K'NEX Gears

Learn by building, predicting and testing

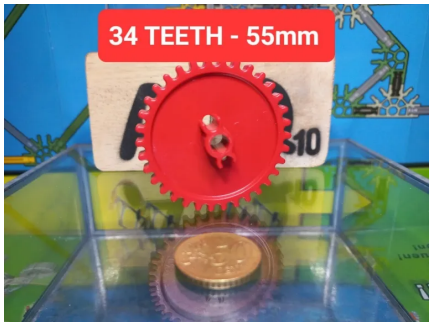
> Gears transfer turning motion. They can change direction, speed and the available turning force. Chains can carry motion between axles that are farther apart.

How Gears Work

A gear is a wheel with teeth around its edge. When the teeth of two gears mesh, turning one gear makes the other gear turn.

Gears are often hidden inside everyday objects. They can be found in clocks, hand mixers, wind-up toys, drills and many other machines. Bicycles use toothed wheels and a chain to transfer motion from the pedals to the rear wheel.

Small 14-tooth gears: standard and push-on



Medium gear: 34 teeth, about 2.2 in. (55 mm)

Look closely

The gears above differ in size and in the way they attach to a rod. Their tooth counts determine how fast a connected gear will turn.

Driver and Driven Gears

The gear you turn first is called the driver gear. It transfers motion to the next gear, called the driven gear.

When two gears mesh directly, they turn in opposite directions. If the driver turns clockwise, the driven gear turns counterclockwise.

> Try it: turn one gear slowly, watch the second gear, reverse the direction and then swap which gear is the driver.

Adding an Idler Gear

Two or more meshing gears form a gear train. A gear placed between a driver and a driven gear is often called an idler gear.

With three gears in a row, the first and third gears turn in the same direction. In a simple gear train, an idler changes direction but does not change the final theoretical speed ratio.

Faster or More Powerful?

When a large driver gear turns a smaller driven gear, the smaller gear rotates faster. This is called gearing up.

When a small driver gear turns a larger driven gear, the larger gear rotates more slowly but can provide more turning force. This is called gearing down.

Large driver -> small driven More speed Less available turning force	Small driver -> large driven Less speed More available turning force

A gear system cannot increase both speed and turning force at the same time. Real models also lose some energy through friction and movement between parts.

Think of a Bicycle

A bicycle transfers motion using sprockets and a chain. When you turn the pedals, the front sprocket pulls the chain. The chain then turns the sprocket connected to the rear wheel.

Unlike two gears that mesh directly, sprockets connected by an uncrossed chain rotate in the same direction. A chain can also transfer motion between axles that are some distance apart.

A higher bicycle gear can make the bicycle travel farther for each turn of the pedals, but requires more force. A lower gear makes it easier to start or climb a hill.

Classic K'NEX large chain links, about 1.2 in. (32 mm) each

K'NEX chains are assembled from separate links. Every link must face in the same direction so that the chain can move smoothly.

Important

K'NEX chain links and sprockets come in different sizes. Always use parts that are designed to work together.

Turning a Corner

Most ordinary gears mesh while their rods remain parallel. Sometimes motion must be transferred between axles that point in different directions.

A hand mixer or hand-operated drill is a familiar example. You turn a handle around one axle, while another part rotates around an axle at a right angle to it.

Medium crown gear: 34 teeth, about 2.2 in. (55 mm)

A K'NEX crown gear has raised, sideways-facing teeth. These allow it to mesh with another gear at an angle of 90 degrees. This changes the direction of the axle as well as the direction of the motion.

From Rotation to Another Movement

A turning handle can also move a window up or down, move a part backward and forward, turn clock hands at different speeds or operate the beaters of a mixer. Gears form part of mechanisms that control how an entire model moves.

Build, Predict and Test

Build two parallel rods with a K'NEX gear on each rod. Before turning them, make a prediction.

1. Which direction will the second gear turn?
2. Will it turn faster, slower or at the same speed?
3. What changes when you swap the driver and driven gears?
4. What happens when you add an idler gear?
5. Can you arrange two gears so that their rods are at right angles?
6. Can you transfer motion over a distance using a chain?

> Record your prediction, draw the model, add arrows to show movement, write down what you observe and finish with your conclusion.

Safety

Keep fingers, hair and loose clothing away from motorized gears and other moving parts. Test a new mechanism by turning it carefully by hand before adding a motor.

Continue Building

The official K'NEX Education building instructions include a crank fan, car window, blender, phonograph, eggbeater, stationary bicycle and chainsaw. These models can be used to investigate speed, direction, crown gears, chains and different types of movement.

Open the official K'NEX Gears Building Instructions

> The best engineering investigations begin with a prediction, followed by careful building, observation, adjustment and another test.