



# Welcome to the Theatre of Science IGCSE Physics module on Electricity!

I'm a qualified physics teacher streaming free, interactive lessons via my Facebook page and YouTube channel.

**I'll never hold anything back from students that might help them with their exams.** So these print outs are free, and the suggested homework and further reading pdf is also free.

I'm **entirely** funded by people supporting me at <https://ko-fi.com/theatreofscience>  
If you're finding these lessons useful, contribute towards me wages and I'll post you nice things! I don't need much from each viewer to make it a job; it's a weird and wonderful business model!



# Theatre of Science IGCSE Physics Electricity 1: Static Electricity!

You might want to make notes/sketches while I talk about atoms!

Electrons move **from** the bag **to** your hair.  
So your hair becomes negatively charged.

**WHY** does your hair stand on end though?!

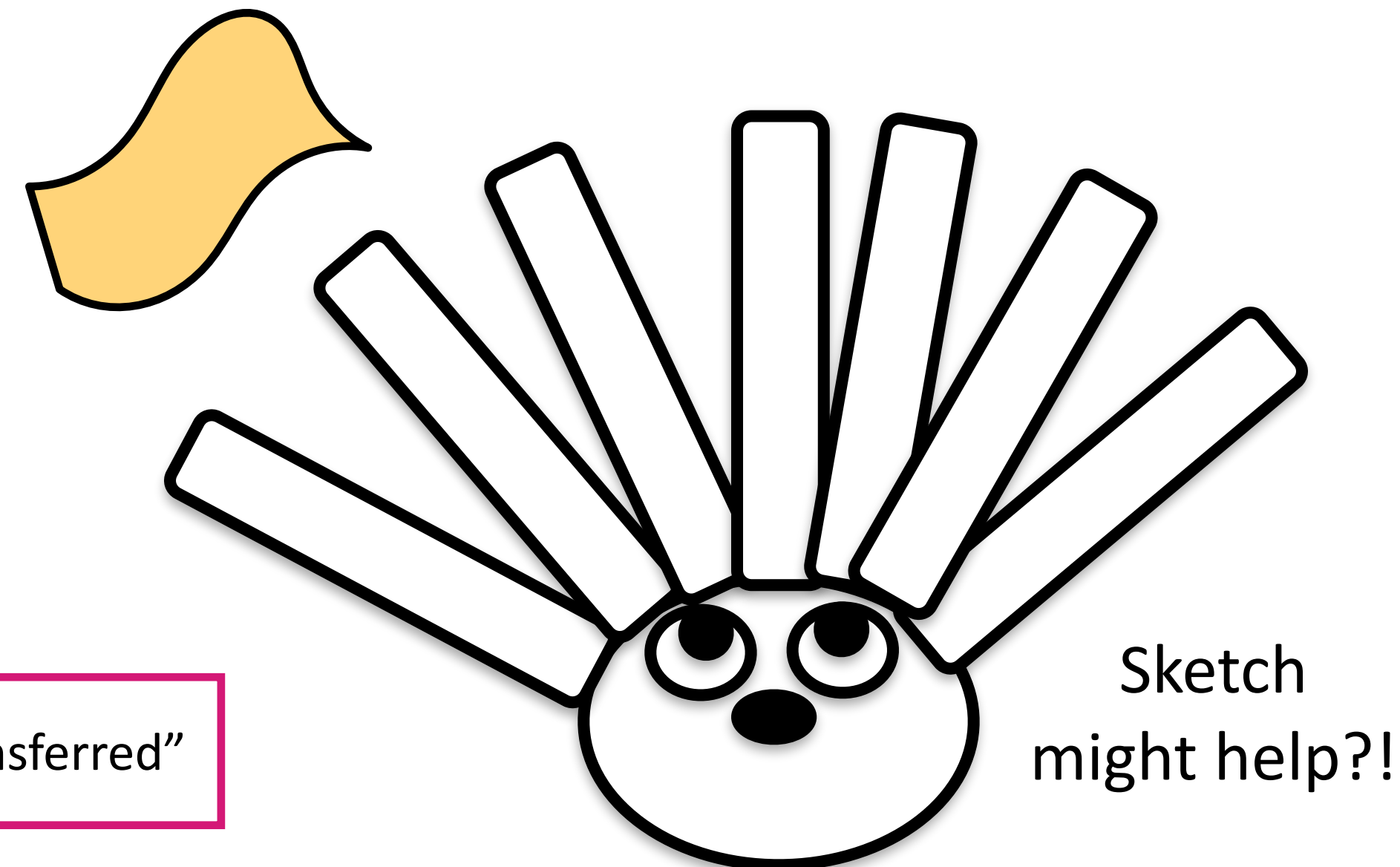
Notes: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

What charge does each object has after the electrons have moved?

If electrons move...

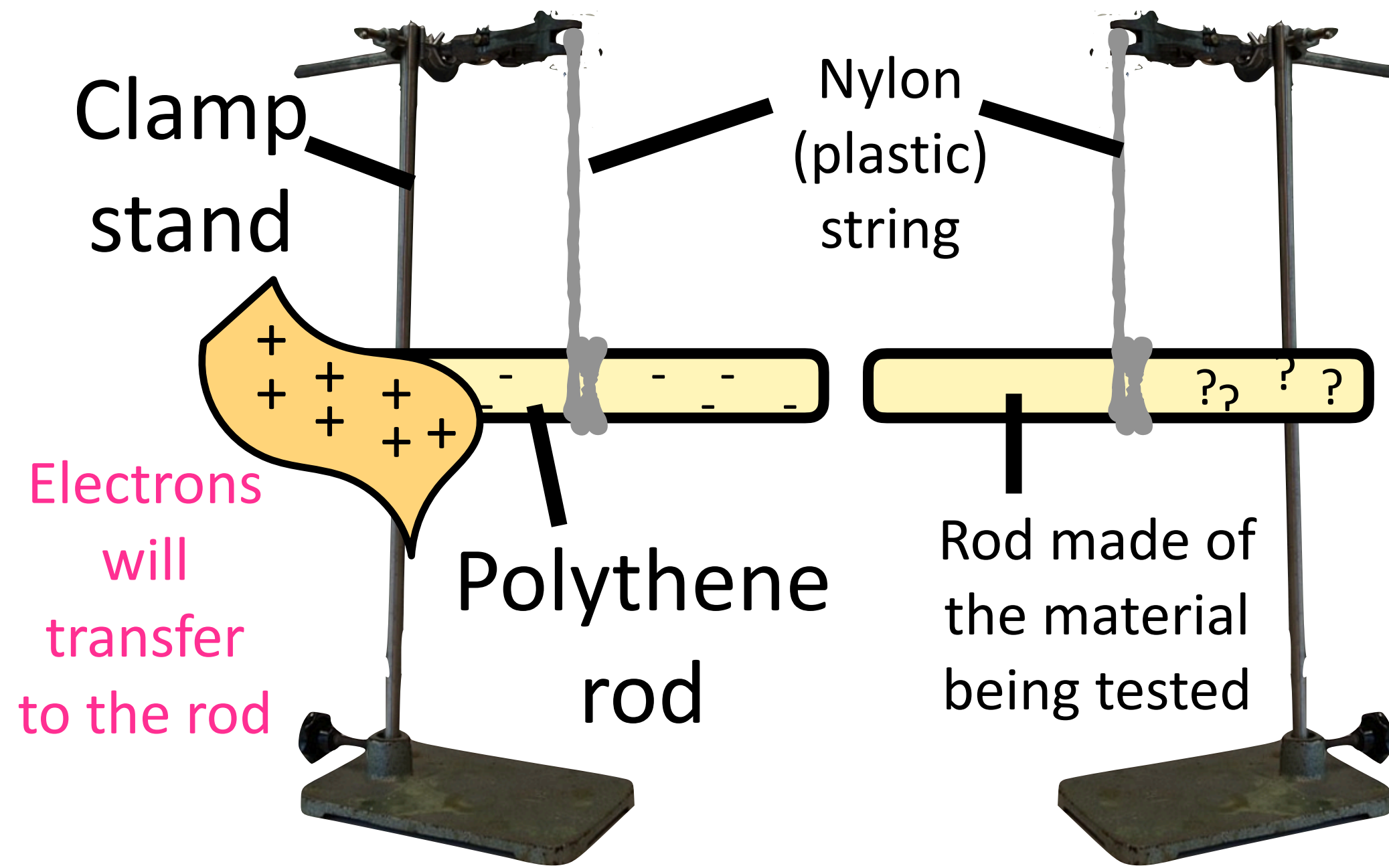
- 1) FROM bag / balloon TO hair. Bag is \_\_\_\_\_ Hair is \_\_\_\_\_
- 2) FROM hair TO wool. Wool is \_\_\_\_\_ Hair is \_\_\_\_\_
- 3) TO you FROM polyester carpet. Carpet is \_\_\_\_\_ You are \_\_\_\_\_

You don't need to remember this! In the exam best just to say "electrons were transferred"



Sketch might help?!

# Simple experiment to detect electrostatic charges



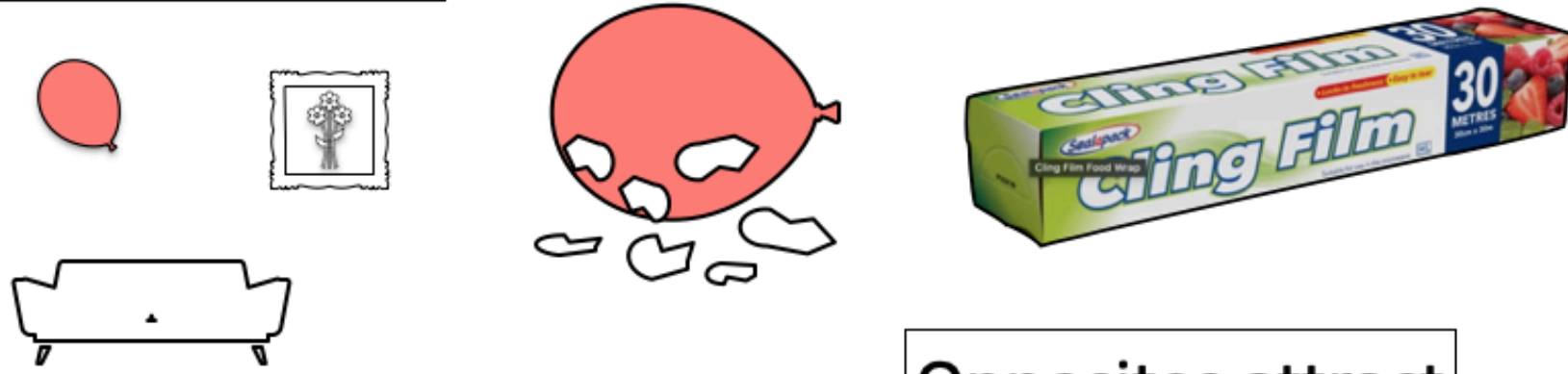
1. Hold the polythene rod in the centre and rub the ends with a cloth.
2. Hang rod from the clamp stand being careful not to touch the ends.
3. Do the same with the rod being tested (using a different cloth)

1. What might you expect the rods to do? (3 options!)
2. Why not use metal wire to hang the rods?
3. I test 8 rods. Name 2 things that must stay the same for each test, to get reliable results. (Eg. Length of rod. Humidity of room).
4. Why is it important to use a different cloth for each rod being tested?



# Theatre of Science IGCSE Physics: Electricity 2: Conductors & Insulators!

I told you *something* last week that wasn't true. But what was it?

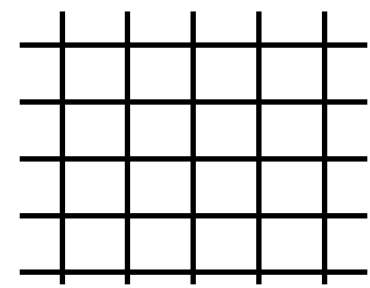


Clue: these pictures prove me wrong!

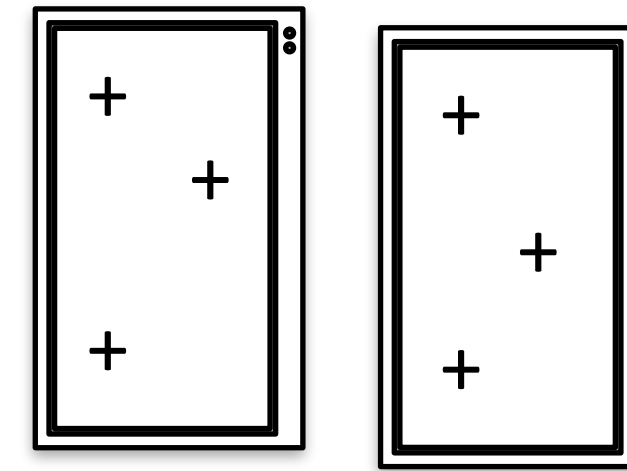
Opposites attract

- Electrons can be transferred between objects
- Charged objects aren't attracted to neutral objects
- Electrons can flow through humans
- Materials can be tested to find out if they're charged
- Electrons can move FROM balloons TO hair
- Atoms have positive charges at their centres

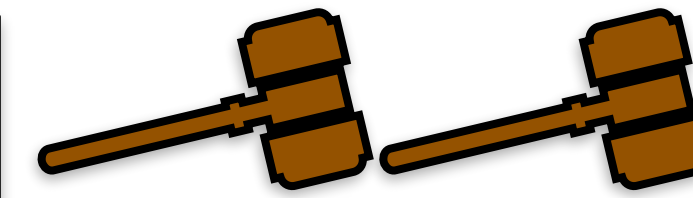
Problem: Coal - burned to produce electricity - releases tiny pieces of ash and dust that cause diseases and damage the environment. You have...



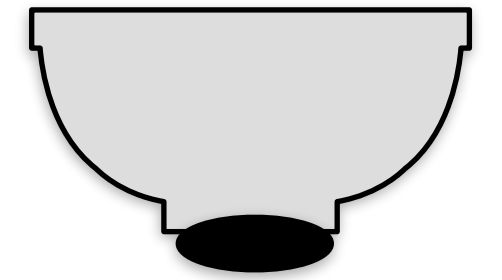
A negatively charged grid



Positively charged metal plates



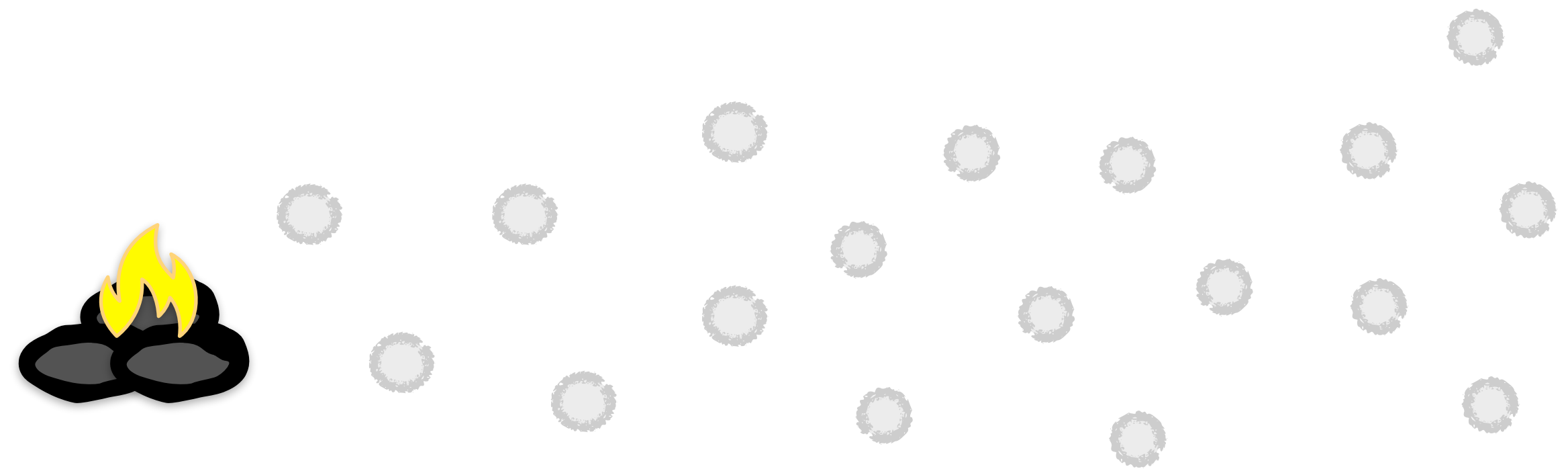
Two hammers that automatically hammer every few minutes!



A funnel (big as you like)

Can you solve the problem?! Sketch your ideas on the picture below.

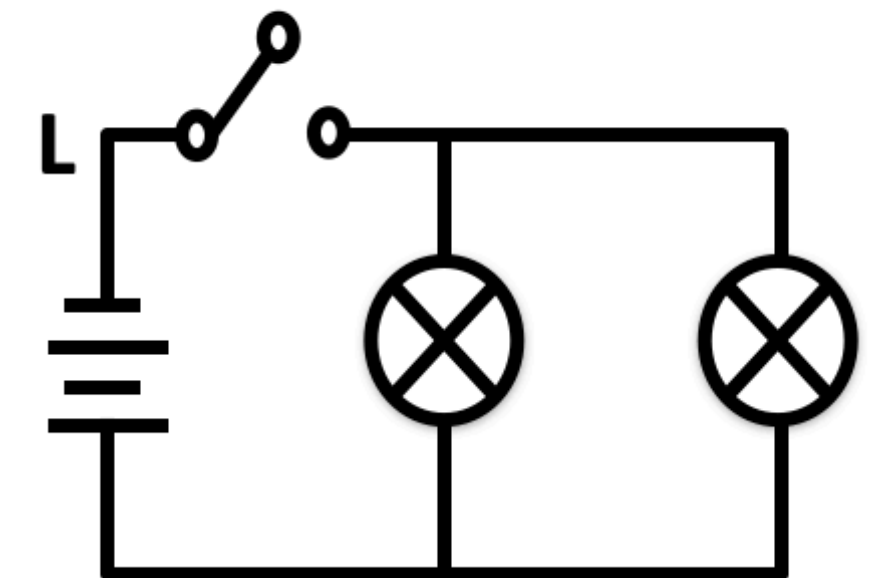
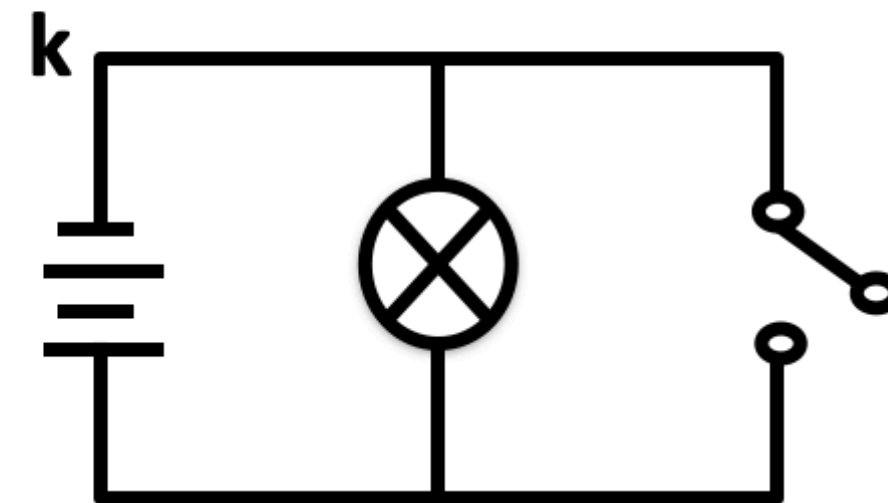
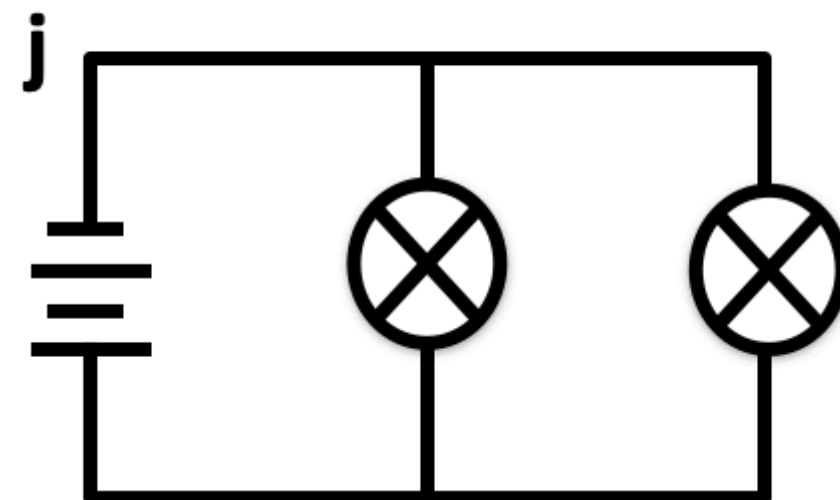
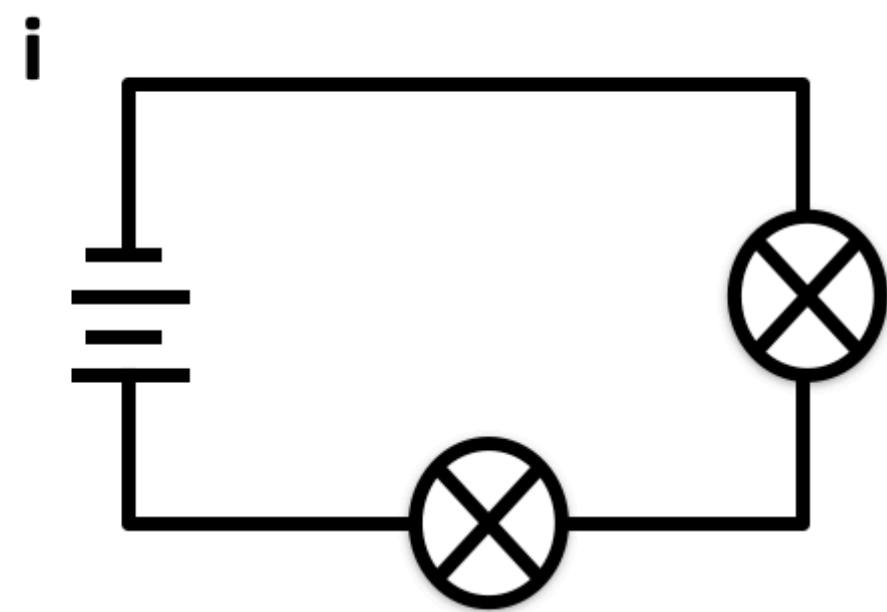
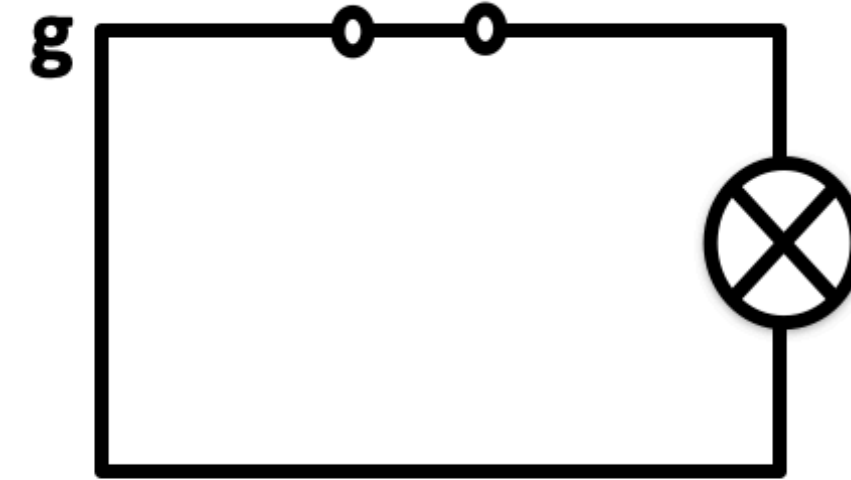
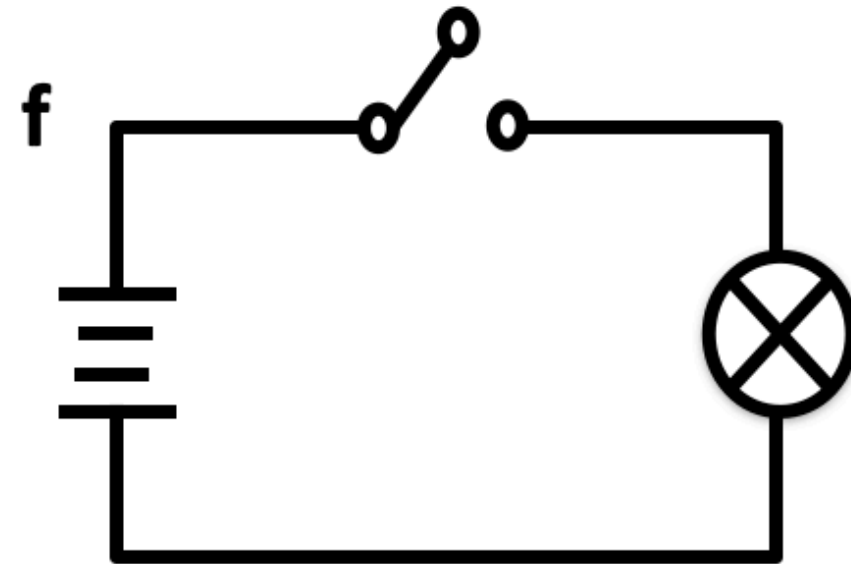
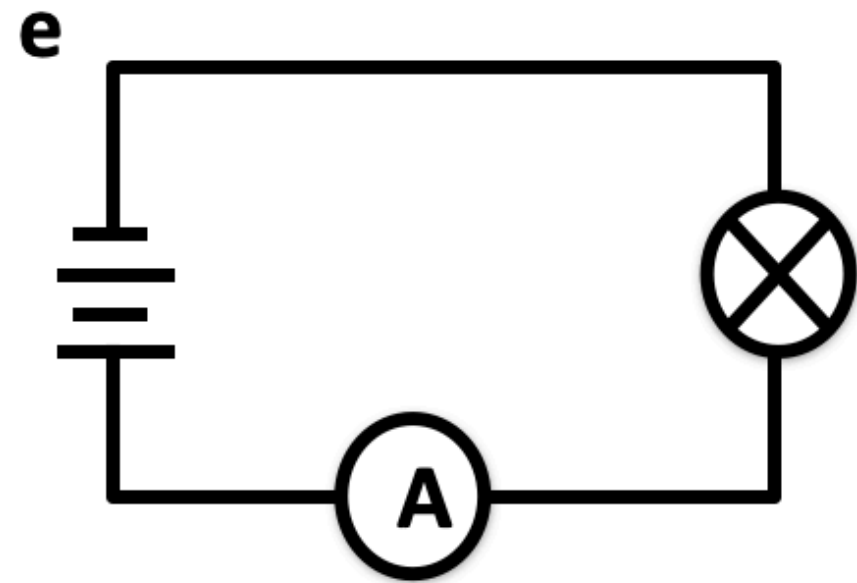
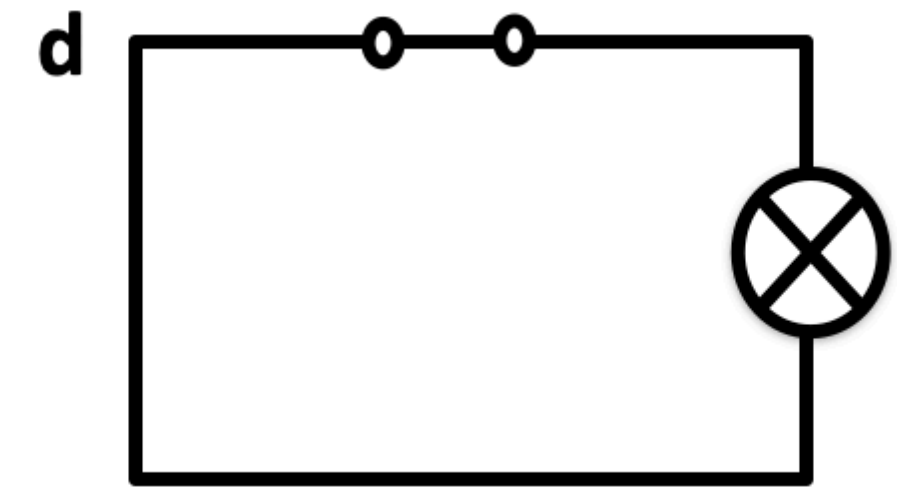
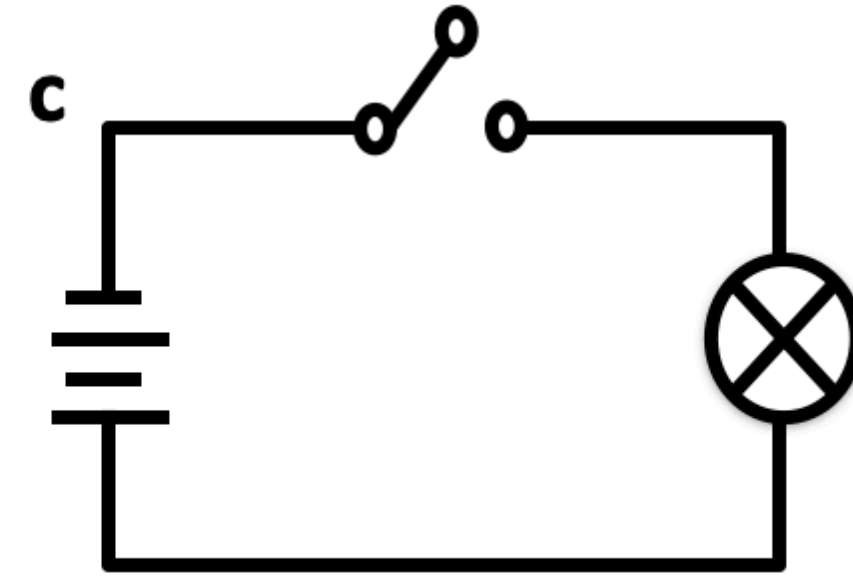
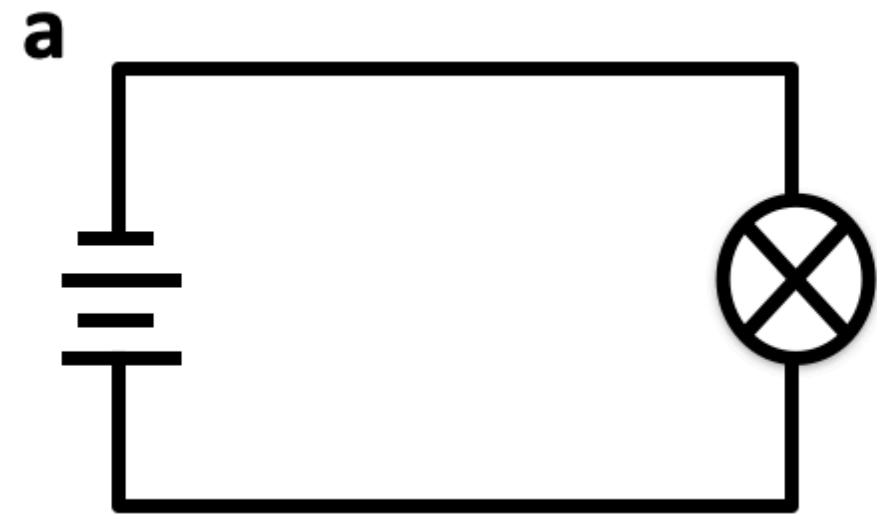
Is the paper charged in this scenario?  
Explain why / why not





# Theatre of Science IGCSE Physics: Electricity 3: Current

Would these bulb light up?!



