# Bright idea – Electric circuits

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| Bezug zu Kompetenzerwartungen | Die Schülerinnen und Schüler …   * entwickeln selbständig mithilfe geeigneter Software eine elektrische Schaltung zu einer einfachen technischen Problemstellung (z. B. Bedienung einer Lampe mit zwei Wechselschaltern) und bauen diese unter Anleitung selbständig funktionsfähig auf. Sie dokumentieren ihr Ergebnis und berücksichtigen beim Experimentieren die vorgegebenen Sicherheitshinweise. |
| Zeitlicher Rahmen | ein bis zwei Unterrichtsstunden |
| Ressourcen | je Experimentiergruppe: ein bis zwei Schalter, ein Lämpchen mit Kunststoffsockel, zwei Experimentierkabel, eine Rastersteckplatte mit Steckelementen |
| Durchführung | Die Schülerinnen und Schüler zeichnen ein möglichst einfaches Schaltbild für einen Raum mit einer Lampe (z. B. Klassenzimmer), die nur über einen Schalter ein- bzw. ausgeschaltet werden kann, und überprüfen die Funktionsfähigkeit der Schaltung experimentell. Hiervon ausgehend über­le­gen sie sich anschließend, welche Veränderungen notwendig sind, damit man auch in größeren Räumen mit zwei Lichtschaltern (z. B. Physiksaal) das Licht von jedem Schalter ein- bzw. ausschalten kann. Die selbständig erstellten Schaltbilder werden auf ihre Funktionsfähigkeit überprüft und unter Anleitung aufgebaut. |
| Anregungen und Tipps | Kostenlose Programme zur Simulation von Schaltungen z. B.  <http://www.heise.de/download/exact.html> (deutsch) [20.01.2021]  <http://phet.colorado.edu/en/simulation/legacy/circuit-construction-kit-ac> bzw. <http://phet.colorado.edu/en/simulation/legacy/circuit-construction-kit-ac-virtual-lab> (Download oder Virtual Lab, englisch); [20.01.2021] |
| Materialien | AB 1 Various electric circuits  AB 2 Various electric circuits (Exercises)  LH 1 Fachvokabular mit Hinweisen zur Aussprache  LH 2 Lösung zu AB 1 Various electric circuits  LH 3 Lösung zu AB 2 Various electric circuits (Exercises)  MD 1 Wechselschalter\_Simulation  MD 2 exact\_Simulationsprogramm\_dt  MD 3 circuit-construction-kit-ac-virtual-lab\_Simulation\_engl  MD 4 circuit-construction-kit-dc-virtual-lab\_Simulation\_engl |
| Autorin | Alice Schmidkunz, Sigmund-Schuckert-Gymnasium Nürnberg |

## Stundenverlauf: Bright idea

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|  | Struktur | Erläuterung |
| Stundenverlauf: Bright idea | Einstieg | Stiller Impuls „Licht im Klassenzimmer oder Physikraum ein- und ausschalten“  Welcher physikalische Vorgang steckt hinter dem Ein-/Ausschalten des Lichts?  Welche Bauteile benötigt man, um einen Schaltkreis für das Zimmer zu realisieren? Wie kombiniert man sie?  Je nach Wissensstand führt die Lehrkraft an dieser Stelle die Symbolschreibweise für die verwendeten Bauteile ein (vgl. AB 1) oder wiederholt diese nur kurz. |
| Hinführung  (AB 1, LH 2) | Zimmerbeleuchtung über einen Schalter  Die Schülerinnen und Schüler zeichnen ein einfaches Schaltbild für einen Raum, in dem die Beleuchtung nur durch Betätigen eines Schalters ein- bzw. ausgeschaltet wird. In Kleingruppen oder Partnerarbeit (abhängig von der Klassengröße bzw. Ausstattung der Schülerübung) überprüfen sie dies anschließend experimentell unter Anleitung der Lehrkraft.  Bei gleichzeitiger Einführung der Symbolschreibweise und Durchführung dieses Schülerexperiments empfiehlt es sich, die Stunde mit Übungen (AB 2 Aufgaben 1 bzw. 3) abzurunden und einen Schaltkreis mit zwei Schaltern in der nächsten Stunde aufzugreifen. |
| Problemstellung  (AB 1, LH 2) | Zimmerbeleuchtung über zwei Schalter  Bei Zimmern mit zwei Türen reicht jedoch ein Schalter nicht aus. Wie kann man in diesem Fall (unabhängig von der jeweils anderen Schalterstellung) das Licht ein- und ausschalten? (→ “Who´s got a bright idea?“) In der jeweiligen Gruppe suchen die Schülerinnen und Schüler nach einer geeigneten Lösung und zeichnen zu ihrer Idee das entsprechende Schaltbild (AB 1 oder evtl. OV-Folie). |
| Erarbeitung /  Sicherung  (AB 1, LH 2) | Wechselschalter als neuer Bestandteil eines Stromkreises  Mit einer Dokumentenkamera oder einem OHP lassen sich die Lösungsvorschläge im Klassenverband besprechen und ggf. korrigieren. Die Schülerinnen und Schüler erkennen, dass der bisher bekannte Schalter zur Lösung dieses Problems nicht ausreicht, und lernen den Wechselschalter kennen.  Unter Anleitung der Lehrkraft bauen die Schülerinnen und Schüler die funktionie­rende Schaltung auf. |
| Puffer  (AB 1; AB 2, LH 3, MD 1 – 4) | Experimentelle Vertiefung  Statt nur theoretisch Fehler in Schaltbildern zu besprechen, kann im Lehrerversuch die Funktionsweise getestet und eine Korrektur sowohl im Aufbau als auch im gezeichneten Schaltbild vorgenommen werden.  Die vier möglichen Schalterpositionen (einschließlich markiertem Stromfluss) können als Hausaufgabe gezeichnet werden.  Weitere einfache Schaltungen aus dem Alltag lassen sich im Unterricht (in dieser oder der darauffolgenden Stunde) oder als Hausaufgabe anschließen (vgl. AB 2, LH 3, Einbezug von Programmen zur Schaltungssimulation MD 1 – 4). |

