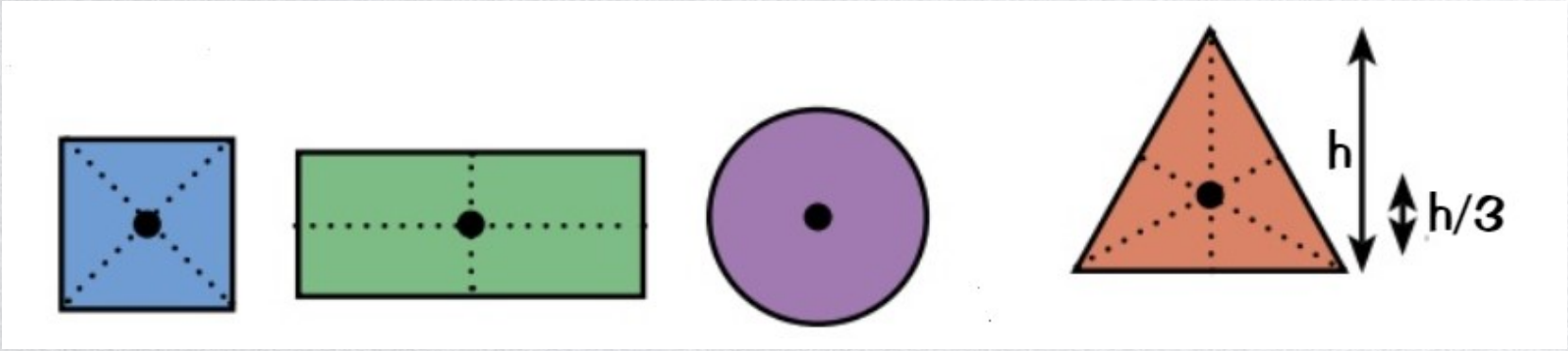
Centre of mass

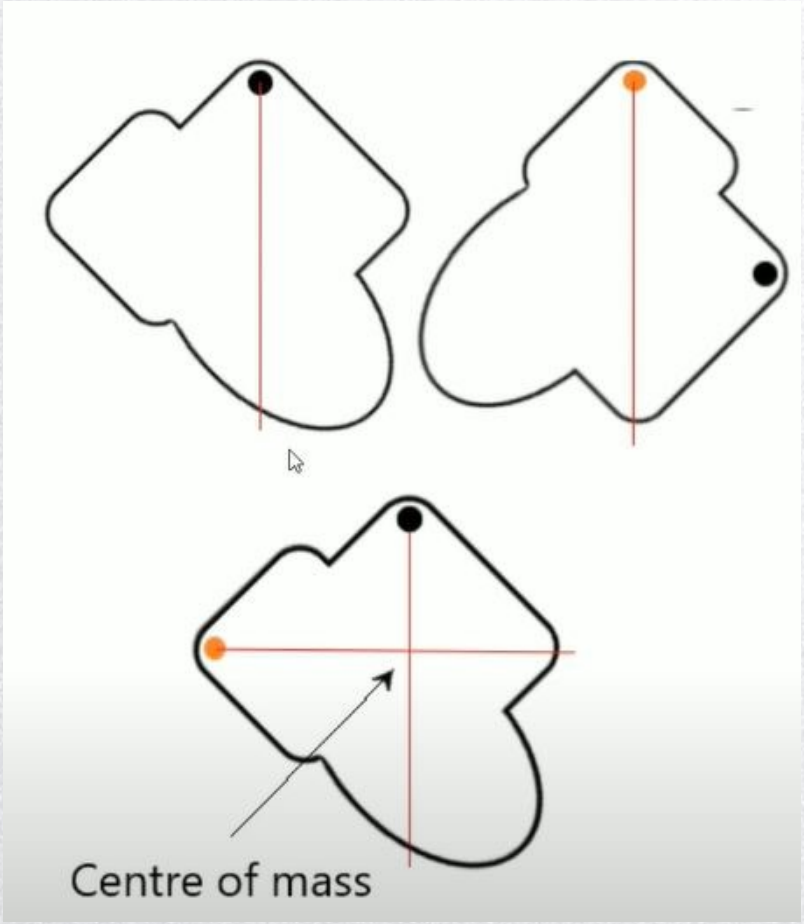
Centre of mass

Centre of mass is the point on an object where the overall mass can be *considered* to be concentrated and hence where the weight of the object is considered to act.