Extension: what would you see in each case?

1. 4 coulombs of charge passes through a lamp in 1 second. What current is flowing?

2. 9000 coulombs of charge pass through a circuit in 3600 seconds. What current is flowing?

3. The longest lightening flash ever was 30 000 amps and carried a charge of 510 000 coulombs. How many seconds did it last?

4. How long will it take for a 12A current to transfer 2520C of charge? Give your answer in minutes.

$$\text{Current (I)} = \text{Charge (Q)} / \text{Time (t)}$$

5. A light bulb with a current of 0.5 amps flowing through it is left on for ten minutes. How much charge flows through the bulb in that time?

### Past Paper Questions

A current of 20A is the same as

- A: 20 amps per coulomb
- B: 20 coulombs per second
- C: 20 amps per second

### Which symbol shows a battery?



### A bulb lights up. This proves:

- A: A current is flowing
- B: There is a cell connected
- c: There is a battery connected
- D: The bulb is faulty



# Theatre of Science IGCSE Physics: Electricity 4: Voltage

List some differences between the pizza and power station model. Which model do you think is better?

Which of these statements are most accurate? Improve the least accurate ones by changing the sentences!

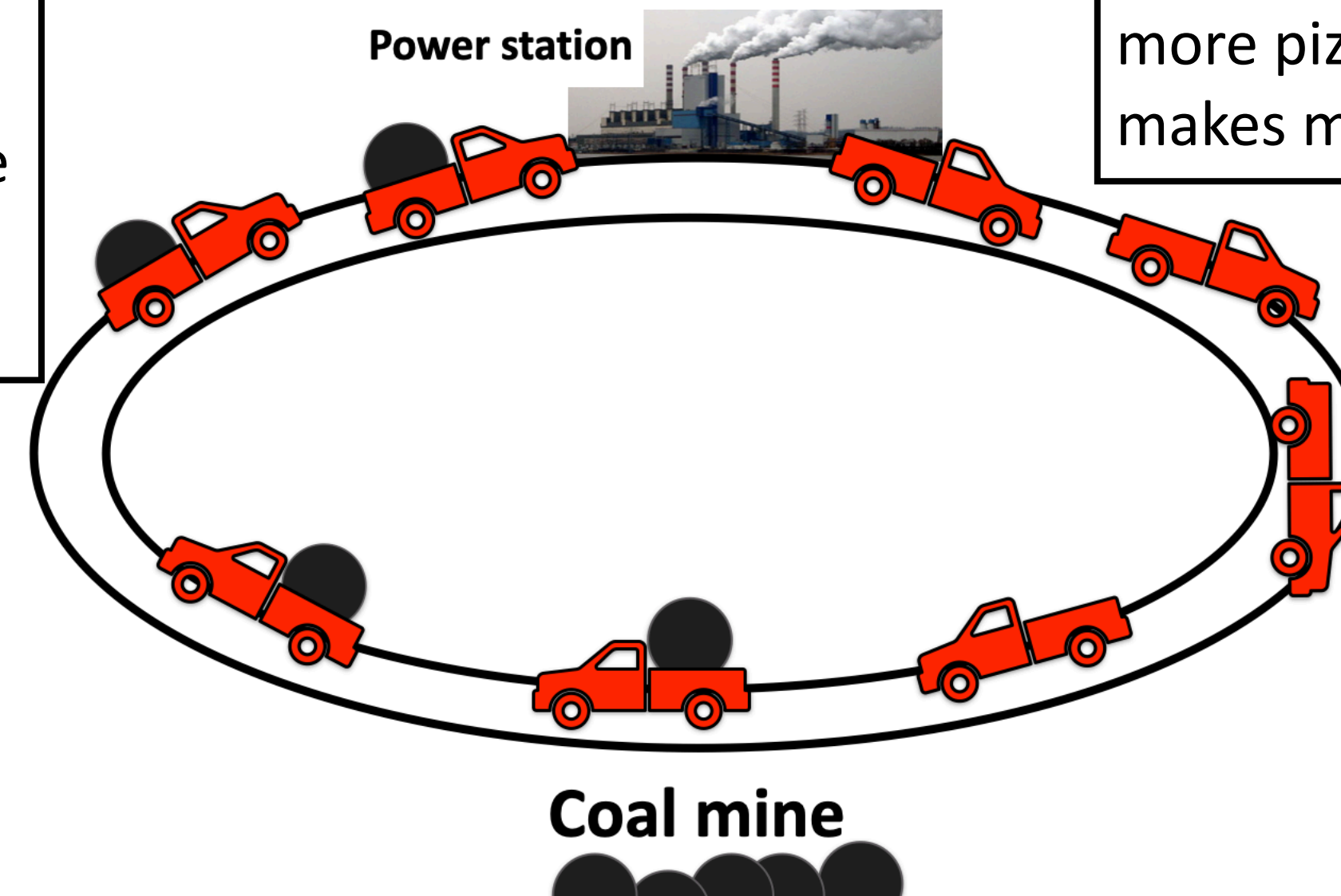
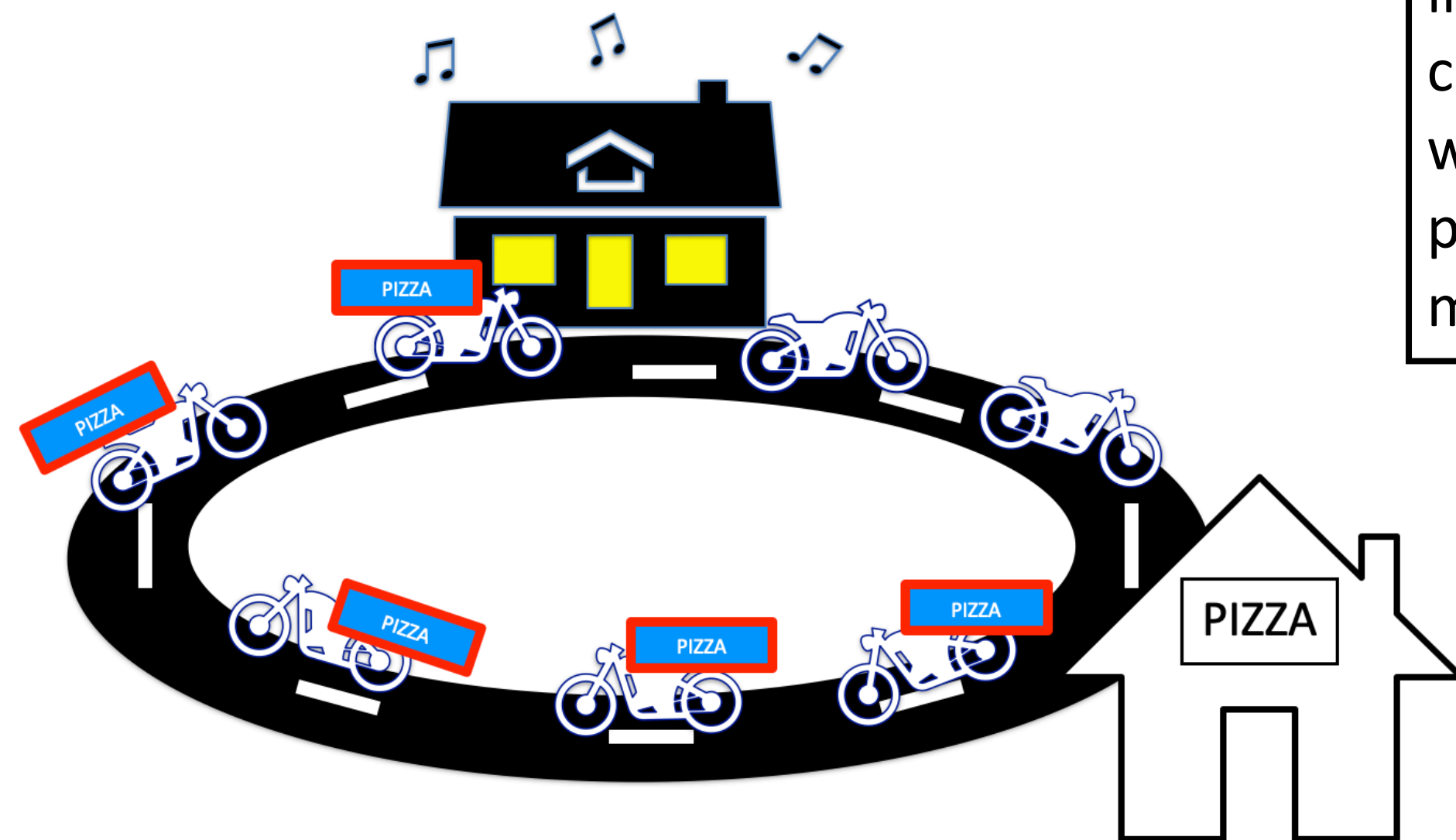
“The power station stops working when the mine runs out of coal. This is like the relationship between a bulb and a battery”

“The potential difference across the battery is represented by how much pizza is made”

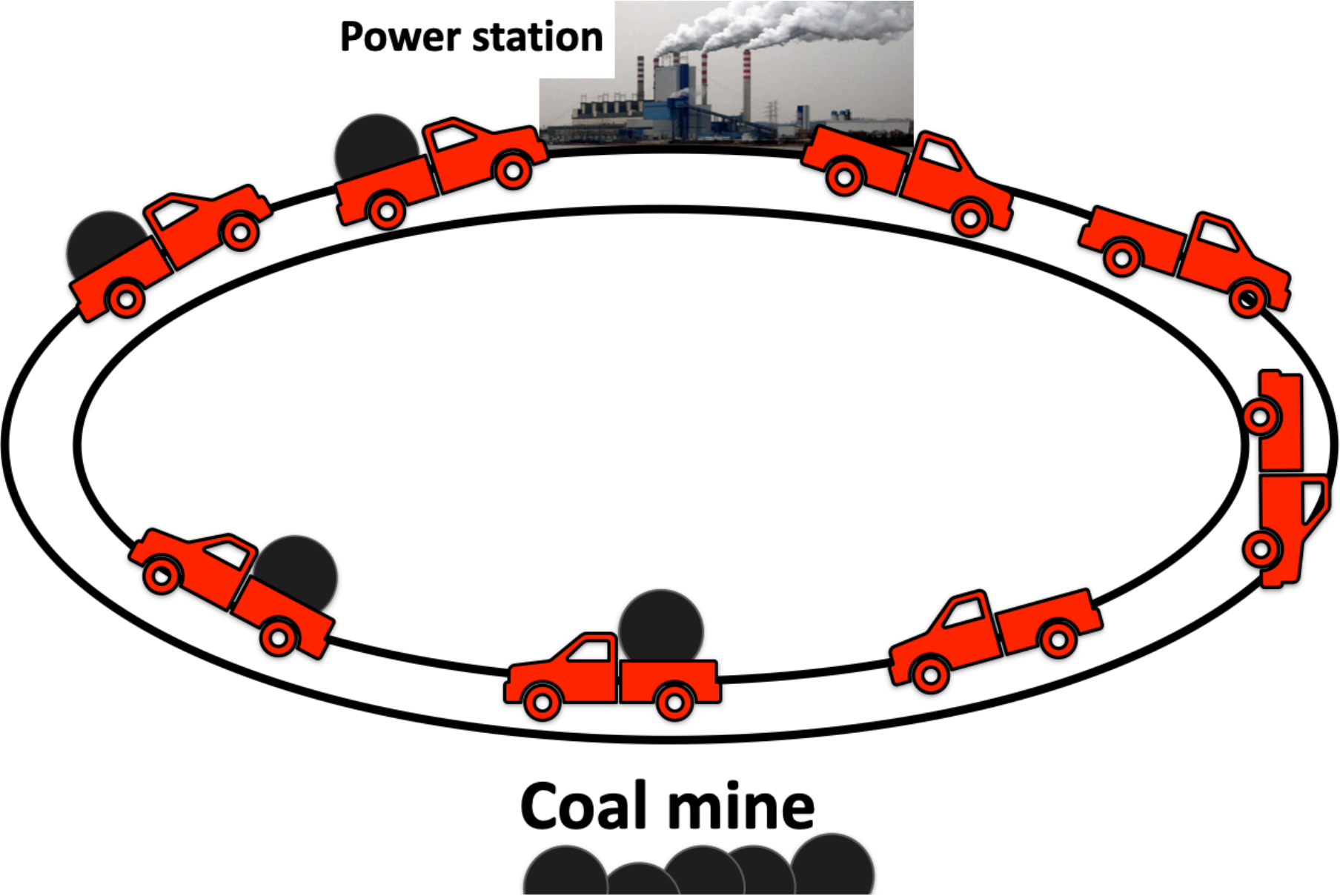
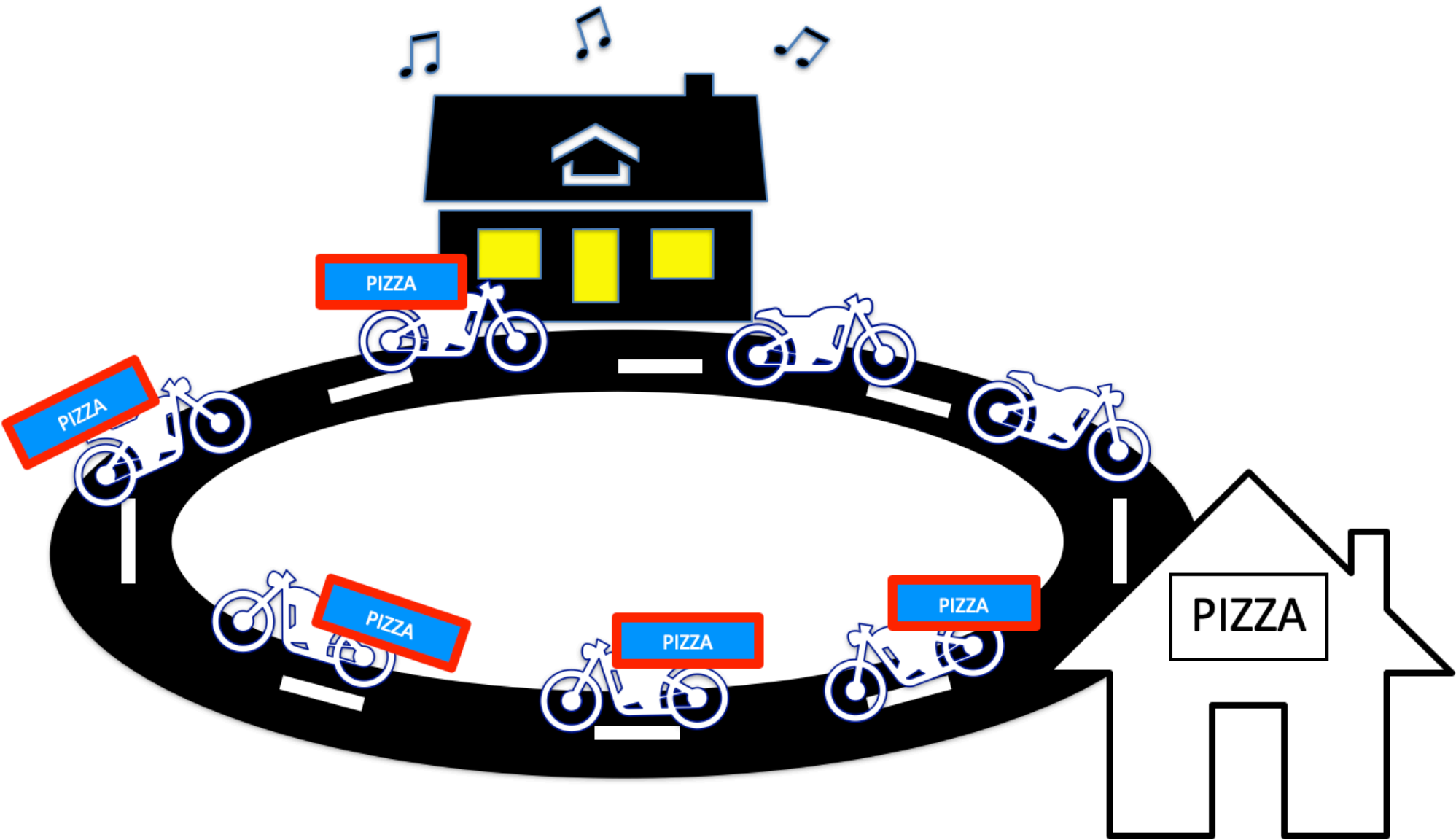
“Adding a cell to a circuit gives the bulb more energy, like adding a coal mine would give the power station more energy”

“The trucks represent electrons. The current is how many electrons pass a point per second”

“If a bulb needs more energy to work, the battery gives more energy to the charges. Just like if a party needs more pizza, the shop makes more pizza”



You may wish to make notes on this page!

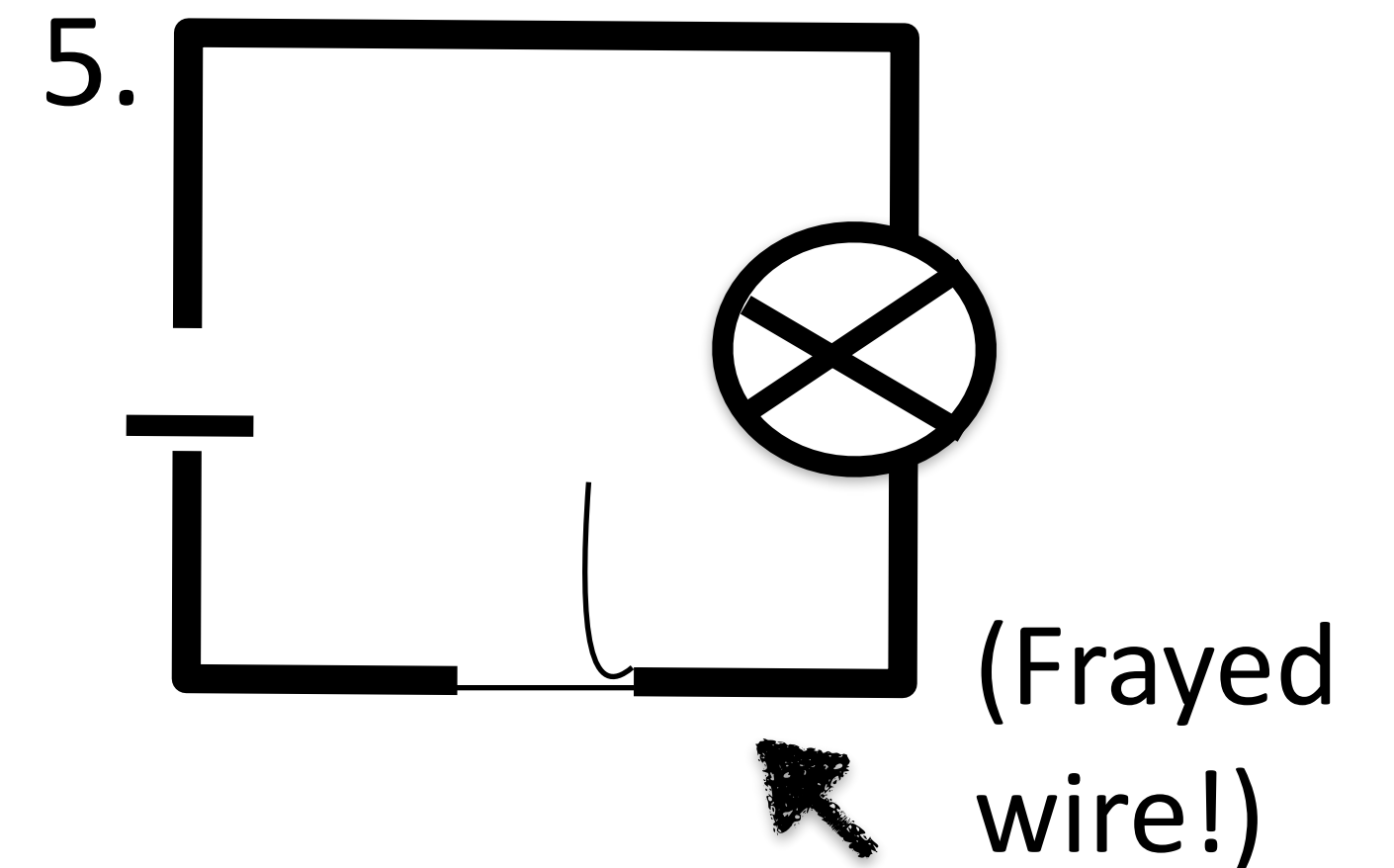
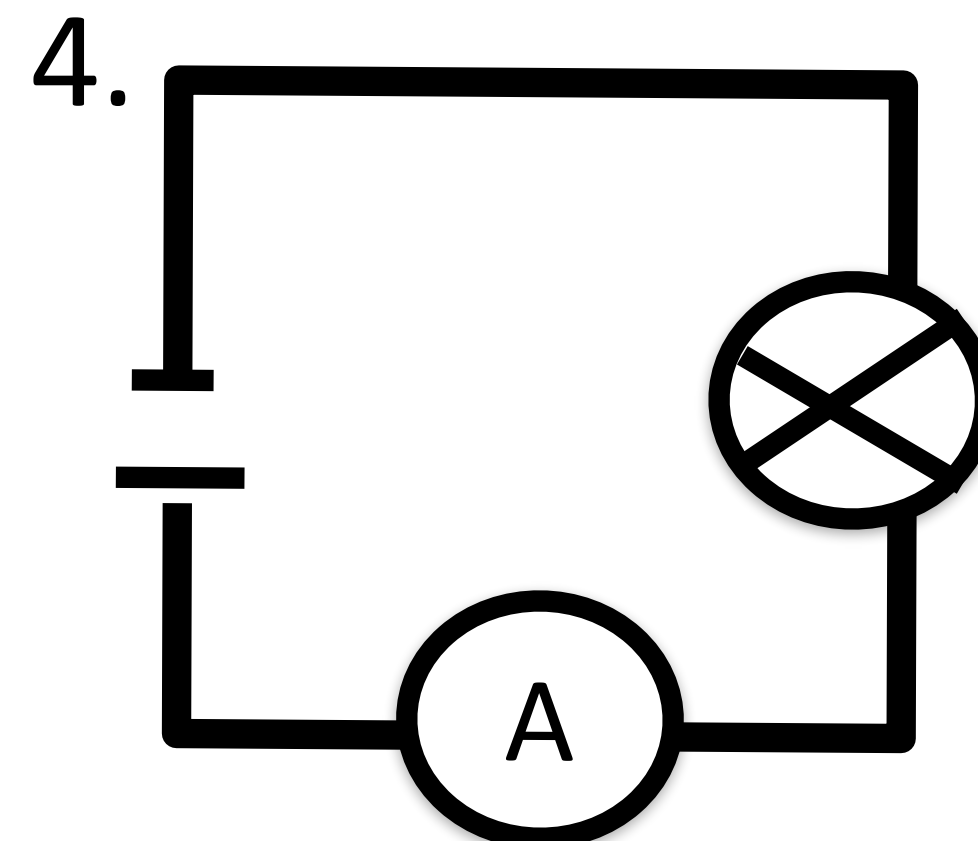
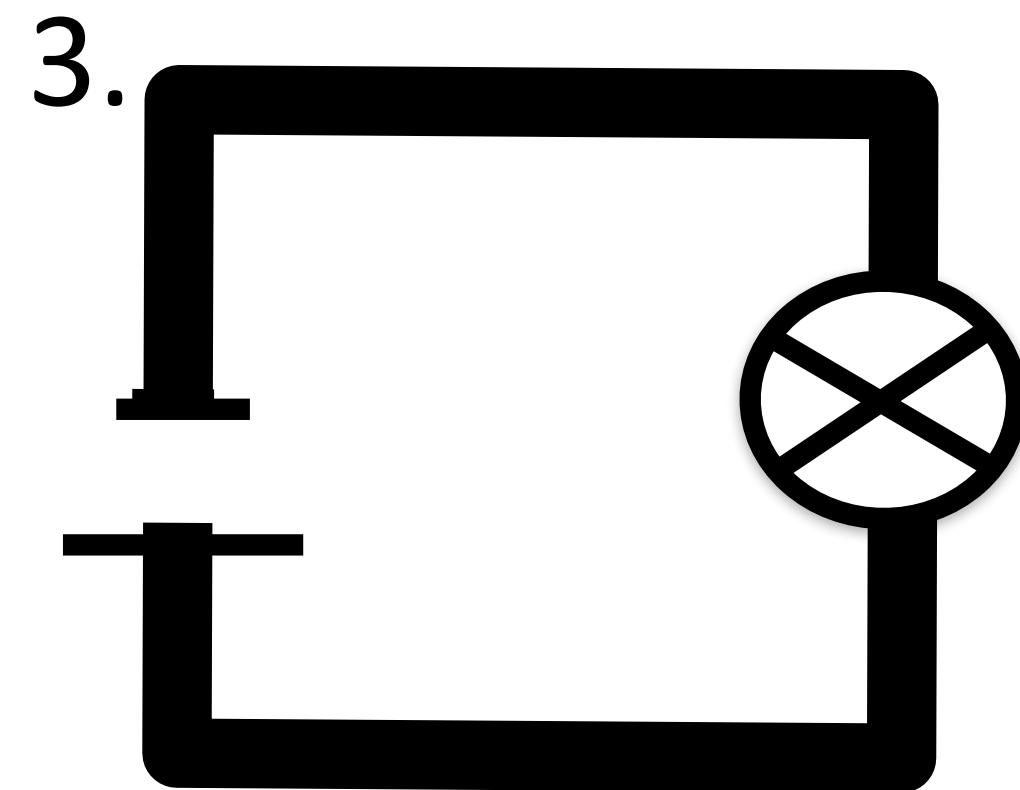
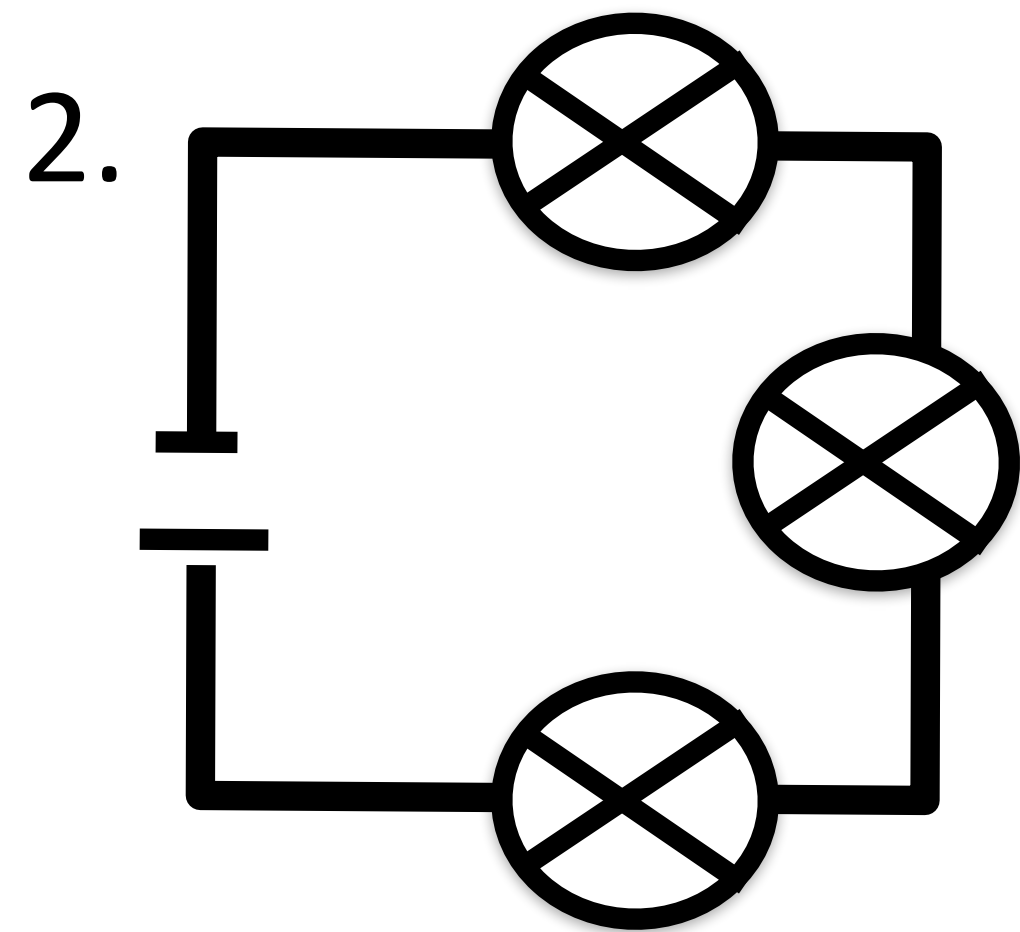
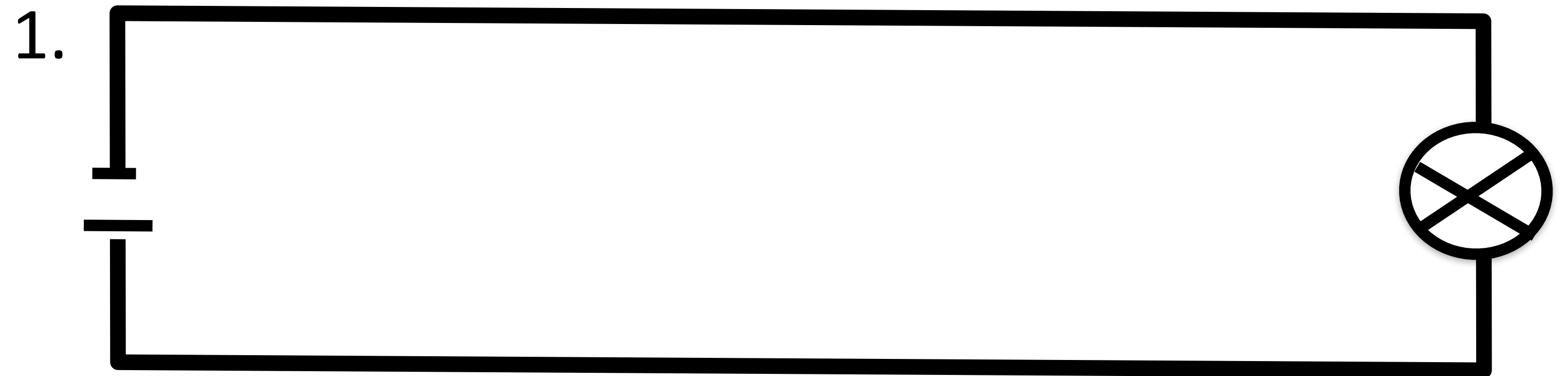
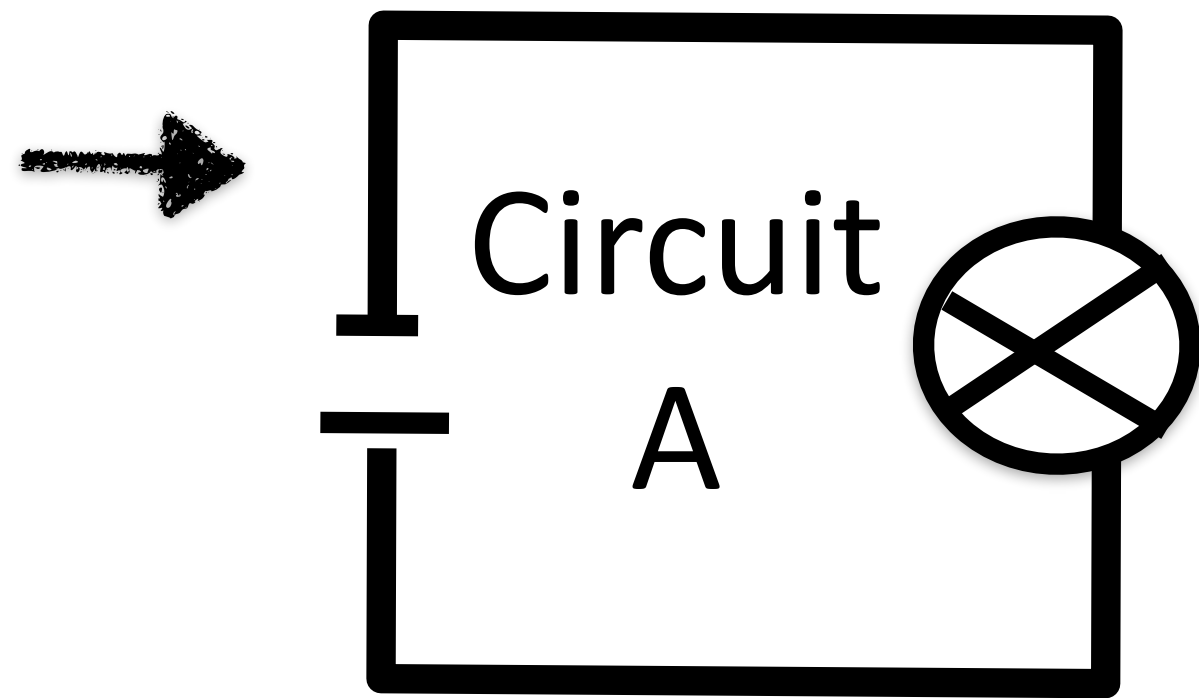






