CAIE Physics A-level

10 - D.C. Circuits

Flashcards

What is meant by electromotive force and what common abbreviation is used for this term?

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Electromotive force or emf is the work done by an energy source in driving charge around the entire circuit, per unit charge.

Considering energy, what is the main difference between emf and potential difference (pd)?

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Electromotive force or emf is the work done by an energy source in driving charge around the entire circuit, per unit charge. The potential difference between two points in a circuit is the work done transferring charge from these two points, per unit charge. The circuit Pd does not account for the internal resistance within the battery/cell, the emf does.

Define internal resistance.

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Internal resistance is the resistance within a power source due to the materials and components which make it up.

How does the internal resistance affect the terminal potential difference?

How does the internal resistance affect the terminal potential difference?

$$\varepsilon = V + Ir$$

Where ‘ε’ is the emf, ‘V’ is the terminal pd, ‘I’ is the current and ‘r’ is the internal resistance.

Therefore $V = \varepsilon - Ir$, so the larger the internal resistance in the source, the smaller the terminal pd.

True or false? The emf of a source and its terminal voltage will always be the same.

True or false? The emf of a source and its terminal voltage will always be the same.

False.

Not all of the energy given to the charges in the source (e.m.f) makes it out of the cell.

What are 'lost volts'?

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‘Lost volts’ refer to the difference in voltage between that supplied by the source and the amount available to the circuit.

They are ‘lost’ due to the internal resistance of the source.

Lost volts = Ir

Give an equation which relates e.m.f to load and internal resistance.

Give an equation which relates e.m.f to load and internal resistance.

$$\varepsilon = I(R+r)$$

Where ε = e.m.f, I = current, R = load resistance, and r = internal resistance.

In other words: e.m.f = IR + Ir = V + v

Where V = terminal voltage (ie. volts used in the circuit), v = lost volts (ie. volts used in the source).

Describe an experiment to determine the internal resistance of a source.

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Set up a circuit with a source, ammeter and variable resistor in series, and a voltmeter in parallel.

Vary the resistance and measure the voltage and current (take several readings).

Plot a V-I graph.

$V = -rI + \varepsilon$ corresponds to $y=mx+c$

The internal resistance = -m (-gradient).

What is Kirchhoff's first law?

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The total current going into a junction is equal to the total current leaving the junction.

(i.e. charge is conserved)

What is Kirchhoff's second law?

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For any path (loop) of a circuit, the sum of all of the potential differences must equal the total emf of the circuit.

How would you derive an expression that defines the total resistance in a series circuit from Kirchoff's second law?

How would you derive an expression that defines the total resistance in a series circuit from Kirchoff's second law?

Kirchoff's second law dictates that:

$$V_{Total} = V_1 + V_2 + V_3 + \dots$$

Therefore, provided the current is invariant

$$R_{Total} = R_1 + R_2 + R_3 + \dots$$

How do you find the total resistance in a parallel circuit?

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How do you find the total resistance in a parallel circuit?

Kirchoff's laws dictate that when in parallel, for each component:

$$V_{Total} = V_1 = V_2 = V_3 \text{ etc.}$$

This yields the following statement for the resistances of the components:

$$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3 + ...$$

True or false? Adding a resistor to a circuit in parallel will always reduce the total resistance.

True or false? Adding a resistor to a circuit in parallel will always reduce the total resistance.

True.

Total resistance drops the more paths there are for the current to take.

How can you measure the current in a circuit?

How can you measure the current in a circuit?

You can measure the current in a circuit with an ammeter connected in series.

How do you measure the potential difference of a component?

How do you measure the potential difference of a component?

Using a voltmeter, connected in parallel across the component being measured.

True or false? In parallel circuits the total voltage in each loop is the same.

True or false? In parallel circuits the total voltage in each loop is the same.

True.

$$V_{total} = V_1 = V_2 = V_3$$

How do you calculate the total voltage in series circuits?

How do you calculate the total voltage in series circuit circuits?

$$V_{total} = V_1 + V_2 + V_3 + \ldots\ldots$$

How does the current vary between each component of a series circuit?

How does the current vary between each component of a series circuit ?

The current through all of the components is the same. The current does not vary.

Is the current in each component of a parallel circuit the same?

Is the current in each component of a parallel circuit the same?

No, each branch of a parallel circuit has different currents.

The voltage across each branch must remain the same in order to uphold Kirchoff's second law. The higher the resistance of a branch, the lower the current flow through that branch will be.

If you connect two cells in series what will be the total emf?

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$$\varepsilon_{total} = \varepsilon_1 + \varepsilon_2.$$

In a series circuit, if two cells are connected negative to negative, would their emfs add up or cancel out?

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They will cancel out. The total emf would be equal to:

$$\varepsilon_{total} = \varepsilon_1 - \varepsilon_2.$$

What is the purpose of a potential divider?

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To provide variable potential difference, or to provide a constant specific potential difference.

How does the voltage across a component in a potential divider correspond to its resistance?

How does the voltage across a component in a potential divider correspond to its resistance?

The proportion of the total voltage which is dropped across the component is equal to the proportion of the circuit resistance which it contributes.

