EASY **SCIENCE**

The Power of BALANCE

You don't have to be a tightrope walker to do balancing tricks. But you have to realise that objects behave as if all their weight was concentrated at one point, called the centre of gravity.

You have probably balanced a ruler on your finger before. The slightest movement causes the ruler to tilt and fall off. When you find the exact spot where your finger needs to be to balance the ruler, you have found the ruler's centre of gravity.

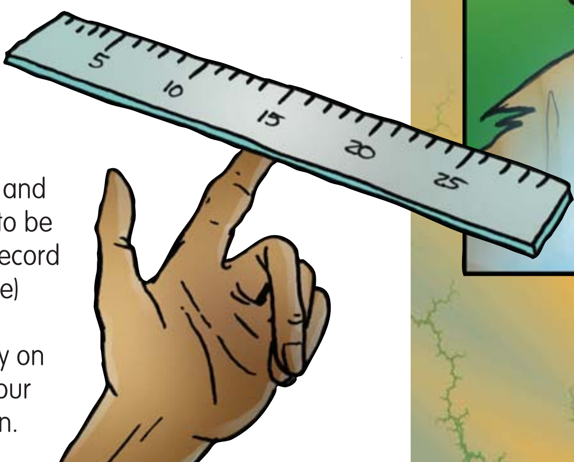
The centre of gravity is the exact spot on the ruler where there is the same amount of weight on the one side of the spot as there is on the opposite side. Once you change the weight anywhere on the ruler, the centre of gravity changes too.

CHASING THE CENTRE OF GRAVITY

Get a friend or two to help you, and let's use our fingers to chase the centre of gravity of a ruler as we add weights to one of the ends.

You will need:

- A ruler (wood or stiff plastic)
- Five cent coins
- Pencil and paper



Place the ruler on your finger as shown and find the place where your finger needs to be so that the ruler is perfectly balanced. Record that number in your chart (see next page) under 0 .

Ask a friend to place a 5c coin exactly on the 1 cm mark of the ruler. Now move your finger so that the ruler is balanced again.

EASY SCIENCE

EasyScience is produced by the South African Agency for Science and Technology Advancement (SAASTA), an operational unit of the National Research Foundation. SAASTA's mission is to promote the public understanding, appreciation and engagement with science and technology among all South Africans.
Visit the website: www.saasta.ac.za for more information.

SAASTA
SOUTH AFRICAN AGENCY FOR SCIENCE AND TECHNOLOGY ADVANCEMENT

Look to see exactly where your finger is on the ruler and write down the number on the ruler in your chart under 1. Did you move your finger toward, or away from the 5c coin?

Now ask your friend to place another 5c coin on top of the first and again find the spot where your finger perfectly balances the ruler. Record this number on your chart. How does this number compare with the number for one 5c coin? If you put three 5c coins on the one centimetre mark, where will your finger need to be to balance the ruler? Try to see if you were right.

Continue the experiment with four, five and six 5c coins. Each time, try to guess where your finger will need to be to balance the ruler. Were your predictions correct? How many 5c coins can be placed on the 1 cm mark and still be balanced by moving your finger?

Number of coins	0	1	2	3	4	5	6
Finger position							

Changing the number of coins

Now try an experiment where you keep the centre of gravity where it is, directly over your finger, but move different numbers of 5c coins along the ruler. Make a chart like the one below. Take a ruler and place it on your finger again so that the ruler is perfectly balanced.

