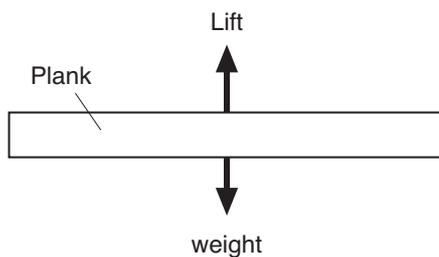


# MEASURING AND IMPROVING STABILITY IN STRUCTURES

Every year people are injured by objects such as unstable filing cabinets which topple over. Objects should be designed to be stable so that when they are tilted or pushed they will not spill over or topple.

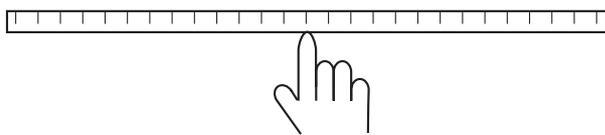
## THE SCIENCE OF STABILITY

Before considering stability it is important that the term **centre of gravity** (centre of mass) is fully understood. Why is it easier to lift a long heavy plank at the centre rather than near the ends? Although the force of gravity acts on the whole plank, the weight of the plank seems to be concentrated at its centre. This point is known as the centre of gravity. Lift the plank at its centre of gravity and it will balance. Lift it at any other point and you will need to overcome the turning effect.

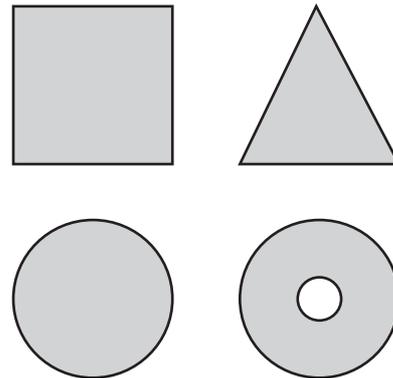


**The centre of gravity is the point through which all of the weight of the object or structure seems to act.**

It is fairly easy to find the centre of gravity of an object such as a metre rule by moving it until it balances on the end of a finger. It will be somewhere near the 50 cm mark. It becomes more difficult with irregular shaped objects.

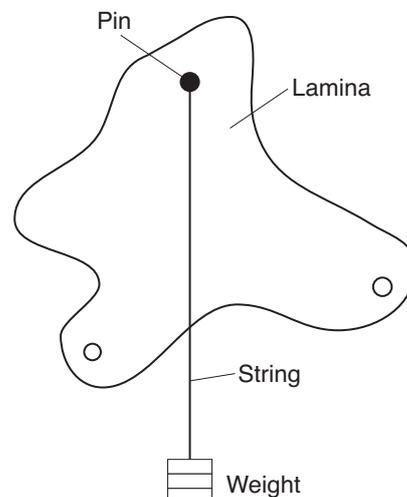


Try to work out where the centre of gravity is on the shapes below.



## FINDING THE CENTRE OF GRAVITY OF AN IRREGULAR SHAPE

Cut out an irregular shape from a flat piece of card (lamina). Pierce three holes at different points around the edge. Insert a pin through one of the holes and let the card hang freely. Attach a plumbline to the same pin and mark the position of the plumbline. The centre of gravity is somewhere on this line since the card hangs with its centre of gravity vertically below the pivot pin. Repeat with the other two holes. The centre of gravity of the lamina is the point at which the lines cross.



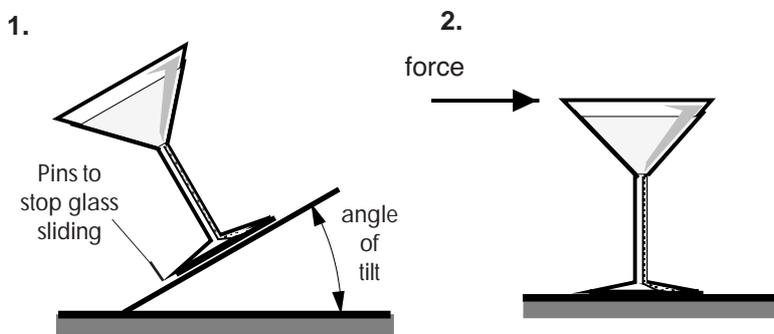
### MEASURING STABILITY

We need to measure a structure's stability so that:

- We can improve its stability.
- We can give a guarantee of stability.

You can measure the stability of a structure in at least two ways:

1. Place the structure on a surface such as a table. Tilt the table until the structure is about to topple. Measure the angle of tilt.
2. Apply a force to a point in the structure, for example, at a certain height above its base. When the structure is just about to topple, record the force.



If an object or structure is in equilibrium (balance) the equilibrium is:

- Stable** if the object or structure will return to its original position after being moved slightly to one side.
- Neutral** if the object or structure is still in equilibrium after being moved slightly to one side.
- Unstable** if after a slight movement to one side the object or structure falls and keeps falling.