# Theatre of Science IGCSE Physics: Electricity 5: Resistance!

Would the circuits below have more, less, or the same resistance than circuit A? (Would it be harder, easier or no different for the voltage to push the current round them? All bulbs are identical)



# Questions! *Don't forget units!*

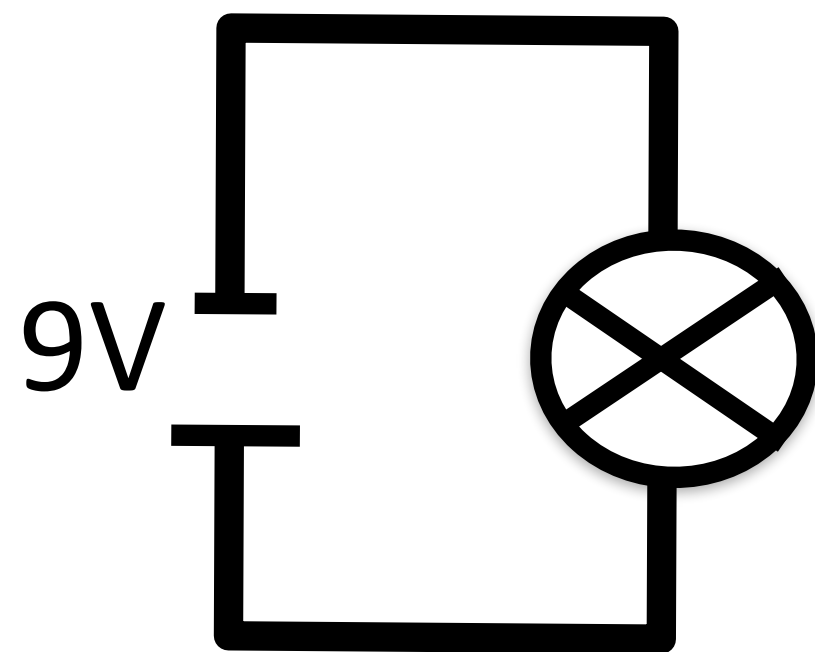
$$\begin{aligned} \text{Current} &= \text{Voltage} \div \text{Resistance} \\ \text{Voltage} &= \text{Resistance} \times \text{Current} \\ \text{Resistance} &= \text{Voltage} \div \text{Current} \end{aligned}$$

1. The current flowing through a bulb is 2A and the Voltage across it is 10V. What's the resistance of the bulb? \_\_\_\_\_

2. The voltage across a battery is 6V. The resistance of the circuit is 3  $\Omega$ . How much current flows through the circuit? \_\_\_\_\_

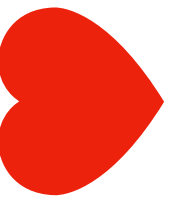
3. A resistor has a voltage across it of 20V and a current of 5A flowing through it. What's the value of the resistor? \_\_\_\_\_

4.



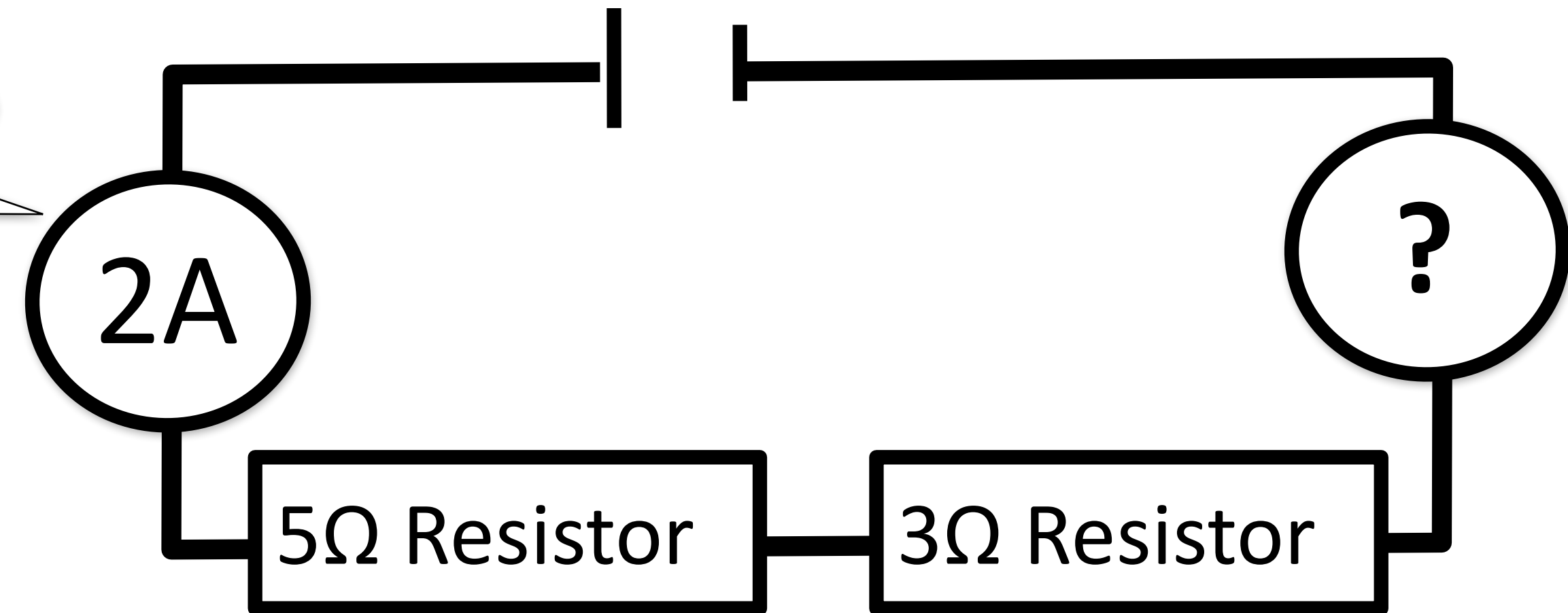
This circuit has 3A flowing through it. What's the bulb's resistance? \_\_\_\_\_

5. I have thicker wires, thinner wires, and a spare bulb. How can I change the circuit in 4. to make the bulb shine brighter?



(Ammeter showing the current's 2 Amps).

Current = Voltage  $\div$  Resistance  
Voltage = Resistance  $\times$  Current  
Resistance = Voltage  $\div$  Current



What's the..?

Total resistance of the circuit \_\_\_\_\_

Reading on the second ammeter \_\_\_\_\_

Voltage across the 5  $\Omega$  resistor \_\_\_\_\_

Voltage across the 3  $\Omega$  resistor \_\_\_\_\_

So what's the voltage of the battery? \_\_\_\_\_

Too hard? Match the answers!

Too easy?  
- What's a quicker way to work out the total voltage?



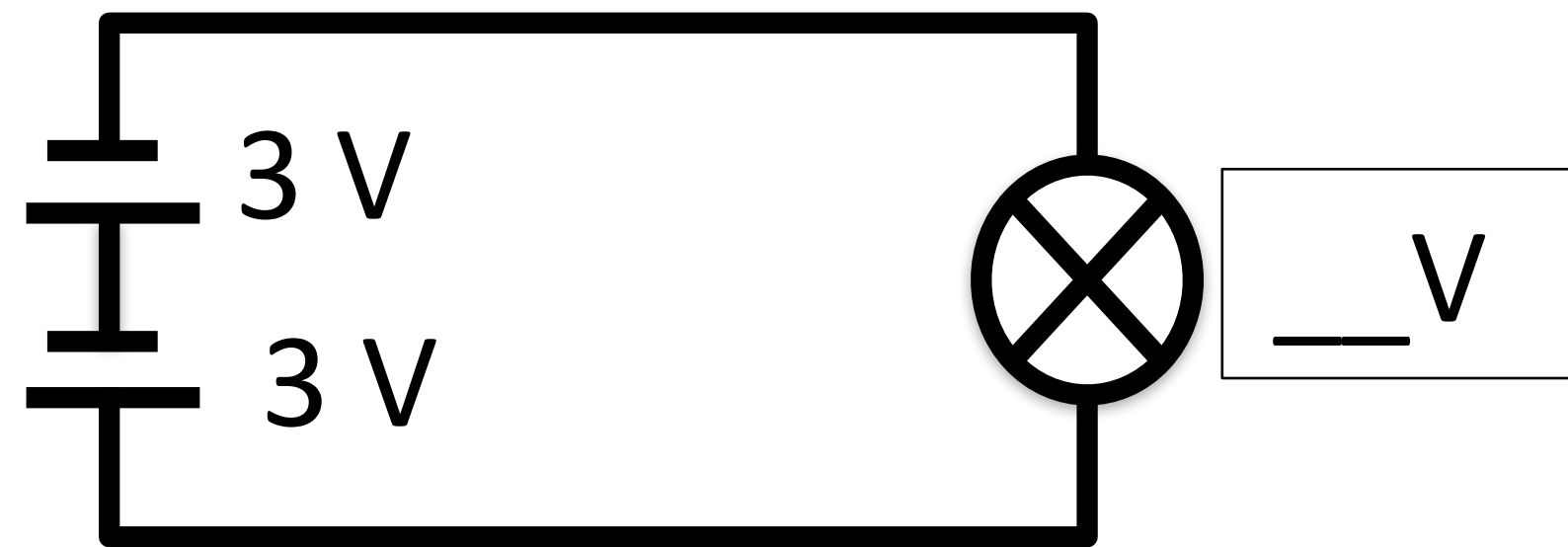
# Theatre of Science IGCSE Physics: Electricity 6: Series and parallel circuits!

Fill in the gaps to make these circuits work properly

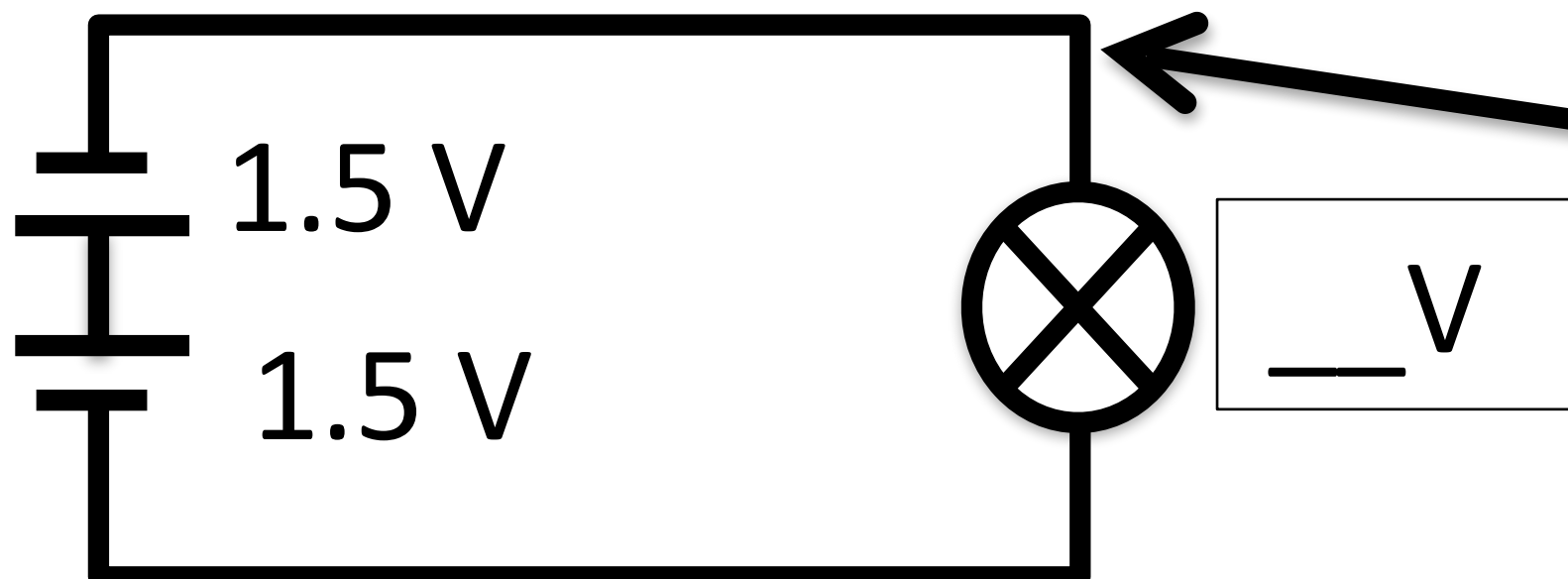
1.



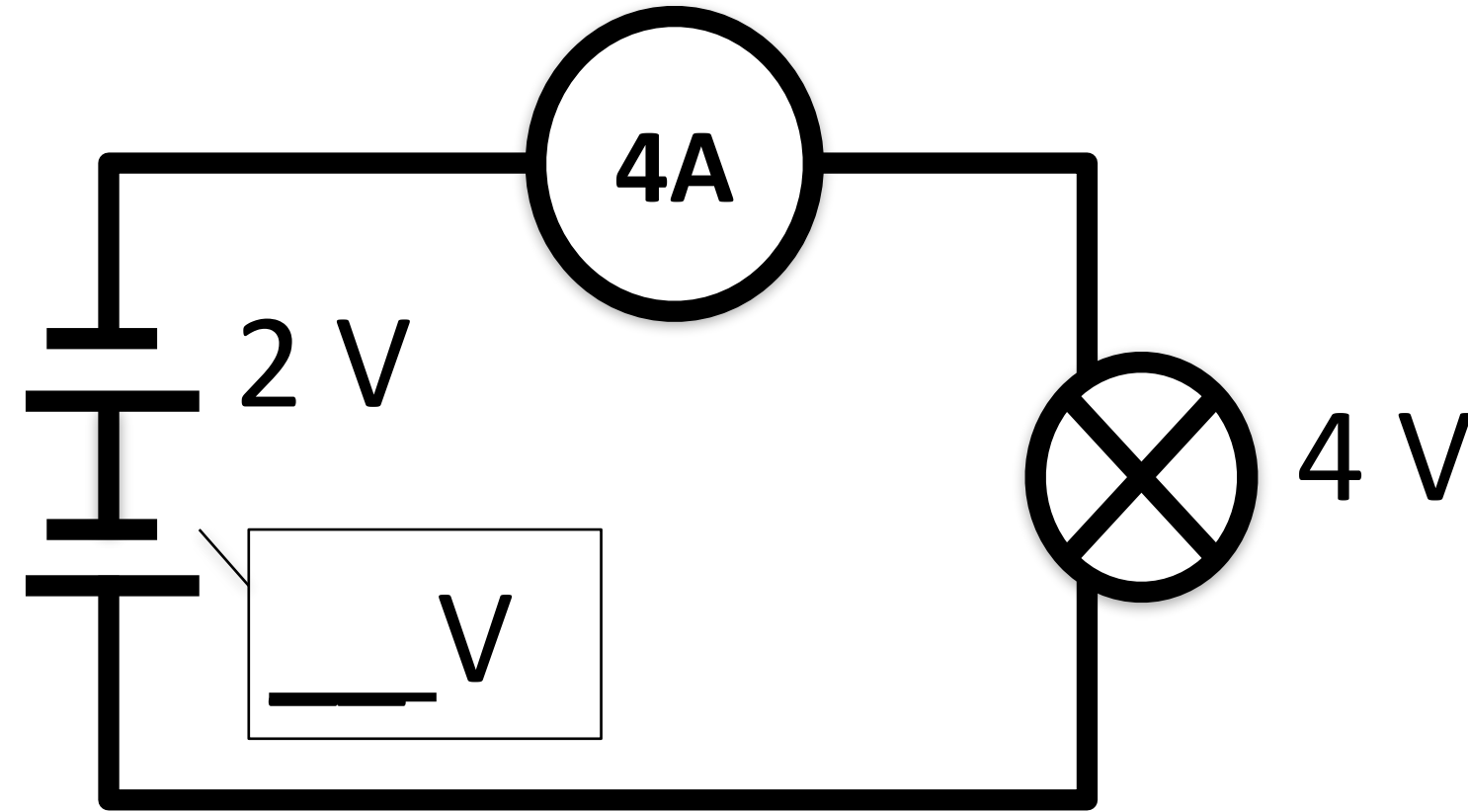
3.



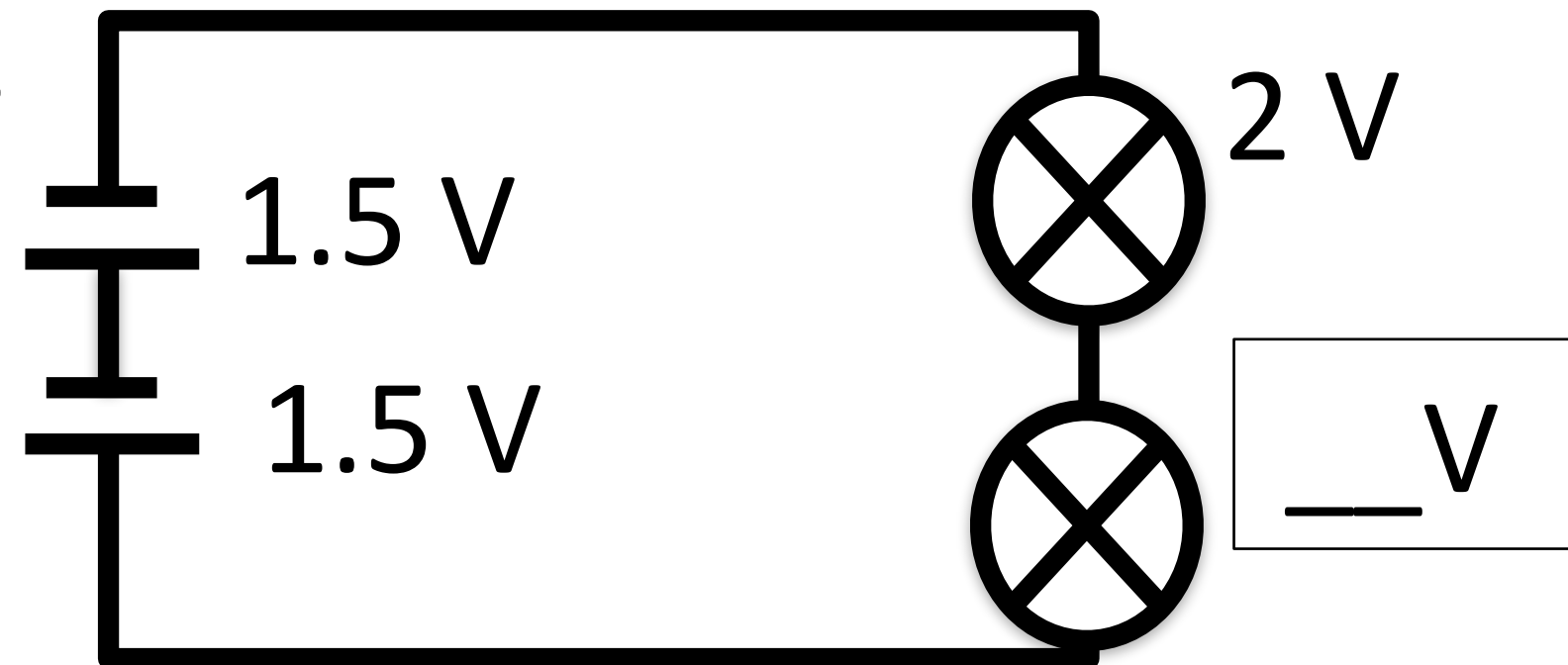
5.



2.



4.



(Bulbs are not identical!)

$V = IR$   
(Voltage = Current x Resistance)

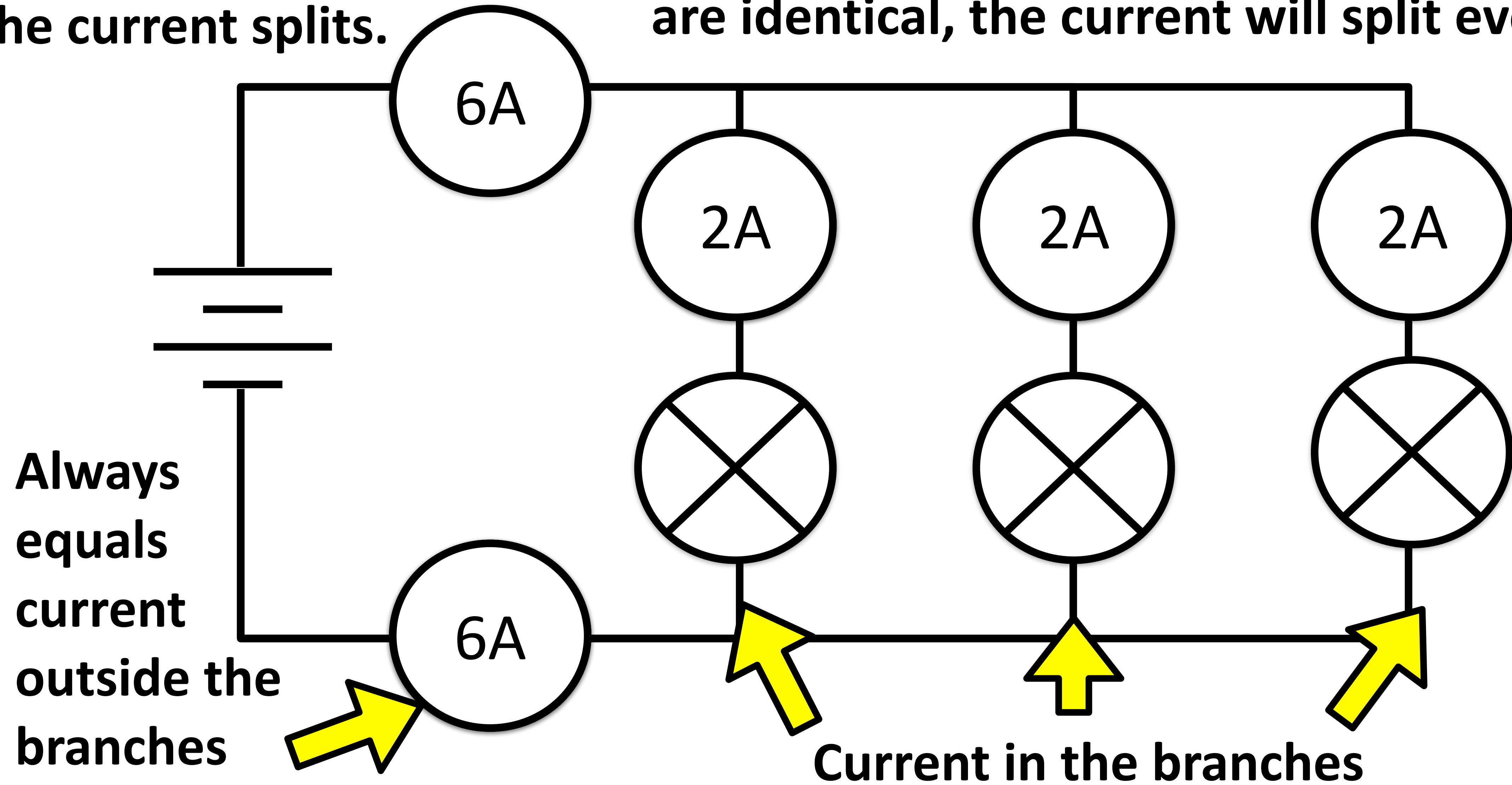
5. What's the resistance of the bulb in question 2?  
\_\_\_\_\_  
\_\_\_\_\_

Actually this circuit still isn't working!  
Why not?

