Task

To first connect up an AND circuit, and then an OR circuit, and come to the understanding that electrical switching conditions can be assigned to logical statements.

Equipment

Plug-in board	06033.00	1
Changeover switch	39169.00	2
Wire building block	39120.00	4
Lamp holder E10	17049.00	1
Connecting cable, 25 cm, red	07313.01	1
Connecting cable, 25 cm, blue	07313.04	1
Filament lamp, 12V/0.1 A, E10, 1 pc.	07505.03	(1)
Power supply, 0...12 V-,6 V~, 12 V~	13505.93	1

Set-Up and Procedure

First Experiment

— Connect up the circuit as shown in Fig. 1; the changeover switches A and B have the function of on/off switches in this circuit.
— Switch on the power supply and adjust it to the 12 V rated voltage of the lamp.
— Open and close A and B; observe the lamp at each different switching condition; note your observations in Table 1, using the following symbols (see Fig. 1):
  Switch open: 0
  Switch closed: 1
  Lamp does not light up: 0
  Lamp lights up: 1
— Set the power supply to 0 V and switch it off.

Second Experiment

— Set up the experiment as shown in Fig. 2; here again, the changeover switches A and B have the function of on/off switches in this circuit.
— Switch on the power supply and adjust it to the 12 V rated voltage of the lamp.
— Open and close A and B; observe the lamp at each different switching condition; note your observations in Table 2, using the same symbols as in the first experiment (see Fig. 2):
— Set the power supply to 0 V and switch it off.

Observations

Table 1

Switching conditions Switch A	Switch B	Lighting up of the lamp
0	0	
0	1	
1	0	
1	1	

Table 2

Switching conditions Switch A	Switch B	Lighting up of the lamp
0	0	
0	1	
1	0	
1	1	

Fig. 1

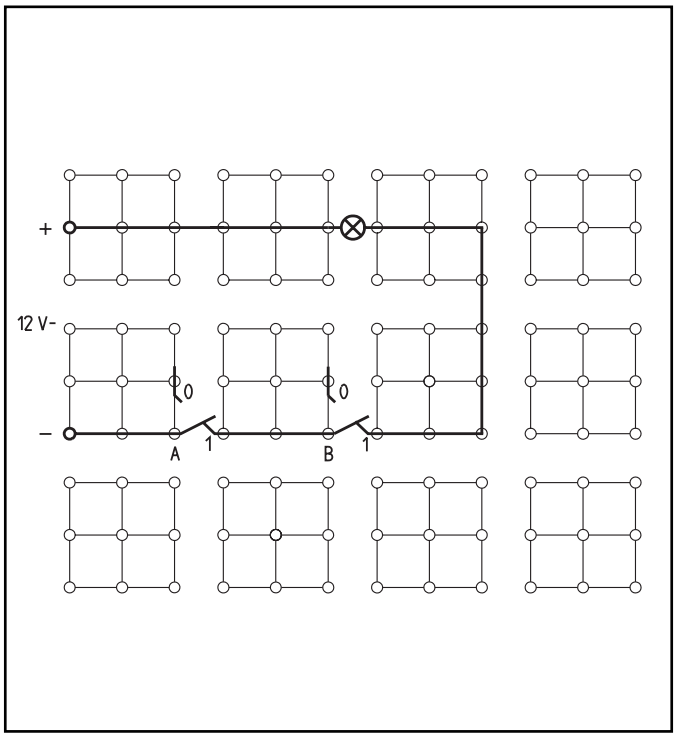
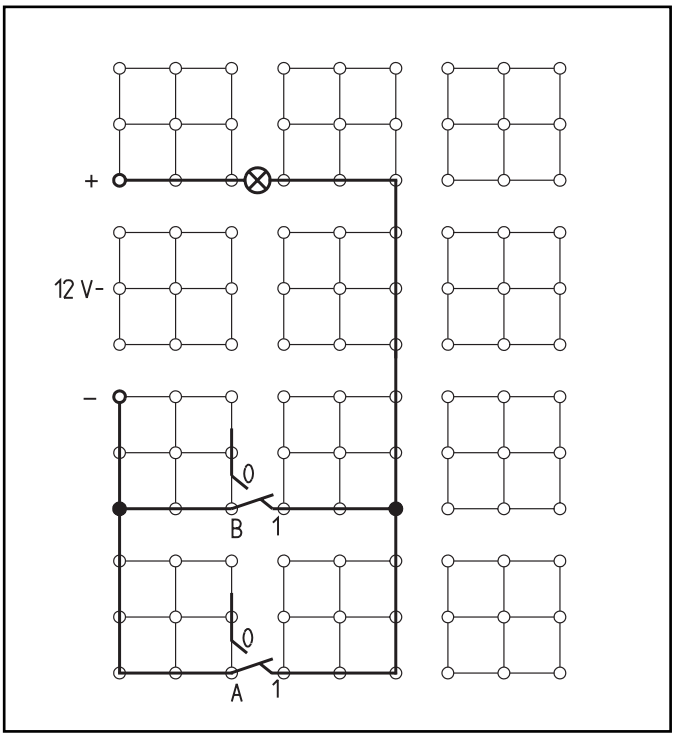


Fig. 2



Evaluation

1. How many different possible switch positions (switching conditions) are there with two switches?

2. a) Why is the circuit used in the first experiment called an AND circuit?

   b) Why is the circuit used in the second experiment called an OR circuit?