## AB 1 Various electric circuits

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In your classroom you turn on the lights using a single switch.

Show this in a circuit diagram using the electrical symbols from the list.

Construct the circuit. (**Pay attention and carefully follow all the instructions your teacher gives you!**)

Large rooms with two entrances usually have a switch close to each entrance.

Draw an electric circuit that allows you to switch the light on and off from both positions.

There are two ways to connect two switches. What are the problems?

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If your idea was not correct, try it once more:

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Number of possible combinations of switch positions: \_\_\_\_\_\_\_\_\_\_\_\_\_

Draw all these combinations, write down whether the light bulb lights up and mark the current flow.

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Construct the circuit. (**Pay attention and carefully follow all the instructions your teacher gives you!**)

Common electrical symbols:

– +

|  |  |  |  |
| --- | --- | --- | --- |
| wire |  | single battery cell |  |
| wires joined |  | DC power supply | + – |
| wires not joined |  | AC power supply | ~ |
| light bulb |  | motor | M |
| (SPST) switch  (= Single Pole, Single Throw) |  | SPDT switch  (= Single Pole, Double Throw) |  |
| SPTT switch  (= Single Pole, Triple Throw) |  |  |  |

(drawings: A. Schmidkunz)

## AB 2 Various electric circuits (exercises)

Draw a circuit diagram for each situation.



1. **Passenger compartment illumination**

The interior lighting in a vehicle is turned on when the door on the driver’s or the passenger’s side is opened.

1. **Headlights and fog lights**



1. When a switch is thrown both headlights of a car are turned on or off.

For experts:

1. There are also two fog lights. These can only be turned on if the two headlights of a car are turned on.

(bear in mind: If one headlight or fog light is defective, the other one will still work.)



1. **Lift**

The lift in a skyscraper is designed with a cabin door and a landing door. In order to prevent accidents the cabin can only move when both doors are closed.

1. **Traffic lights**
2. At a pelican crossing[[1]](#footnote-1) the red light indicates it is not safe to cross and the green light indicates that it is safe to do so. The light changes directly from red to green and vice versa.





Traffic lights usually have three lights.

1. Assume only one light (red, yellow or green) is on at a time.

For experts:

1. In some countries (e.g. Germany) there is a combination of red and yellow lights just before the light turns green.

all photos: © clipdealer

## LH 1 Fachvokabular mit Hinweisen zur Aussprache

|  |  |  |
| --- | --- | --- |
| Englisch | Aussprache (BrE) | Deutsch |
| alternating current (abbr. AC) | ˌɔːltɜːnətɪŋ ˈkʌrənt | Wechselstrom |
| bright | braɪt | hell, leuchtend, strahlend |
| bright idea | braɪt aɪˈdɪə | glänzende Idee |
| cabin door | ˈkæbɪn dɔː(r) | Kabinentür |
| circuit | ˈsɜːkɪt | Stromkreis |
| direct current (abbr. DC) | ˌdaɪrekt ˈkʌrənt | Gleichstrom |
| landing | ˈlændɪŋ | (Treppen-)Absatz, Stockwerkflur, Schachtöffnung |
| landing door | ˈlændɪŋ dɔː(r) | Schachttür |
| light bulb | ˈlaɪt bʌlb | (Glüh-)Lampe, Glühbirne |
| pedestrian light/pelican crossing | pəˌdestriən laɪt/ˌpelɪkən ˈkrɒsɪŋ | Fußgängerampel |
| series/parallel circuit | ˈsɪəriːz/ˌpærəlel ˈsɜːkɪt | Reihen-/ Parallelschaltung |
| shaft | ʃɑːft | Schacht |
| short-circuit | ˌʃɔːt ˈsɜːkɪt | Kurzschluss |
| switch | swɪtʃ | Schalter |
| toggle switch | ˈtɒɡl swɪtʃ | Kippschalter |
| two-way connection | ˌtuː weɪ kəˈnekʃn | Wechselschaltung |
| wire | ˈwaɪə(r) | Kabel |

## LH 2 Lösung zu AB 1 Various electric circuits

power supply

switch

light bulb

In your classroom you turn on the lights using a single switch.