6. The bulb in question 1 is identical to that in question 2. What's the current through it?  
\_\_\_\_\_

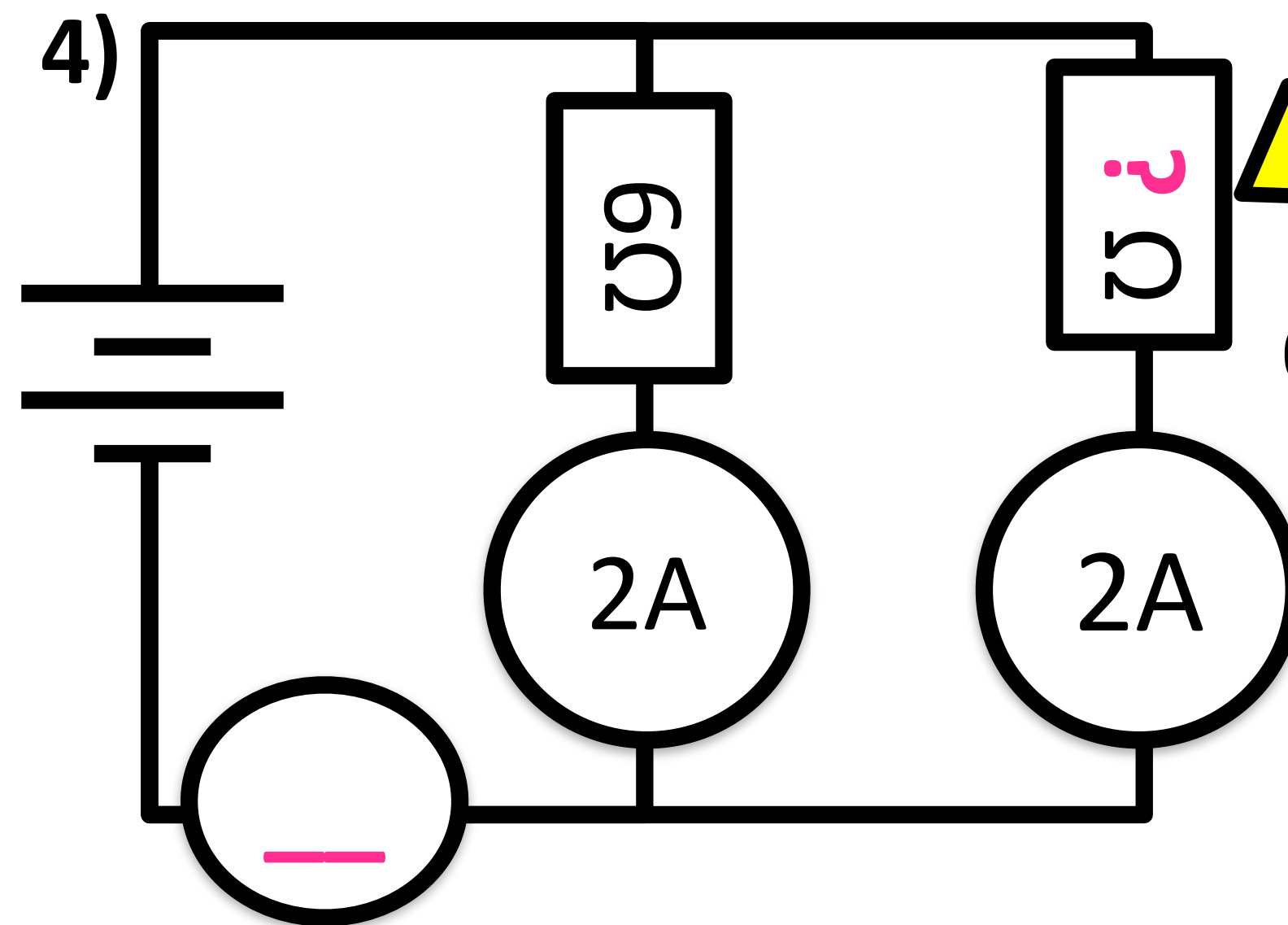
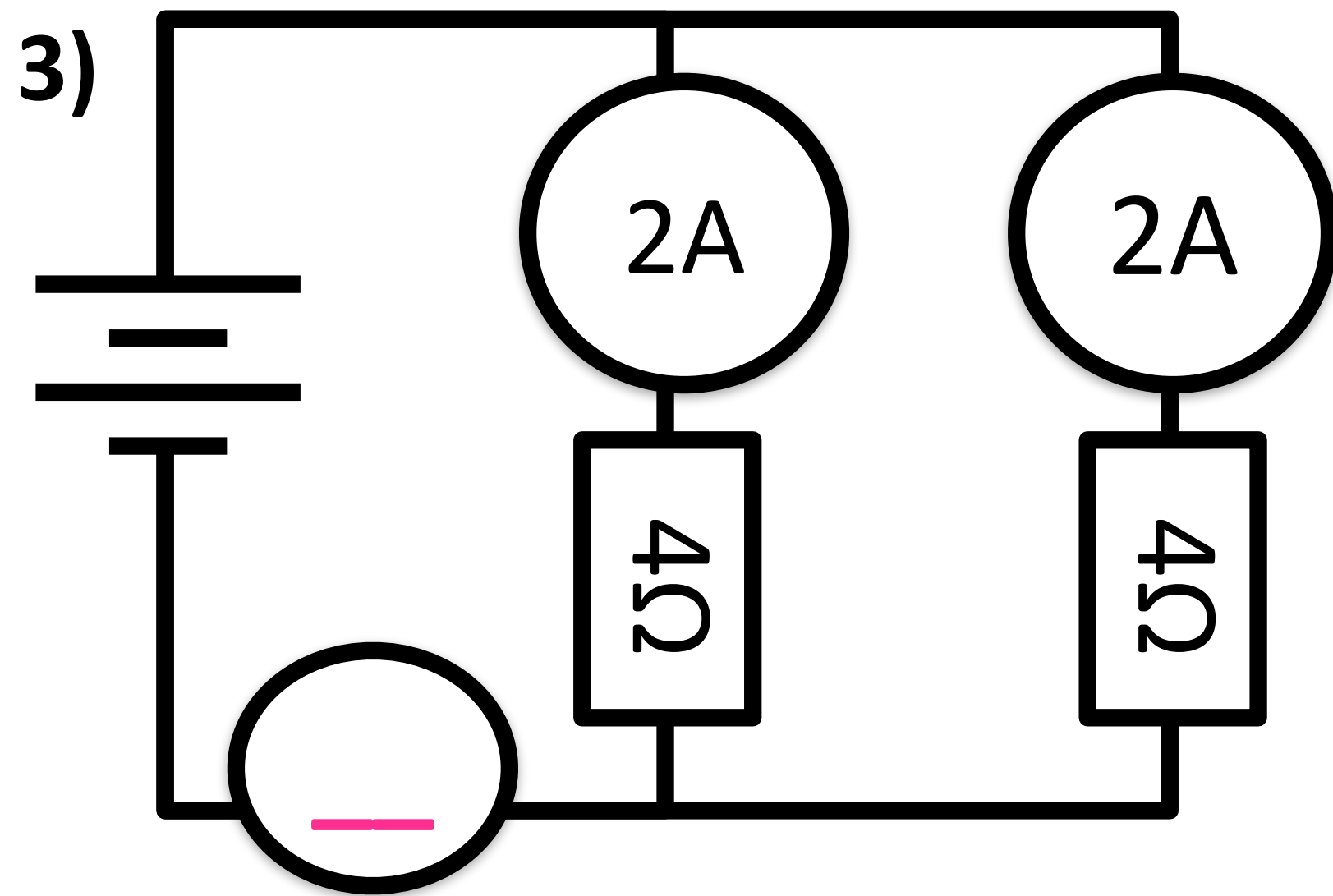
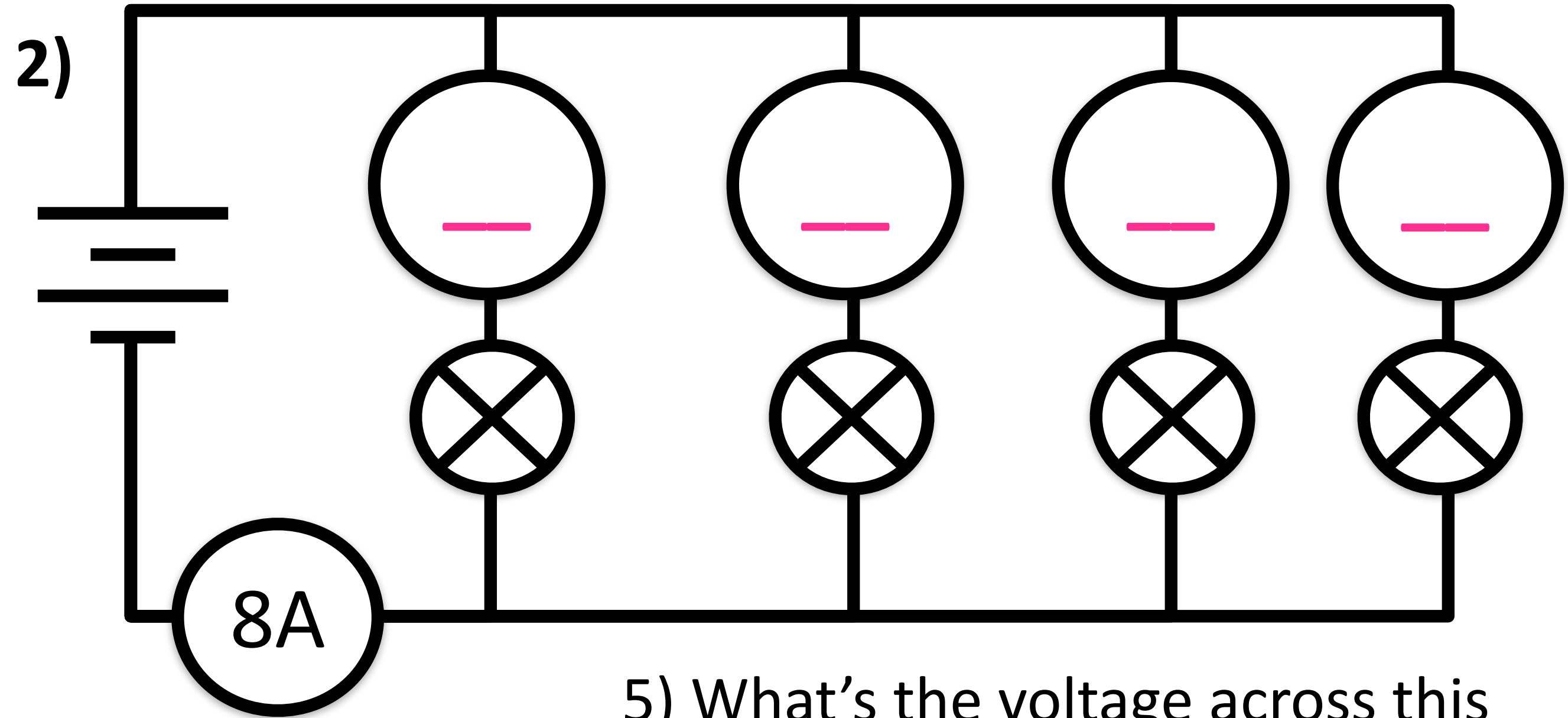
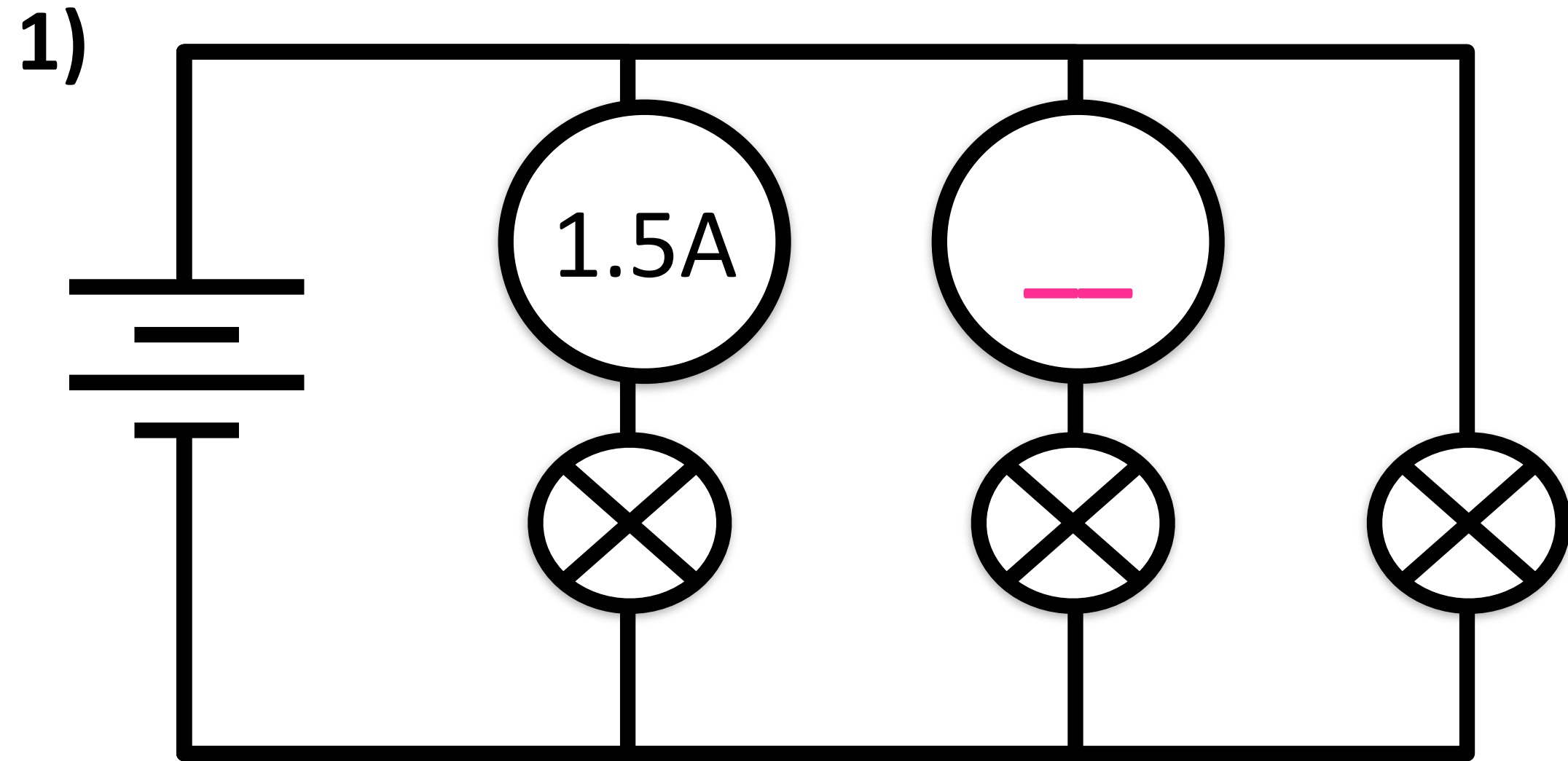
**In a parallel circuit,  
the current splits.**

**If the components ('things in the circuit')  
are identical, the current will split evenly.**

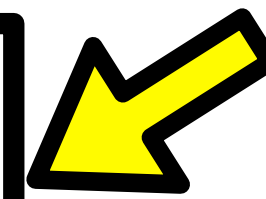


**Thank you for supporting me on Kofi!**

Complete the readings on the ammeters. All bulbs are identical.



5) What's the voltage across this resistor?

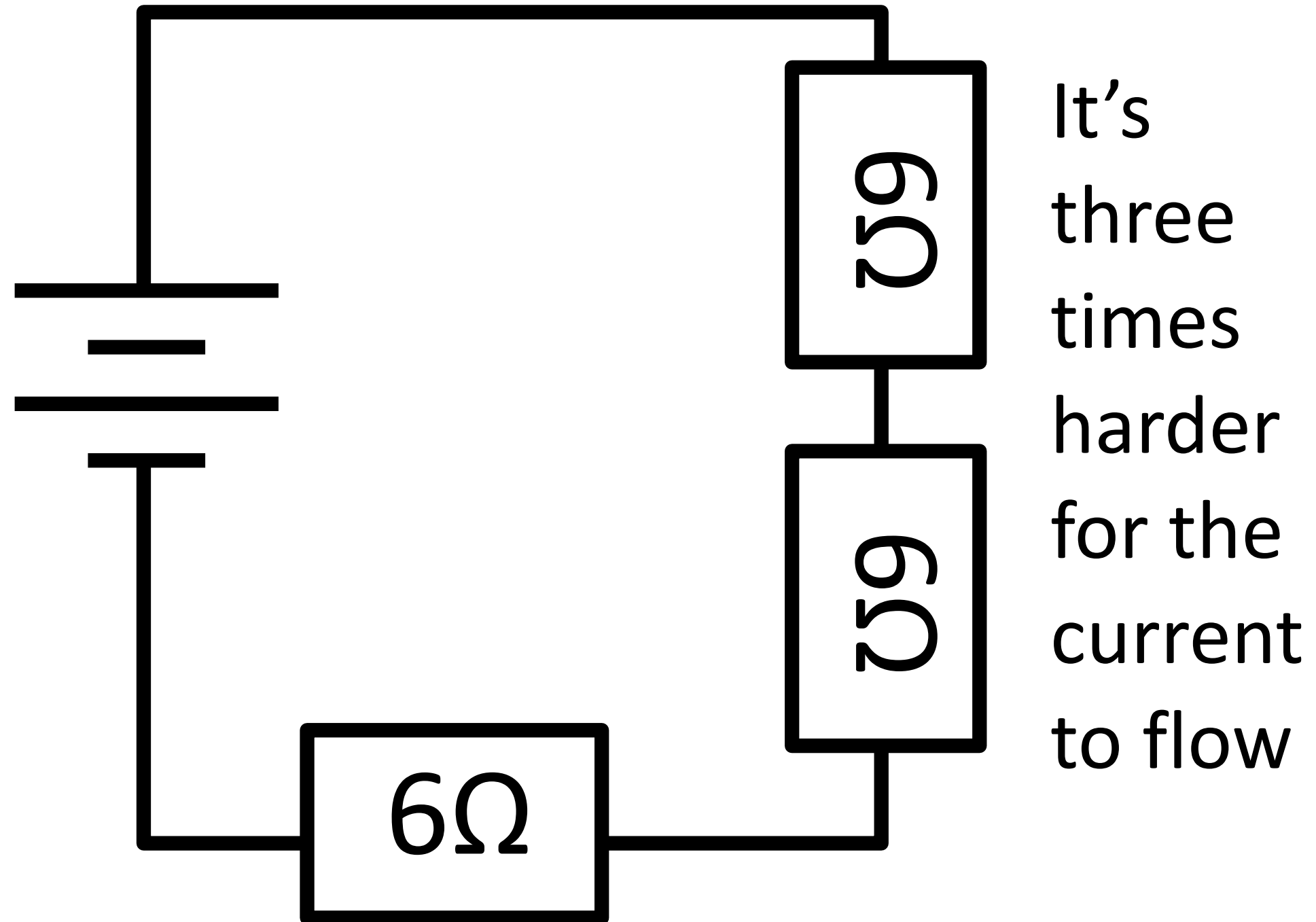


6) Are the voltages across all the bulbs in Q2 the same?

7) Are the voltages across all the bulbs in Q2 the same as the voltages in Q1?

Add resistors in series.

Total resistance goes **up**



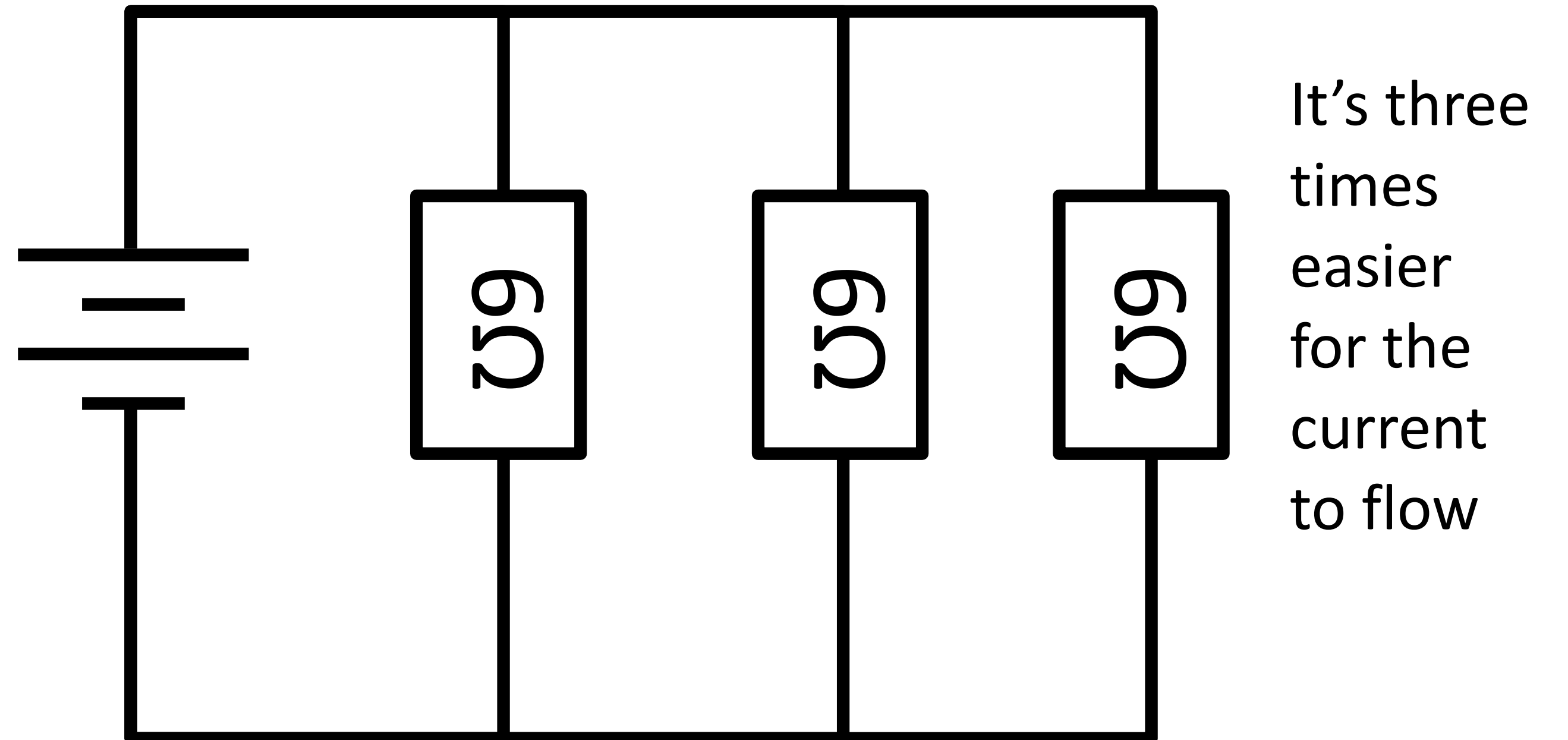
It's three times harder for the current to flow

(Total resistance here is  $18\ \Omega$ )

So total current round circuit goes...?

Add resistors in parallel

Total resistance goes **down**



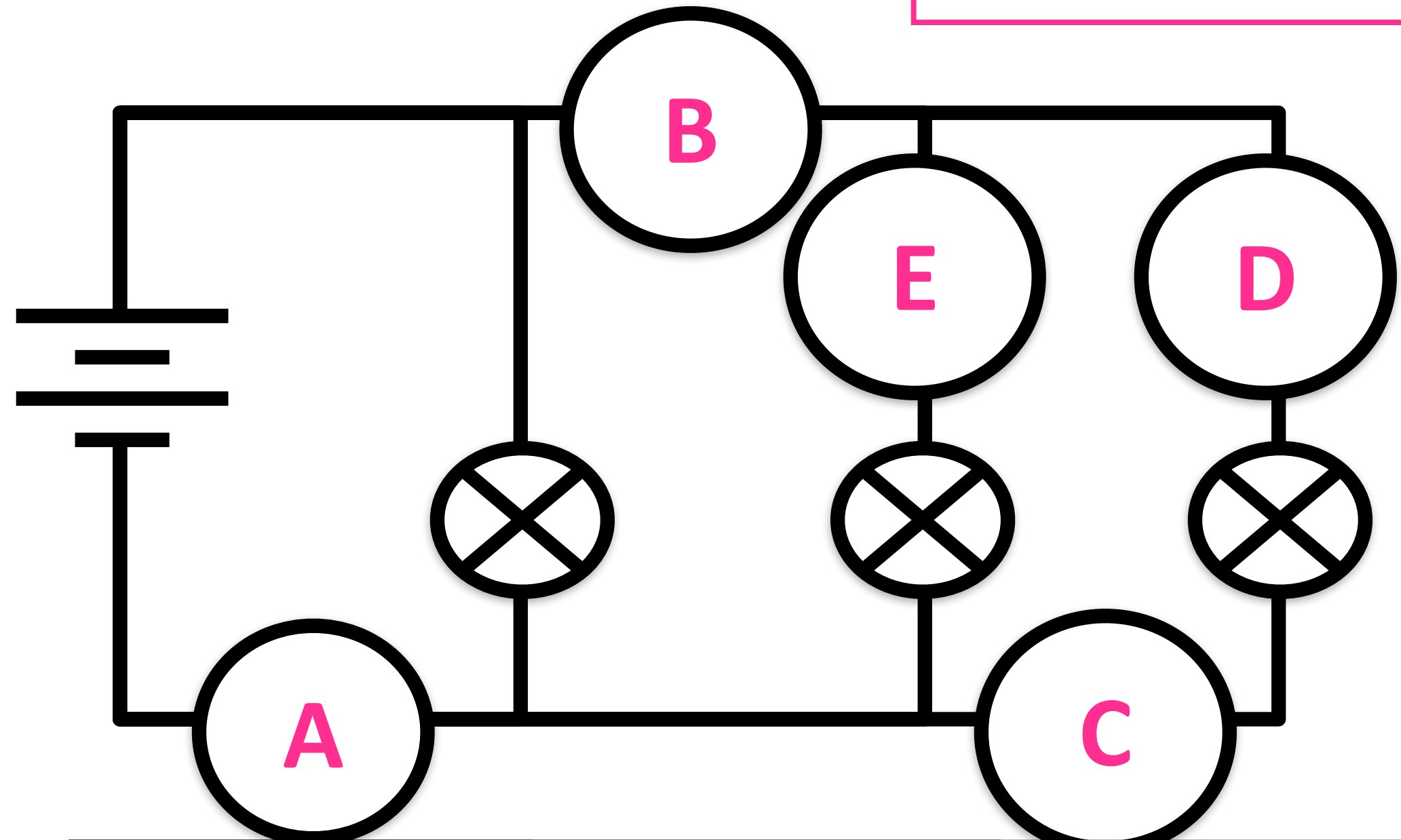
It's three times easier for the current to flow

(Total resistance here is ... )

So total current round circuit goes...?

Complete the readings on the ammeters. All bulbs are identical.

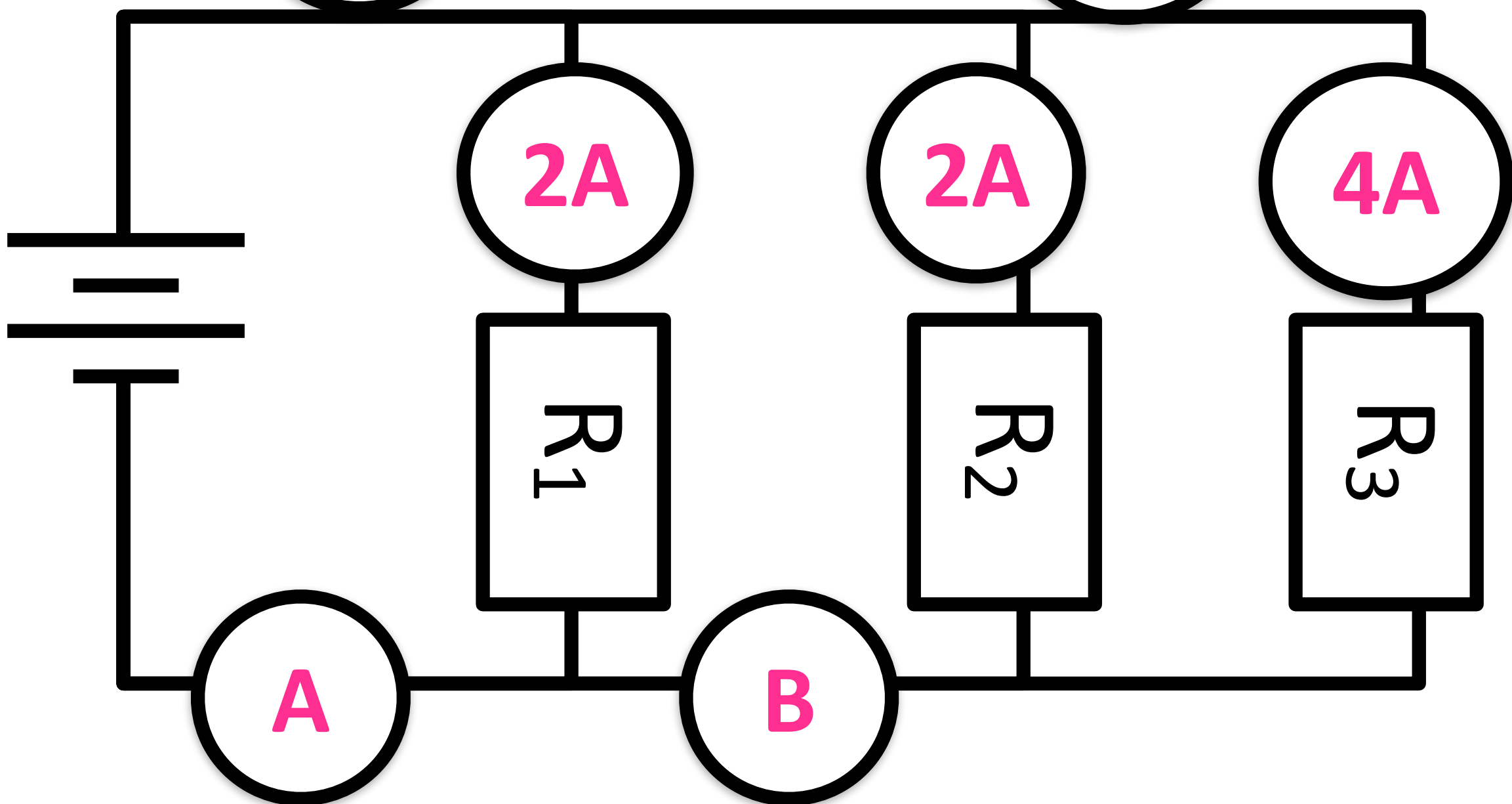
1)



a) Which ammeter shows the highest reading? \_\_\_\_\_

b) Which ammeters show identical readings? \_\_\_\_\_

2)

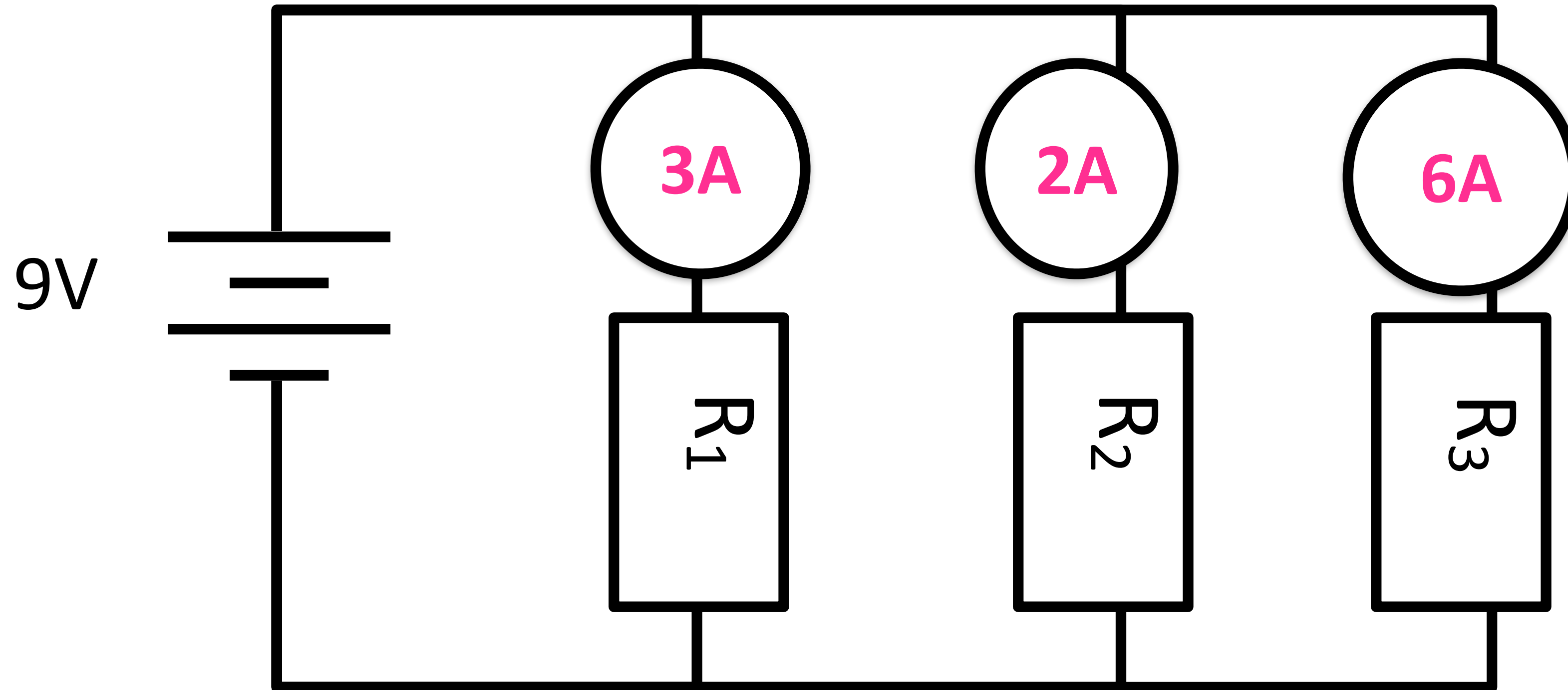


a) What's the reading on ammeter A? \_\_\_\_\_

b) What's the reading on ammeter B? \_\_\_\_\_



$$V = IR$$



1) What's the voltage across R<sub>3</sub>?

2) What's the voltage across R<sub>2</sub>?

