



On the road

Imagine what it would have been like to travel long distances without cars, motorbikes and bicycles. A few hundred years ago you would not have been able to use any of those wheeled vehicles. In fact, the **wheel** itself was not invented until about 3500 BC. How different would our lives be without wheels?

Levers in a spin

Wheels are levers that rotate around the fulcrum. They are attached to a smaller wheel called an **axle**. The wheel and the axle turn in circles around the **fulcrum**, but the wheel moves through a larger circle than the axle. Like other **levers**, a wheel and axle can be used as a **force multiplier** or a **speed multiplier**. A wheel and axle act as a force multiplier when the **effort** is applied to the big wheel. If the effort is used to move the small axle, the machine acts as a speed multiplier.

This wheel and axle acts as a force multiplier. The driver can turn the steering wheel with very little effort. The outer edge of the steering wheel turns through a bigger distance than the steering column. The steering column moves a smaller distance than the steering wheel, but applies a much greater force on the heavy tyres of the car.



This wheel and axle acts as a speed multiplier. A big force from the engine moves the axle a short distance. The wheel turns in a much larger circle than the axle. The outside edge of the wheel spins very quickly compared to the axle.

Compound machines

Cars and bicycles are **compound machines**. They are made up of many simple machines working together. As well as the wheels and axles that move them along, they have levers like handlebars, handbrakes and brake pedals. A special kind of wheel, called a **gear**, is another simple machine found in cars and bikes.

Handbrake

*This handbrake is a **first-class lever**. When the rider squeezes the handbrake, their effort is transferred along the cable to the brake pads that press against the wheel.*

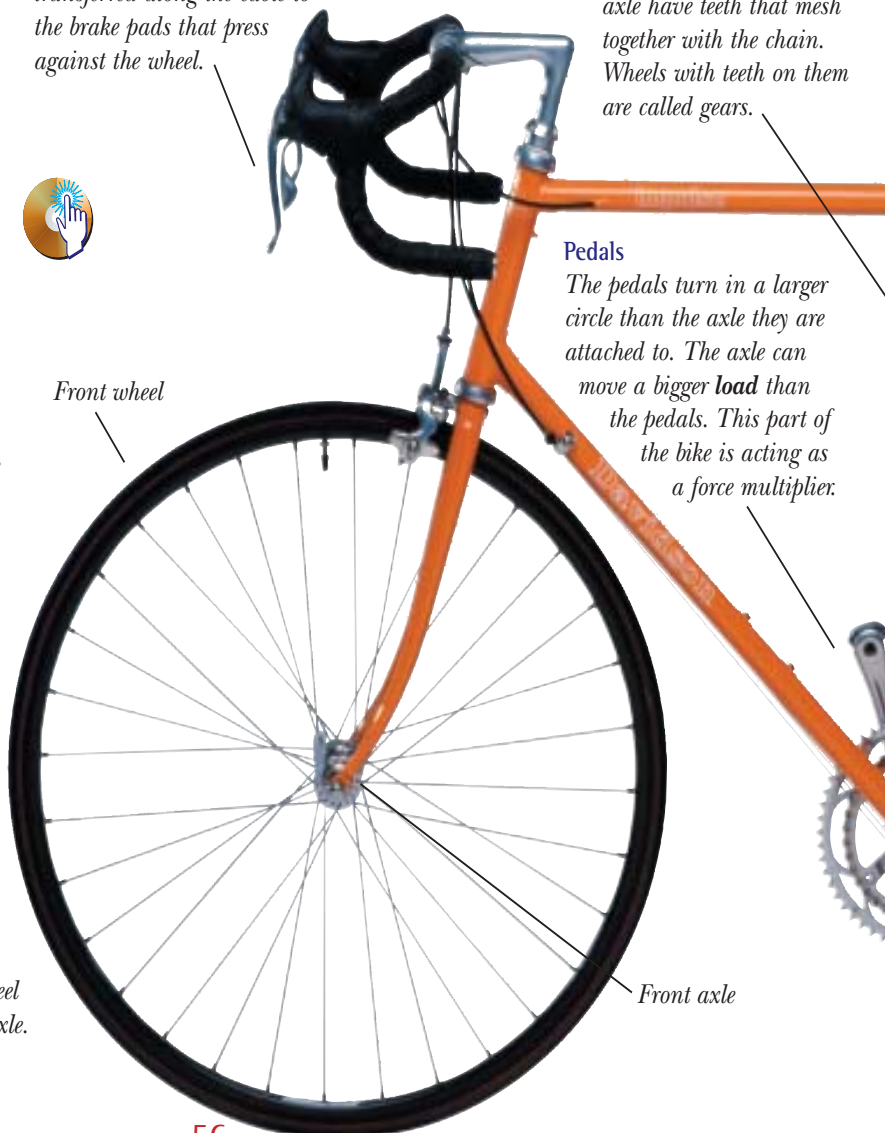


Bike chain

It is possible to join wheels or axles together with chains or belts. Bikes have chains rather than belts because they are less likely to slip off. The pedals' axle and the rear axle have teeth that mesh together with the chain. Wheels with teeth on them are called gears.

