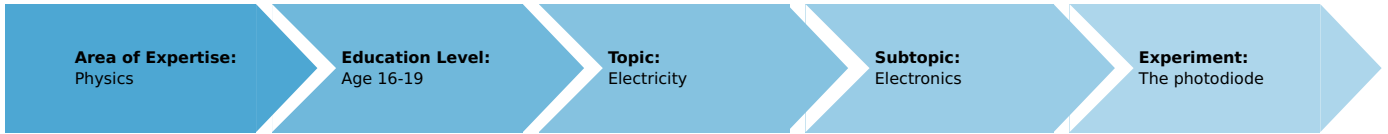


The photodiode (Item No.: P1401200)

Curricular Relevance



Difficulty



Difficult

Preparation Time



10 Minutes

Execution Time



20 Minutes

Recommended Group Size



2 Students

Additional Requirements:

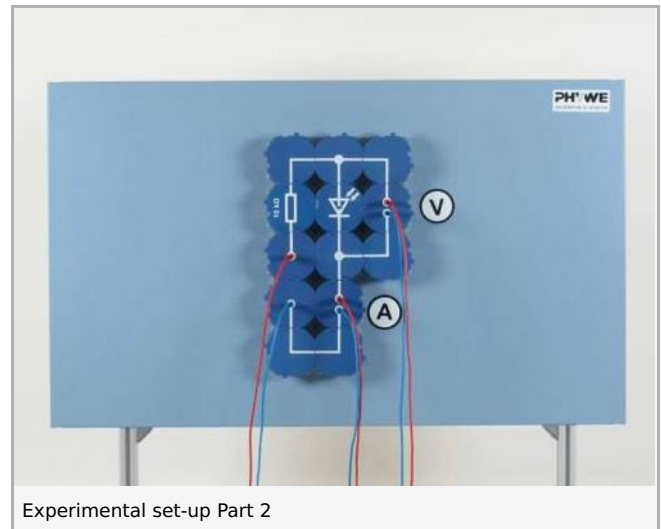
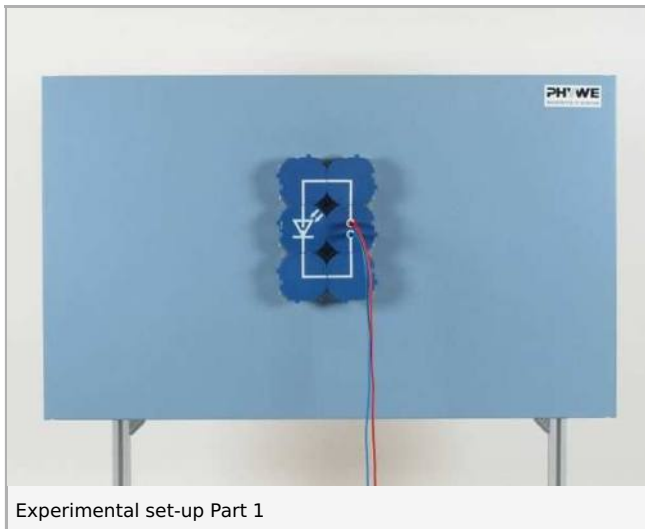
Experiment Variations:

Keywords:

Principle and equipment

Principle

It is to be shown that, when light is incident on it, a photodiode generates an electric voltage and can supply a current. In addition, an examination is to be made of how the characteristic curve of a photodiode changes when light is incident on it.



Equipment

Position No.	Material	Order No.	Quantity
1	Multimeter ADM2, demo., analogue	13820-01	2
2	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
3	Demo Physics board with stand	02150-00	1
4	Clamp on holder	02164-00	1
5	Connector interrupted, module DB	09401-04	2
6	Junction, module DB	09401-10	2
7	Photodiode, module DB	09453-00	1
8	Resistor 10 kOhm, module DB	09415-10	1
9	Electr.symbols f.demo-board, 12 pcs	02154-03	1
10	Connector, angled, module DB	09401-02	5
11	Connector, T-shaped, module DB	09401-03	2
12	Boss head	02043-00	1
13	Universal clamp	37715-00	1
14	Support rod, stainless steel, 500 mm	02032-00	1
15	Flashlight, w/o battery, medium	08164-00	1
16	Connecting cord, 32 A, 1000 mm, red	07363-01	3
17	Connecting cord, 32 A, 1000 mm, blue	07363-04	3
18	Battery cell, 1.5 V, baby size, type C	07922-01	2