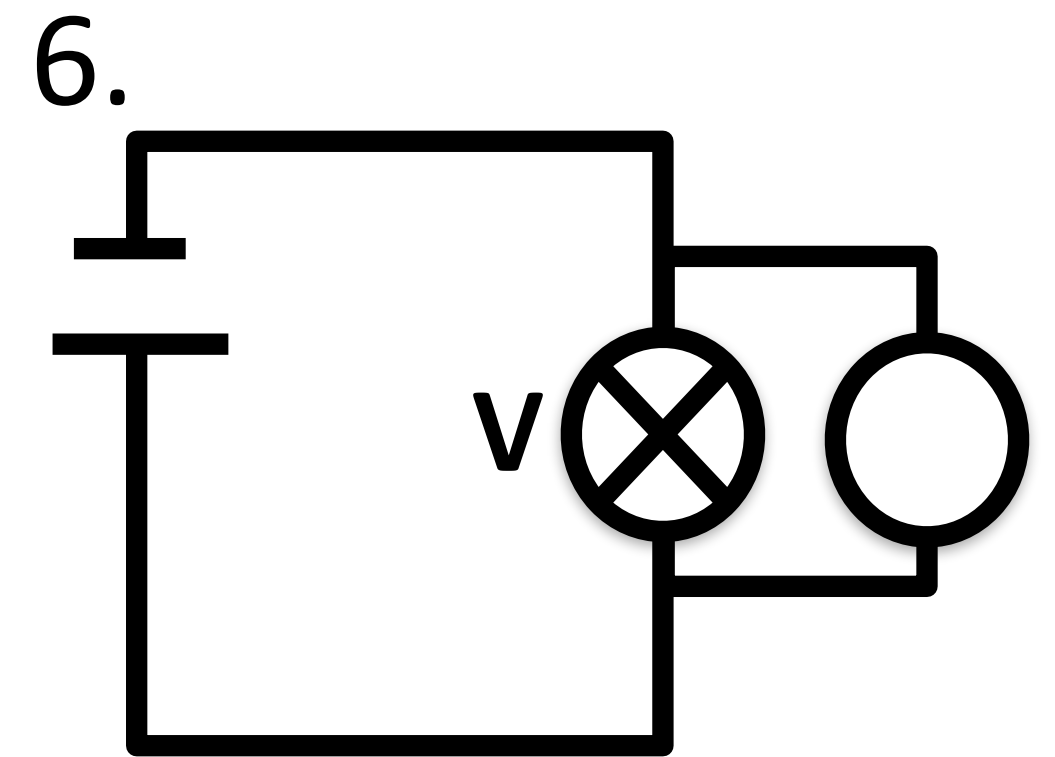
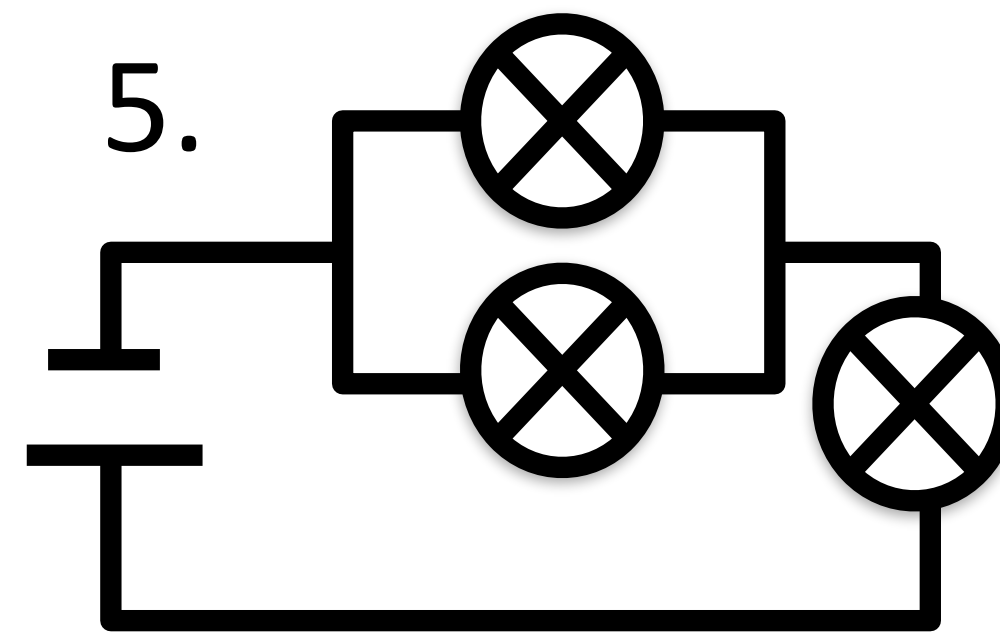
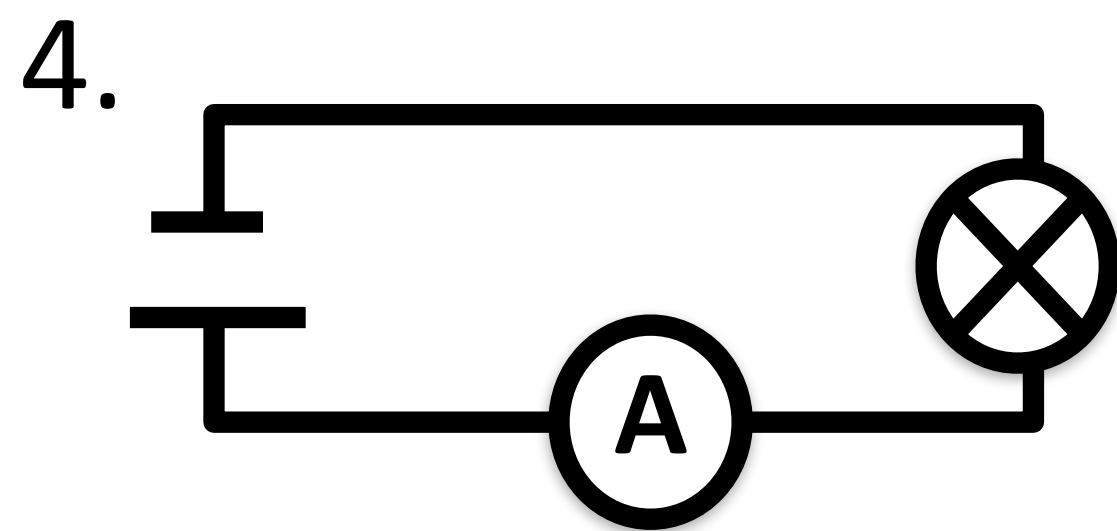
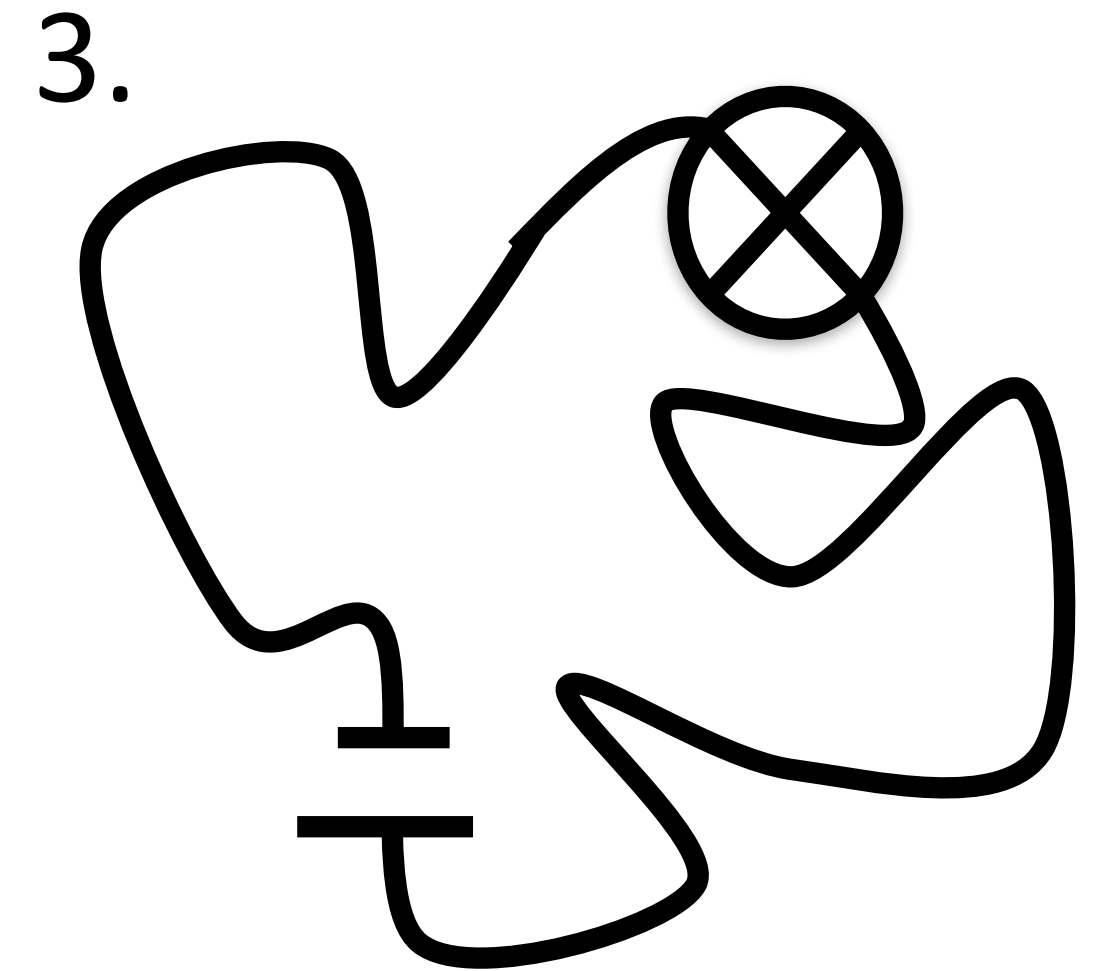
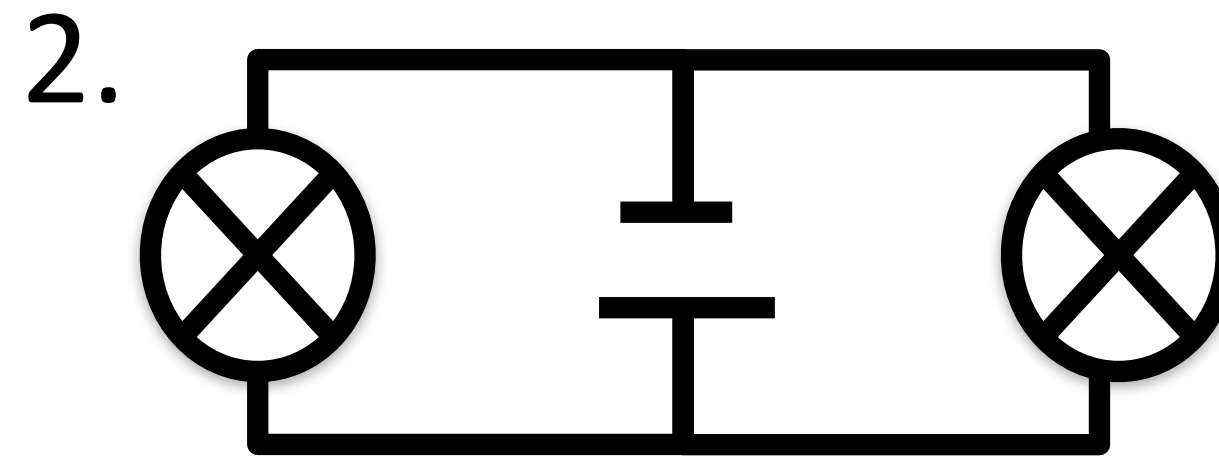
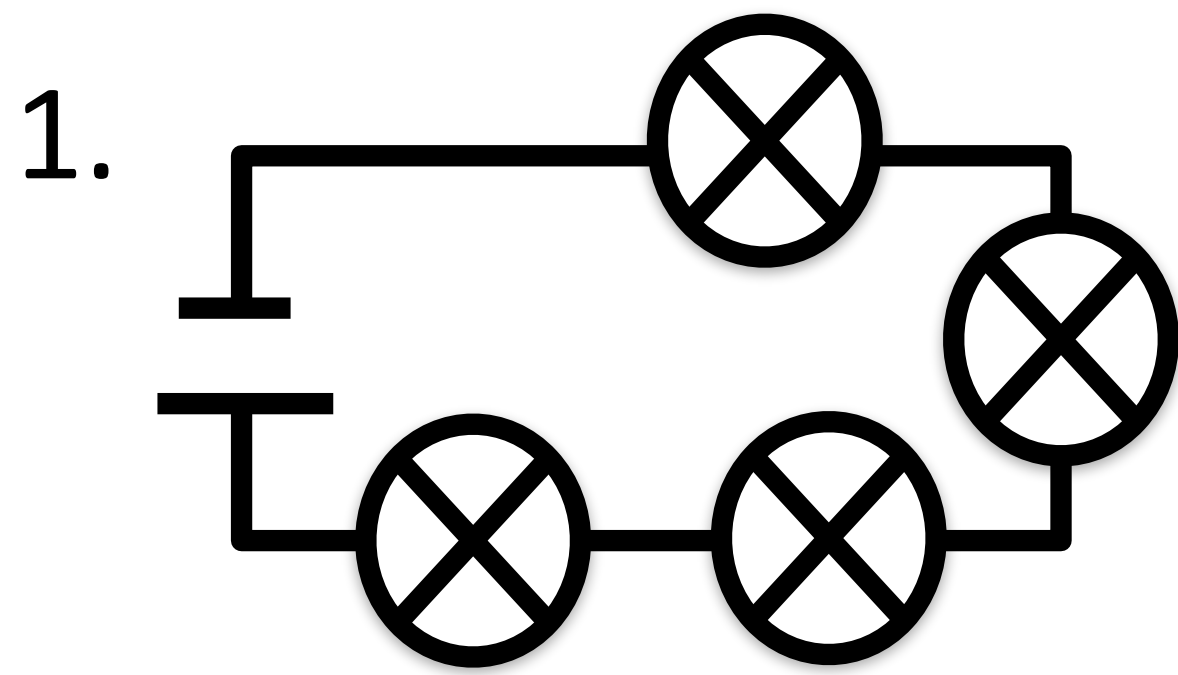
3) What's the resistance of R<sub>1</sub>?



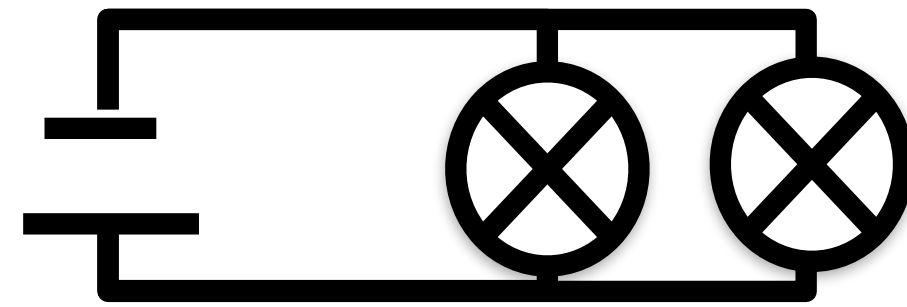
# Theatre of Science IGCSE Physics: Electricity 7: Ohm's Law..?

RECAP ON LAST WEEK

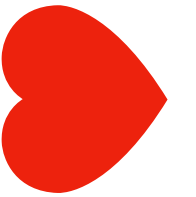
## SERIES OR PARALLEL?



# Decide if each sentence is talking about Series or Parallel Circuits or both!



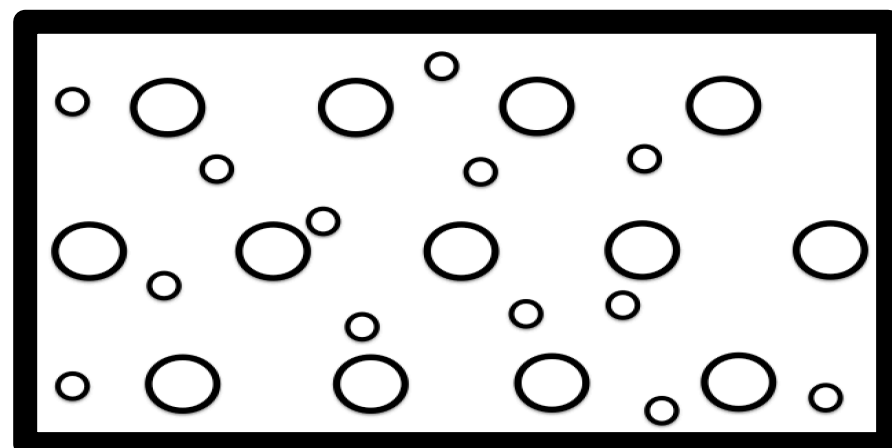
	True of series Circuits?	True of parallel Circuits?
If one bulb breaks, none of them light up.		
If the circuit has two switches, both have to be pressed to make the machine work.		
Use less wiring		
Bulbs share voltage so shine less brightly		
Bulbs shine with the same brightness however many are added		
If one bulb breaks the others keep working		



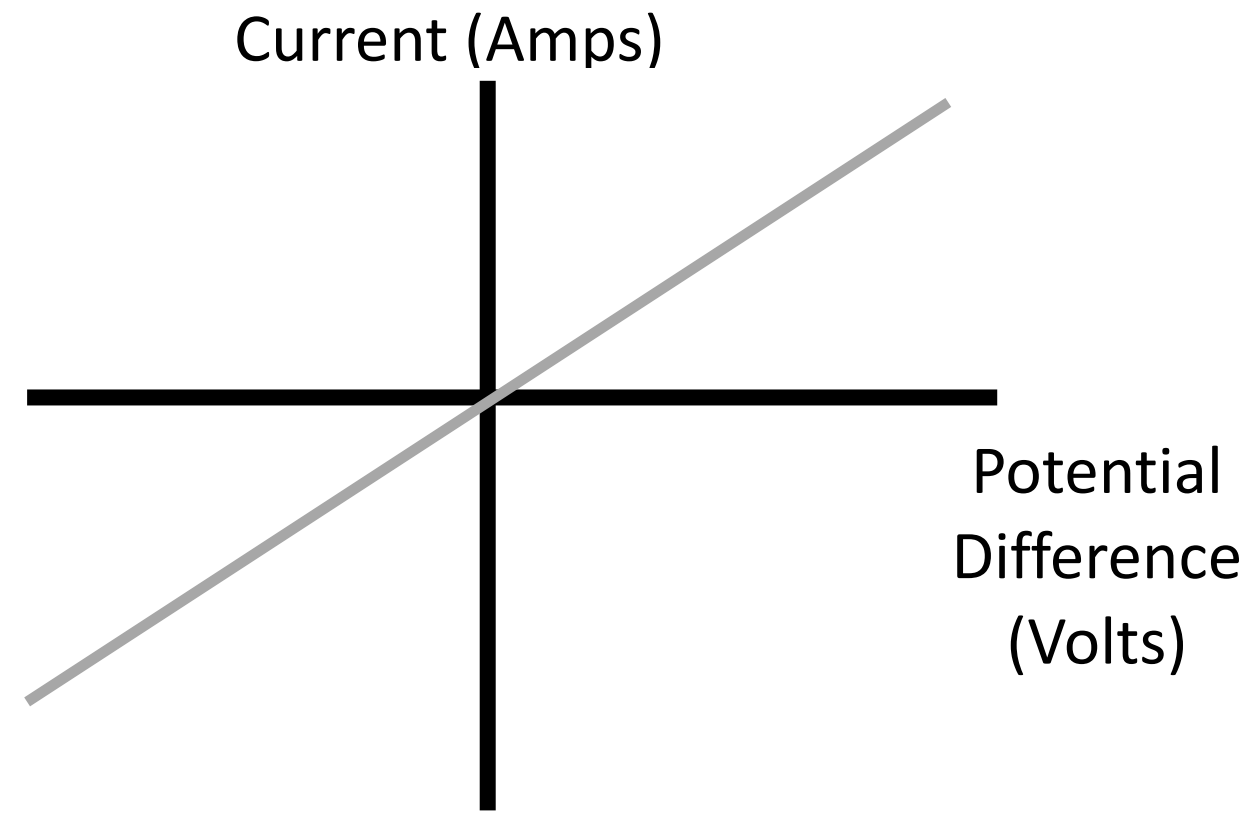
Thank you for supporting me on Kofi!

# What's wrong with this description?

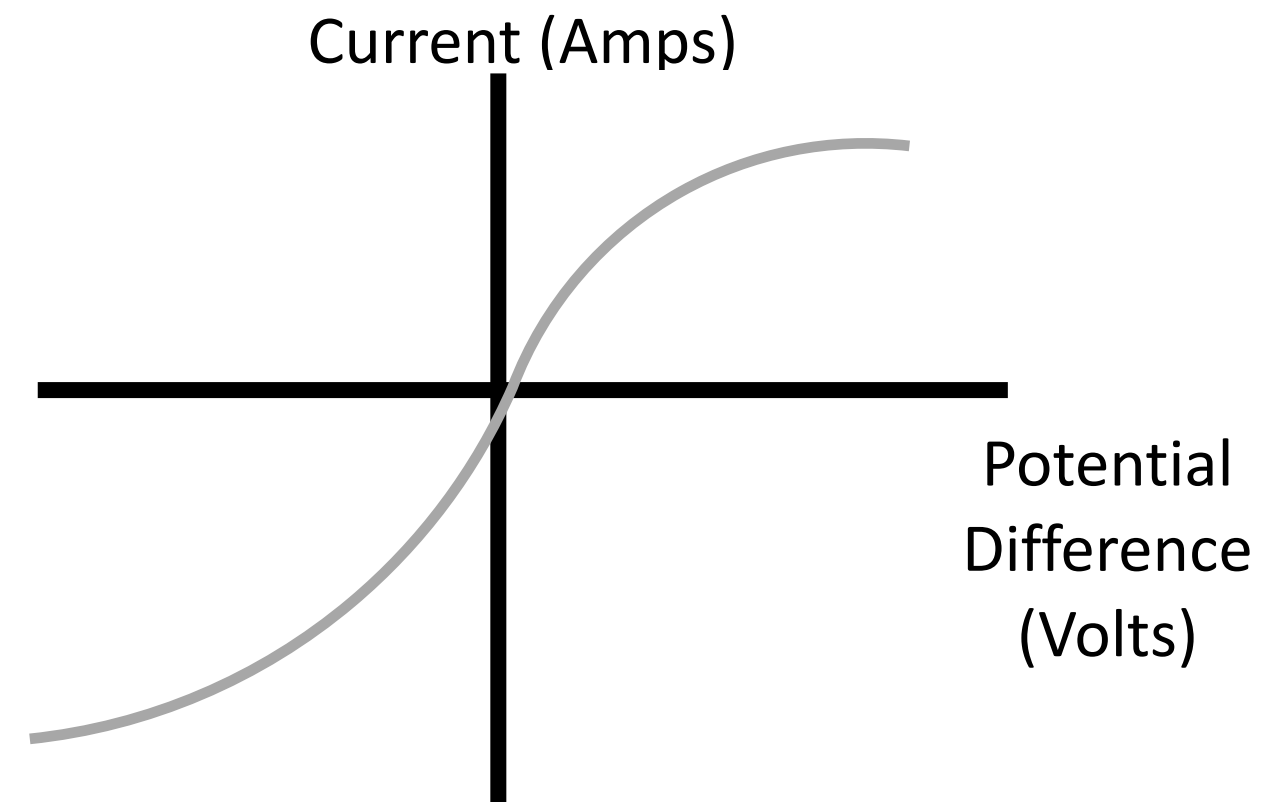
“Resistance is caused by free electrons colliding with protons in a wire. The protons start to vibrate, causing the wire to warm up”



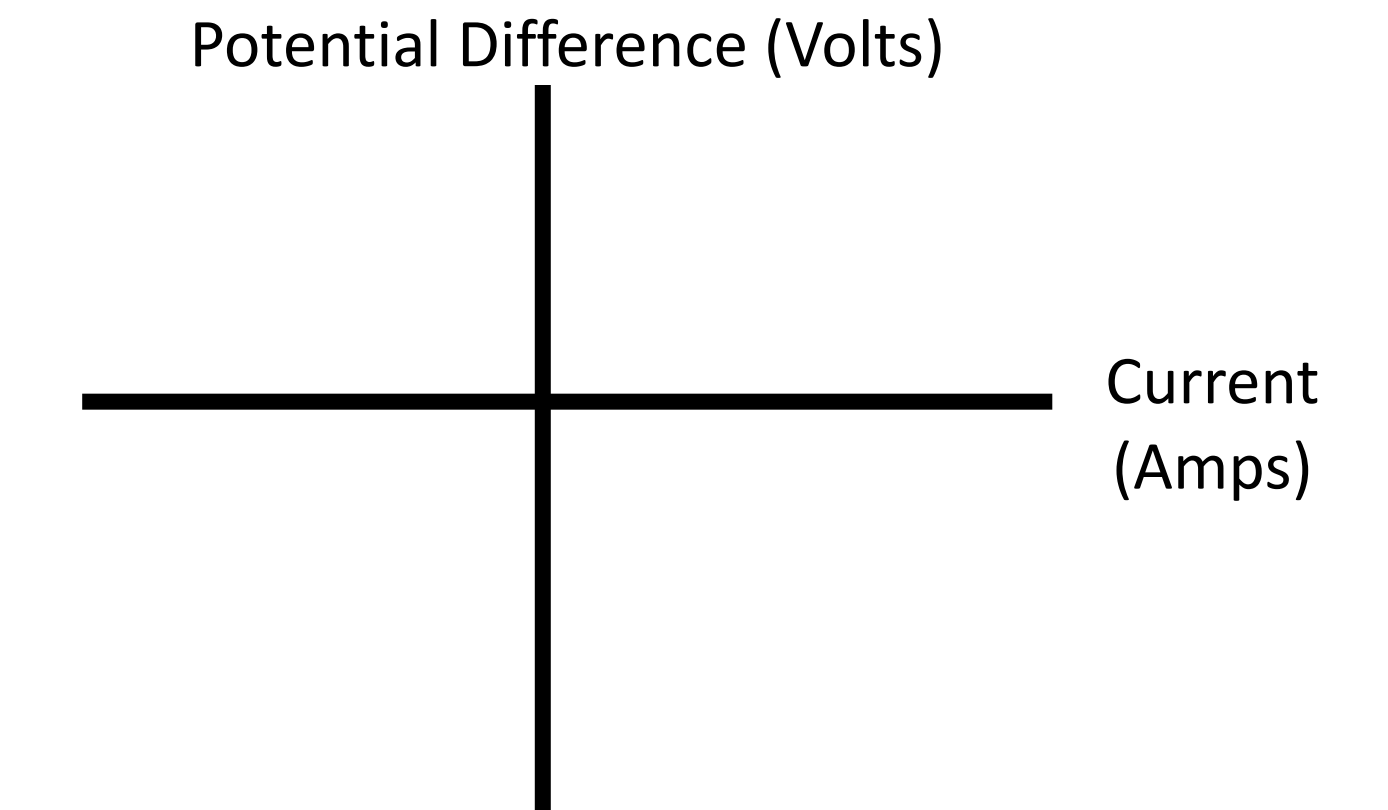
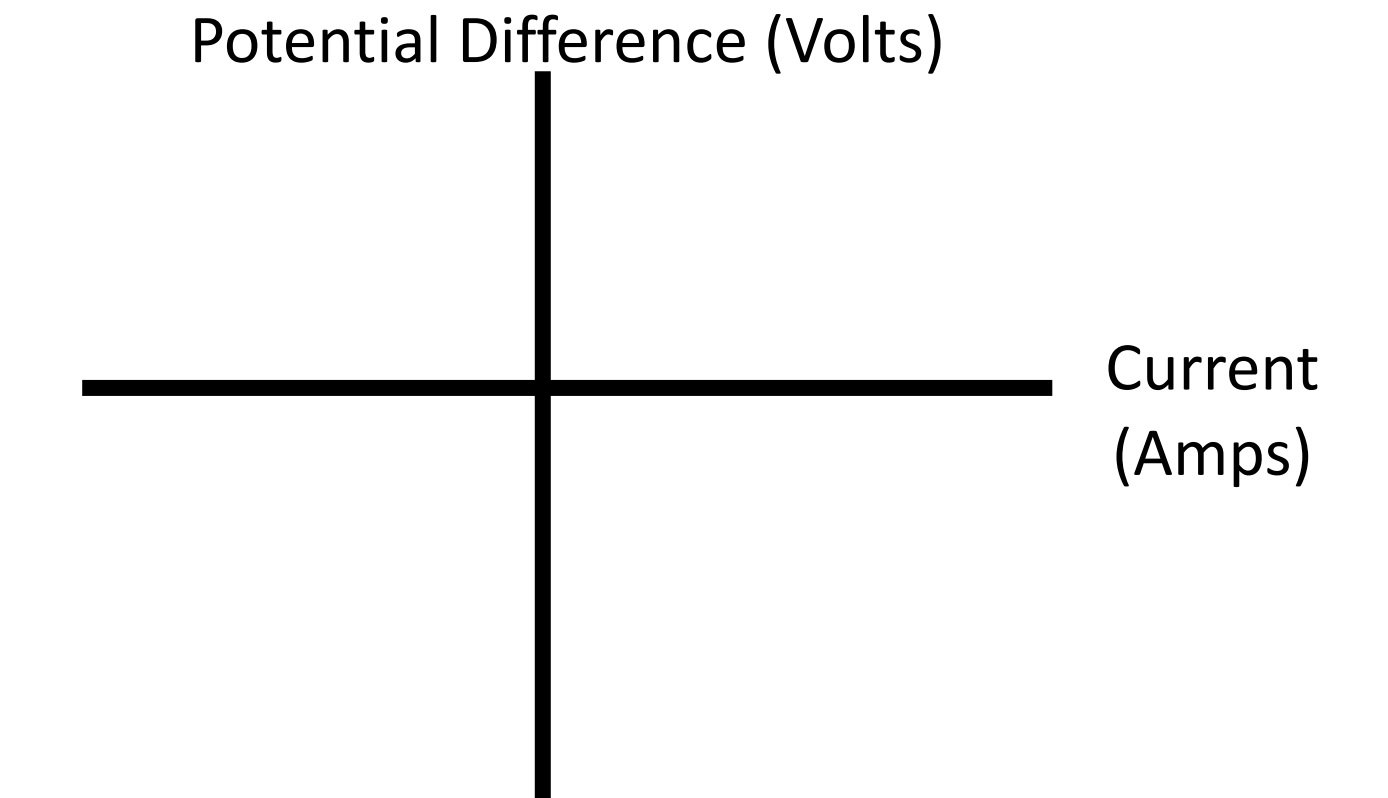
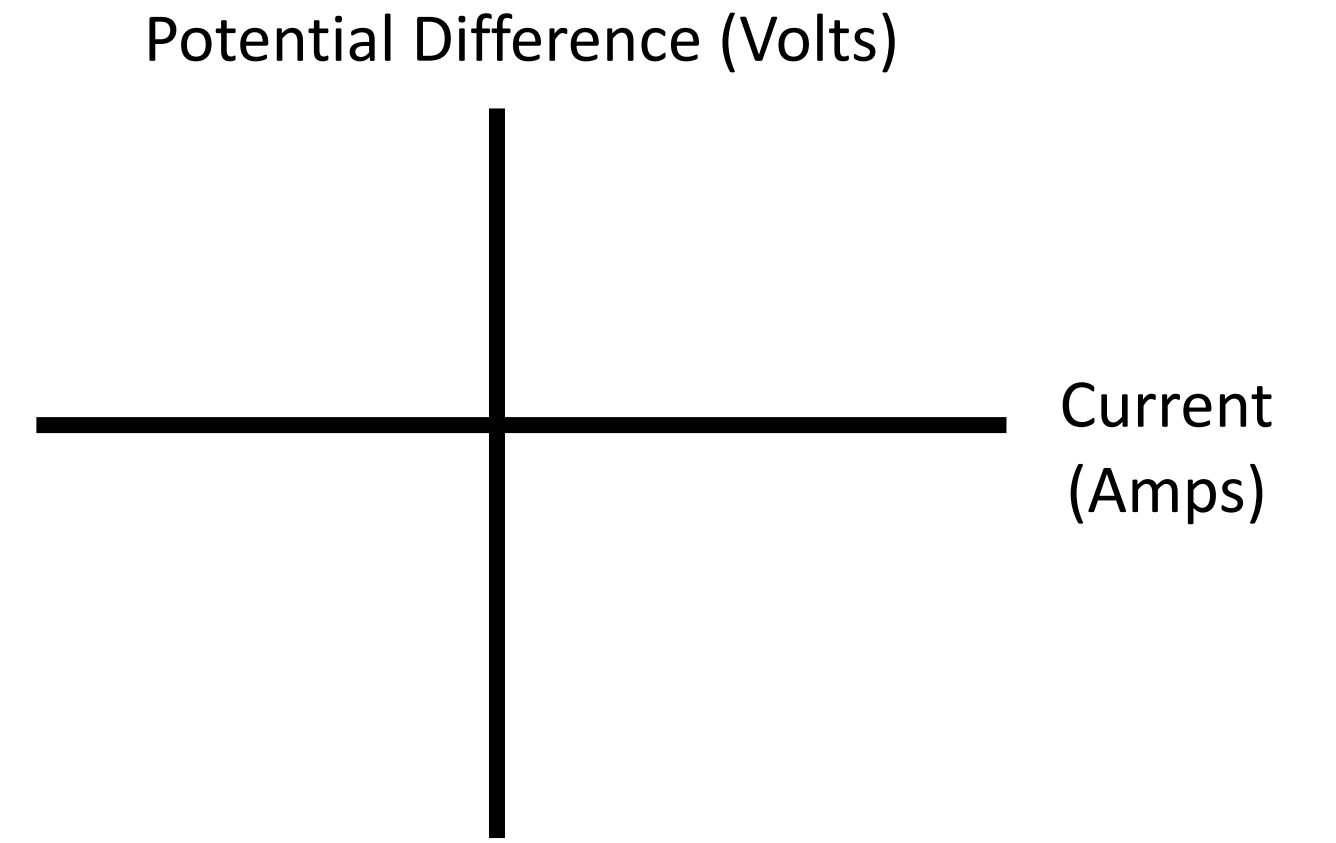
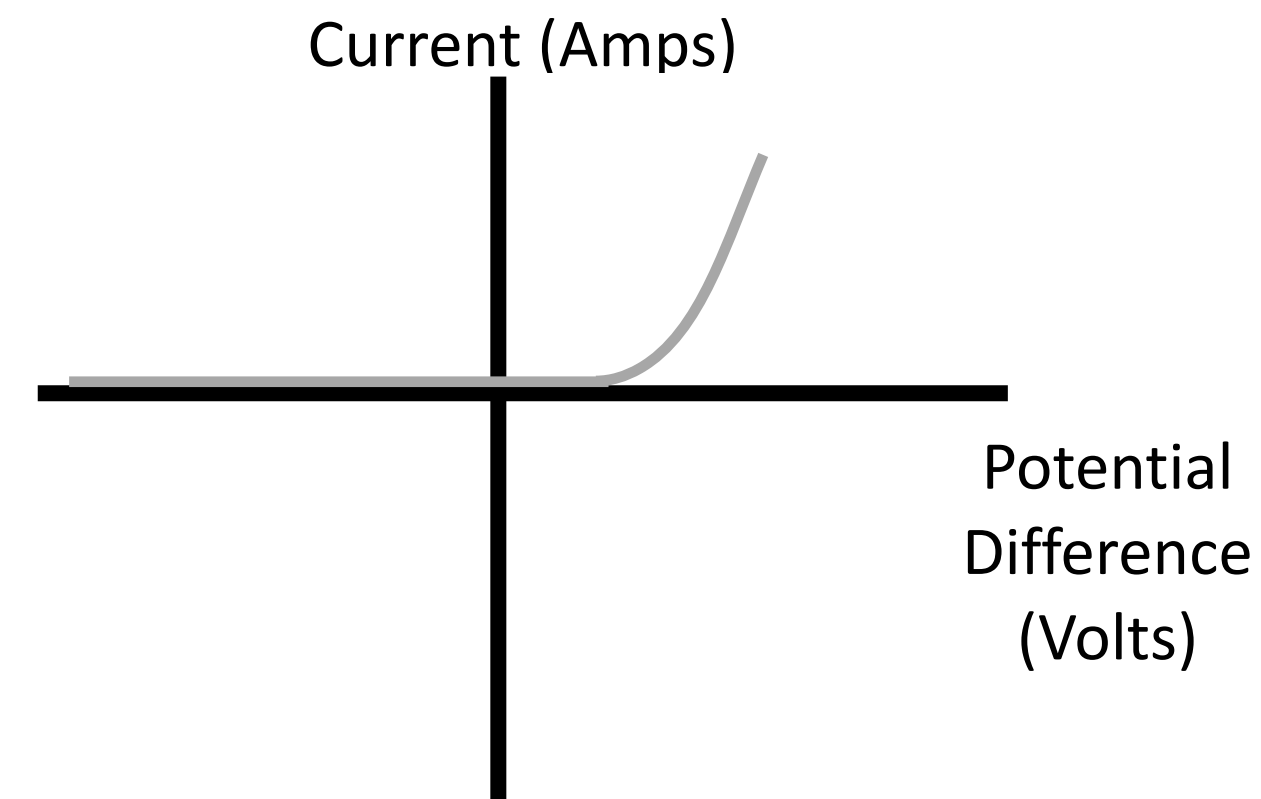
Fixed resistor



