

Exhibit 2015:

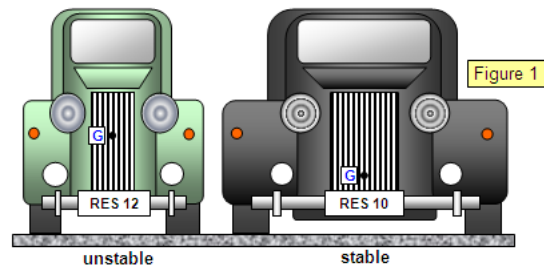


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Stability

The position of the centre of gravity of an object affects its stability. The lower the centre of gravity (G) is, the more stable the object. The higher it is the more likely the object is to topple over if it is pushed. Racing cars have really low centres of gravity so that they can corner rapidly without turning over.

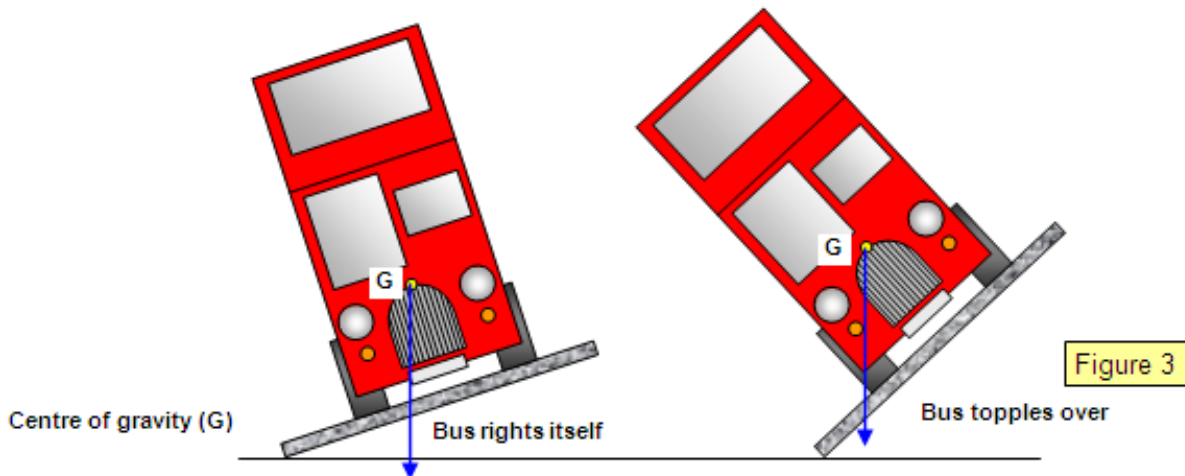
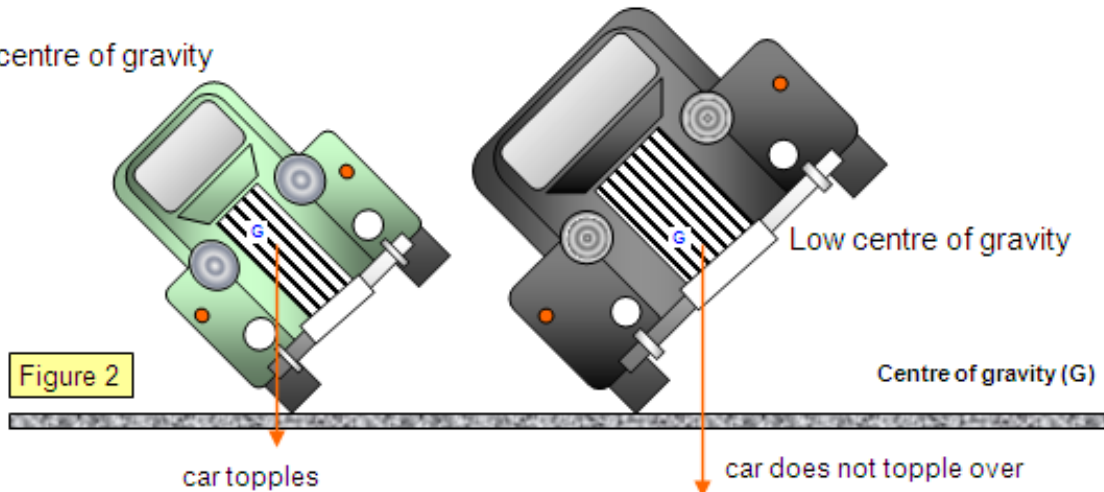
Increasing the area of the base will also increase the stability of an object, the bigger the area the more stable the object. Rugby players will stand with their feet well apart if they are standing and expect to be tackled.



If an object is tilted it will topple over if a vertical line from its centre of gravity falls outside its base.

