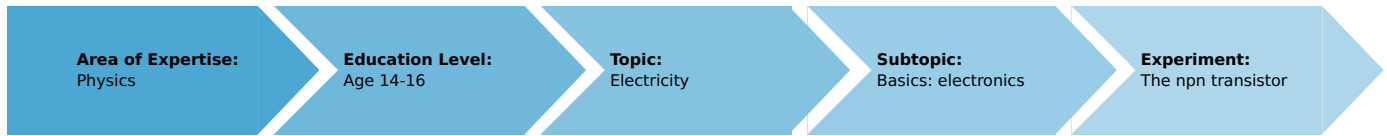


# The npn transistor (Item No.: P1383100)

## Curricular Relevance



### Difficulty



Intermediate

### Preparation Time



10 Minutes

### Execution Time



10 Minutes

### Recommended Group Size



2 Students

### Additional Requirements:

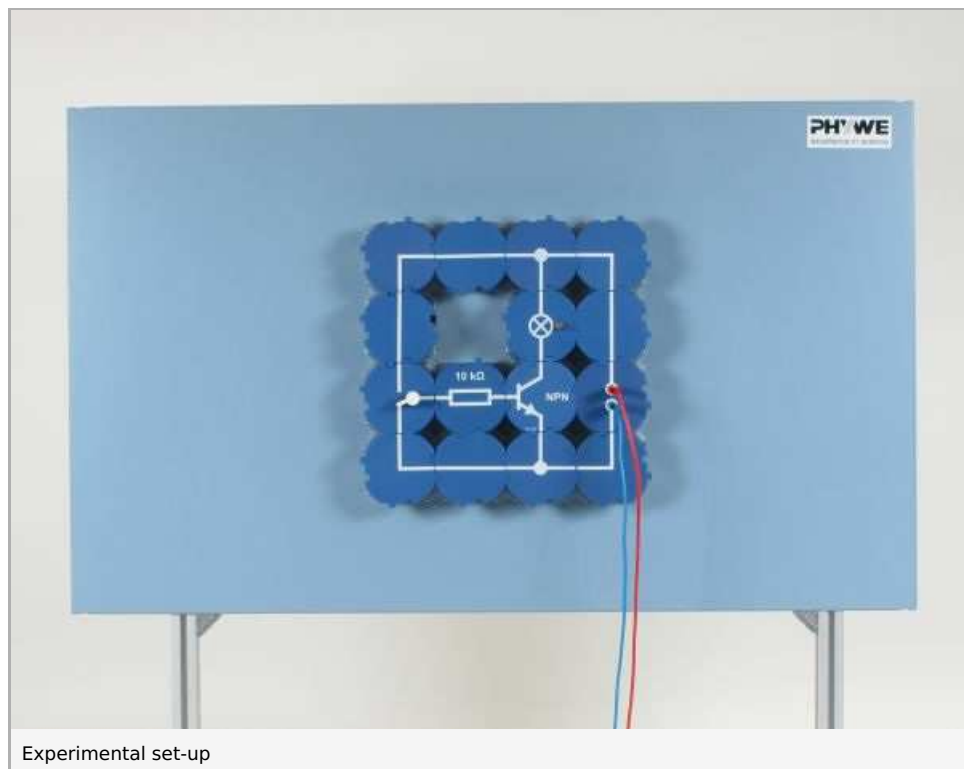
### Experiment Variations:

### Keywords:

## Principle and equipment

### Principle

A demonstration is to show that a current can only flow from the emitter to the collector of a npn-transistor when the base is connected to the positive terminal of a direct current source, so that the blocking effect of the base-emitter barrier layer is overcome.

