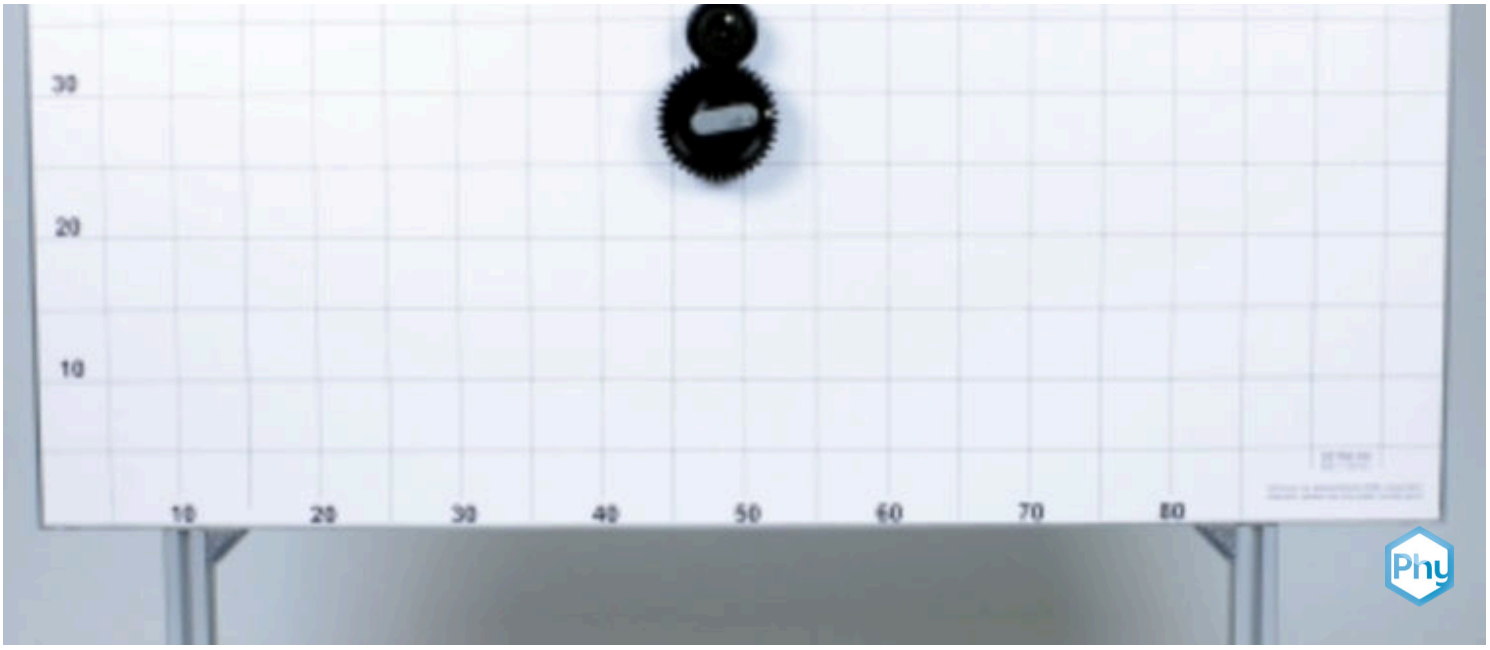
Gear drive



P1254200

Physics | Mechanics | Forces, work, power & energy

Difficulty level	Group size	Preparation time	Execution time
medium	-	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/667149c23f7b140002193127

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General information

Application

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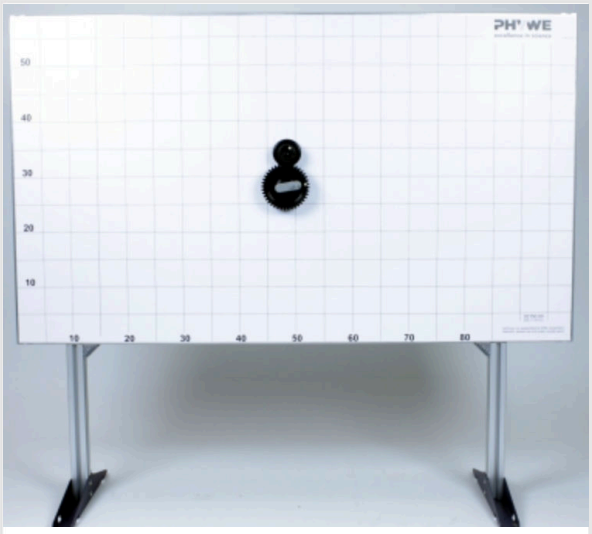

Fig. 1: Experimental setup

The machine element gear is a wheel with teeth evenly distributed around its circumference. Two or more gears paired with each other form a gear drive or gear mechanism. The gears are of different sizes and have different numbers of teeth, which are arranged in such a way that they operate at a certain speed and torque ratio.

Gear drives are used in a variety of applications to ensure precise and stable power transmission. One example is gear drives in vehicles, which are used to transmit the torque of the engine to the drive wheels and generate different speeds and torques.

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Other information (1/2)

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Prior knowledge

The students need prior knowledge of "gear drives".