Set-up and procedure

1st. Experiment

- Set up the experiment as shown in Fig. 1; first select the measurement range of 1 V-, then 1 mA-.
- Direct the light of a torch on the photodiode; vary the intensity of illumination while observing the voltage and current; note your observations (1)



Fig. 1

2nd. Experiment

- Change the experimental set-up to that in Fig. 2, starting with the polarity of the photodiode in the forward direction; select measurement ranges 1 V- and 1 mA-; first take care that as little light as possible is incident on the photodiode (if necessary, cover it).
- Increase the direct voltage up to 0.60 V in suitable steps (see Table 1) and enter the measured values for voltage and current in Table 1.
- Turn the photodiode building block through 180° and replace it in the circuit, again increase the voltage stepwise (see Table 1) and enter the measured values in Table 1; turn the voltage on the power supply down, change the polarity of the photodiode back to that for the forward direction
- Use holding material to fix the torch to the edge of the board and at a distance of about 20 cm from it
- Set the power supply to 0.6 V; switch on the torch, bundle the lightbeam and illuminate the photodiode with it
- Reduce the voltage in suitable steps (see Table 1) and enter the measured voltage and current values in Table 1; hereby reverse the polarity of the ammeter when the current becomes negative, reverse the polarity of the source of voltage when the adjusting knob for voltage reaches the 0 stop, reverse the polarity of the voltmeter when the voltage becomes negative
- Arrange for stronger illumination (e.g. torch at a 10 cm distance) and repeat the measurements