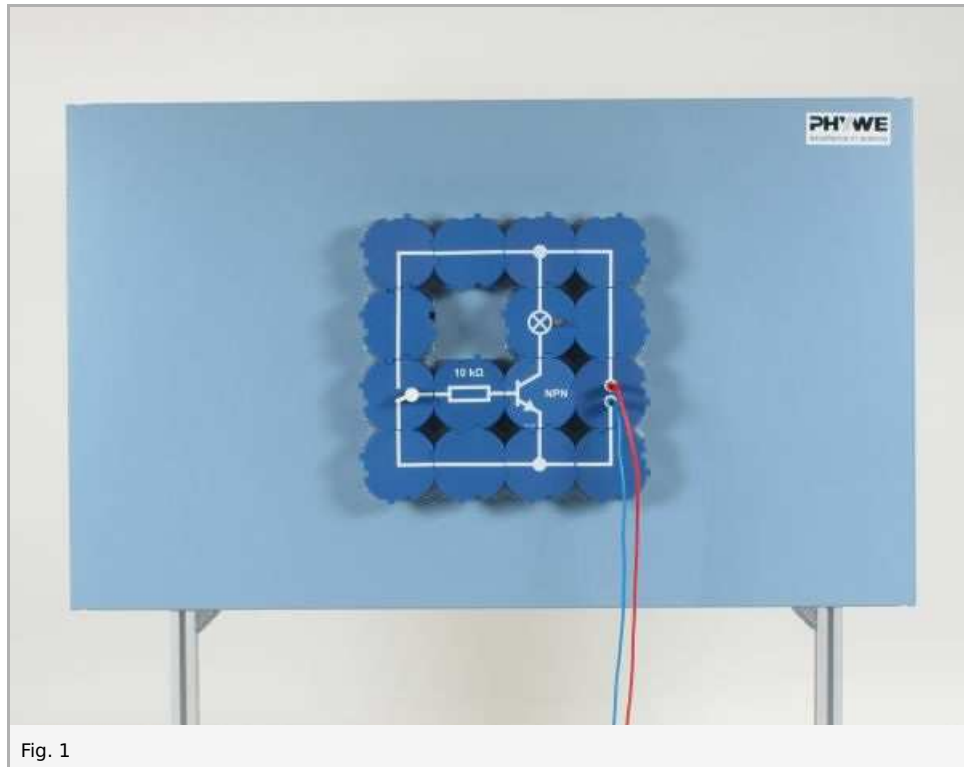


## Equipment

Position No.	Material	Order No.	Quantity
1	PHYWE power supply, universal DC: 0...18 V, 0...5 A / AC: 2/4/6/8/10/12/15 V, 5 A	13500-93	1
2	Demo Physics board with stand	02150-00	1
3	Switch, change-over, module DB	09402-02	1
4	Transistor BC337, module DB	09456-00	1
5	Socket for incandescent lamp E10 ,module DB	09404-00	1
6	Connector interrupted, module DB	09401-04	1
7	Resistor 10 kOhm, module DB	09415-10	1
8	Electr.symbols f.demo-board, 12 pcs	02154-03	1
9	Connector, straight, module DB	09401-01	4
10	Connector, angled, module DB	09401-02	4
11	Connector, T-shaped, module DB	09401-03	2
12	Filament lamp 6 V/3 W, E10, 10 pcs.	35673-03	1
13	Connecting cord, 32 A, 1000 mm, red	07363-01	1
14	Connecting cord, 32 A, 1000 mm, blue	07363-04	1

## Set-up and procedure

- Connect up the circuit as shown in Fig. 1, but do not yet insert the base resistor  $R_B$  in the circuit.
- Set the power supply to 6 V direct voltage; first connect the collector to the negative terminal and the emitter to the positive terminal of the current source; observe the filament lamp (1).
- Reverse the polarity of the direct voltage and observe the filament lamp (2).
- Insert the base resistor  $R_B$  in the circuit, operate the changeover switch several times, observe the filament lamp (3).



## Observation and evaluation

### Observation

1. No current flows from the emitter to the collector with the base connection open.
2. No current flows from the emitter to the collector with the base connection open, regardless of the polarity of the collector-emitter voltage.
3. No current flows when the base connection is connected to the negative terminal of the current source via a resistance. Current does flow, however, when the base connection is connected to the positive terminal of the current source via a resistance; the lamp lights up.

### Evaluation

For a current to flow from the emitter to the collector, the base must be connected to the positive terminal of the current source.

An npn transistor consists of a very thin and weakly doped p-conducting layer, that is sandwiched between two strongly doped n-conducting regions. The layer in the middle is called the base, the two outer regions are the collector and the emitter. Diffusion of electrons and electron holes at the junction of the base and the emitter results in a barrier layer impoverished in charge carriers, because the negative electrons and the positive electron holes recombine there. An electrical field builds up between the positive donor ions in the n-region and the negative acceptor ions in the p-region, and this prevents a flow of current from the emitter to the base.

Only when this inner electric field is overcome by an external voltage of correct polarity can electrons penetrate through the emitter-base junction, into the base and on through to the area of the base-collector junction, which is of correct polarity for passage of electrons. When the base is connected to the negative terminal of the current source, however, then the blocking effect of the base-emitter barrier layer is increased even further.

### Remarks

The maximum blocking voltage of the base-emitter barrier layer is 5 V. At higher voltages the base-emitter diode loses its blocking effect. This also occurs when voltage is applied between the collector and the emitter, and the collector is connected to the negative terminal of the current source.