Principle

A single-stage gear mechanism is used to demonstrate the structure and mode of operation of the gear drive.

Other information (2/2)

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Learning objective

The aim of this experiment is to give students a better understanding of the function of gear drives, as well as their applications and designs.

Tasks

The students are supposed to pay attention to the direction of rotation of the wheels and formulate observations about this.

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Safety instructions

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The general safety instructions for experimentation in science lessons apply.

Theory (1/2)

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Rotational speed and torque are converted in gearboxes by arranging gears or pulleys of different sizes.

The change in the rotational speed from a driving to a driven gear is characterised by the so-called *transmission ratio* i. It is defined as follows:

$i = n_1/n_2$

n_1 = the speed of the driving gear

n_2 = the speed of the driven gear

If the transmission ratio i is 2, this means that the driving gear rotates twice as fast as the driven gear.

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Theory (2/2)

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The transmission ratio can also be determined using the ratio of the number of teeth:

$i = z_2/z_1$

z_1 = the number of teeth of the driving gear

z_2 = the number of teeth of the driven gear

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Equipment

Position	Equipment	Item no.	Quantity
1	PHYWE Demo Physics board with stand	02150-00	1
2	Axle on fixing magnet	02151-04	2
3	Gear wheel, 20 teeth	02350-13	1
4	Gear wheel, 40 teeth	02351-03	1
5	Wheel and axle	02360-00	1
6	Marker, black	46402-01	1
7	Screw clamp	02014-01	2

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Setup and procedure

Setup and procedure

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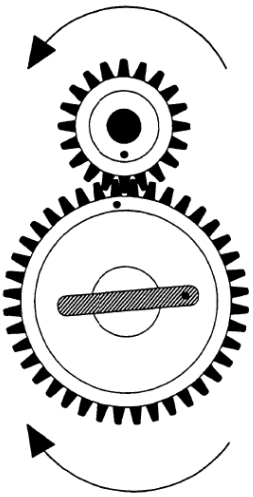

Fig. 2

- Unscrew the axles from the thread, place a gear wheel on each and screw the axles tight; place the fixing magnets on the demo board so that the teeth of the gear wheels mesh with each other; the marking points of the gear wheels should be on top of each other (Fig. 2)
- Place the crank on the large gear wheel and turn it once, paying attention to the movement of both markings and the direction of rotation of the wheels.
- Sketch the directions of rotation on the board (Fig. 2) using a marker pen and formulate a statement about the observations.
- Place the crank on the small gear wheel and perform the rotations - also in the opposite direction - and note down the observations.

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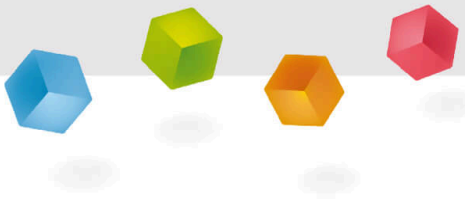

Report

Observation

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The small gear wheel makes twice as many rotations in the same time as the large one. The gears rotate in opposite directions.

If the large gear wheel is driven by the small one, the large one makes half as many rotations in the same time, always in the opposite direction.

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Evaluation (1/3)

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Gear drives are used to transmit power and to transmit and convert rotary movements.

Power is transmitted without slip by a pair of gears meshing positively, whereby the pitches T of the gears (distances from one point of a tooth to the same point of the neighbouring tooth) must be the same.

The transmission ratio i is decisive for the power transmission:

$i = n_{tr}/n_g$

with

n_{tr} = speed of the driving gear and

n_g = speed of the driven gear.

Evaluation (2/3)

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If N is the number of revolutions of a gear wheel during the time t, then the following applies:

$n = N/t$

and therefore

$i = n_{tr}/n_g$

The peripheral speeds of the gears must be the same due to the lack of slippage:

$v_{tr} = v_g.$

If Z_{tr} and Z_g are the number of teeth, then it follows that:

$Z_{tr} \cdot T \cdot n_{tr} = Z_g \cdot T \cdot n_g,$

$n_{tr}/n_g = Z_g/Z_{tr} = i.$

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Evaluation (3/3)

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The transmission ratio can therefore be determined as the quotient of the number of teeth of the driven and driving gear wheel. In the experiment carried out $Z_1 = 40$ and $Z_2 = 20$ were true, i.e. the ratio $Z_1/Z_2 = 2/1$. This means that the smaller wheel rotates twice as fast as the larger one, regardless of whether it is driving or being driven. During the experiment, the transmission ratio first had the value 1/2, then 2/1.

Notes

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The torque that can be transmitted by a gear drive is significantly greater than that which can be transmitted by a belt drive due to its positive locking.

Technical applications of gear drives that the students are likely to be familiar with are, for example, the gearboxes in cars or the gears in mechanical clockworks.

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Task

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In a gear mechanism, the number of teeth of the gears involved are $z_1 = 5$ and $z_1 = 10$.

Calculate how often the large wheel (R_2) rotates in one second when the small one (R_1) rotates 5 times per second.

- 10 times per second
- 8 times per second
- 2.5 times per second
- 5 times per second

Slide	Score / Total
Slide 17: Gear drive	0/1

Total score 0 / 1

Show solutions Repeat

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