Chapter 3: Electricity: Circuits and Their Components

Exercises — Let Us Enhance Our Learning

Q1 Choose the incorrect statement.

(i) A switch is the source of electric current in a circuit.

(ii) A switch helps to complete or break the circuit.

(iii) A switch helps us to use electricity as per our requirement.

(iv) When the switch is in 'OFF' position, there is an air gap between its terminals.

SOLUTION

Option (i) is incorrect because a switch is NOT the source of electric current in a circuit.

The source of electric current is the electric cell or battery.

A switch is a simple device that either completes or breaks a circuit — it controls whether current flows, but does not generate it.

Options (ii), (iii), and (iv) are all correct statements about switches as described in the chapter.

Answer: (i) — A switch is NOT the source of electric current; the cell/battery is.

Q2 Observe Fig. 3.16. With which material connected between the ends A and B, the lamp will not glow? [Fig. 3.16 shows a conduction-tester circuit with a cell and lamp, and two free wire ends A and B where different materials can be inserted.]

SOLUTION

The lamp will not glow when an electrical insulator is connected between ends A and B.

When a material is placed between A and B, it completes the circuit only if electric current can pass through it.

Materials through which current can flow easily are called conductors — the lamp glows when a conductor is placed between A and B.

Materials through which current cannot pass are called insulators — the lamp does NOT glow when an insulator is placed between A and B.

Examples of insulators: rubber, plastic, glass, wood, wax, paper, cork.

Examples of conductors: metals such as iron, copper, aluminium (keys, coins, metal spoons).

So, connecting rubber, plastic, glass, wood, wax, paper, or any other insulator between A and B will not allow the lamp to glow.

Answer: An electrical insulator (such as rubber, plastic, glass, or wood) connected between A and B will not allow the lamp to glow.

Q3 In Fig. 3.17, if the filament of one of the lamps is broken, will the other glow? Justify your answer. [Fig. 3.17 shows two lamps connected in series with an electric cell.]

SOLUTION

No, the other lamp will also not glow if one lamp's filament is broken.

In Fig. 3.17 the two lamps are connected in series — they share the same single path for current.
A broken filament creates a break (gap) in this single path, making the circuit open.
When the circuit is open, current cannot flow through any part of it.

As stated in the chapter: 'A broken filament stops the flow of current, preventing the lamp from glowing.'
Since no current flows in an open circuit, neither lamp — including the one with an intact filament — will glow.

Answer: No — a broken filament makes the series circuit open; current stops flowing and neither lamp glows.

Q4 A student forgot to remove the insulator covering from the connecting wires while making a circuit. If the lamp and the cell are working properly, will the lamp glow?

SOLUTION

No, the lamp will not glow.

Electric current flows through the metal core of a wire, not through its plastic or rubber covering.
Plastic and rubber are electrical insulators — current cannot pass through them.
If the insulating covering is not removed from the wire ends, the metal core of the wire cannot make contact with the terminals of the cell or lamp.
This leaves a gap (break) in the circuit path, so the circuit remains open even

when the cell and lamp are working properly.
Since no complete path exists for current to flow, the lamp will not glow.

Answer: No — the insulating covering prevents metal contact, leaving an open circuit; the lamp will not glow.

Q5 Draw a circuit diagram for a simple torch using symbols for electric components.

SOLUTION

A simple torch contains: a battery (two cells in series), a lamp (incandescent or LED), a switch, and connecting wires.

Circuit diagram description (using standard symbols from Table 3.2 in the chapter):
— Draw the battery symbol (two cells in series: long line = positive terminal, short line = negative terminal for each cell, connected end-to-end).
— Connect one terminal of the battery to one end of the switch symbol.
— Connect the other end of the switch to one terminal of the lamp symbol (circle with a cross for an incandescent lamp).
— Connect the other terminal of the lamp back to the other terminal of the battery.

The circuit forms a closed loop: Battery (+) → Switch → Lamp → Battery (−).
When the switch is in 'ON' position the circuit is closed and current flows from the positive terminal of the battery through the switch and lamp, making it glow, and returns to the negative terminal.

Answer: Circuit: Battery (+) → Switch (ON) → Lamp → Battery (−), drawn as a closed loop using standard symbols from Table 3.2.

Q6 In Fig. 3.18:
(i) If S2 is in 'ON' position, S1 is in 'OFF' position, which lamp(s) will glow?
(ii) If S2 is in 'OFF' position, S1 is in 'ON' position, which lamp(s) will glow?
(iii) If S1 and S2 both are in 'ON' position, which lamp(s) will glow?
(iv) If both S1 and S2 are in 'OFF' position, which lamp(s) will glow?
[Fig. 3.18 shows a circuit with lamps L1 and L2, and switches S1 and S2. S1 is in the main line; L1 and L2 are in the circuit with S2 controlling a branch.]

