Canal & River Trust

STEM

Canal Crane

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Canal & River Trust charity number: 1146792

Developed with support from Rolls-Royce

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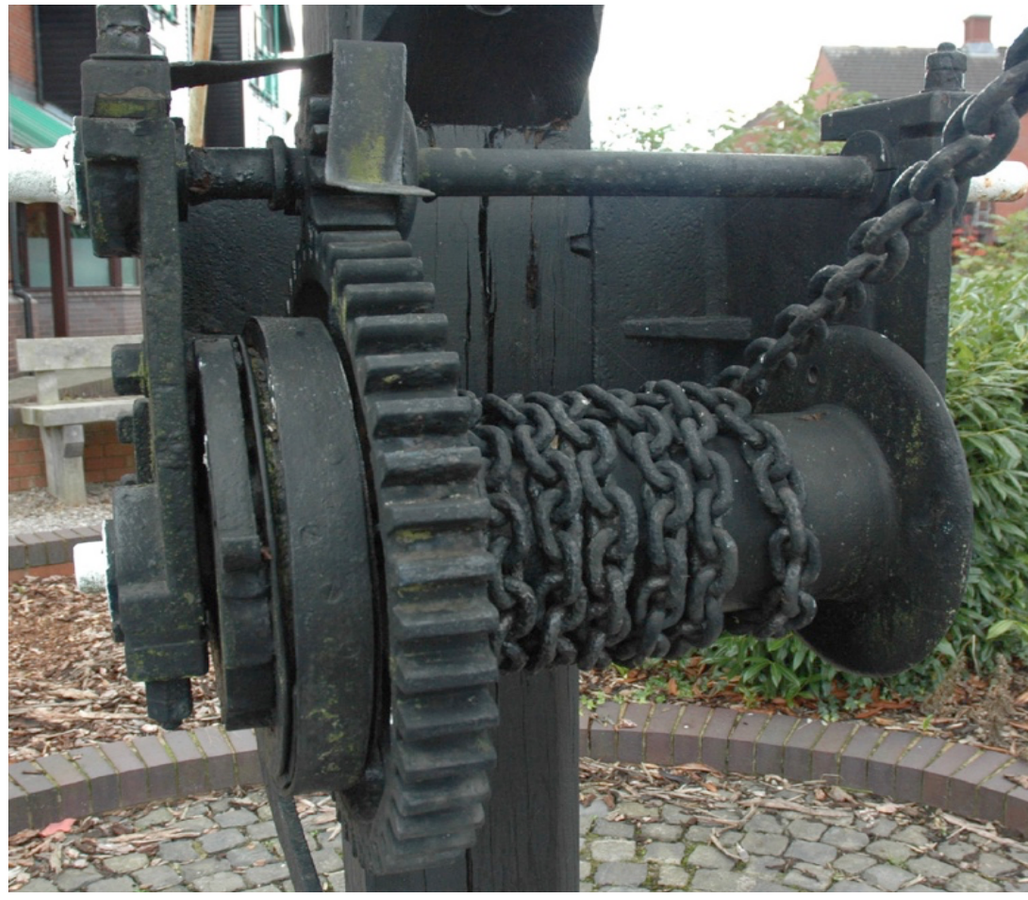
Objectives

- Describe examples of **mechanisms** we use.
- Understand one key **feature of gears.**
- Recognise that some mechanisms allow a **smaller force** to have a **greater effect.**