For **simple (regular) shapes**, the centre of mass is by looking for **lines of symmetry**.



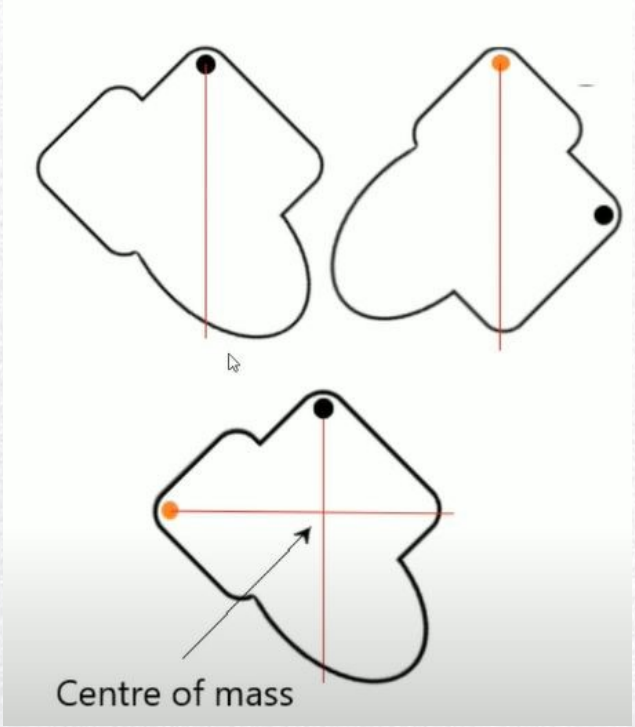
Centre of mass



Centre of mass

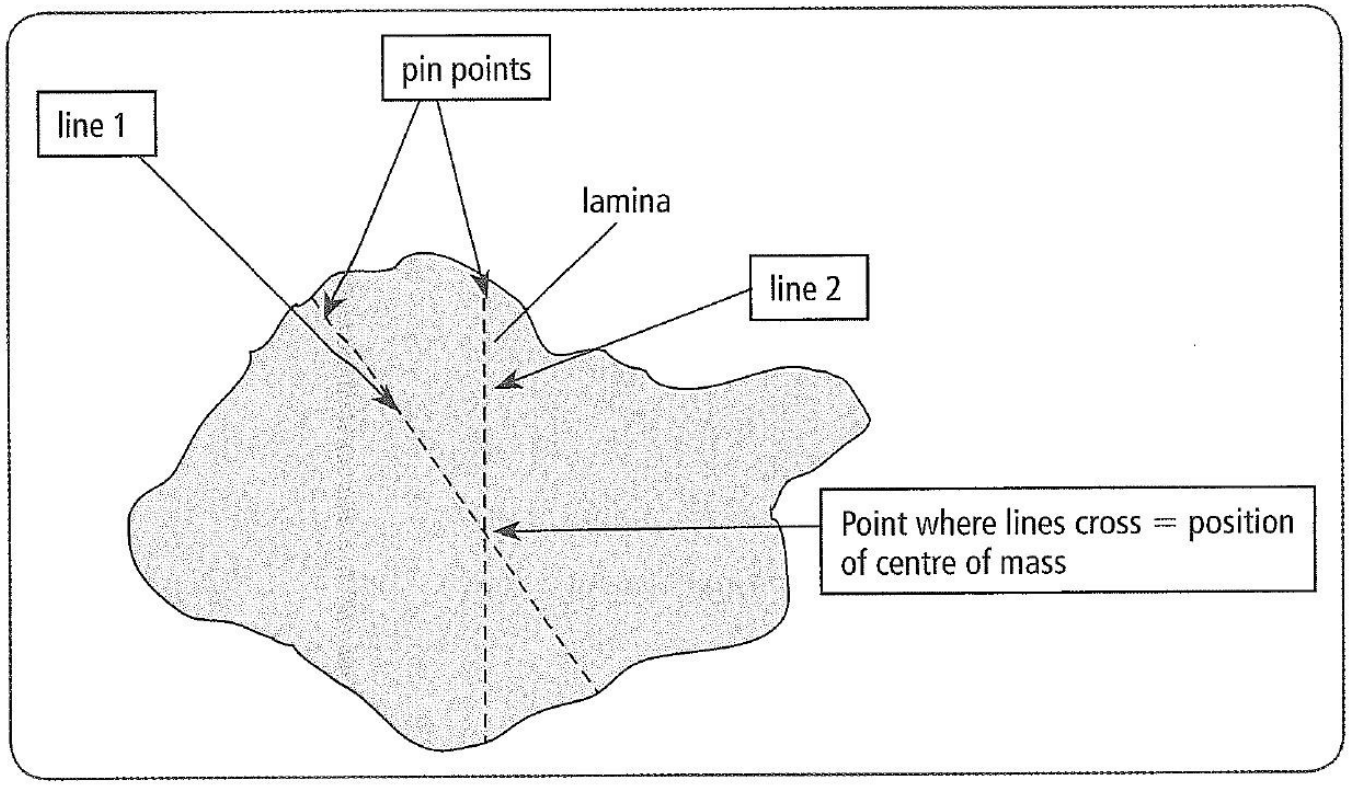
The centre of a plane lamina can be determined with a simple experiment:

1. Push pin through point anywhere on edge of lamina
2. Allow lamina to swing and eventually hang still
3. Mark a vertical line downwards
4. Take out pin and push through a second point
5. Again, let the lamina settle and mark a second vertical line
6. The point of intersection between lines = center of mass



Centre of mass

The centre of mass of a very thin object (a lamina) can be found by experiment:



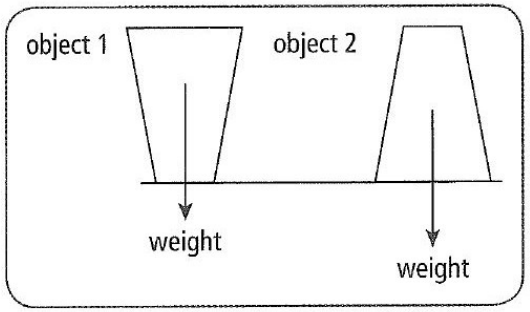
Push a pin through a point on the edge of the lamina and allow it to swing freely. Use a plumb line (a small mass on a piece of string) to mark a vertical line from the pin point across the lamina. Repeat for a second point on the edge of the lamina. Where the two lines cross is the position of the centre of mass.

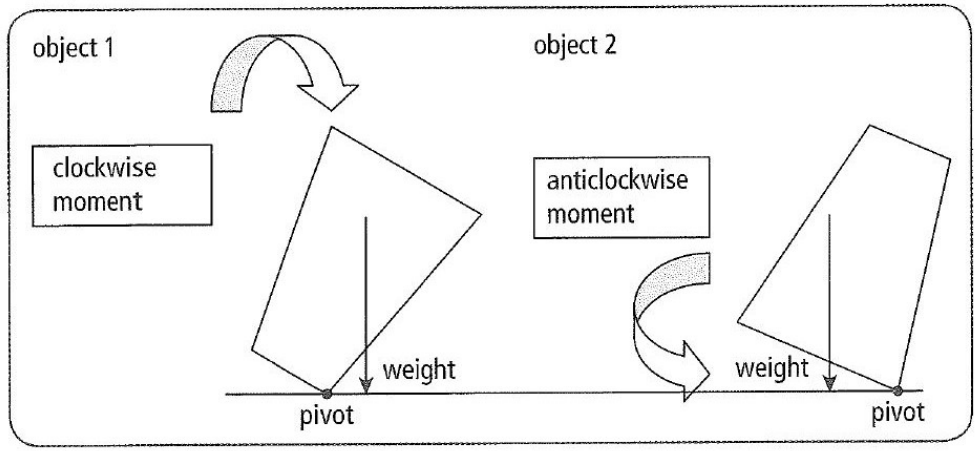
Centre of mass

The position of the **centre of mass** affects the **stability** of an object.