3. Assuming each of these circuits had been prepared with 3 switches, at how many switching conditions would the lamp light up?
   a) in the AND circuit:

   b) in the OR circuit:

4. Draw the circuit diagram for an AND circuit (in Fig. 3) and for an OR circuit (in Fig. 4). Each circuit should contain two on/off switches and a lamp.

Fig.3

Fig.4

5. Where are AND and OR circuits used?
   AND circuits

   OR circuits

(What is to be understood under AND and OR circuits?)

The students should become familiarized with the construction and function of both AND circuits and OR circuits. They are to experimentally determine the truth table for each type of circuit and gain the knowledge that one can assign electrical switching conditions to statements which are true or false, or to values of 1 or 0.

Notes on Set-Up and Procedure

When the students have already experimented with change-over switching, they should experience no great difficulty in connecting up the circuits.

Observations

Table 1

Switching conditions Switch A	Switch B	Lighting up of the lamp
0	0	0
0	1	0
1	0	0
1	1	1

Table 2

Switching conditions Switch A	Switch B	Lighting up of the lamp
0	0	0
0	1	1
1	0	1
1	1	1

Evaluation

1. There are 4 different possibilities.
2. a) The AND circuit has been given this name because the lamp only lights up when switch A **and** switch B are closed.
   b) The OR circuit has been given this name because the lamp only lights up when switch A **or** switch B is closed (or both are closed).
3 a) The lamp would only light up in one single switching condition (all three switches closed).
   b) The lamp would light up when at least one of the three switches was closed.
4. See Fig. 3 and Fig. 4.
5. AND circuits: Washing-machines first start their wash programme when the mains switch is switched on **and** the lid or door of the machine is closed. A press for car body parts does not start to work until a switch is operated by both the the right hand and the left hand.
   OR circuits: The lighting on a staircase is switched on when a switch is pressed either on the ground floor, **or** on the second floor, **or** on the third floor. An alarm signal for a car is set off when a car door, **or** the car bonnet, **or** the car boot is opened.

Remarks

It must be clear to the students, that the switching condition of AND and OR circuits can be assigned to statements whose linkage can be true or false. For this they should, for example, look carefully at the evaluation of circuit diagrams drawn in point 4 of the evaluation, and at the truth tables, and then explicitly formulate the symbolized statements in the truth tables line by line (e.g. Table 1, line 3: When switch 1 is closed (1) and switch 2 is open (0), then the lamp does not light up (0).

Fig. 3

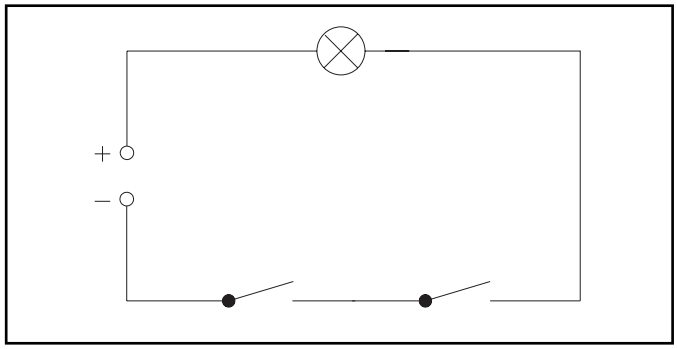
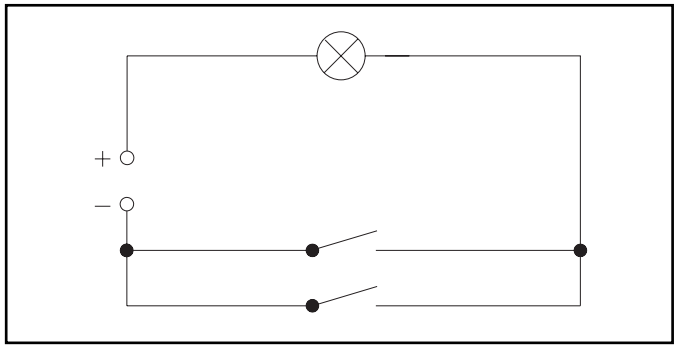


Fig. 4



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(What is to be understood under AND and OR circuits?)

Room for notes