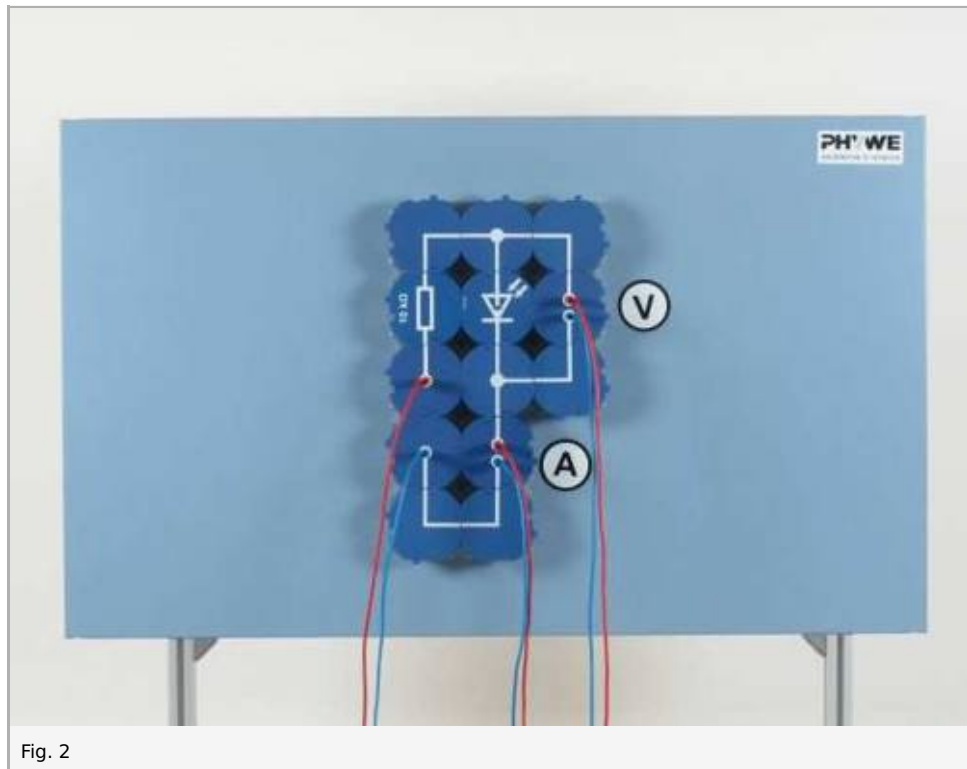


Fig. 2

Observation and evaluation

Observation

Table 1: The characteristic curve of a photodiode

	$\frac{U}{V}$	$\frac{I}{mA}$
Without illumination	0.20	0.00
	0.41	0.00
	0.45	0.03
	0.50	0.08
	0.55	0.24
	0.60	0.64
	-0.50	0.00
	-1.00	0.00
With average illuminating intensity	0.60	0.65
	0.57	0.27
	0.56	0.14
	0.55	0.02
	0.54	-0.04
	0.53	-0.14
	0.52	-0.20
	0.51	-0.26
	0.50	-0.30
	0.47	-0.40
	0.44	-0.46
	0.40	-0.50
	0.30	-0.55
	0.20	-0.57
	0.00	-0.58
-0.50	-0.59	
-1.00	-0.59	
With higher illuminating intensity	0.62	0.64
	0.61	0.51
	0.60	0.32
	0.59	0.11
	0.58	0.00
	0.57	-0.22
	0.55	-0.41
	0.52	-0.59
	0.50	-0.82
	0.40	-0.93
	0.30	-0.97
	0.20	-1.00
	0.10	-1.02
	0.00	-1.04
-0.50	-1.05	
-1.00	-1.05	

1. When light is incident on the photodiode, the measuring instrument shows a voltage of about 0.4 V ... 0.6 V. The current is

highly dependent on the illuminating intensity (0 mA. .. 1 mA).

Evaluation

A photodiode can generate electrical energy when light is incident on it. In the barrier layer of the photodiode, electrons and mobile holes are liberated from their bindings by light energy.

Fig. 3 shows the measured characteristic curves. When the photodiode has forward direction polarity and is not illuminated, then the course of the characteristic curve is like that for a silicon rectifying diode. The conductivity state current starts at a conductivity state voltage of about 0.4 V and then increases very sharply.

With photodiode polarity in the inverse direction, no measurable current flows when no light is incident on the photodiode. The characteristic curve is shifted to negative current values when the photodiode is illuminated.

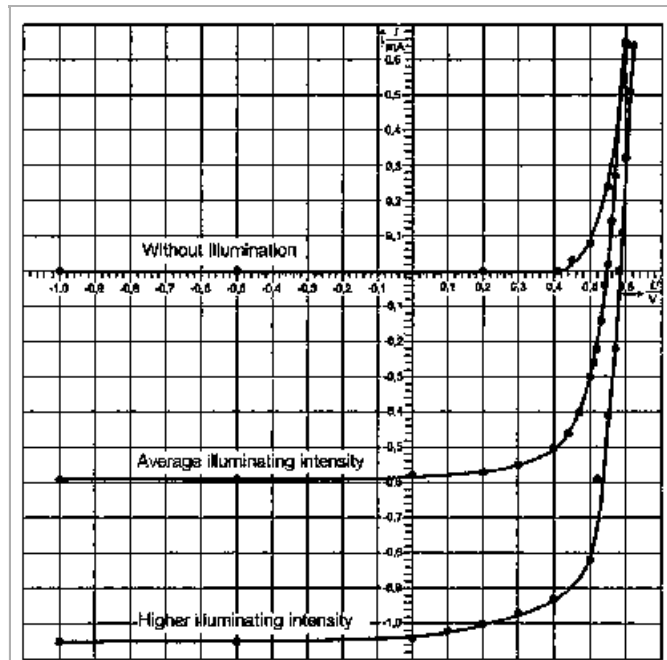


Fig. 3: The characteristic curve of a photodiode

Remark

The short-circuit current of a photodiode is proportional to the illuminating intensity. It is therefore frequently used as an exposure meter.