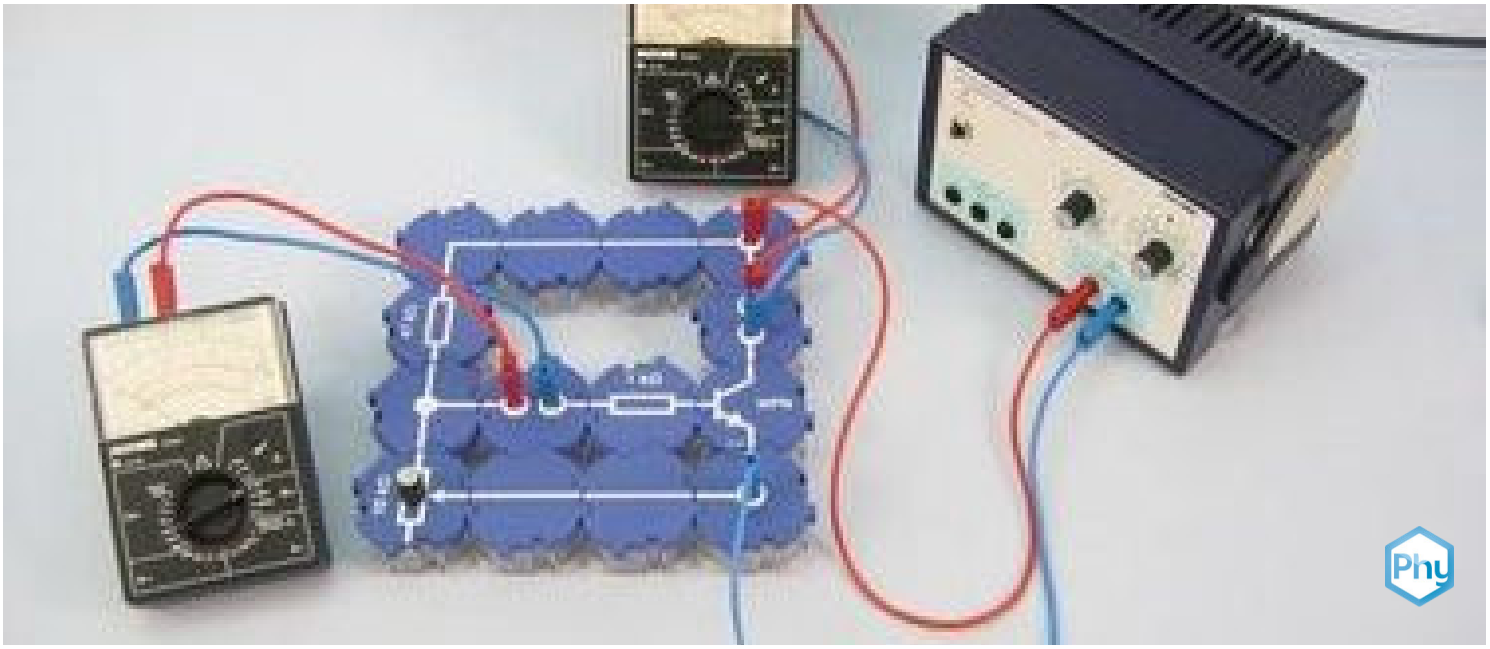
The current-voltage characteristic of an NPN transistor



In this experiment, the current-voltage characteristics of an NPN transistor are recorded.

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/631634369ebaee00039a2ee8

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Teacher information

Application

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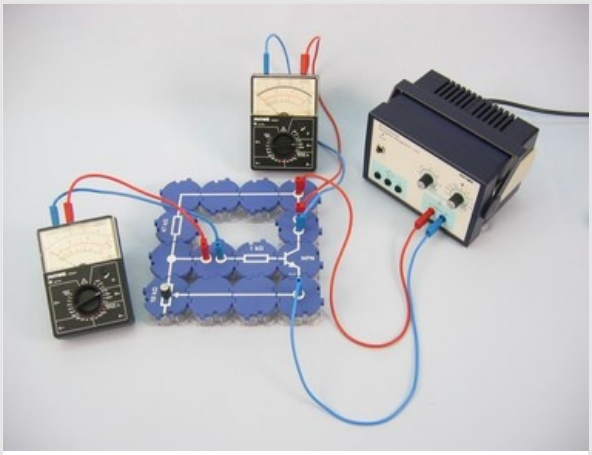

Experimental setup

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 record current-voltage characteristics of an NPN transistor.

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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 recognise that a transistor has different current-voltage characteristics for different base currents. To do this, the students examine the current-voltage characteristics of a transistor and determine the output resistance at an operating point as an example.

Other teacher information (2/3)

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Task

The students are to record five current-voltage characteristics of the transistor for different base current strengths. Then the output resistance of the transistor at $5\,V$ should be approximately determined on the characteristic curve for $I_B = 30\,\mu A$.

Principle

When a transistor is operated in the saturation range, its output resistance is almost constant, which is visible in a linear course of the current-voltage characteristic. This resistance can be adjusted via the base current.

The differential output resistance is given by $r = \Delta U_{CE} / \Delta I_C$

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Other teacher information (3/3)

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Notes

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

Safety instructions

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

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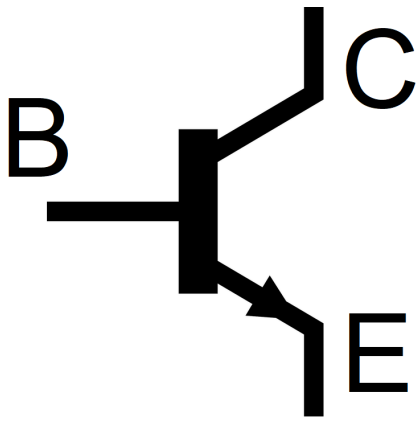
Student information

Motivation



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 to record the current-voltage characteristics of a transistor and to determine the output resistance of a transistor.