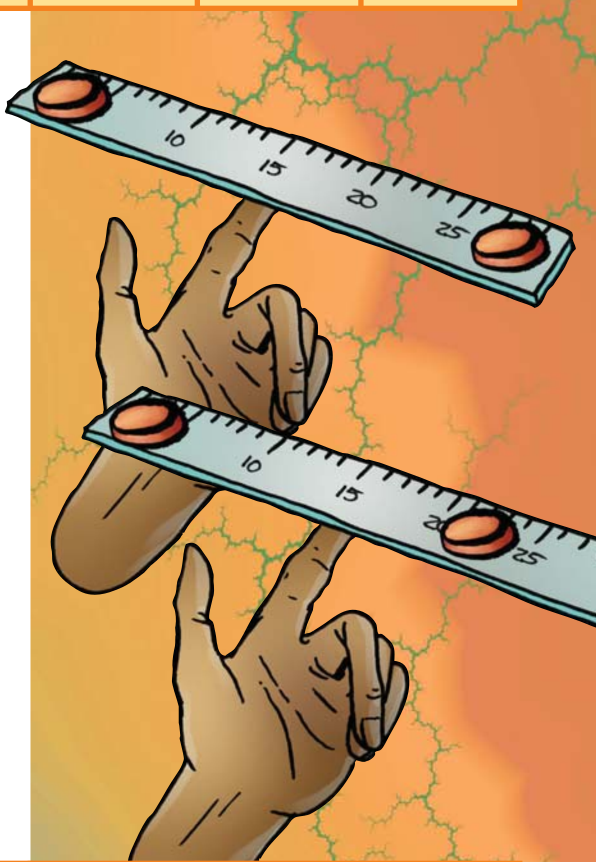
Ask your friend to place one 5c coin exactly on the 1 cm mark on your ruler. This is your "balance 5c". You will not move this 5c coin or your finger for the rest of the activity. Place another 5c coin on the opposite end of the ruler from the "balance 5c". Move this 5c coin until the ruler is perfectly balanced. Record the position of the 5c coin in the chart under 1.

Have your friend place another 5c coin on top of the first on the side of the ruler opposite the "balance 5c coin". Find the place where the two 5c coins balance the one "balance 5c coin" on the other side. Write this number in the chart under 2.

Is it possible to balance three 5c coins on one side with one on the other? See if you and your friend can find the number on the ruler where the three coins need to be to make it work.

Can you predict where four 5c coins would need to be to balance one 5c coin on the other side? Try it to see if you were right. What is the greatest number of 5c coins that can be balanced on one side of the ruler with only one 5c coin on the 1 cm mark on the other? On what number does this stack of coins need to be?

Now you can try to balance different amounts of 5c coins on one side with **two** 5c coins on the 1 cm mark on the other. Compare the answers to your first chart. In what ways are they similar and different?



Number of coins	0	1	2	3	4	5	6
Finger position							

GRAVITY

When you drop something, it falls faster and faster towards the ground. This is caused by a force called gravity. Gravity holds us on the ground, and holds the Moon in its orbit around Earth. It is a force of attraction that pulls matter together. Every bit of matter in the Universe, from an atom to a star, exerts its own gravitational pull on all other matter. The strength of this pull depends on the mass of both objects and the distance between them. Objects feel heavy because of the force of gravity acting on them. Heavier objects experience bigger pull than lighter objects.

CENTRE OF GRAVITY

Because the Earth's gravity pulls on all atoms equally, it pulls any object down as if its weight were concentrated in one point, called the "centre of gravity". It is also know as the centre of mass.

If an object is balanced or hung so that it does not fall over, the balancing point must be exactly over the centre of gravity so that the gravitational force and the supporting force exactly cancel each other out and do not cause the object to turn and fall over. We say the acting forces are in "equilibrium", or balanced. If the centre of gravity is not over the balancing point of an object, the object is not stable and will turn and fall over.

FIND THE CENTRE OF GRAVITY

You can find the centre of gravty of an irregular shaped piece of cardboard.

You will need:

- Cardboard
- Scissors
- String
- Thumbtack or small pin
- Notice board (or any other vertical surface that you can stick a pin into)
- A weight (like a washer or piece of clay)

Cut an irregular shape from the cardboard as in the illustration. Make three holes in the edge.

Tie the weight to one end of the piece of string. When you hold up the string, the weight will make it hang straight down in a vertical line. Hang your shape on the notice board with the thumbtack, using one of the three holes in the card. Tie the other end of the string to the thumbtack.