The following diagrams show that the position of the centre of gravity is important in toppling. The higher the centre of gravity the more likely an object is to topple over if it is tilted.

High centre of gravity

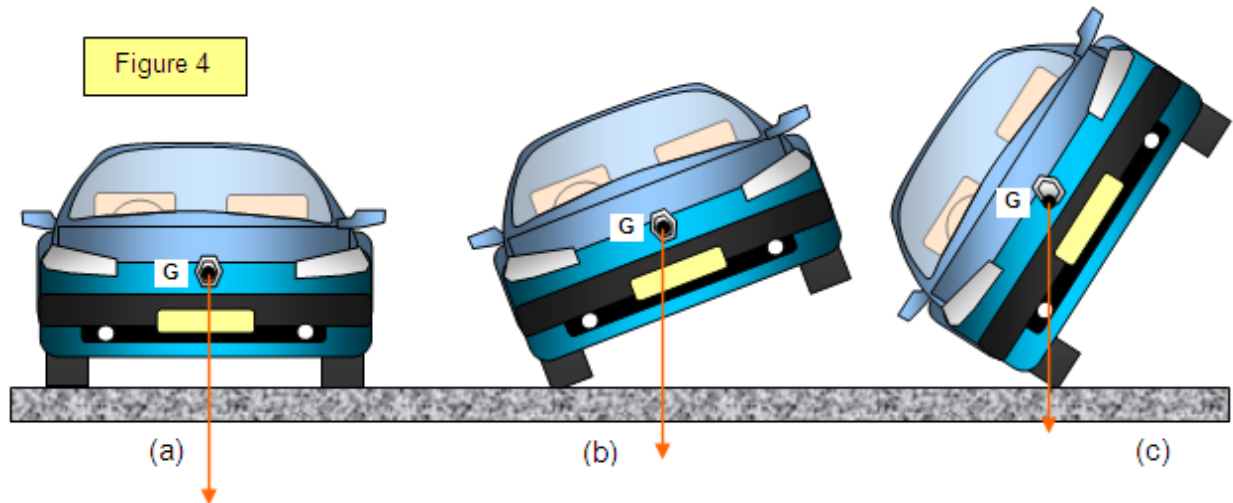


Buses must be tested to see that they do not tip over even if the bottom deck is empty and the top deck is full of people.

[schoolphysics stability of vehicles with low and high centre of gravity animation](#)

To see an animation of the stability of cars click on the animation link. The next set of diagrams (Figure 4) shows a car tilting at ever increasing angles until eventually it will topple!





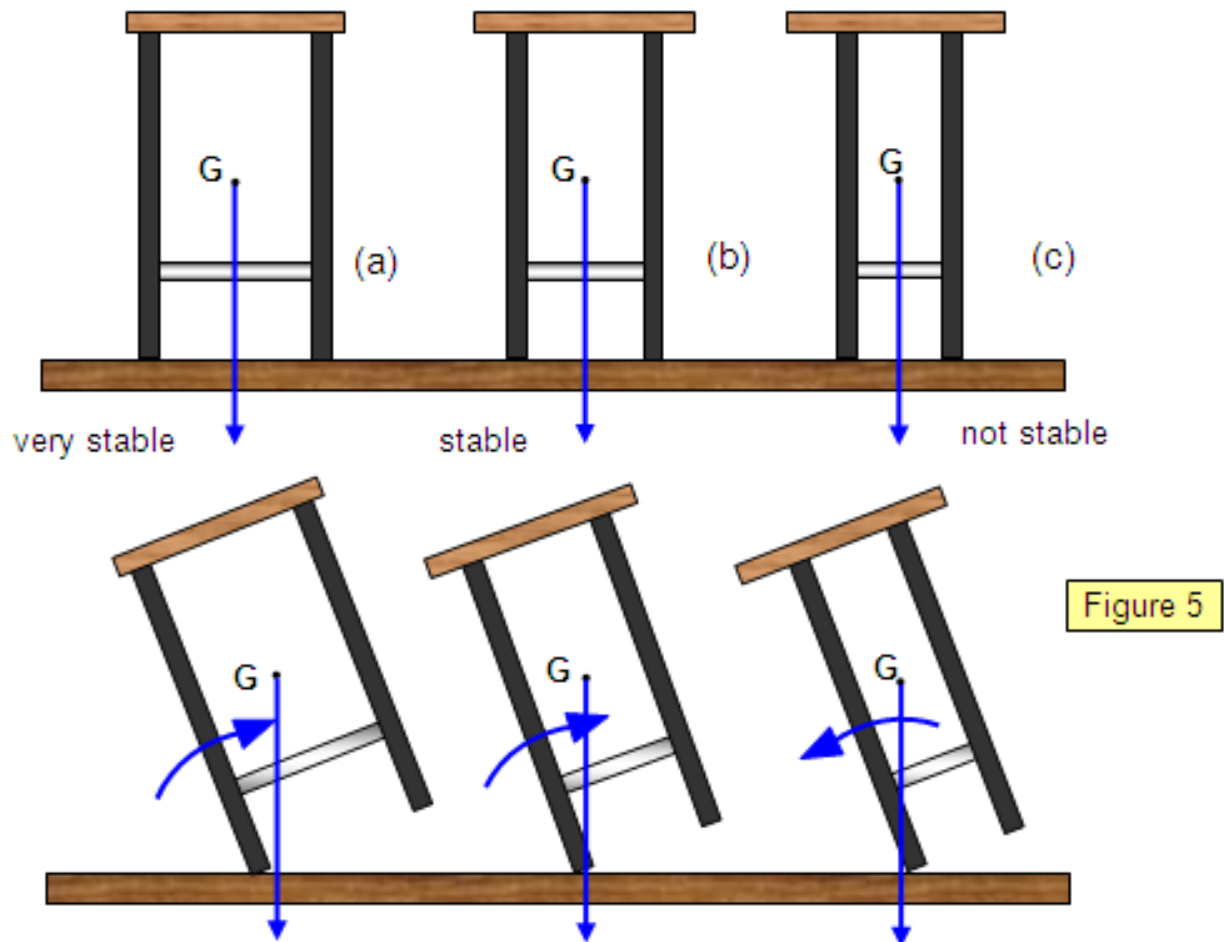
In Figure 4(a) the car is flat on the road. In Figure 4(b) the car is tilted but because the vertical line through the centre of gravity is inside the case of the car and so the car falls back to the level again. But in Figure 4(c) the vertical line from the centre of gravity falls outside the base and so the car topples over.

