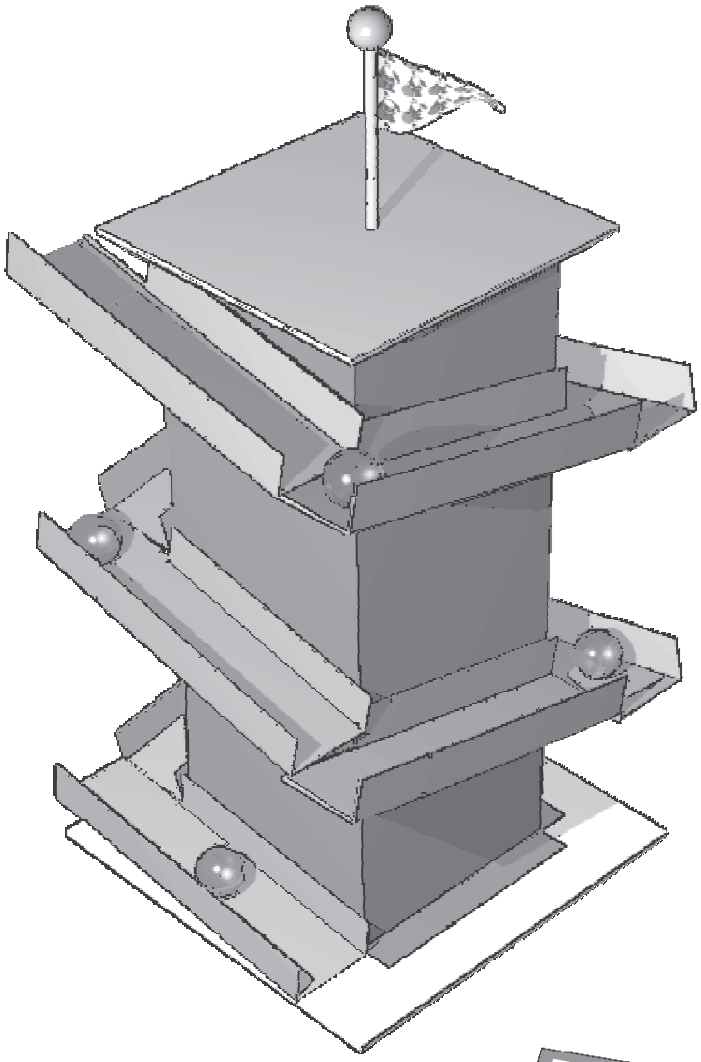


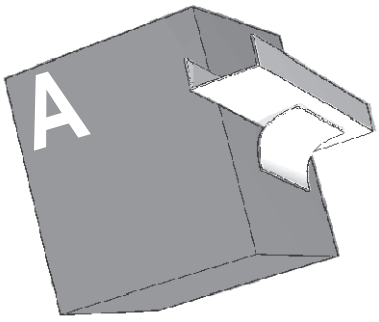
This small card tower with its series of ramps is essentially simple. Its simplicity is deceptive, for it needs to be well made to work at all. It's an excellent exercise for testing and developing card handling skills.

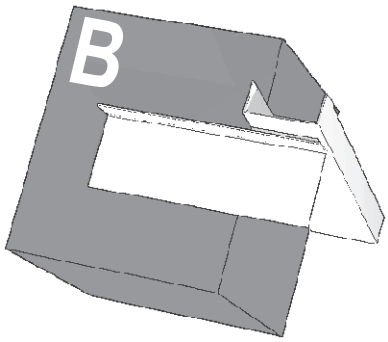
The basic structure is a square tower using the technique explained fully on the 'Boxing Clever' page. It starts life as an A4 sheet of thin card. Allowing for the tabs, it makes a tower 19cm tall with sides approximately 7cm wide. The thickness of the 9cm square top is unimportant, but the base should be made of stiff card and of a generous size.

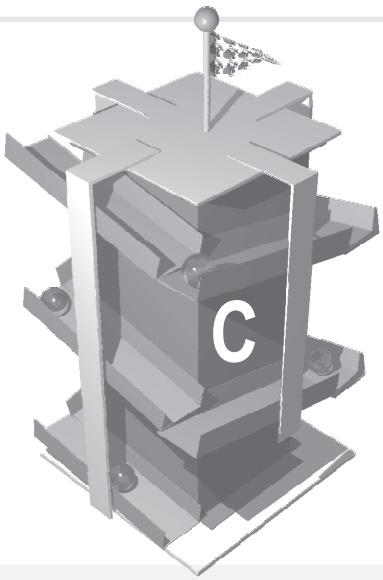
The ramps are also fashioned from thin card. They are strips between 4 and 5cm wide, scored and folded to give side walls 1cm high.
They can be scored and folded independently, or cut from longer pre-folded strips.

The challenge is to have a minimum of eight ramps so that the marble has to travel twice around the tower.

This task can be undertaken at two levels.
If you use small wooden beads for rolling down the track then the model, as shown, will be adequate. If glass marbles are used then the structure will need to be strengthened to withstand the extra forces. That's the important part of the task for older children.







The marbles are quite heavy so they bend the ramps downward as they run. The children will notice this and many will attempt to remedy the problem by adding a support beneath each ramp, as in example A above. The ramp will still sag. The force acting downwards will bend the support as well as the ramp. Many children will add a second piece of card over the top of the first. Their theory being that the thicker the better! I think the problem is that they only see the ramp and the surface it's fastened to - not the object. Gluing a support to the adjacent surface, as in B above, is so simple - though not obvious. Past experience suggests that very few children will discover this option, it will be up to the teacher to point the way.
An alternative approach is to join all the ramps on any one side of the tower, as in C. The strips of card will be in tension when the weight of the marble is added, though you'll have to support the top angle somehow.

.If the ramps are steeply inclined the marble will accelerate very quickly. Everyone will be able to appreciate the kinetic energy the marble carries, even if they can't understand it! The faster moving marble will probably 'smash' its way through the retaining wall of the next ramp when it reaches a corner. Either the marble will have to be slowed down or the ramp wall will have to be strengthened - or both.

The presence of these factors makes this an excellent model for exploring energy and forces.