Show this in a schematic diagram using

the common circuit symbols (see list).

Construct the circuit. (**Pay attention and carefully follow all of the instructions your teacher gives you!**)

Large rooms with two entrances usually have a switch close to each entrance.

Draw an electric circuit that allows you to switch the light on and off from both positions.

There are two ways to connect two switches. What are the problems?

switches in series switches in parallel

power supply

switch 2

switch 1

light bulb

OR - circuit

power supply

switch 2

switch 1

light bulb

AND - circuit

OR-circuit

Each switch is placed in its own separate branch.

Problem: The light bulb will light up if at least one switch is closed, i.e. if both switches are closed and you open just one, there is still light.

AND-circuit

Each switch is connected in a way that there is only one way for the current to flow between the two switches.

Problem: The light bulb will light up only if both switches are closed.

(drawings: A. Schmidkunz)

If your idea was not correct, try it once more:

light bulb

power supply

two-way switching

SPDT switch 1

SPDT switch 2

Two-way switching

Each switch controls one wire in and two wires out (so-called Single Pole, Double Throw switch).

When the light bulb lights up, changing the position of either switch will switch it off. If you also change the position of the other switch, the light bulb will light up again.

Number of possible combinations of switch positions: 4

Draw all of these combinations, write down whether the light bulb lights up and mark the current flow.

light bulb

lights up

SPDT switch 1

up

SPDT switch 2

up

light bulb

does not light up

SPDT switch 1

up

SPDT switch 2

down

light bulb

lights up

SPDT switch 1

down

SPDT switch 2

down

light bulb

does not light up

SPDT switch 1

down

SPDT switch 2

up

Construct the circuit. (**Pay attention and carefully follow all the instructions your teacher gives you!**)

(drawings: A. Schmidkunz)

Common circuit symbols:

– +

|  |  |  |  |
| --- | --- | --- | --- |
| wire |  | single battery cell |  |
| wires joined |  | DC power supply | + – |
| wires not joined |  | AC power supply | ~ |
| light bulb |  | motor | M |
| (SPST) switch  (= Single Pole, Single Throw) |  | SPDT switch  (= Single Pole, Double Throw) |  |
| SPTT switch  (= Single Pole, Triple Throw) |  |  |  |

(drawings: A. Schmidkunz)

## LH 3 Lösung zu AB 2 Various electric circuits (Exercises)

Draw a circuit diagram for each situation.

1. **Passenger compartment illumination**

The interior lighting in a vehicle is turned on when the door on the driver’s or the passenger’s side is opened.

car

battery

switch 2

(passenger´s side)

switch 1

(driver´s side)

compartment illumination

OR - circuit

1. **Headlights and fog lights**
2. When a switch is thrown both headlights of a car are turned on or off.

car

battery

headlight on the right

switch (headlights)

headlight on the left

(drawings: A. Schmidkunz)

For experts:

There are also two fog lights. These can only be turned on if the two headlights of a car are turned on. (bear in mind: If one headlight or fog light is defective, the other one will still work.)

fog light on the right

fog light on the left

car

battery

headlight on the right

switch 1 (headlights)

headlight on the left

switch 2 (fog lights)

AND - circuit

(fog lights)

1. **Lift**

The lift in a skyscraper is designed with a cabin door and a landing door. In order to prevent accidents the cabin can only move when both doors are closed.

(electric) motor

power supply

switch 1

(landing door)

switch 2

(cabin door)

M

AND - circuit

(drawings: A. Schmidkunz)

1. **Traffic lights**
2. At a pelican crossing[[2]](#footnote-2)1 the red light indicates it is not safe to cross and the green light indicates that it is safe to do so. The light changes directly from red to green and vice versa.

green light

red light

power supply

SPDT switch

Traffic lights usually have three lights.

1. Assume only one light (red, yellow or green) is on at a time.

green light

red light

power supply

SPTT switch

yellow light

(drawings: A. Schmidkunz)

For experts:

1. In some countries (e.g. Germany) there is a combination of red and yellow lights just before the light turns green.

green light

red light

power supply

SPDT switch

yellow light

SPDT switch

switch

(drawing: A. Schmidkunz)

1. previously **Pelicon** Crossing – **PE**destrian **LI**ght **CON**trolled Crossing [↑](#footnote-ref-1)
2. 1 previously **Pelicon Crossing** – **PE**destrian **LI**ght **CON**trolled Crossing [↑](#footnote-ref-2)