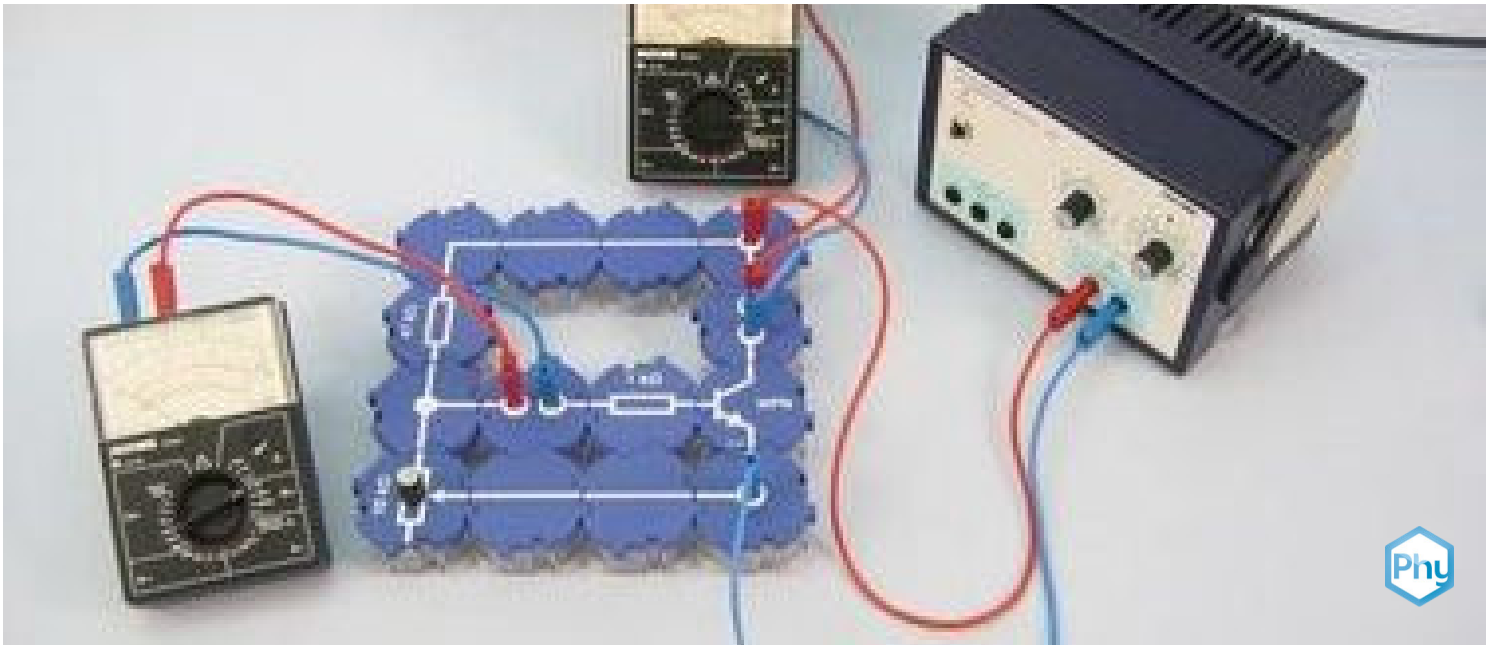
The transistor as a direct current amplifier



In this experiment, the current gain factor of an NPN transistor is determined.

Physics > Electricity & Magnetism > Electronics

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/63161c3813aa4c0003fd3b41

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Teacher information

Application

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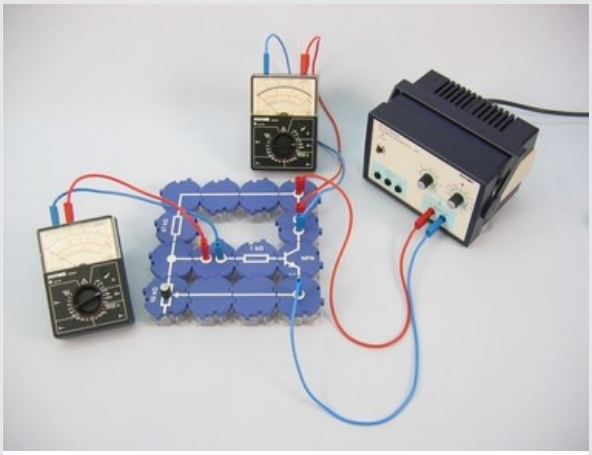

Experimental setup

Transistors are an important element in modern electrical engineering for controlling electrical currents.