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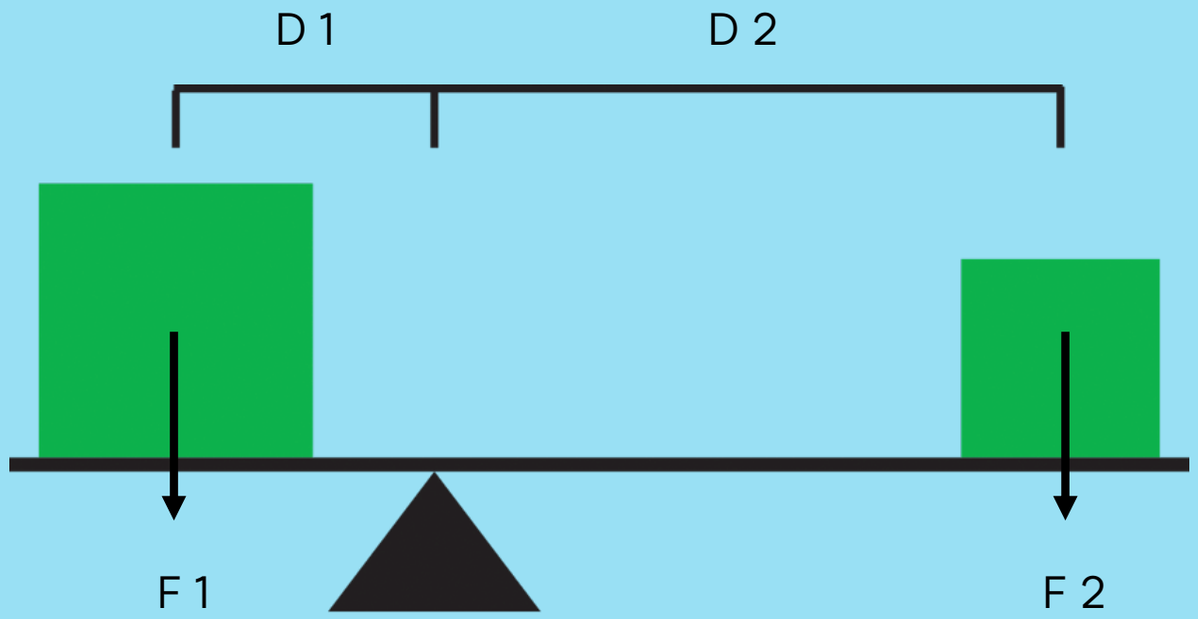
Revision: Mechanisms

F = Force
D = Distance

F1D1 = F2D2
∴
F1/F2 = D2/D1

= **Mechanical Advantage**



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Revision: Mechanisms

"Give me a lever long enough and a fulcrum on which to place it, and I shall move the world".
Archimedes

Unfortunately Not!

Such a lever would have to be millions of metres long for an average adult to move the Earth 1mm. Levers can get very big. The lever in this picture would break because it is not big enough. We need another mechanism...

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Where are Gear Trains used?

