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MAGNETIC ACCELERATOR

What is a magnetic accelerator?

A magnetic accelerator uses *magnets* to give metal balls *energy*. It works in a different way to most particle accelerators, which use *electric fields* to accelerate a beam of particles and *magnets* to bend and focus the beam.

How does it work?

It seems strange that when you roll a ball toward the first magnet, the ball all the way down the other end eventually flies off at a much faster speed than the first one! Thinking about it, the ball seems to gain energy for free. But we know that this can't be true – you don't get something for nothing - so where does the energy come from?

The initial configuration of the accelerator looks like:



After the accelerator has been set off, it looks like:



The fact that the energy changes from ball to ball down the accelerator is just like in a Newton's Cradle – it is a transfer of *momentum*. The ball on the left hits the magnet and its *momentum* gets transferred through to the ball on the far side, just like in billiards. But that doesn't explain why the final ball moves faster. The trick is that the second setup has a lower *magnetic potential energy* than the first. Some of the *potential energy* of the initial setup is converted into *kinetic energy* of the final ball, making it go faster. So overall, the system has the same total energy the whole time, but it is converted from one type to another.

Things to try...

- Try changing the initial configuration of metal balls. For example, try starting with just one ball next to each magnet. Does the accelerator still work? Why do you think this is?
- Try changing the distance between the magnets (you can do this by creating another magnet gap just as when you made the accelerator). Does this affect how fast the final ball goes?
- Why do you think a real particle accelerator doesn't use magnets to accelerate the particles?