According to the designation as "**trans**fer res**istor**" transistors are controllable resistors and are thus used as switches but also as amplifiers in many areas. From the amplification of audio signals in low frequency ranges to the switching of high power in motor controls to the processing of high frequency data streams, different types of transistors are used.

In this experiment, students learn about the amplifier properties of NPN transistors.

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Other teacher information (1/3)

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Prior knowledge

Students should be able to build and understand simple circuits. Ideally, the students should have already theoretically worked out the concept of a transistor. Furthermore, the students should already know how a transistor works as a switch.

Learning objective

The students should realise that the collector current can be controlled by the base current. To do this, the students investigate the relationship between collector and base current strength both qualitatively and quantitatively.

Other teacher information (2/3)

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Task

Investigate the relationship between base and collector current strength by regulating the base current with a potentiometer.

Principle

The base current is regulated by a voltage divider via the potentiometer and a fixed $47k\Omega$ resistor. The adjusted voltage from the voltage divider causes a current to flow through the base resistor to the base of the transistor. Since the n-doping of the emitter is significantly lower than the p-doping of the base, more electrons flow from the emitter into the base than can be recombined there. These excess electrons continue to flow as collector current. The strength of this current can be controlled via the base current. The exact amplification factor can vary depending on the design.

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37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
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Notes

It must be ensured that the maximum power dissipation of the transistor is $P_V = 600\,mW$ is not exceeded. This is ensured if the collector current intensity remains below $30\,mA$.

Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

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info@phywe.de
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Student information

Motivation

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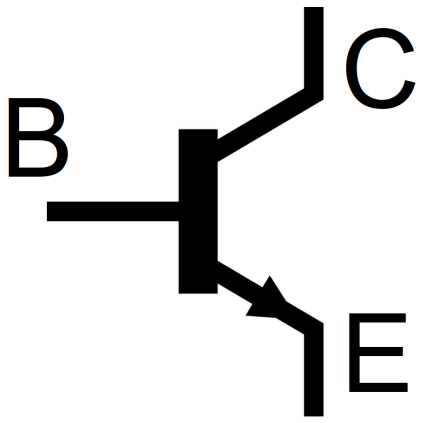

Circuit symbol of a transistor

Transistors are used in electronics for switching and amplifying currents. Like diodes, transistors consist of doped semiconductor materials.

The connections of the NPN transistor are marked with base (B), collector (C) and emitter (E) as shown in the adjacent circuit symbol. You can distinguish the emitter from the collector by the arrow.

In this experiment you will learn how an NPN transistor can be used as an amplifier.

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37079 Göttingen
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Fax: 0551 604 - 107
info@phywe.de
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Equipment

Position	Material	Item No.	Quantity
1	Straight connector module, SB	05601-01	4
2	Angled connector module, SB	05601-02	1
3	T-shaped connector module, SB	05601-03	1
4	Interrupted connector module with sockets, SB	05601-04	2
5	Angled connector module with socket, SB	05601-12	2
6	Resistor module 47 kOhm, SB	05615-47	1
7	Resistor module 1 kOhm, SB	05614-10	1
8	Potentiometer module 10 kOhm, SB	05625-10	1
9	NPN transistor module BC337, SB	05656-00	1
10	Connecting cord, 32 A, 250 mm, red	07360-01	1
11	Connecting cord, 32 A, 250 mm, blue	07360-04	1
12	Connecting cord, 32 A, 500 mm, red	07361-01	2
13	Connecting cord, 32 A, 500 mm, blue	07361-04	2
14	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
15	PHYWE Analog multimeter, 600V AC/DC, 10A AC/DC, 2 MΩ, overload protection	07021-11	2