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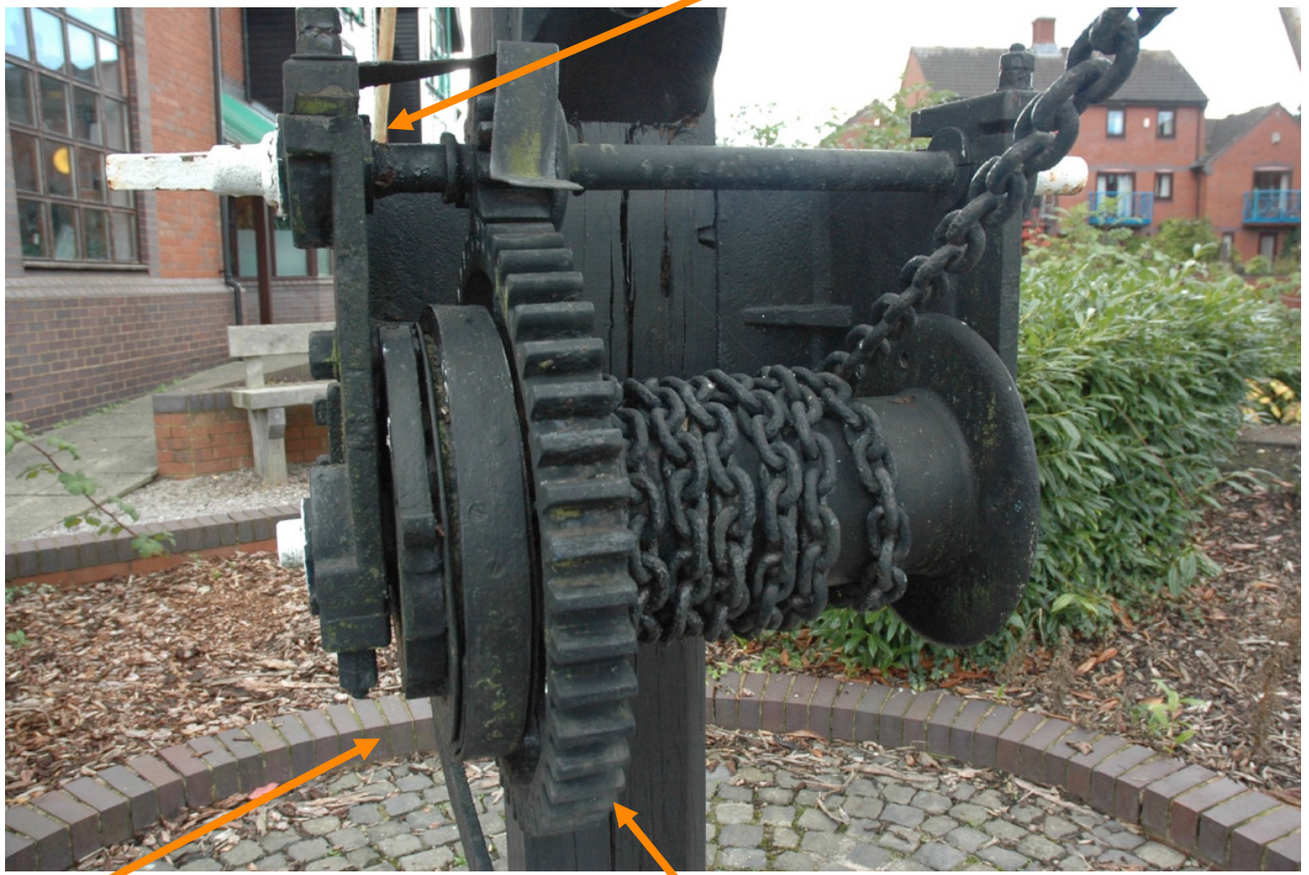
A real-life crane: Fradley Wharf



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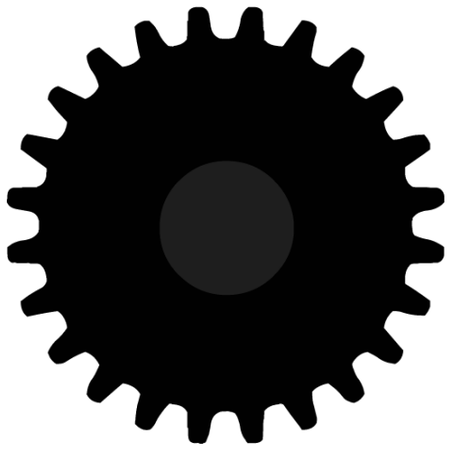
Definition of gear & gear trains

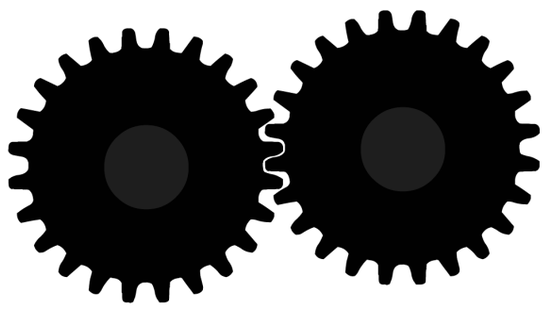


Gear

A rotating part with cut **teeth** which **mesh** with another toothed part to transmit rotational energy.

Gear Train

Two or more gears working in a sequence.