Draw a straight line down the string. Do the same with the other two holes. The centre of gravity is where the three lines cross.

Another way of finding the centre of gravity of an object like a piece of card, is to move the object around on your fingertip until it balances nice and flat without tilting in any direction. Try this with an index card, but first take a guess where its centre of gravity may be.

BALANCE IN OUR LIVES

We don't often think about balance, but we use it every day, all day long. Many of our most basic actions such as standing and getting out of a chair depend on how we balance our bodies.

Sit in a chair with your back against the back of the chair and your hands at your sides. Without using your hands and without leaning forward, try to stand up. Can you do it? NO!

Try again. This time, keep your back straight and bend at your waist to lean forward a little bit. Try standing up again. Lean forward until you can do it. Notice how far forward you need to lean to stand up. What do you think this has to do with centre of gravity?

Now try this: Place your left shoulder and left foot against a wall as shown. Try to raise your right foot and keep it raised. Can you do it? NO! It is impossible, because to stand on your left foot only, you need to shift your centre of gravity over to your left foot, but the wall won't allow you to do this.

You can see this by doing a simple experiment. Stand with your feet about half a metre apart. Without shifting your weight, lift your right foot straight up. It will probably go back down immediately. Now shift your weight so that you will be able to lift your right foot up and keep it up. Describe how you changed your body position to be able to balance yourself on your left foot.

BALANCING ACT

Have you ever tried to balance something long and thin on the palm of your hand or the tip of your finger? Some skinny objects are easier to balance than others. The length of the object and the way its mass is spread out makes a big difference in how easy it is to balance. In the following activity, see if you can get into the balancing act!

You will need:

- An unsharpened pencil with eraser
- Ruler
- Metre stick
- Ball of clay (about the size of a golf ball)

Place the eraser end of the pencil on the palm of your hand and let go. Try to balance it. It's not that easy!

Now take a ruler and try to balance it on the palm of your hand. Do you find it easier, harder, or about the same as balancing the pencil?

Now try balancing the metre stick on the palm of your hand. How did it go this time?

Place a ball of clay on the top of the pencil and try balancing the pencil again. Is it easier or harder with the clay? Try the same activity with the ruler. Then move the clay down to the middle of the ruler and try balancing it again. Was it easier or harder than before?

Try balancing the metre stick, first with the ball of clay on top and then with the ball of clay near the bottom of the metre stick. What do you notice?

BALANCING: SHORT AND SIMPLE

There is a way to make short things like the pencil you used easier to balance. If you add some weight to the pencil in the right way, you could balance it all day long!

You will need:

- An unsharpened pencil
- Thin wire (20 - 22 gauge)
- Metal washers
- Tape

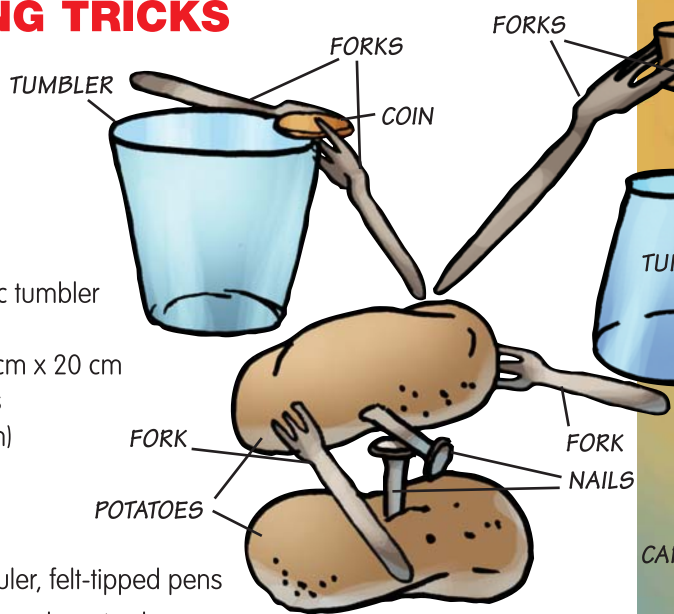
Ask an adult to help you cut a 25 - 30 cm length of wire. Wrap the middle of the wire once or twice around the pencil as shown. You should have about the same length of wire on each side of the pencil. Tape the wire to the pencil to make sure it does not slip down.