SOLUTION

In Fig. 3.18 all four components form a SINGLE series loop: starting from the cell, the current path is cell → S1 → L1 → S2 → L2 → back to the cell. Both switches (S1 and S2) and both lamps (L1 and L2) lie one after another in this one loop — there is no parallel branch.
In a series circuit, current can flow only when the ENTIRE loop is closed. If either switch is open, the whole loop is broken and no current flows anywhere, so neither lamp glows.

(i) S2 is ON, S1 is OFF:
S1 is open, so the series loop is broken. No current flows through any part of the circuit.
Neither L1 nor L2 will glow.

(ii) S2 is OFF, S1 is ON:
S2 is open, so the series loop is broken. Even though S1 is closed, current cannot complete the loop.
Neither L1 nor L2 will glow.

(iii) Both S1 and S2 are ON:
Both switches are closed, so the series loop is complete. Current flows through the whole loop.
Both L1 and L2 glow.

(iv) Both S1 and S2 are OFF:
Both switches are open — the loop is broken. No current flows.
Neither L1 nor L2 will glow.

So the lamps glow only when BOTH switches are ON (case iii).

Answer: (i) Neither; (ii) Neither; (iii) Both L1 and L2; (iv) Neither. In this single series loop, both lamps glow only when both switches are ON.

Q7 Vidyut has made the circuit as shown in Fig. 3.19. Even after closing the circuit, the lamp does not glow. What can be the possible reasons? List as many possible reasons as you can for this faulty operation. What will you do to find out why the lamp did not glow? [Fig. 3.19 shows a simple closed circuit with a cell, switch (closed), lamp, and wires.]

SOLUTION

Possible reasons why the lamp does not glow even though the circuit is closed:

1. The lamp's filament is broken (fused) — a broken filament stops the flow of current.
2. The electric cell is discharged (dead) — a dead cell cannot supply current.
3. The insulating (plastic/rubber) covering was not removed from the wire ends — insulation prevents metal-to-metal contact, leaving an effective open circuit.
4. A wire has come loose from a terminal — this creates a hidden break in the circuit.
5. The lamp is not fitted properly in the lamp holder — poor contact prevents current from passing through the lamp.
6. The cell is not fitted properly in the cell holder — poor contact means current cannot leave the cell.
7. One or more connecting wires themselves are broken inside their covering.

How to find out why the lamp did not glow:
— Build a working conduction tester (a known good cell + lamp).
— Test each component and wire one by one by touching the tester's free ends to both terminals of the component.
— If the tester lamp glows, that component/wire is working; if it does not glow, that component/wire is the fault.
— Start by testing the cell, then the lamp, then each wire segment in turn until the faulty component is identified.

Answer: Possible faults: fused lamp filament, dead cell, insulation not stripped from wire ends, loose connection, lamp or cell not properly fitted, broken wire. Test each component with a working conduction tester to locate the fault.

Q8 In Fig. 3.20, in which case(s) the lamp/LED will not glow when the switch is closed? [Fig. 3.20 shows four series circuits, each with a switch: (a) an incandescent lamp with a single cell; (b) an incandescent lamp with a single cell; (c) an LED with a battery; (d) an LED with a battery. The LED points the same way in (c) and (d), but the battery is connected the opposite way round in the two cases.]

SOLUTION

Recall from the chapter: 'Electric current can pass through an LED in one direction only.' An LED glows only when its positive terminal (longer wire) is connected towards the positive terminal of the battery. An incandescent lamp, however, has a plain filament and glows no matter which way the current flows through it.

Case (a) — an incandescent lamp in series with a cell and a closed switch:
The circuit is complete and the lamp does not depend on polarity, so it GLOWS.

Case (b) — again an incandescent lamp in series with a cell and a closed switch:
Same as (a): a complete circuit with a polarity-independent lamp, so it GLOWS.

Case (c) — an LED with the battery connected so that current is pushed against the LED's forward direction (the LED is reverse-connected relative to the battery):
Current can pass through an LED in one direction only. Here the connection is the wrong way round, so no current flows through the LED.
The LED does NOT glow.

Case (d) — the SAME LED, but the battery is connected the opposite way round to (c), so now current is pushed in the LED's forward (glow) direction:
The LED is correctly forward-connected, current flows through it, so it GLOWS.

Therefore the lamp/LED fails to glow ONLY in case (c).

Answer: Only in case (c) — there the LED is connected the wrong way round with respect to the battery, and current cannot pass through an LED in the reverse direction. In (a) and (b) the incandescent lamps glow regardless of polarity, and in (d) the LED is correctly forward-connected, so all three glow.