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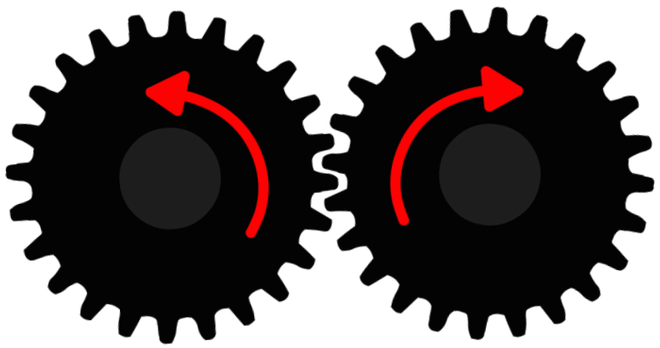
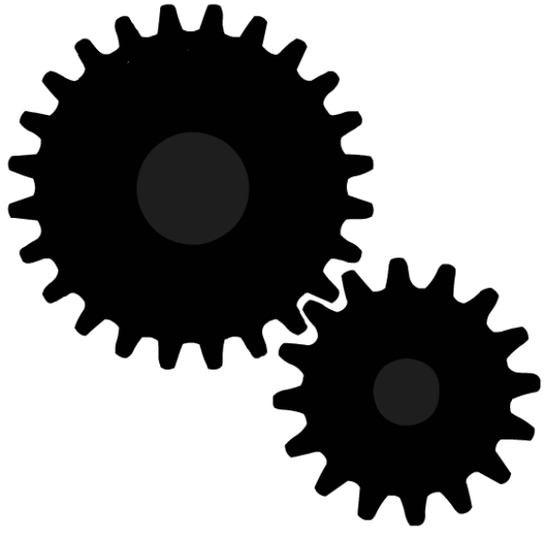
Why are gear trains needed?

Change direction of rotation.



Change axis of rotation.

Change speed of rotation.



What else?

You will investigate

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Experiment 1: Gear ratio

Steps:

1. Collect a gear set.
2. Experiment by turning the small and medium cog wheels.
3. Add the large cog wheel.
4. Measure the circumference of each gear using a piece of string or by counting the number of teeth (Write down the measurements).
5. Write down the number of turns of the small and medium cogs, to a full turn of the large cog.
6. Calculate the large:small, large:medium, medium:small gear ratios.

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Experiment 2: Crane

Steps:

1. Collect a crane set and build your crane.
2. Feel the weight of an object to be lifted.
3. Experiment with combinations of gears to see which will give you the greatest mechanical advantage.
4. Record your findings.

Notes:

Cranes are normally bolted to the ground to stop them tipping. Hold the base of the crane down to stop yours tipping.

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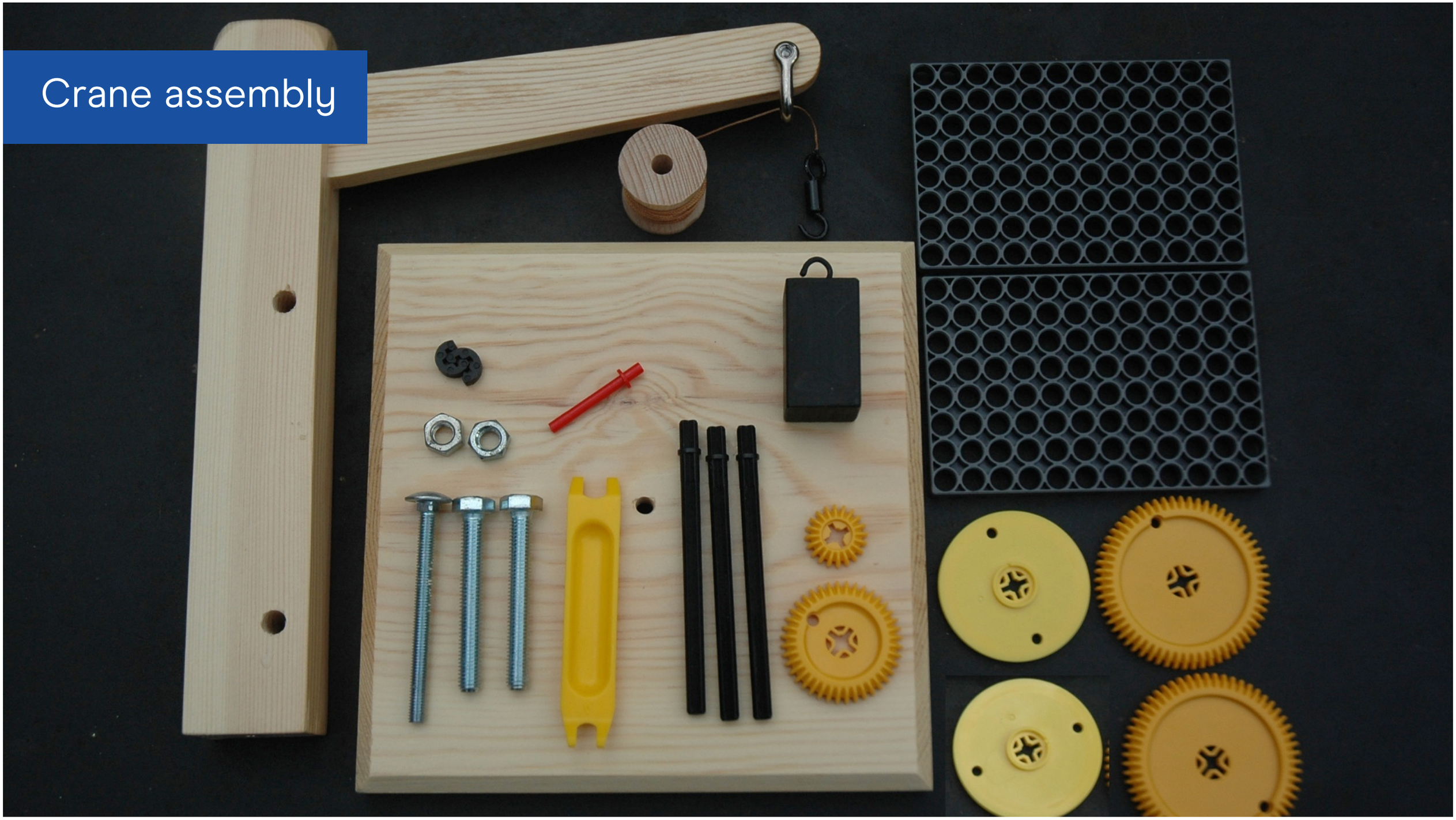

