosives were developed, armies used all sorts of mechanical machines to hurl rocks at their enemies. For this sort of machine, accuracy and control are important as well as power!

You are asked to design a machine that can throw a table tennis ball across a distance of 3 metres (or more) so that it lands in a waste-paper basket. The machine must be capable of repeating this many times with a good success rate.

Your machine needs a source of energy to propel the table tennis ball. The ideas illustrated here use different energy sources:

- a falling weight or a sloping runway make use of gravity
- various types of catapult use elastic energy from rubber bands
- coiled springs could also be used

You may think of others, but unlike the army, you cannot use explosives!

Remember that elastic bands or springs may snap suddenly. Always wear eye protection and be careful to fix your machine firmly in place (use a G-clamp to fix it to the bench) while you are using it.

You should work out your design and check it with a teacher to help in choosing the right type and size of materials to use.

Throw 10 balls with your machine and count how many land in the basket. You could make a more challenging target with a large trough, a small trough and a beaker (put in some loose sand or crumpled paper so that the balls don't bounce out!). You could also try increasing the range to see how far you can reach without losing accuracy.