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Fax: 0551 604 - 107

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Set-up

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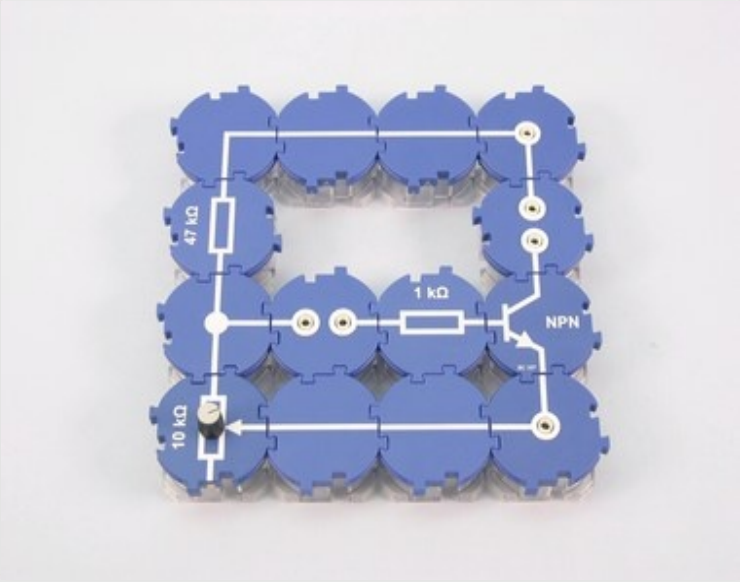

- Build the circuit as shown in the illustrations.
- Turn the potentiometer to the right stop.
- Select the measuring range for the base amperage on the ammeter to $50\ \mu A$ and on the ammeter the collector current strength to the measuring range $30\ mA$.
- Set the operating voltage at the power supply unit to $12\ V$-.

Procedure

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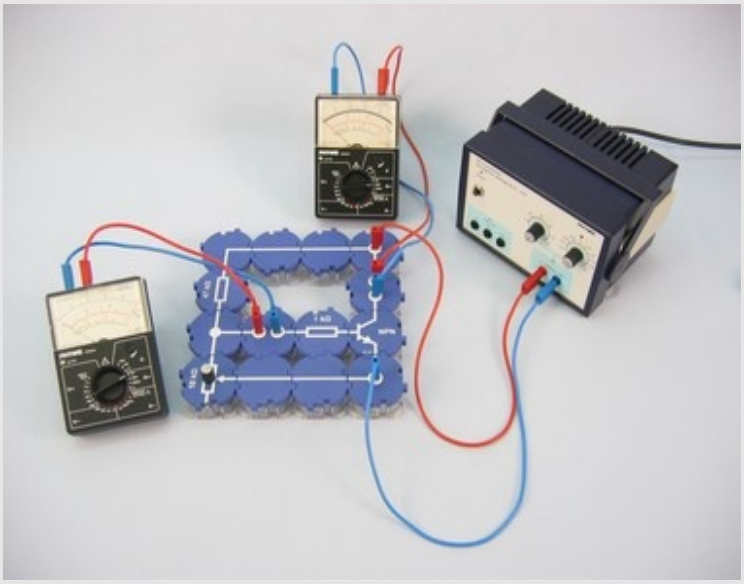

- Switch on the power supply unit when all cables are connected and use the potentiometer to increase the base current in steps of $10\ \mu A$ to $50\ \mu A$.
- For each base current, note the resulting collector current in the table in the report.

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Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
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Report

Table 1

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Enter your recorded readings in the table.

Draw your measurements on a graph:

The base amperage I_B on the x-axis, the collector current intensity I_C on the y-Axis.

$I_B\ [\mu A]$	$I_C\ [mA]$
0	
10	
20	
30	
40	
50	

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Robert-Bosch-Breite 10
37079 Göttingen

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Fax: 0551 604 - 107

info@phywe.de
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Task 1

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The connection between I_B and I_C is...

- ... exponential.
- ... linear.
- ... square.
- ... anti-proportional.

Slide	Score / Total
Slide 14: Evaluation questions	0/3

Total 0 / 3

Solutions | Repeat | Export text

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

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