Add a washer to each end of the wire. Place the eraser end of the pencil on your fingertip to see if it will balance. See if you and a friend can find the best position for the wire and washers so that the pencil stands as straight up as possible.

BALANCING TRICKS

You will need:

- A needle
- Large cork
- Two forks
- Two 5 cm nails
- Two potatoes
- A glass or plastic tumbler
- A large coin
- Thick card – 20 cm x 20 cm
- Four matchsticks
- Clay (play-dough)
- 20 cm stiff wire
- A drawing pin
- Empty egg shell
- Tools: scissors, ruler, felt-tipped pens

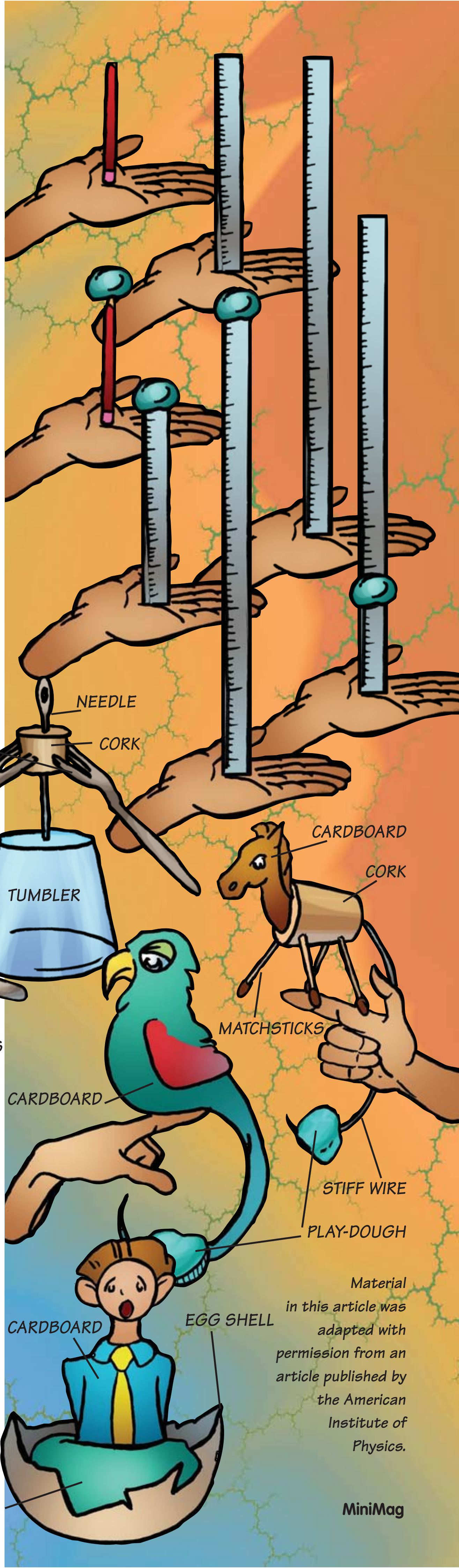


See from the drawings how to do each trick. In all three cases above the forks lower the centre of gravity and make the arrangement stable. See that the forks are evenly spaced either side of the centre of gravity. If one is given a slight push, the whole arrangement will sway a little but should not fall over.

Now try to make the balancing toys on the right. The heavy lump of clay lowers the centre of gravity below your finger (if you are using it to support the toy) and gives stability. The toys should rock forwards and backwards when you push it a little.

Kelly doll

This little chap just won't lie down. Push him over to the side and he bobs up again. To make him, use the flattest end of an empty egg shell and carefully fill it with well-softened play-dough before sticking in a cardboard head and body.



Material in this article was adapted with permission from an article published by the American Institute of Physics.