Lamp



Diode



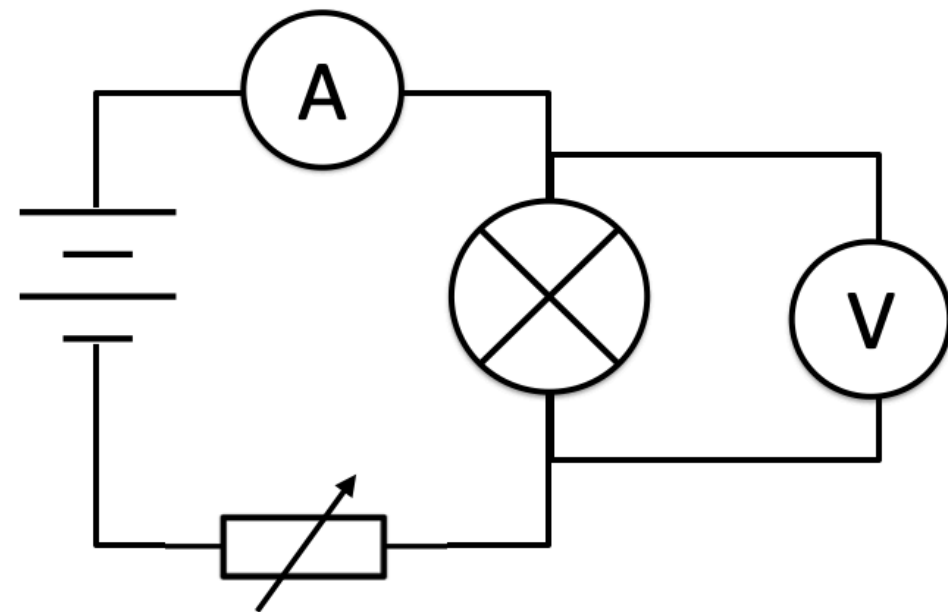


# Theatre of Science IGCSE Physics: Electricity 8: Resistors

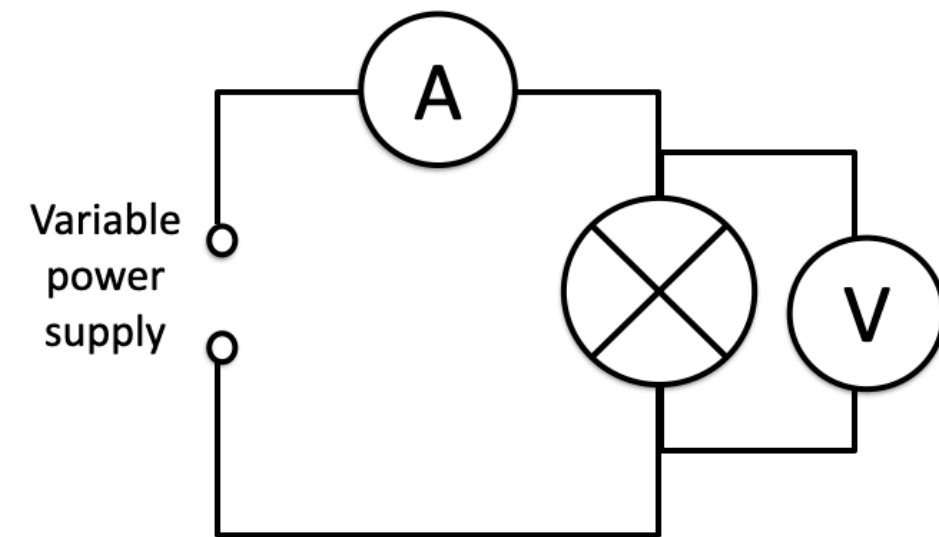
Would these circuits give the results needed to draw a VI graph of the components?

Current (A)	Voltage (V)

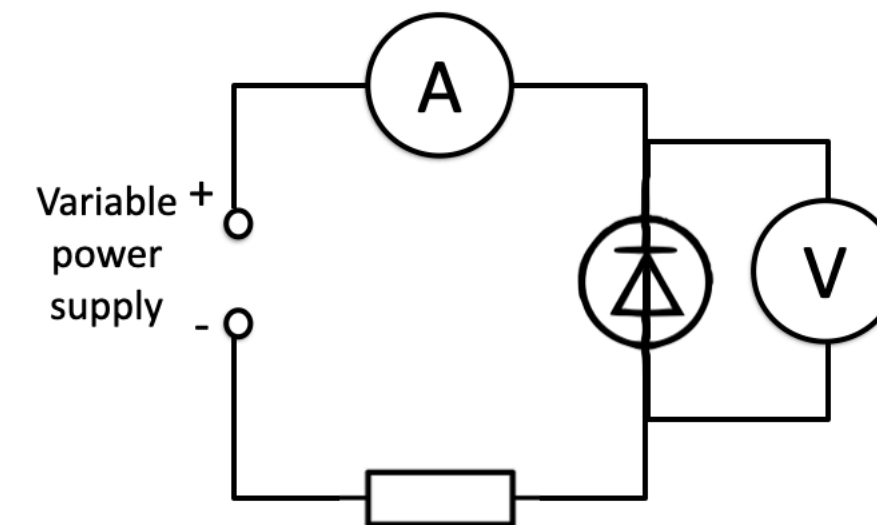
a)



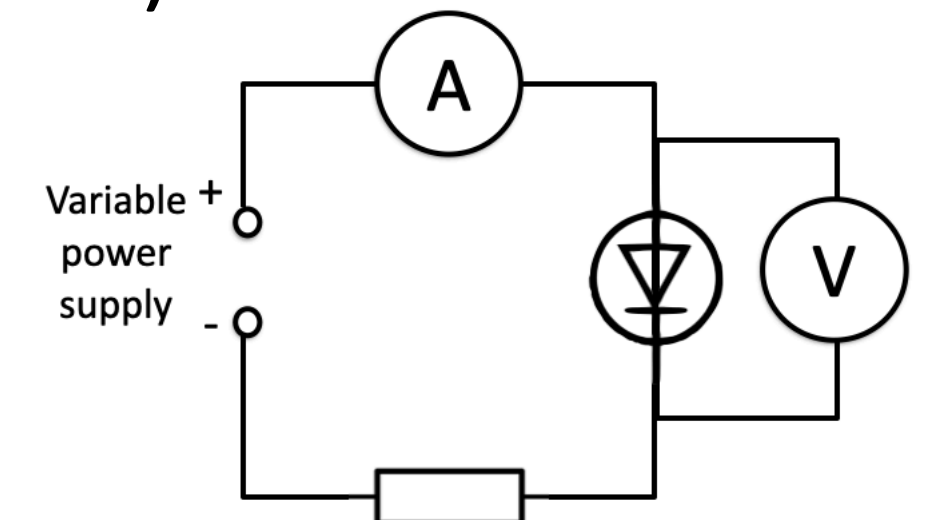
b)



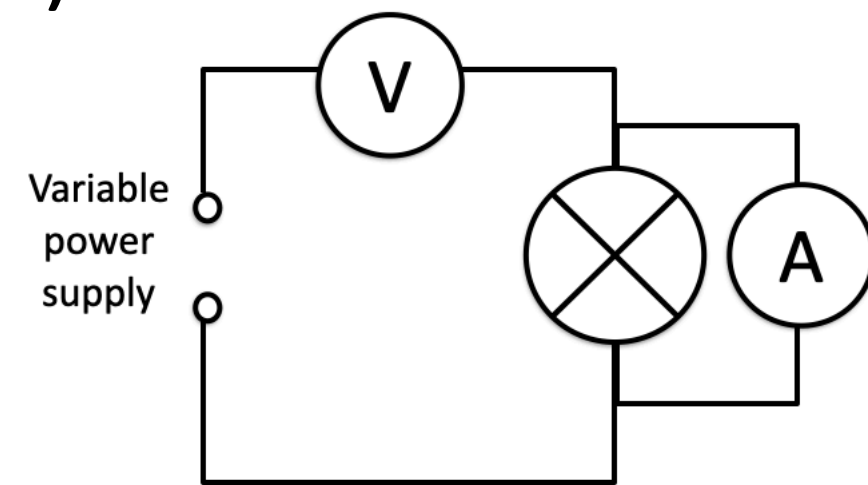
c)



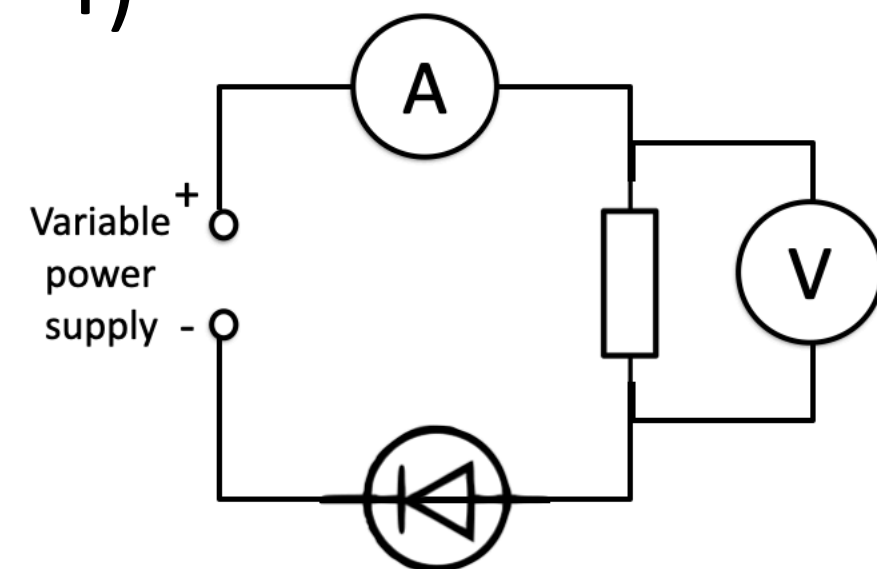
d)



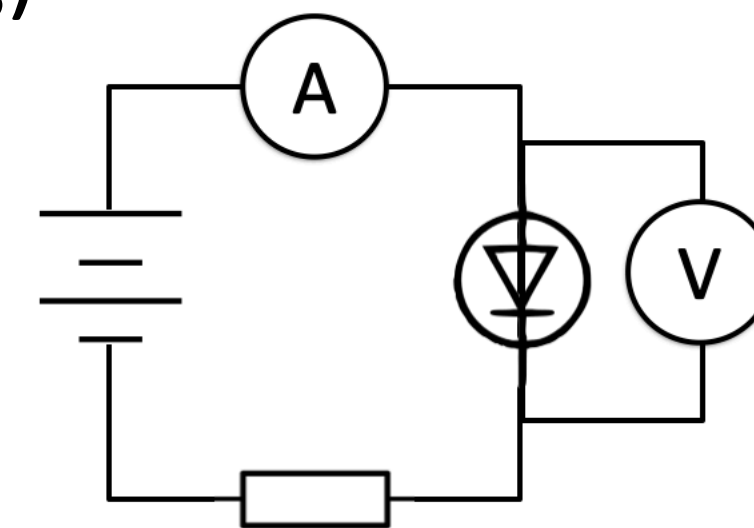
e)



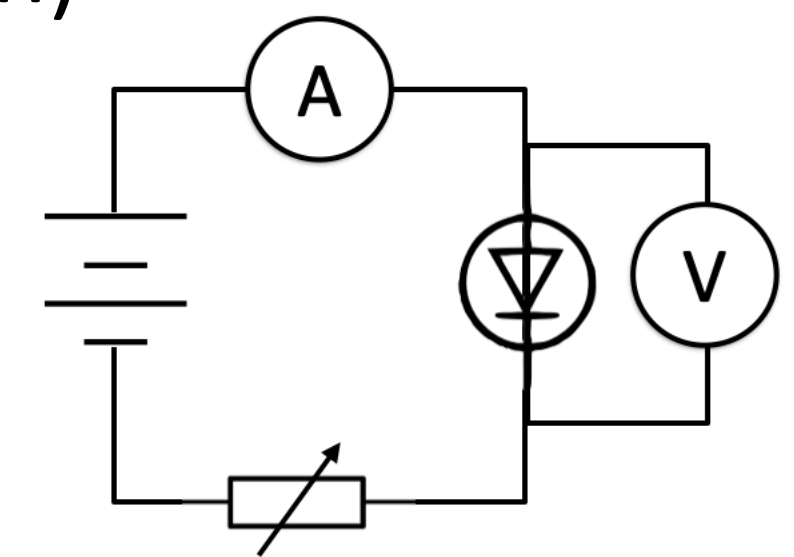
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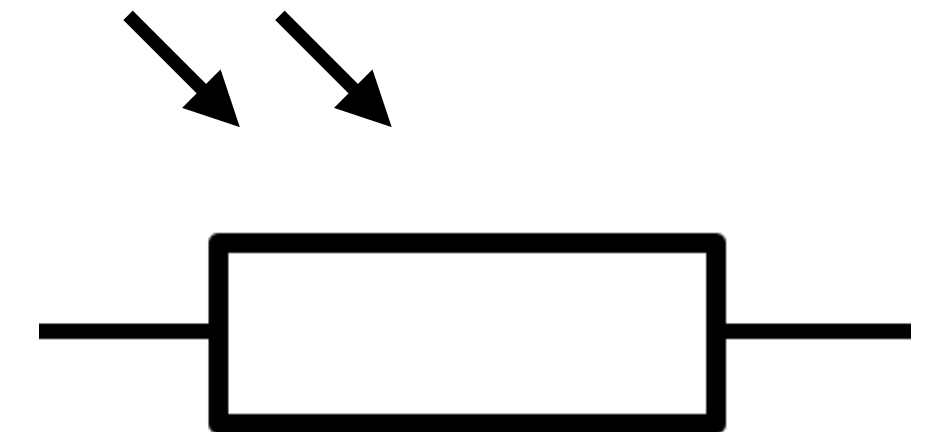
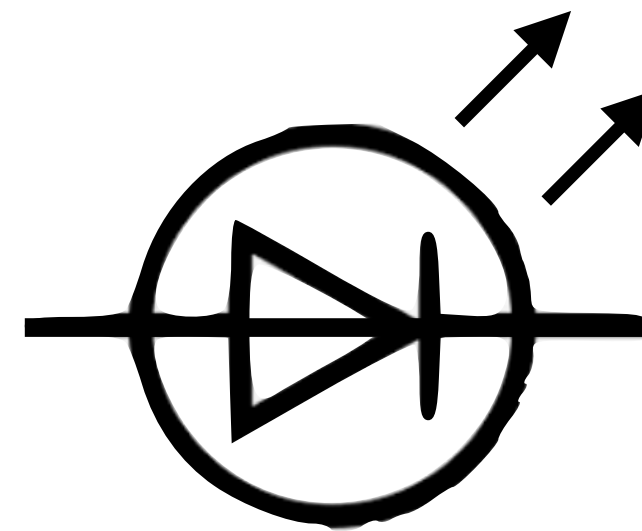
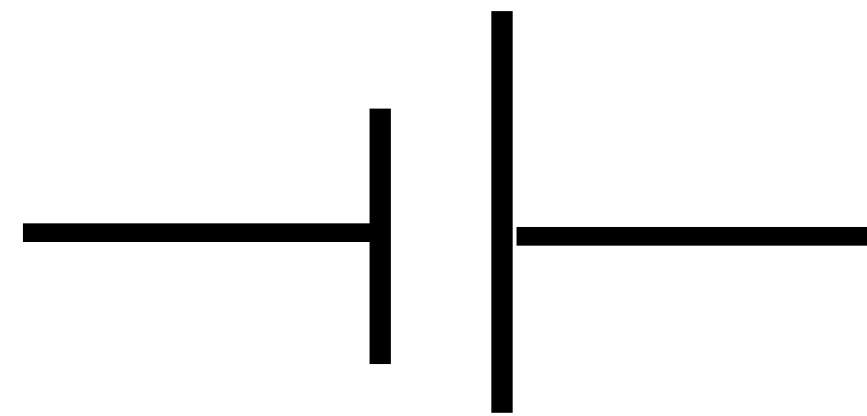
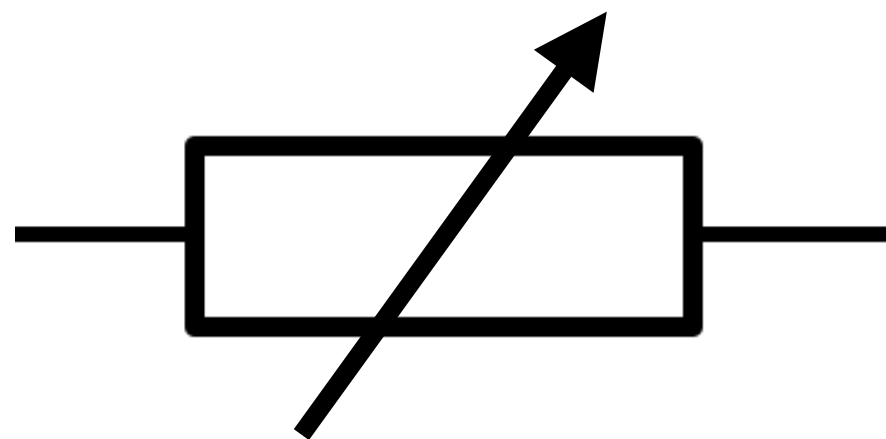
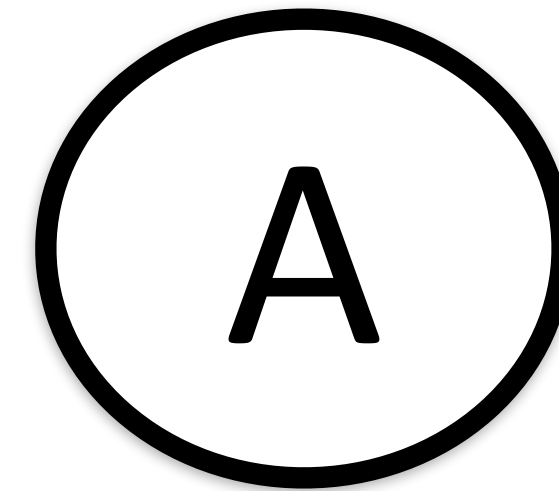
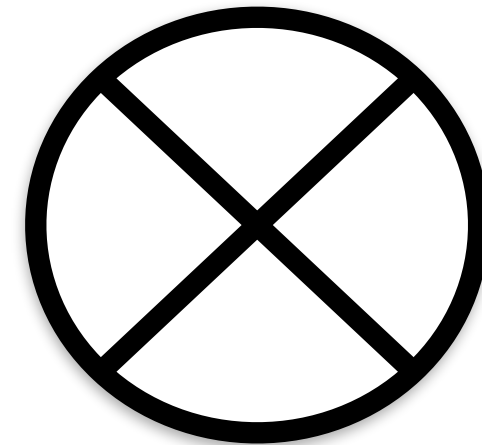
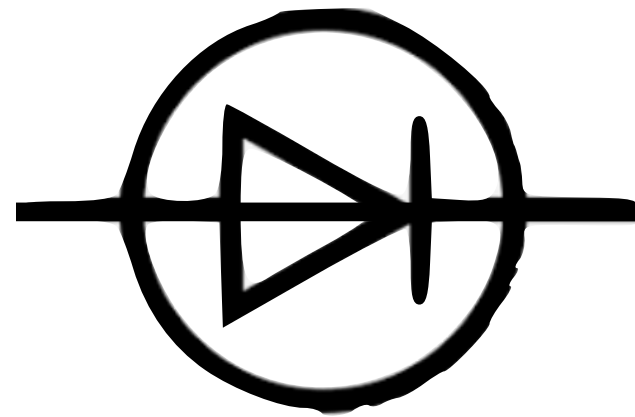
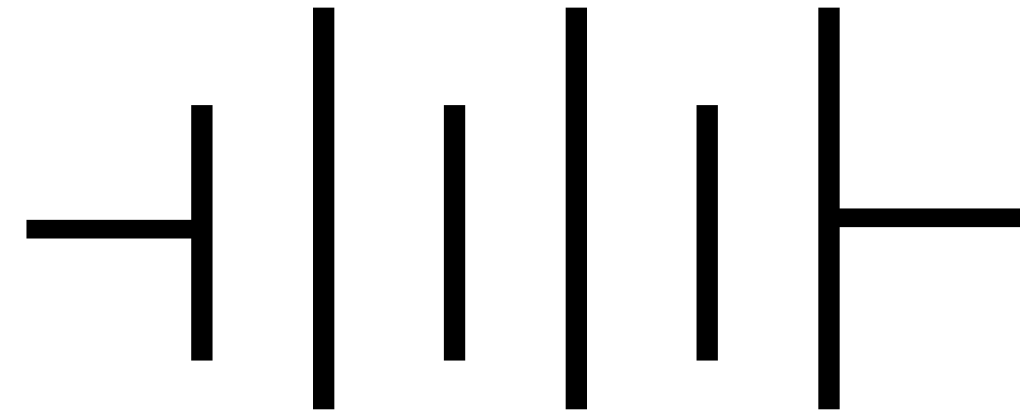
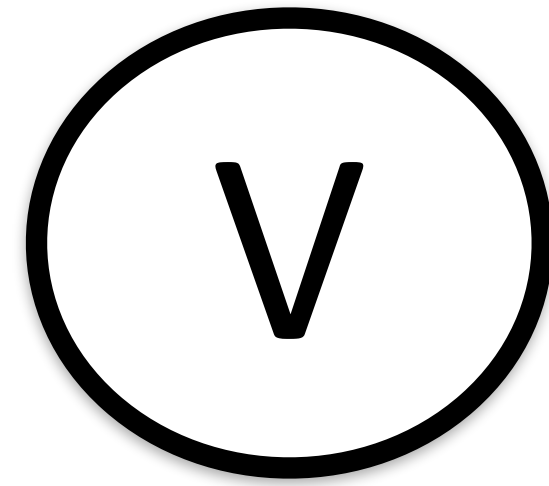
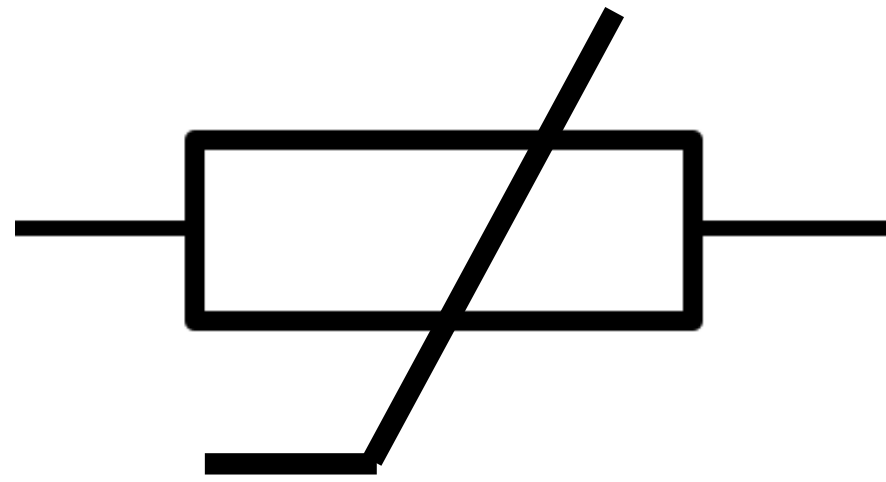
g)



h)



# Circuit Symbol Bingo!





# Theatre of Science IGCSE Physics: Electricity 9: Power

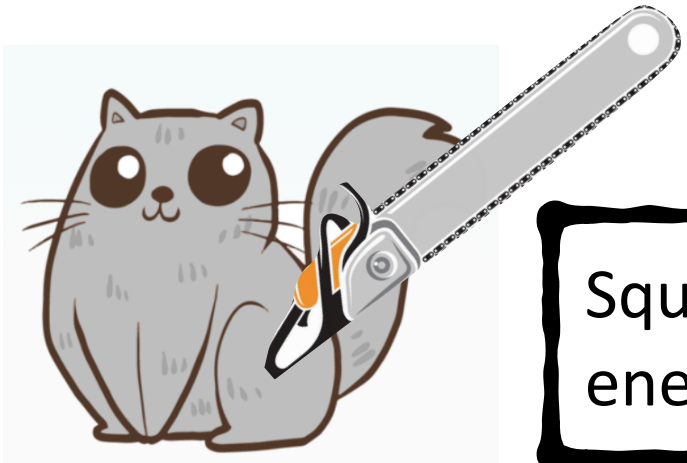
First! Fill in the gaps

Later!

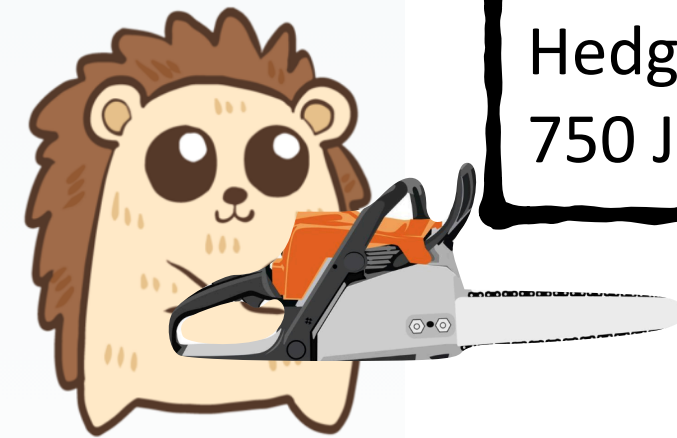
Sketch circuits that could measure the power of a lamp, a bulb and a fixed resistor.