schoolphysics stability of cars animation

To see an animation of the stability of cars click on the animation link.



The effect of size of the base is shown by the three stools in Figure 5. The centres of gravity of all the stools are the same height above the ground but because stool (c) has a much smaller base it topples over if they are all tilted to the same angle while the other two stools return to a level position. Notice that the centre of gravity is not inside the material of the stool.



Which do you think is the safest stool to use in a laboratory?

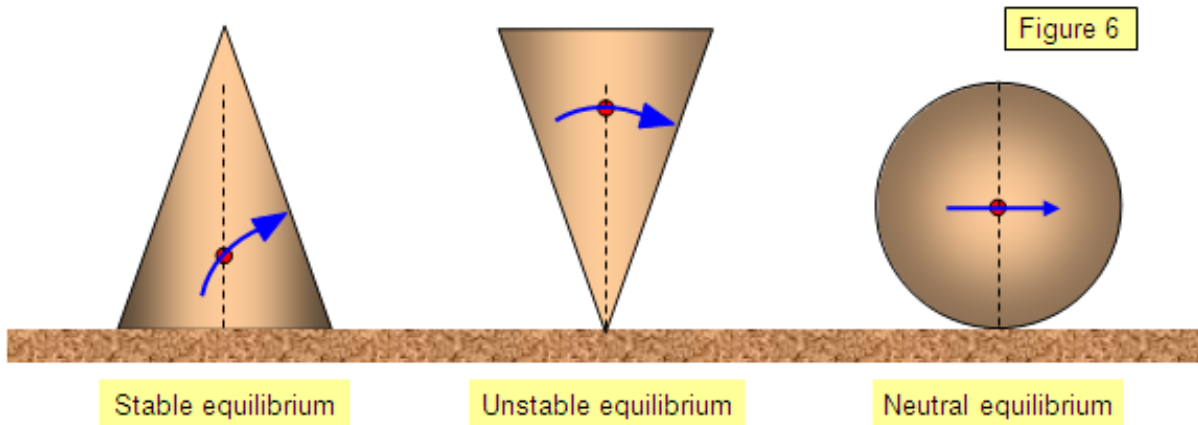
Balancing and equilibrium

If an object is in equilibrium, i.e., if it is balanced, then if a force is applied to the object it will either tilt, tip over or roll. These three conditions are known as:

(a) stable equilibrium (it tilts and then falls back to the original position)

(b) unstable equilibrium (it tilts and then falls over)

neutral equilibrium (it rolls)



Stable – the centre of gravity is raised as it is tilted

Unstable – the centre of gravity is lowered as it is tilted

Neutral – the centre of gravity stays at the same level if it is pushed

The pictures in Figure 7 show why it is not a good idea to stand up and then lean over in a small boat. The high centre of gravity of the standing people makes it all too easy to tip the boat over!