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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 10 kOhm, SB	05615-10	1
8	Resistor module 1 kOhm, SB	05614-10	1
9	Potentiometer module 10 kOhm, SB	05625-10	1
10	NPN transistor module BC337, SB	05656-00	1
11	Connecting cord, 32 A, 250 mm, red	07360-01	1
12	Connecting cord, 32 A, 250 mm, blue	07360-04	1
13	Connecting cord, 32 A, 500 mm, red	07361-01	2
14	Connecting cord, 32 A, 500 mm, blue	07361-04	2
15	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
16	PHYWE Analog multimeter, 600V AC/DC, 10A AC/DC, 2 MΩ, overload protection	07021-11	2

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Set-up

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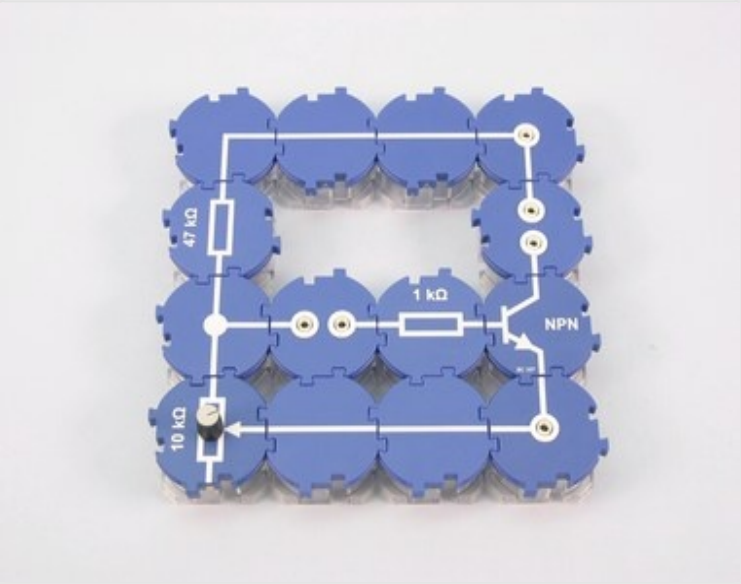

- Build the circuit as shown in the illustrations.
- Turn the potentiometer to the right stop.
- Select the measuring range for the base amperage on the ammeter to $50\ \mu A$ and the measuring range on the ammeter for the collector current strength to $30\ mA$.
- Set the operating voltage at the power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

Procedure

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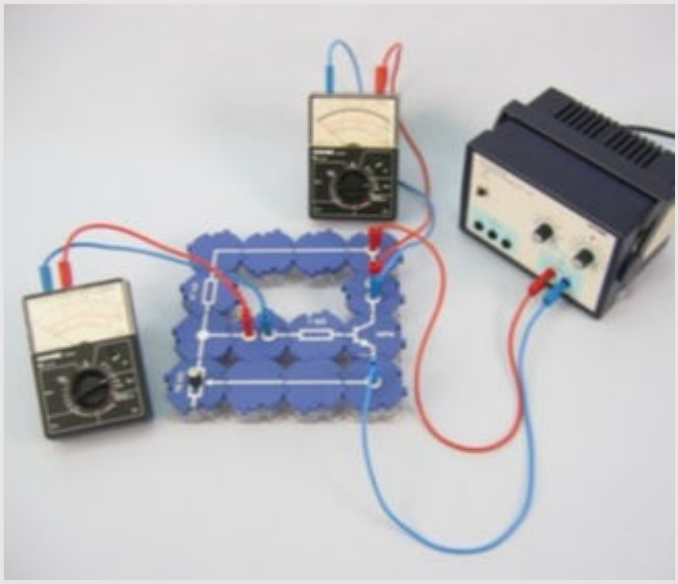
- Switch on the power supply unit when all cables are connected and use the potentiometer to increase the base current in steps of $10\ \mu A$ to $50\ \mu A$. Note the resulting collector current intensity for each base current intensity in the table in the report.
- Repeat this measurement for further voltages U_{CE} in $1\ V$ The voltage at the power supply unit can be reduced step by step.
- For measurements with an operating voltage $U_{CE} < 7V$ In the circuit, replace the $47k\Omega$ Resistance with the $10k\Omega$ Resistance.



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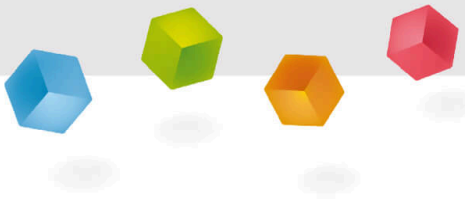

Report

Table 1

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Write down your measurements in the table.

$U_{CE}\ [V]$	$I_C\ [mA]$ at $I_B = 10\mu A$ | $I_B = 20\mu A$ | $I_B = 30\mu A$ | $I_B = 40\mu A$ | $I_B = 50\mu A$				
12					
11					
10					
9					
8					
7					

$U_{CE}\ [V]$	$I_C\ [mA]$ at $I_B = 10\mu A$ | $I_B = 20\mu A$ | $I_B = 30\mu A$ | $I_B = 40\mu A$ | $I_B = 50\mu A$				
6					
5					
4					
3					
2					
0					

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6					
5					
4					
3					
2					
0					

Task 1

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Draw your measurement series for the different base currents on a graph with U_{CE} on the x-axis and I_C on the y-Axis.

Then answer the questions.

The connection between U_{CE} and I_C is...

- ... exponential.
- ... from $0\,V$ linear.
- ... from $2\,V$ linear.
- ... anti-proportional.

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