For example:

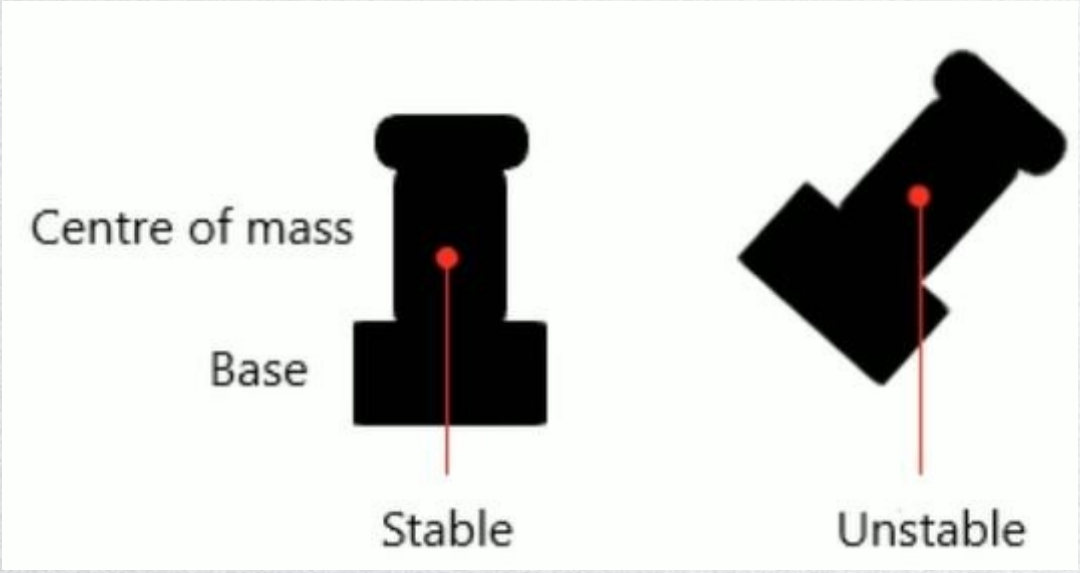
If object 1 is tilted through a small angle, the **weight will act outside the base**. There will be a net moment on object 1 that will cause it to fall over. If object 2 is tilted through a small angle the weight will **still act inside the base**. There will be a net moment on object 2 that will cause it to go back to its original position and it will not fall over.





Stability

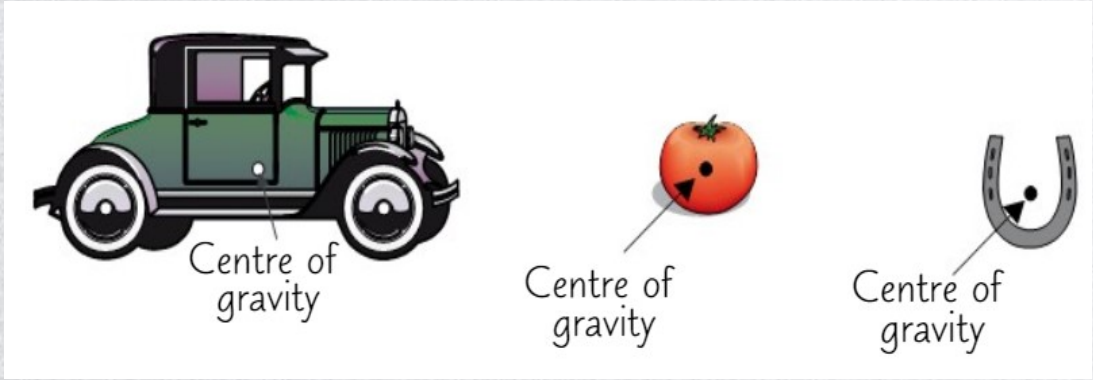
- The stability of an object is determined by its center of mass
- An object is stable **if its weight (the force acting on center of mass) is inside the base of the object**
- An object will **tip over** if the center of mass **falls outside the base of the object**



Centre of gravity

The **centre of gravity** of an object is the single point that you can consider its whole weight to act through whatever its orientation.

The object will always balance around this point, although in some cases the centre of gravity will **fall outside the object (ex. boomerang)**.



Centre of mass vs. Centre of gravity

Is centre of mass same as centre of gravity?

No.

Centre of mass is the point at which the distribution of mass is equal in all directions, and does not depend on gravitational field.

Centre of gravity is the point at which the distribution of weight is equal in all directions, and does depend on gravitational field.

Toppling

The stability of a body is therefore increased by:

(i) Lowering *its centre of mass, and*

(ii) Increasing *the area of its base*