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Group observations

What did you find?

What do you think this means?

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It's **easier** to lift the weight when using the **small and large gear together** in a gear train

More turns are needed to lift the weight when operating the **small gear**

The handled gears rotate in the **same** direction -

The gears working together rotate in **opposite** directions

Using **gear trains** gives a **mechanical advantage**
- It is easier to lift things!

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The physics behind Mechanical Advantage

Can you **calculate** the **gear ratios** associated with using different gears?

Gear ratio = number of **teeth** on the **driven gear** ÷ number of teeth on the **driver gear.**

The difference between these two speeds is called the **velocity ratio,** and can be calculated using the number of teeth.

Where there are two gears of different sizes in a gear train, the **smaller gear** will **rotate faster** than the larger gear.

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The physics behind Mechanical Advantage

If you know the **gear ratio**, and the **speed input** at the **driver gear,** you can calculate the **speed output** at the **driven gear** using the formula:

Output speed = input speed ÷ gear ratio

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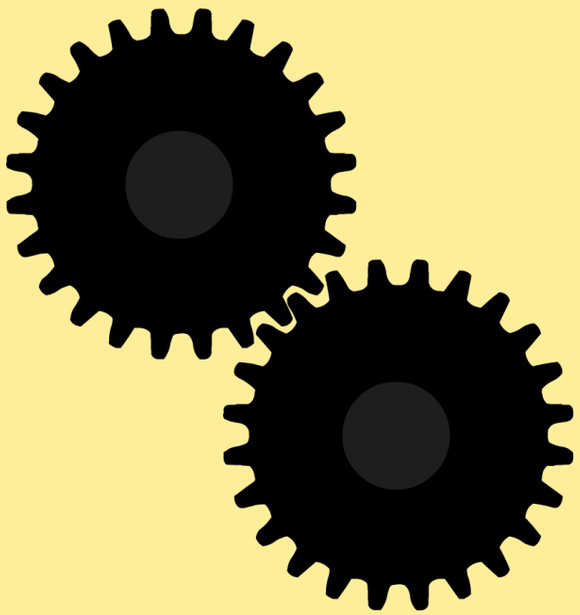
What did you discover?



What **mechanisms** do we use in cranes?

Describe one of the key features of gears.

Some mechanisms allow a **smaller force** to have a **greater effect.**

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