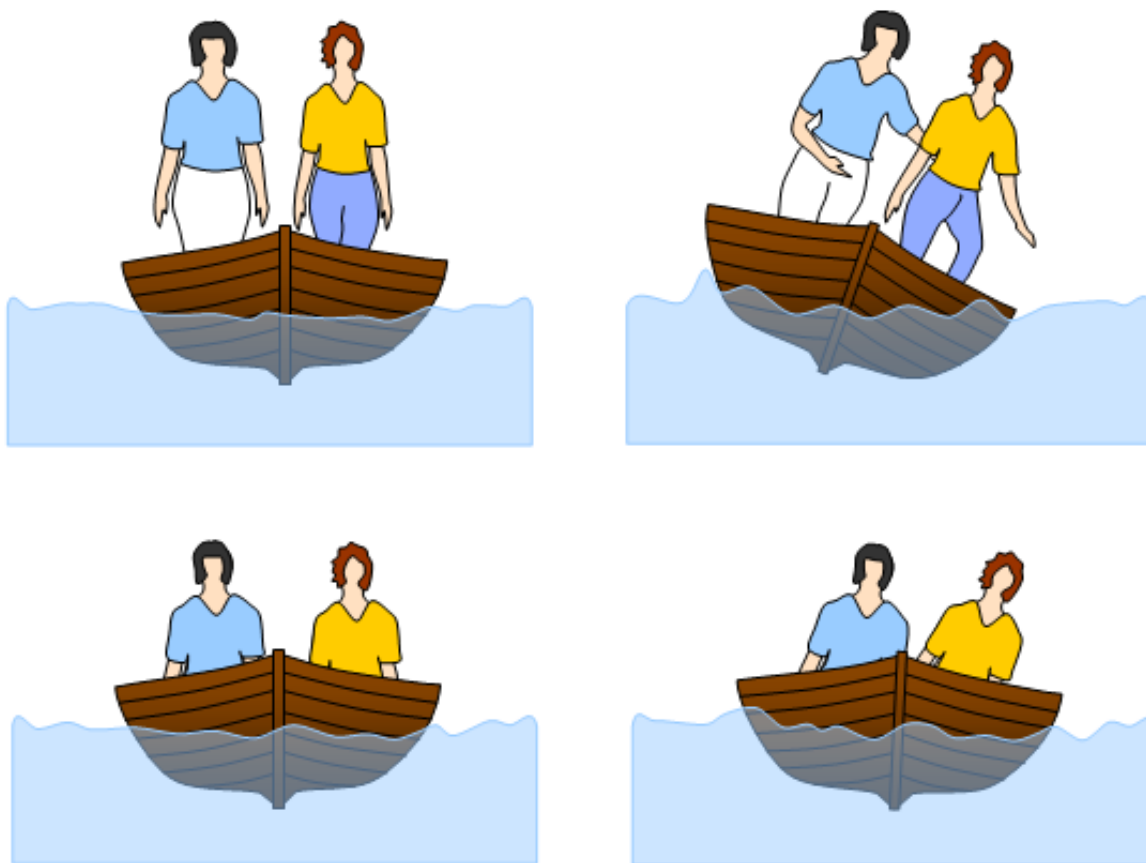


Figure 7

To help ourselves balance we can vary the position of our own centre of gravity by moving our arms and bodies to keep us from falling over.

You will find that stability is important in the following examples:

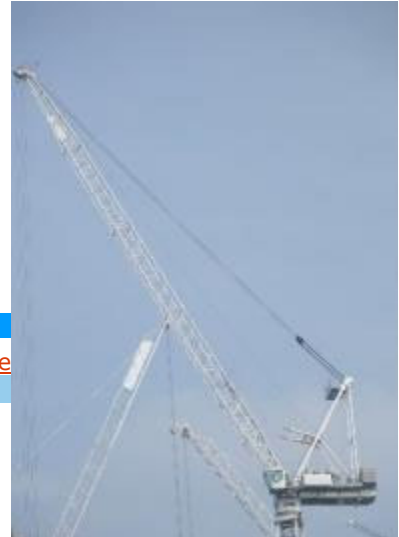
car and bus design
car wheels – small lead weights are fitted to the rim so that the wheel balances in any position
new born animals
furniture design
plank roots in rainforest trees

The aim is to give a broad base and/or a low centre of gravity and therefore stability.



The position of the centre of gravity is also important in balancing in the following examples:

Counterbalance weights to balance the load on a crane
Tightrope walking
Gymnastics and other sports, etc.



A VERSION IN WORD IS AVAILABLE ON THE SCHOOLPHYSICS CD

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