Quality	Equation	Units	Also known as...
	Current = <u>Charge (measured in coulombs)</u> _____?	C/s	_____ (A)
	Voltage = _____? Charge (measured in coulombs)	J/C	_____ (V)
Power =	_____?	J/s	Watt (W)

These animal chums are rebuilding their houses. They have a contest to see who can dismantle their old house the fastest. Calculate how powerful the chainsaws are to work out who will win the contest.



Squirrel's transfers 200 J energy in 30 seconds.

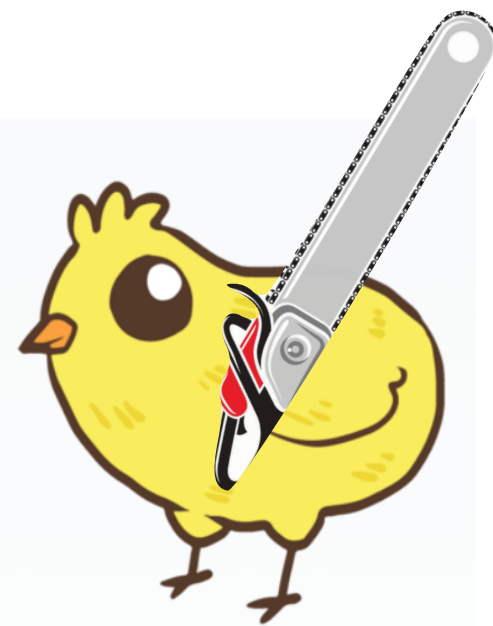


Hedgehog's uses 750 J in 2 minutes.

Rabbit's transfers 1 kilowatt in 1.5 minutes.



$$\text{Power} = \text{Energy} \div \text{Time}$$



Chick's uses 100 J of energy in 15 seconds.



In one minute, Penguin's machine transfers twice the amount of energy that squirrel's does.

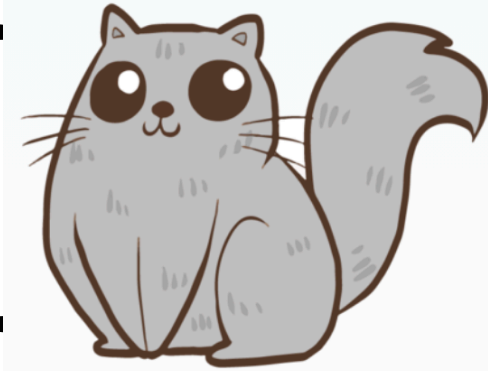
Done? You can put voltage and current into an equation to get power! Look at the equations for voltage and current again; can you see how?



# These chums are lighting their new homes and have some questions.

## Can you answer them?

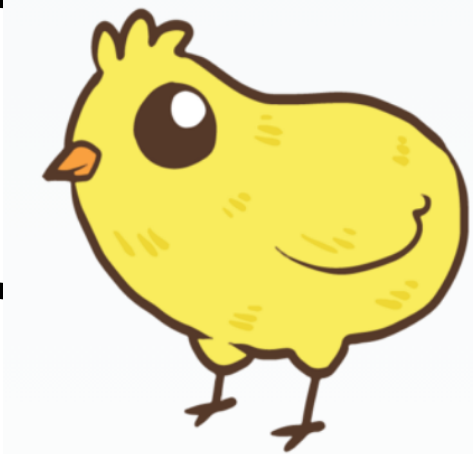
Squirrel's filament bulb operates at a voltage of 230V and has 0.5A running through it. What is its power rating?



Penguin's bulb operates at 12V and has 2A flowing through it. How much energy does it use per second?



Chick's head torch with a power rating of 58W has 2.9A flowing through it. What voltage does it operate at?



Hedgehog's torch has a power rating of 5 at a voltage of 10. How much current will flow through it?



Done? Put voltage, current, energy and time into an equation.

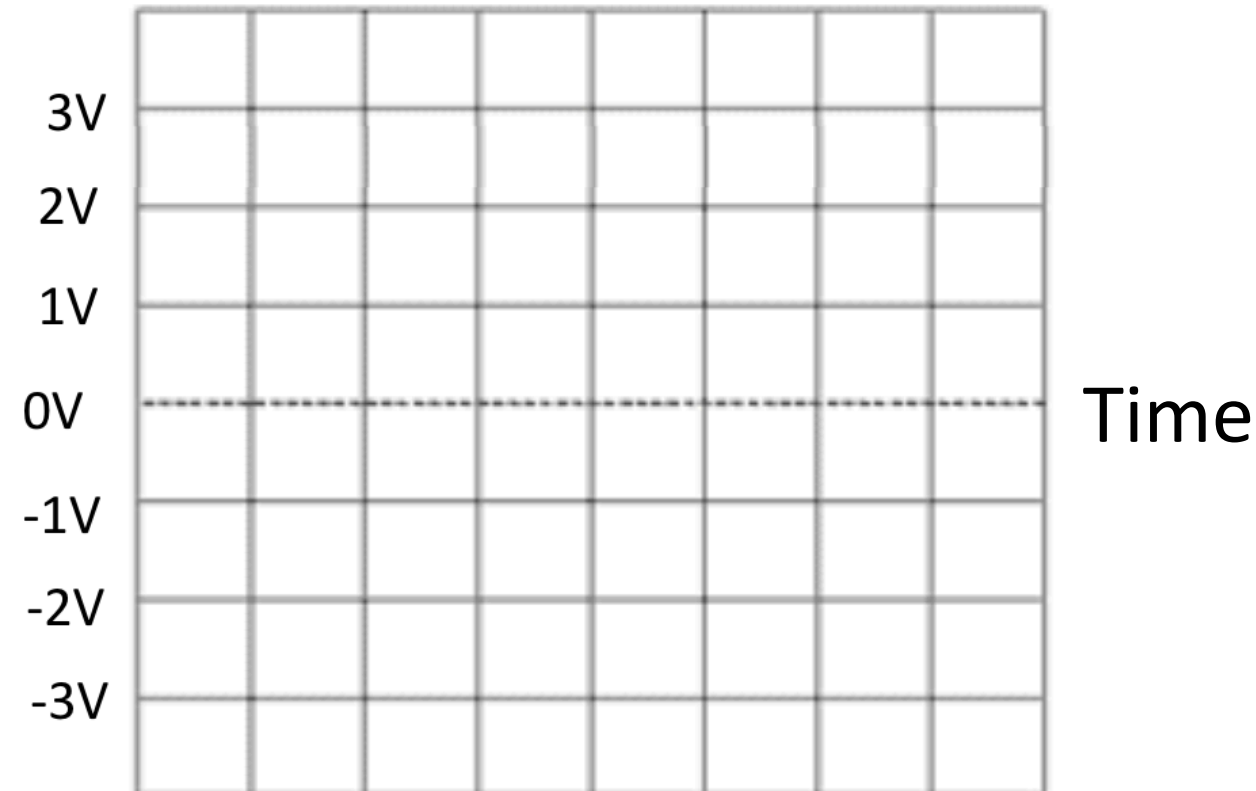




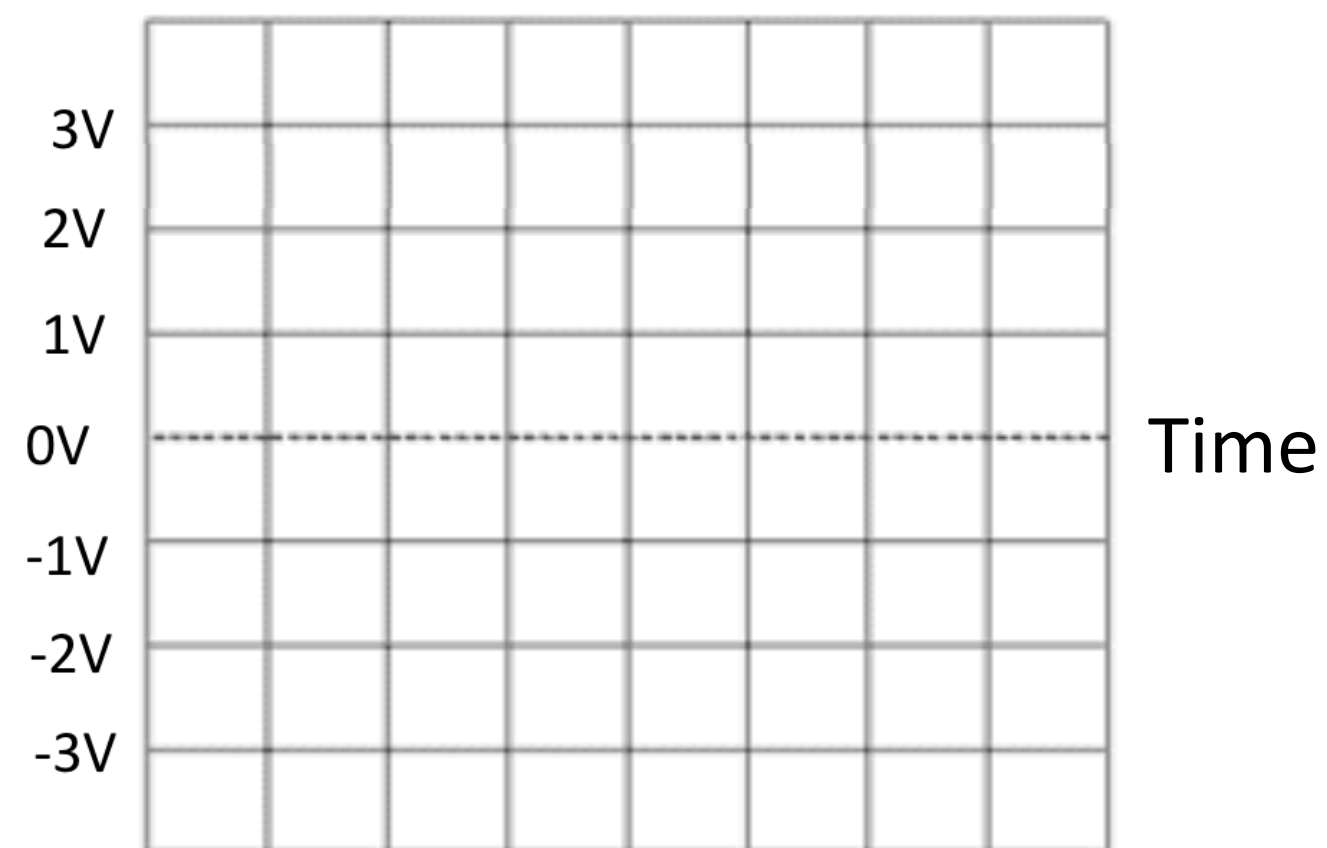
# Theatre of Science IGCSE Physics: Electricity 10: Household Electricity

If you were going to draw a 'wave' that stayed at 2.5V on this graph, what would it look like?

Voltage



Voltage



Which fuse? Choose from 1A, 3A, 5A and 13A.

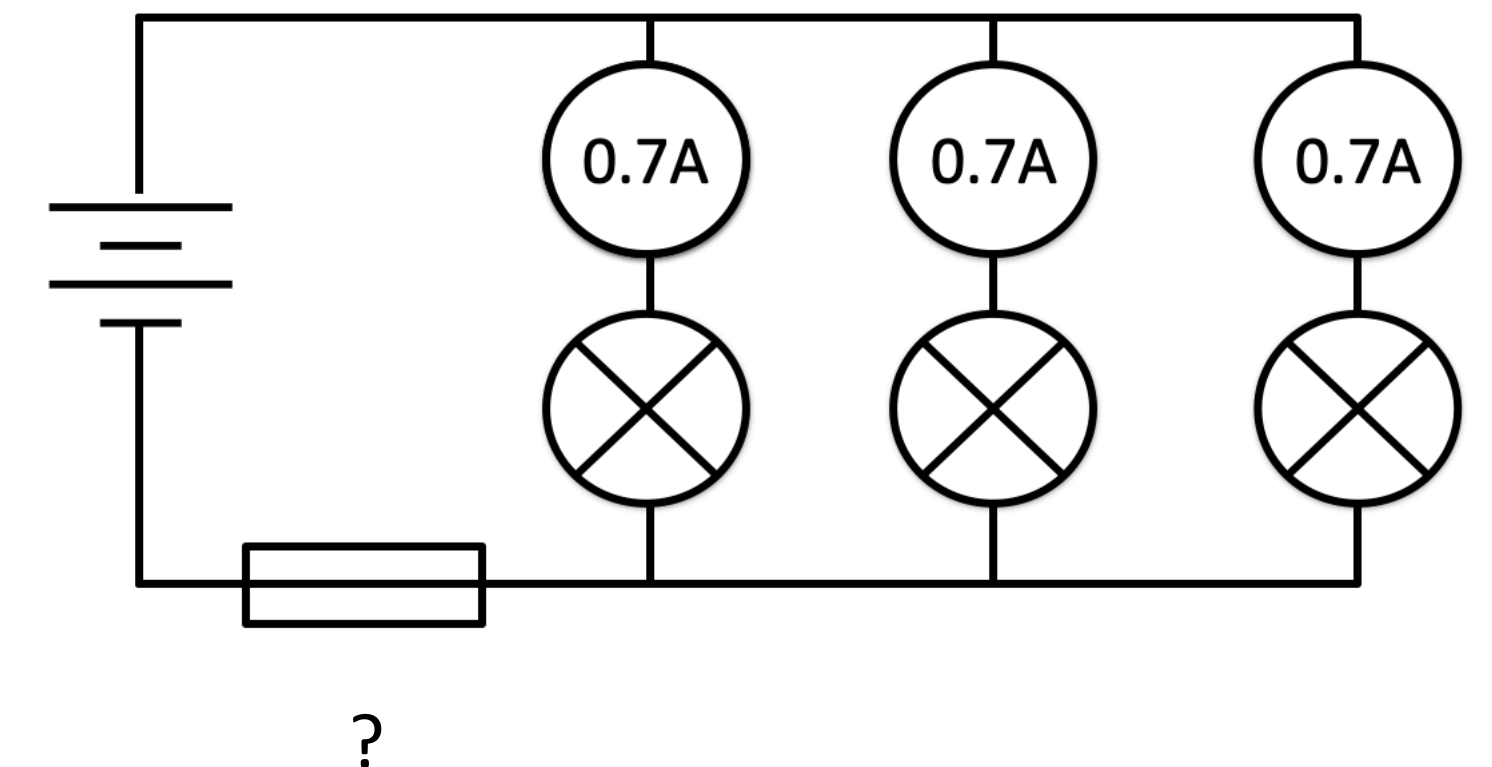
$$\text{Power} = \text{Current} \times \text{Voltage}$$

1) An 800W toaster with a potential difference of 230V?

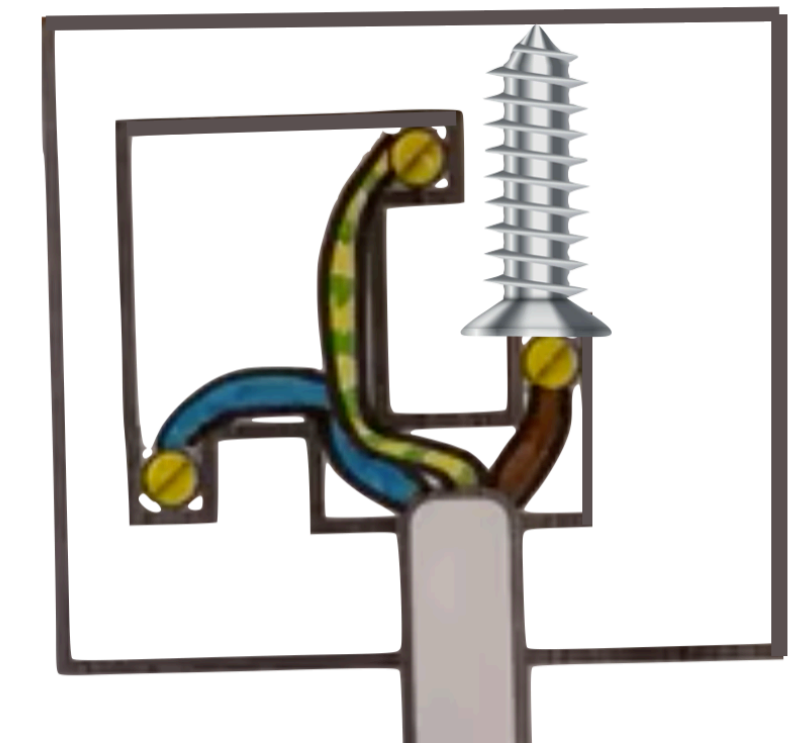
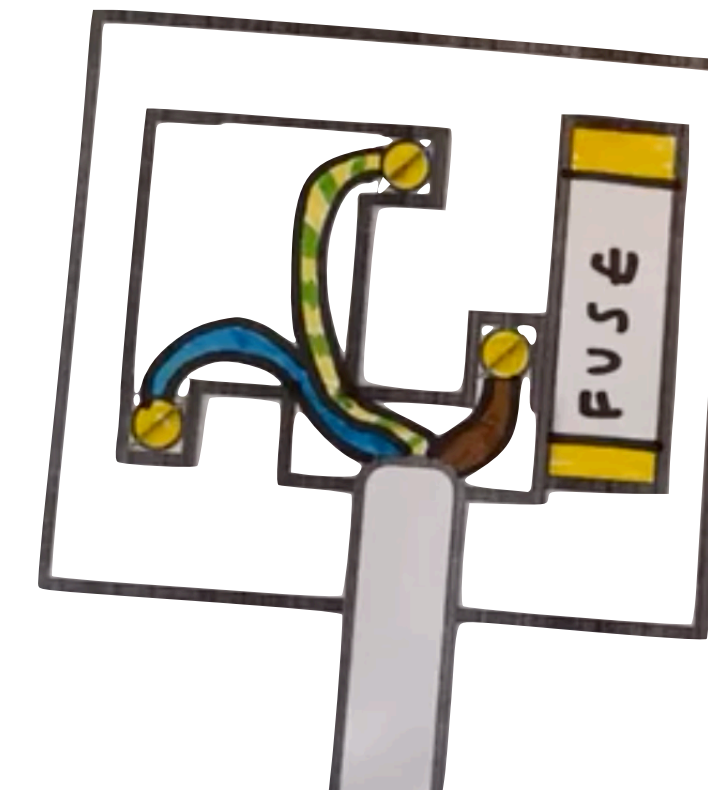
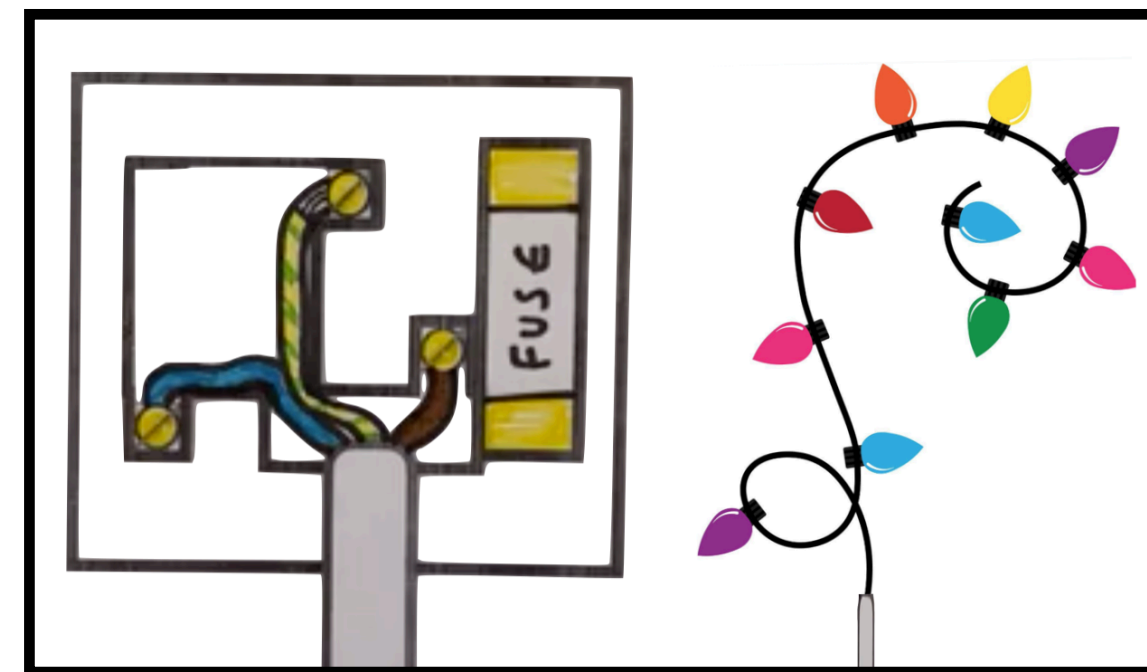
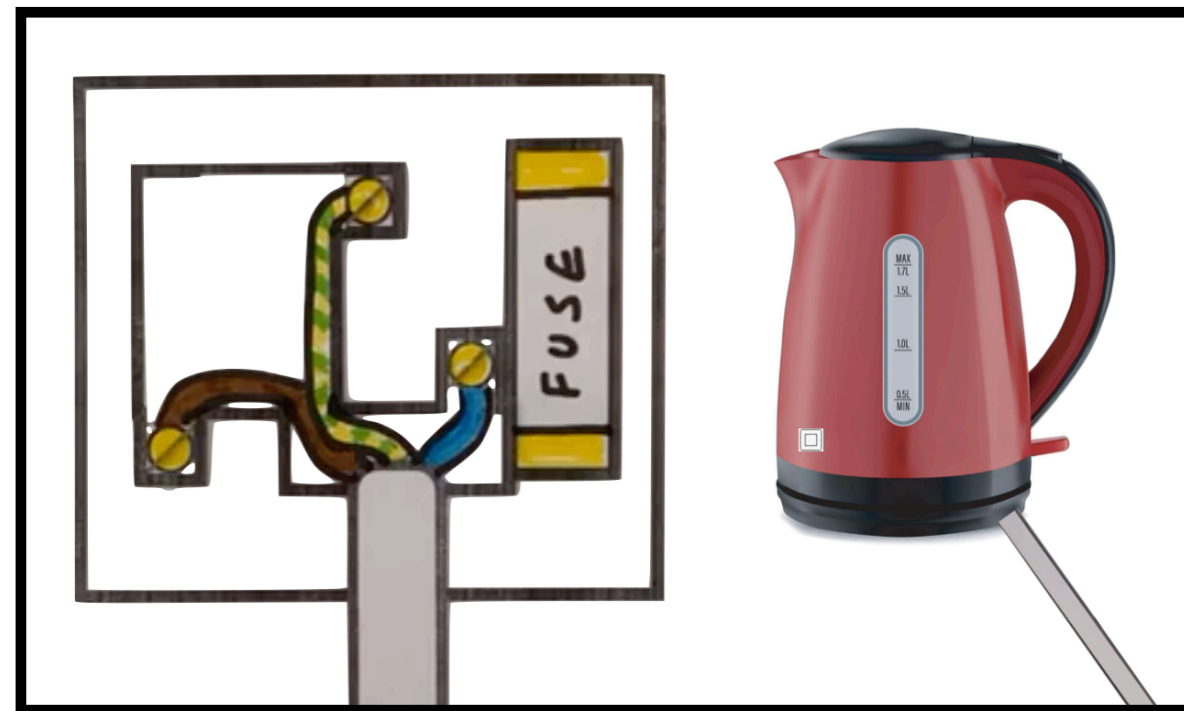
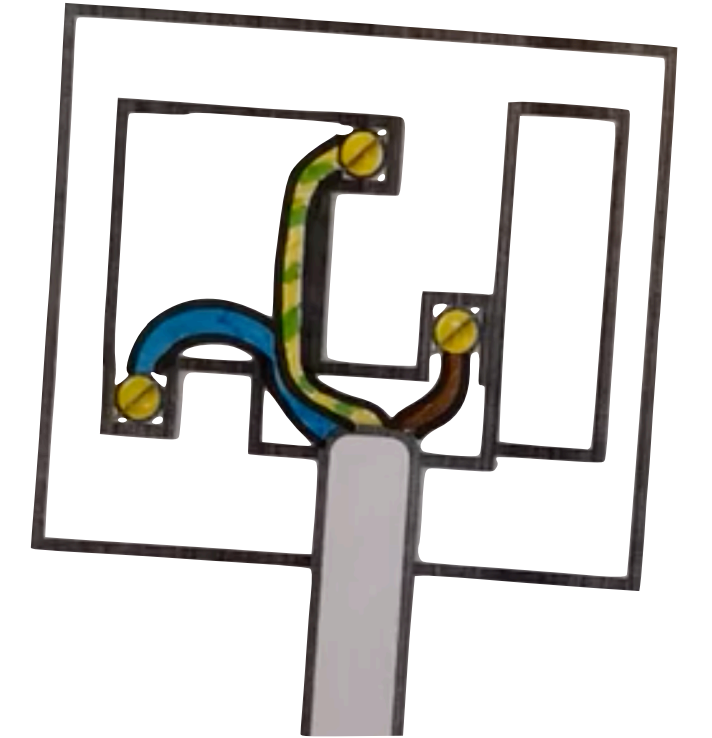
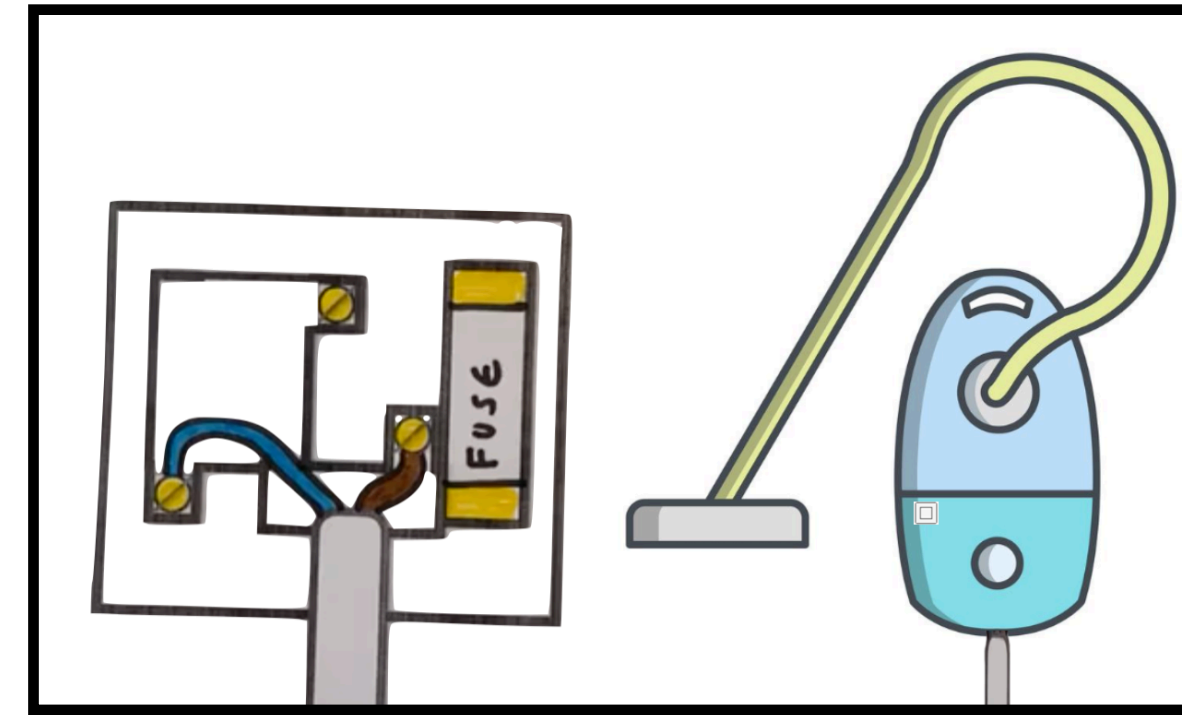
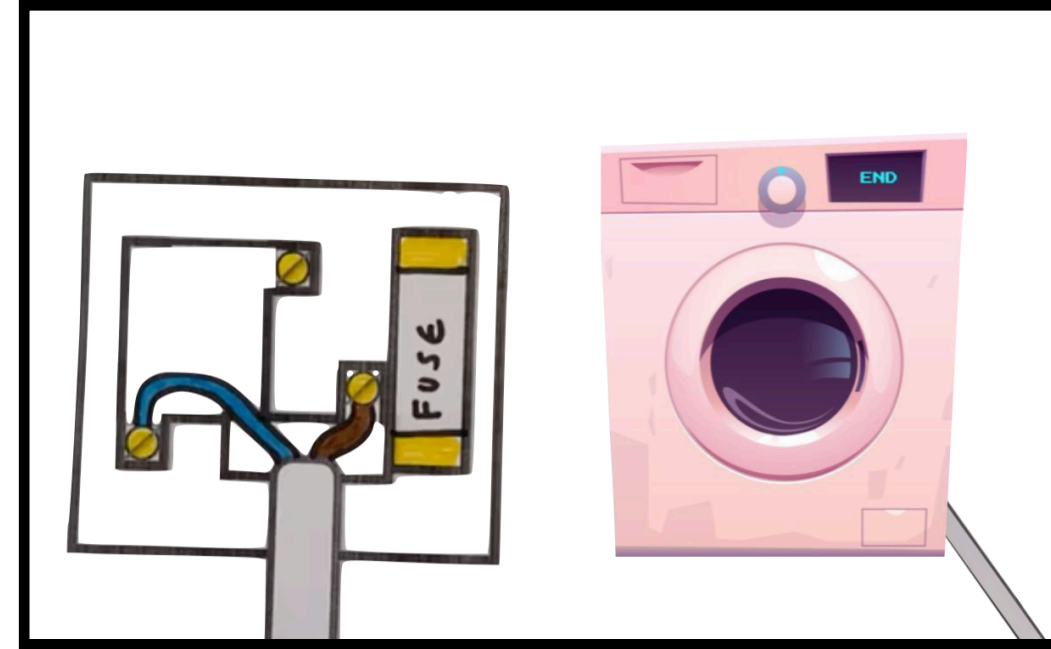
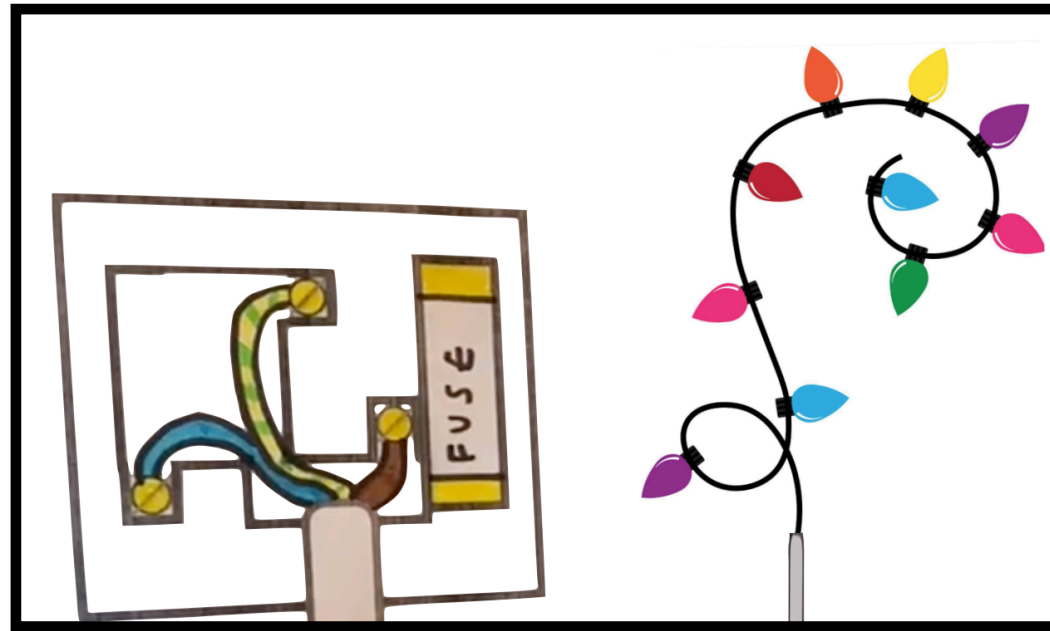
2) A 2.3kW kettle with a potential difference of 230V?