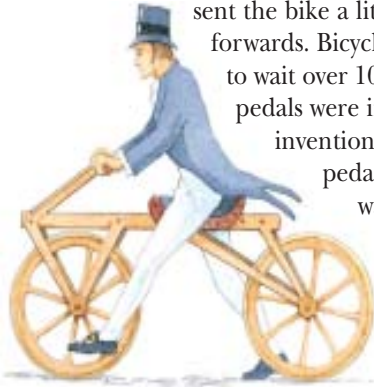
Pedals

The pedals turn in a larger circle than the axle they are attached to. The axle can move a bigger load than the pedals. This part of the bike is acting as a force multiplier.

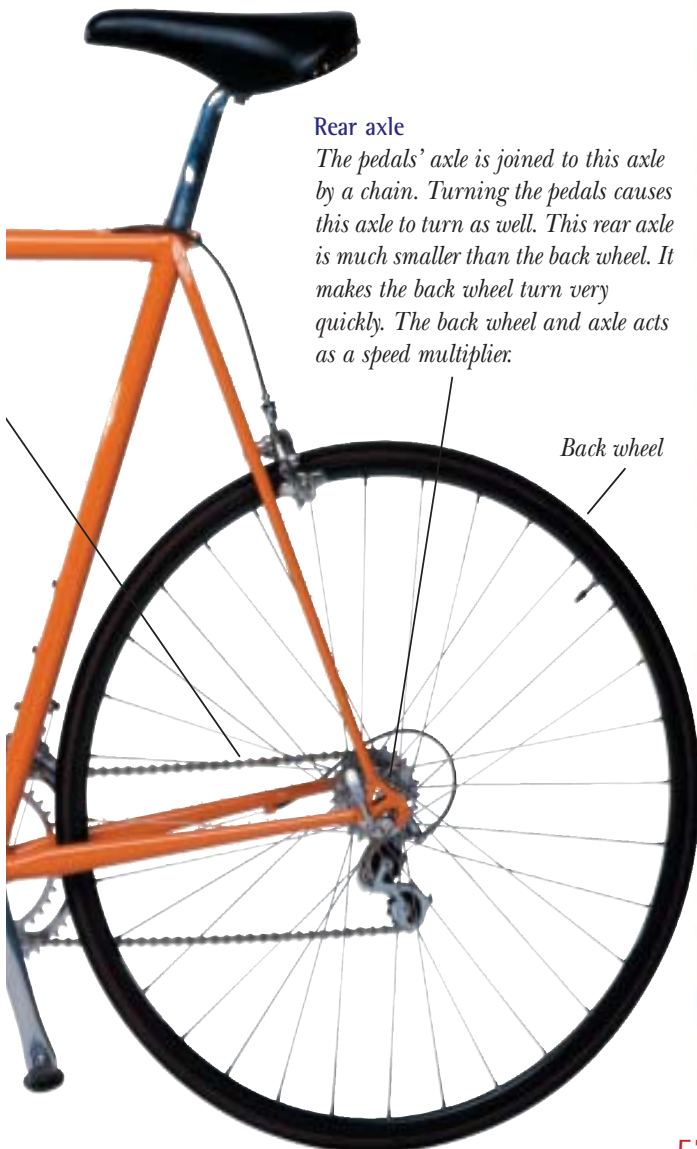




One of the first bicycles invented was called the 'swiftwalker'. It didn't have pedals. The 'walker' had to push off the ground to make the bike go forwards. Both feet were then lifted off the ground and the bike coasted forwards. Another push sent the bike a little further forwards. Bicycle walkers had to wait over 100 years before pedals were invented. The invention of the pedal turned walkers into 'riders', but, without rubber tyres, it was a very bumpy ride!



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Rear axle

The pedals' axle is joined to this axle by a chain. Turning the pedals causes this axle to turn as well. This rear axle is much smaller than the back wheel. It makes the back wheel turn very quickly. The back wheel and axle acts as a speed multiplier.

Back wheel

Activities

REMEMBER

1. Which part of a wheel is like the fulcrum of a lever?
2. Explain the difference between compound and simple machines.

THINK

3. Complete these sentences:
 - (a) When a big wheel is used to turn a small wheel, the _____ is multiplied.
 - (b) When a small wheel turns a bigger wheel, the _____ is multiplied.

COMPARE

4. (a) How does the size of a steering wheel in a bus compare with the size of a steering wheel in a racing car?
 (b) Suggest a reason for the difference in size.



CREATE

5. Make a **belt drive** using Lego® or another building kit. Use appropriate wheels to make:
 - (a) a force-multiplying belt drive
 - (b) a speed-multiplying belt drive
 - (c) a belt drive that does not multiply speed or force.

CONNECT

6. Find out who invented the rubber tyres that are used on bicycles. Also find out when rubber tyres were first used.



I can:

- describe a compound machine as a device made up of many simple machines
- distinguish between speed-multiplying and force-multiplying wheels and axles.