Q9 Suppose the '+' and '–' symbols cannot be read on a battery. Suggest a method to identify the two terminals of this battery.

SOLUTION

Method: Use a working LED (whose positive and negative terminals are known) and two wires.

Step 1: Connect one wire to each terminal of the unknown battery.
Step 2: Connect the other ends of the wires to the two terminals of the LED — any way first.
Step 3: Observe whether the LED glows.

If the LED glows: the terminal of the battery connected to the longer wire of the LED is the positive (+) terminal, and the terminal connected to the shorter wire is the negative (−) terminal.

If the LED does not glow: swap the connections (interchange the two wires at the LED or at the battery). The LED will now glow. Identify the terminals as above.

This works because: as stated in the chapter, 'Electric current can pass through LED in one direction only' — the LED glows only when its positive terminal (longer wire) is connected to the positive terminal of the battery and its negative terminal (shorter wire) to the negative terminal. So the LED acts as a polarity indicator.

Answer: Connect an LED to the battery. The terminal connected to the LED's longer wire (positive terminal) when the LED glows is the battery's positive terminal; the other is negative.

Q10 You are given six cells marked A, B, C, D, E, and F. Some of these are working and some are not. Design an activity to identify which of them are working.
(i) List the items that you require.
(ii) Write the procedure that you will follow.
(iii) With the items, carry out the activity to identify the cells that are working.

SOLUTION

(i) Items required:
— Six cells labelled A, B, C, D, E, F (to be tested)
— One cell holder
— One incandescent torch lamp
— One lamp holder

— Two lengths of electric wire (with insulation removed from both ends)

(ii) Procedure:
Step 1: Assemble a conduction tester — connect one wire from the lamp holder to the cell holder (positive-terminal side), and another wire from the lamp holder's other terminal to the cell holder (negative-terminal side), leaving the cell holder empty.
Step 2: Place cell A in the cell holder, making sure its positive terminal faces the correct side.
Step 3: Observe whether the lamp glows.
Step 4: If the lamp glows, cell A is working. If the lamp does not glow, cell A is not working (dead).
Step 5: Remove cell A and repeat Steps 2–4 for cells B, C, D, E, and F, one at a time.
Step 6: Record results in a table.

(iii) Expected observations and conclusion:
— If the lamp glows when a cell is inserted: that cell is working (has sufficient electrical energy to drive current through the circuit).
— If the lamp does not glow: that cell is not working (discharged/dead).
Record the results for all six cells to identify which are working and which are not.

Answer: Use a lamp-and-holder tester; insert each cell one at a time — lamp glows = cell working, lamp does not glow = cell dead.

Q11 Using an LED that requires two cells in series to glow, Tanya made the circuit as shown in Fig. 3.21. Will the lamp glow? If not, draw the wires for correct connections. [Fig. 3.21 shows two cells stacked one above the other, each with '−' on the left and '+' on the right. A black wire joins the two LEFT (negative) ends of the cells together, while the two RIGHT (positive) ends are led out by separate wires to the LED.]

SOLUTION

No, the LED will not glow in Tanya's circuit as shown in Fig. 3.21.

For an LED that needs two cells to glow, the two cells must first be joined in SERIES — the positive (+) terminal of one cell to the negative (−) terminal of the other — so that their voltages add up. The battery's free ends are then a single + terminal and a single − terminal.

In Fig. 3.21 the cells are wired incorrectly: the black wire joins the two NEGATIVE (−) terminals together, and both POSITIVE (+) terminals are taken out to the LED. Connecting the two cells negative-to-negative does not make a proper series battery — their voltages do not add up to drive the LED, so it cannot get the two cells' worth of voltage it needs.
The chapter also notes that current passes through an LED in one direction only, with the LED's positive (longer wire) terminal towards the battery's positive terminal — which this wiring does not provide either.
As a result no useful current flows and the LED does not glow.

Correct connection:
— Join the two cells in series: connect the '+' terminal of the top cell to the '−' terminal of the bottom cell. This leaves one free '−' terminal and one free '+' terminal for the battery.
— Connect the LED's positive terminal (longer wire) to the battery's '+' terminal.
— Connect the LED's negative terminal (shorter wire) to the battery's '−' terminal.
— Now the two cells add up in series and drive current through the LED in its forward direction, so it glows.

Answer: No — the two cells are wired negative-to-negative (both positive terminals go to the LED), so they are not in proper series and their voltages do not add. Correct it by joining the cells in series (+ of one to − of the other), then connect the battery's + to the LED's longer wire (+) and the battery's − to the LED's shorter wire (−).