

Solution sheet model 1 – Manual generator / Muscle power

Topic task

- The Z40 on the drive axis interlocks with the Z10. The Z10 is permanently connected to a Z40 via an axle.
The Z40 of the drive axle then interlocks with another Z10 on the generator shaft. When the Z40 completes a rotation, the first Z10 and therefore also the Z40 complete four rotations. Therefore, the second Z10 makes $4 \times 4 = 16$ full rotations. The gear ratio for the two-stage transmission gear is therefore 1:16.

Formula

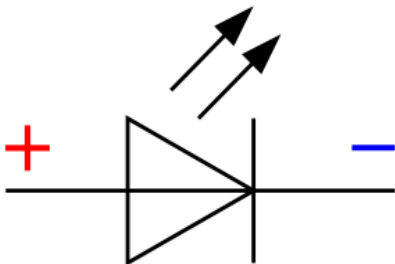
$$\text{Gear stage: } i_1 = \frac{z_{\text{Abtrieb}}}{z_{\text{Antrieb}}} = \frac{10}{40} = 10:40 = 1:4$$

$$\text{Gear stage: } i_2 = \frac{z_{\text{Abtrieb}}}{z_{\text{Antrieb}}} = \frac{10}{40} = 10:40 = 1:4$$

The gear ratio for the overall gear i_{tot} is then calculated by multiplying the individual gear ratios for the respective gear stages.

$$i_{\text{tot}} = (1 * 1):(4*4) = 1:16$$

- To make an LED light up, you must switch it in the forward biased direction. The electrical current can only flow through an LED in one direction. When voltage is applied, electrons or holes are created in the barrier layer of the p-n transition. There is a recombination of electrons and holes. The energy released is output from the diode in the form of light.



LED wiring symbol

When you choose the technical current direction (charge flows from plus to minus), then you say that current flows from the anode (+) to the cathode (-).

- Turning the hand crank causes the generator to convert kinetic energy into electrical energy (current). The second energy converter is our LED, which converts the electrical energy into radiant energy and heat.
- Wind power or hydropower
- Characteristic curve.** The current voltage characteristic curve is characteristic for the respective component, and is therefore considered an important parameter. The relation between the measured values is shown as

a line in a flat coordinate system. The LED is a semiconductor element (semiconductor diode), and its characteristic curve is **non-linear**.

Experimental task

1. Try to show with LEDs that an LED always needs a minimum voltage to output a minimum amount of light. This minimum voltage (forward voltage, threshold voltage) is around 80% from ULED. The maximum permitted current of an LED initially has no influence on this. The reason for this is in how the semiconductor crystal works. Current cannot flow at a very low voltage (e.g. $U = 1.5 \text{ V}$ for batteries). Only when the current is higher are sufficient free electrons released from the inner crystal lattice of the semiconductor material, so that current can flow in the LED.

Source: Thomas Habig: LEDs mit Vorwiderstand. ft:pedia 2/2011, p. 17.

2. Optional: In this experiment, we notice that diodes have colour-specific forward voltages. Therefore, the characteristic curves of green, yellow or red LEDs differ.