In other words: $V/V_T = R/R_T$

How can a potential divider circuit be used as a sensing circuit? (eg. to switch on a fan when it gets warm)

Draw an example of a potential divider that provides A: a constant and specific pd and B: a pd that can be varied?

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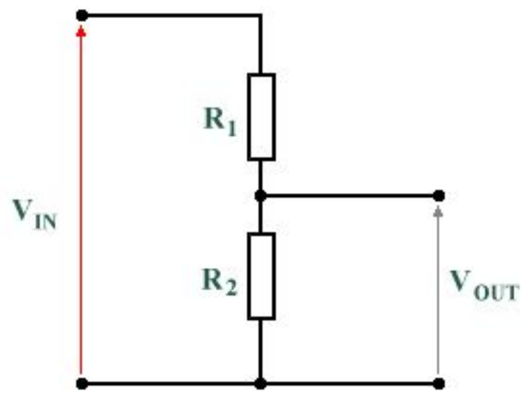
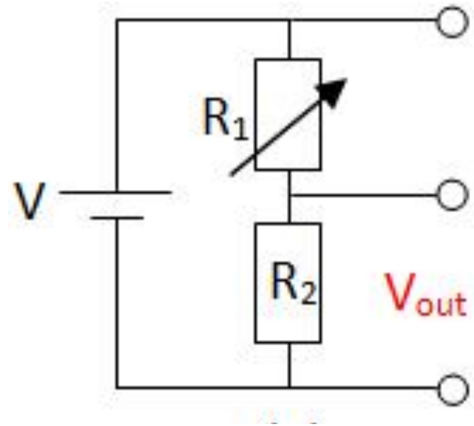
A:



B:



What is a potentiometer?

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A potentiometer consists of a voltmeter, and a three-terminal resistor.

What is the principle of the potentiometer?

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The principle of the potentiometer is that the potential across a segment of wire of uniform cross-section, carrying a constant current is directly proportional to its length.

How do potentiometers work?

How do potentiometers work?

They have a control which allows for the resistance between terminals to be adjusted, while the resistance between the two outer terminals remains fixed. Adjusting the resistances allows for the potential difference in parts of the circuit to be compared.

What are galvanometers used for?

What are galvanometers used for?

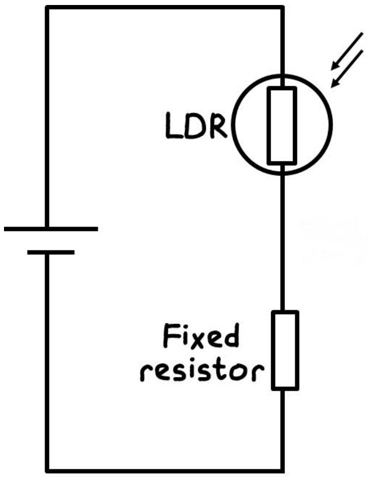
Galvanometers are used to directly measure the emf of the circuit. If the terminal pd (V) is set to zero, the emf, now equal to the voltage of the source (Ir) can be measured. Note that: $\varepsilon = V + Ir$, so if $V=0$, $\varepsilon = Ir$

How can a potential divider circuit be used as a sensing circuit? (eg. to switch on a fan when it gets warm)

Put a resistor that varies with the desired conditions (eg. a thermistor) in the potential divider. Insert the responding load (eg. fan) over either the variable or fixed resistor depending on how the circuit should work.

E.g. In this case as temperature increases, the resistance of the thermistor decreases and so the voltage across it will decrease and the voltage across the other resistor will increase. Therefore, put the fan in parallel with the fixed resistor and as temperature increases it will turn on.

Where should a bulb go to turn this circuit into a light-sensing circuit which switches the light on when it's dark?



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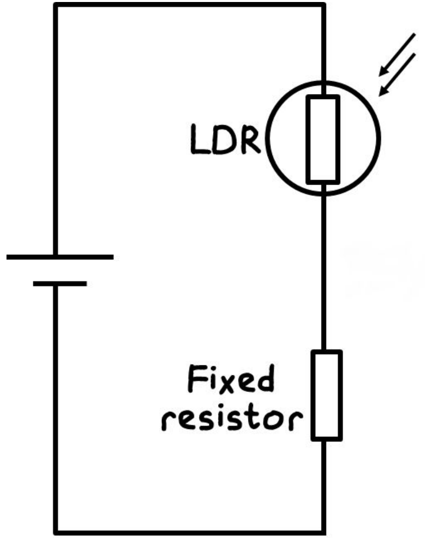

It should be added in parallel with the LDR.

What equation can be used to calculate the voltage out of a potential divider in terms of the input voltage and the resistances in the circuit?

What equation can be used to calculate the voltage out of a potential divider in terms of the input voltage and resistances in the circuit?

$$V_{out} = (R_{out}/R_{total}) \times V_{in}$$

Explain the use of thermistors in potential divider circuits and give a real life example.

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With thermistors, the resistance decreases as the temperature increases. This is because it is a semiconductor. In a fridge freezer if the temperature increases the resistance will decrease causing a larger current so it has more energy to cool.

Explain the use of LDRs in potential divider circuits and give a real life example.

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With LDRs the resistance decreases as the light increases. This is because it is a semiconductor. In a street lamp if the light decreases the resistance will increase, hence turning on the light switch.