3. A 1kW hairdryer plugged into the mains in the UK.

4.



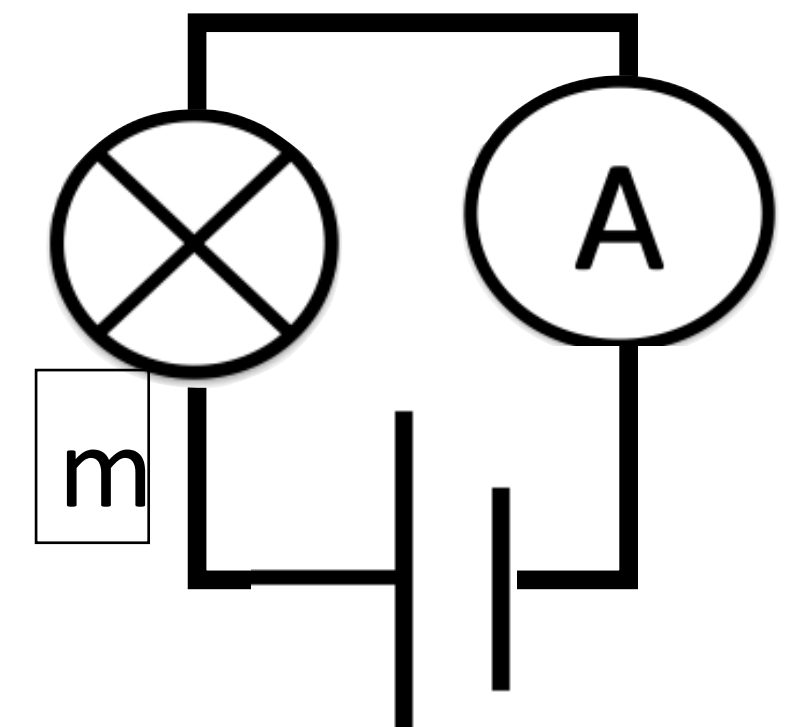
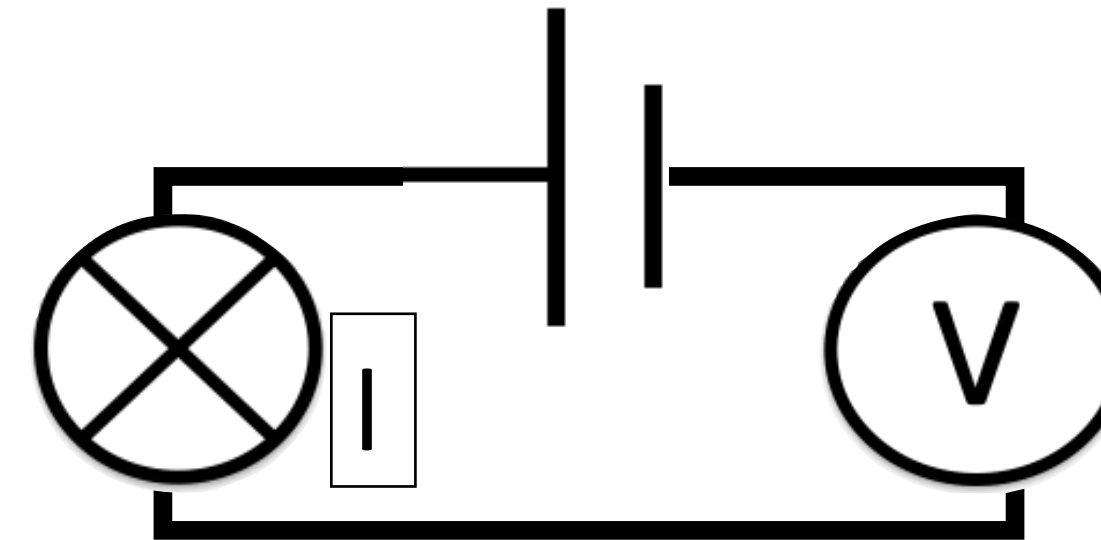
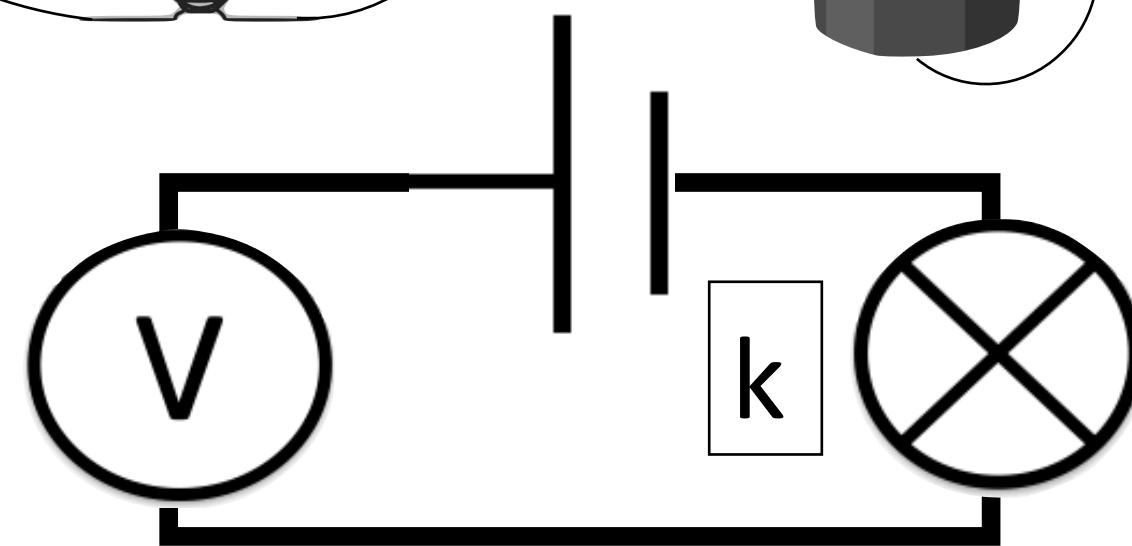
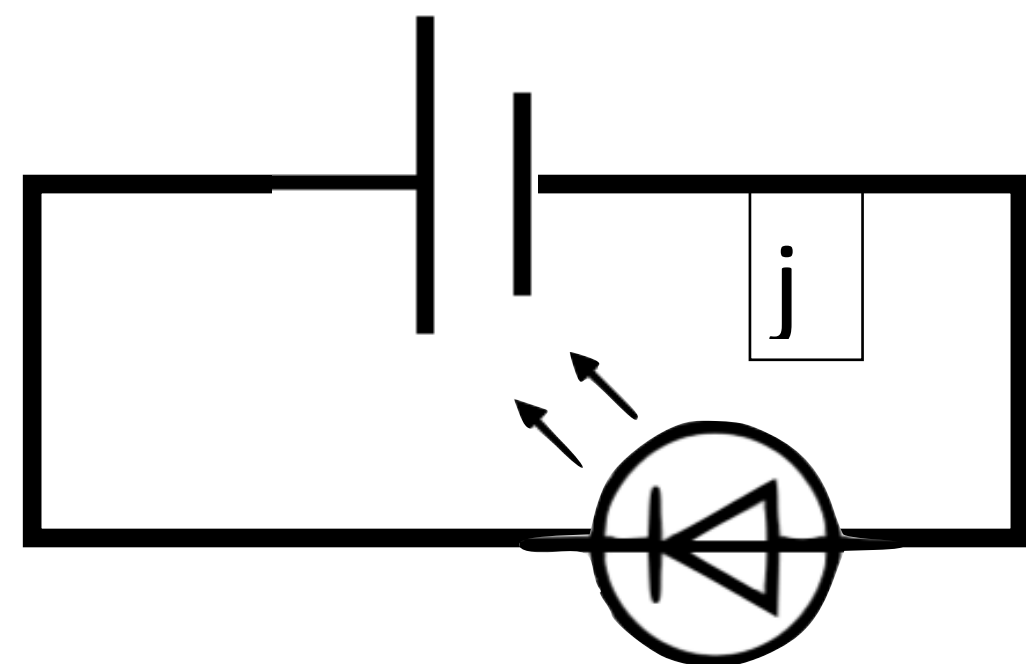
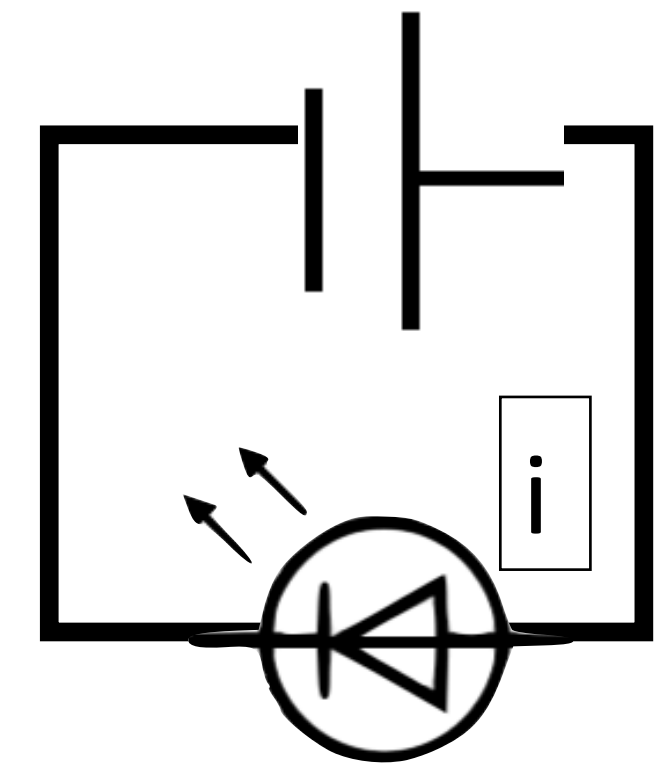
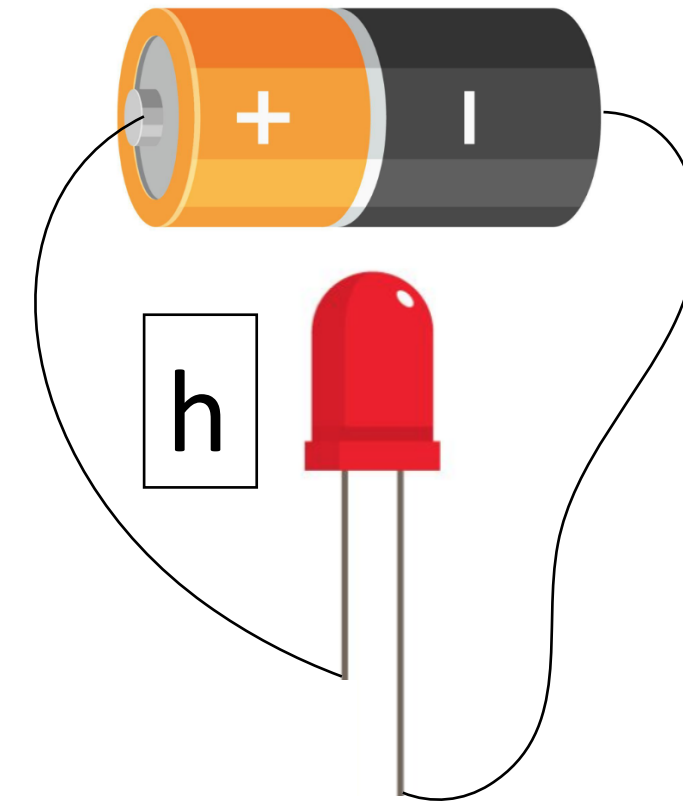
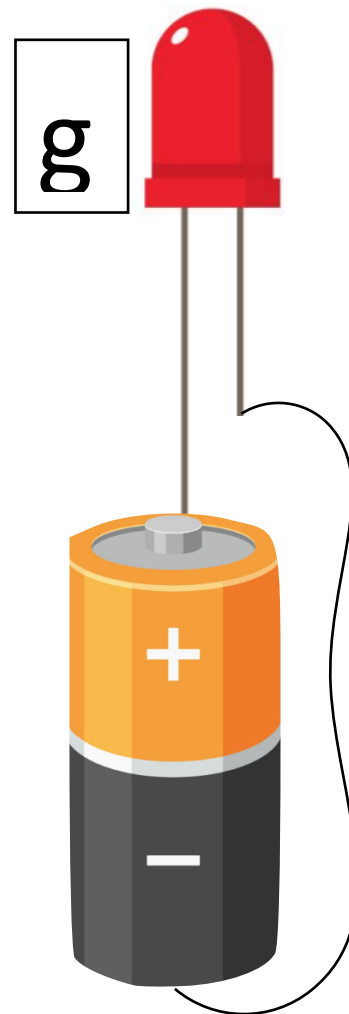
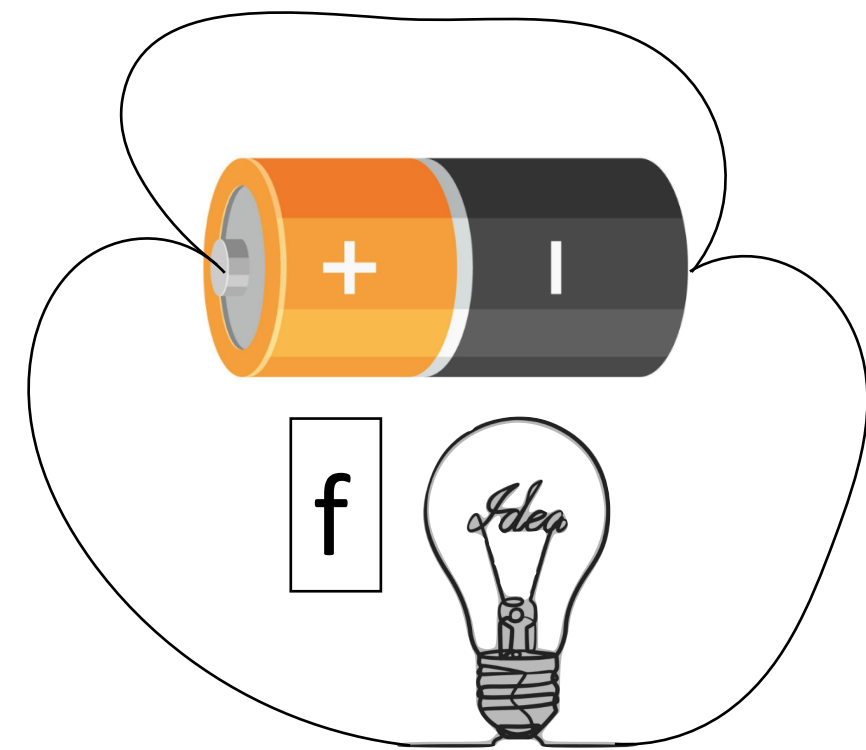
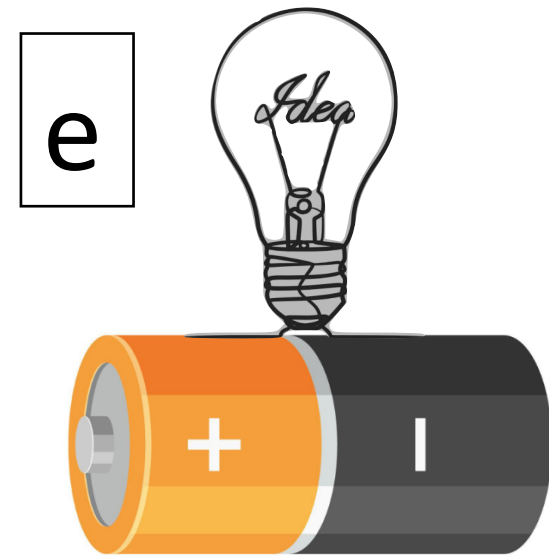
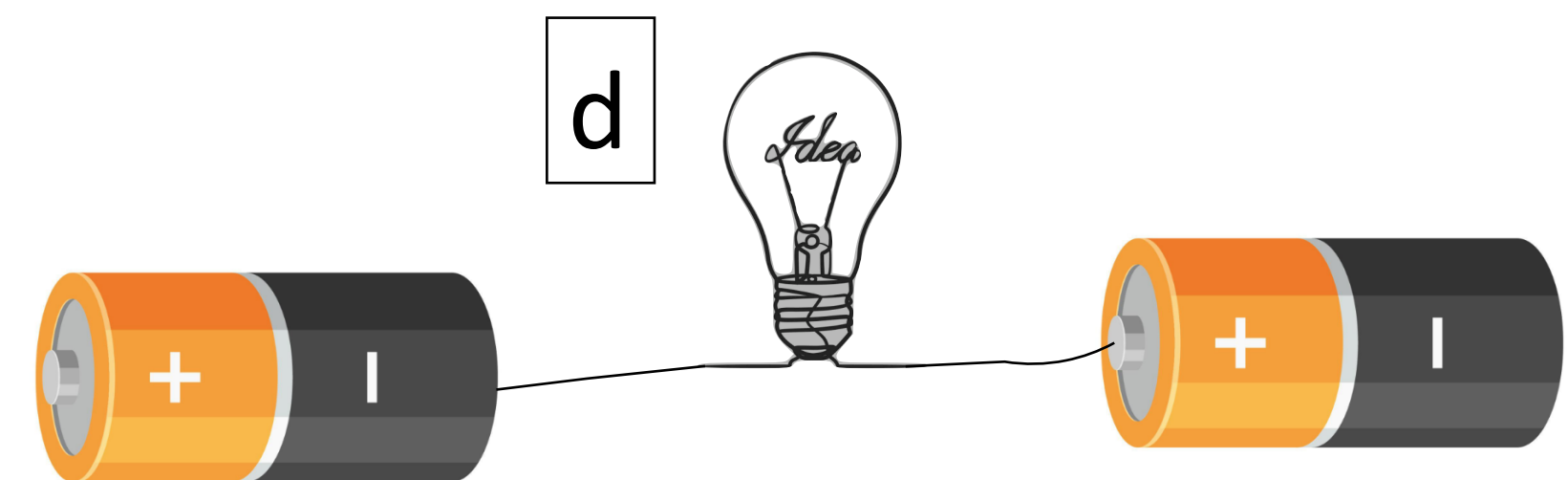
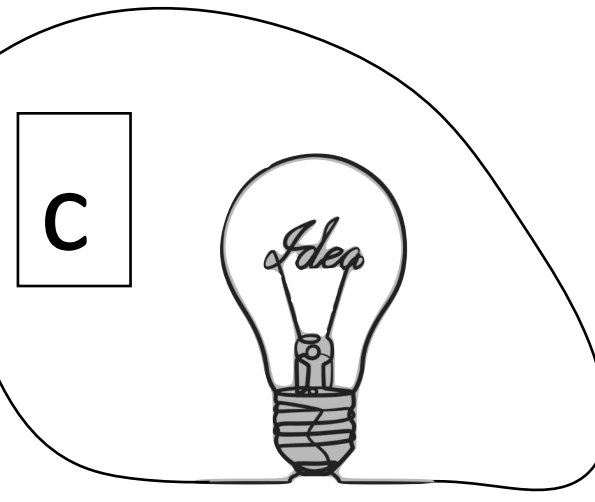
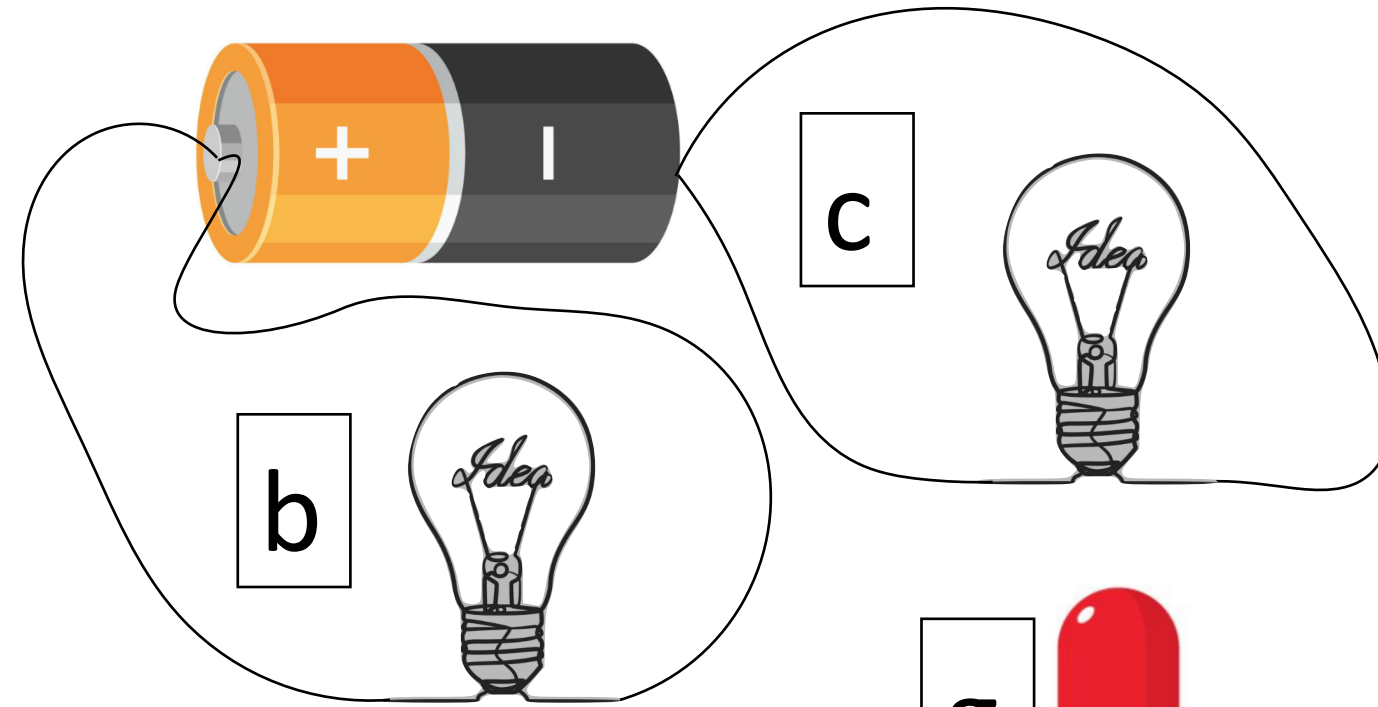
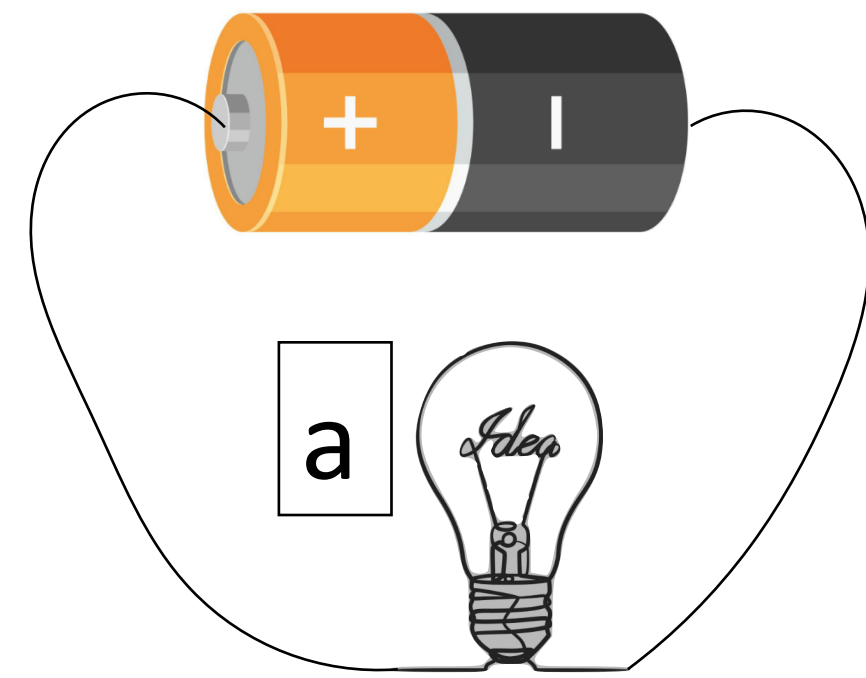
# Safe or Shock?!



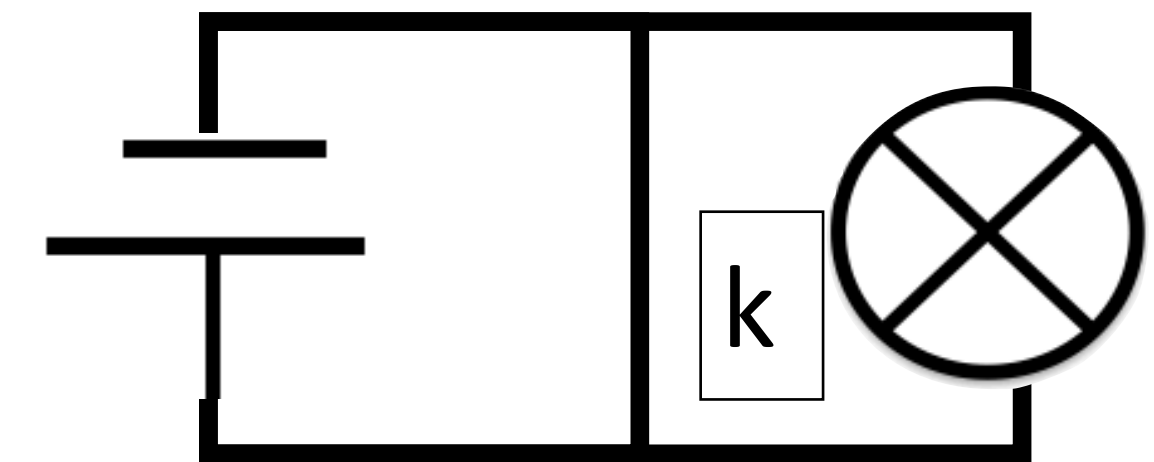
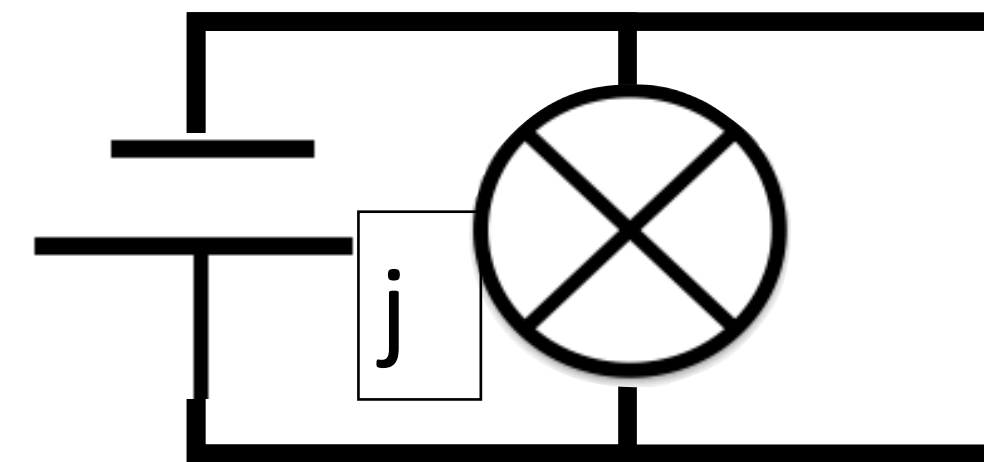
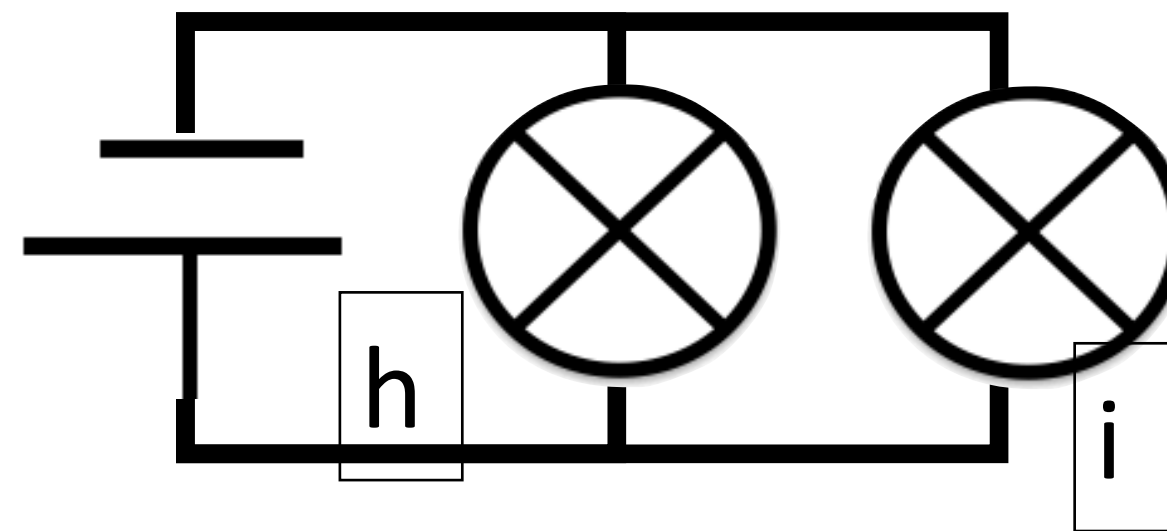
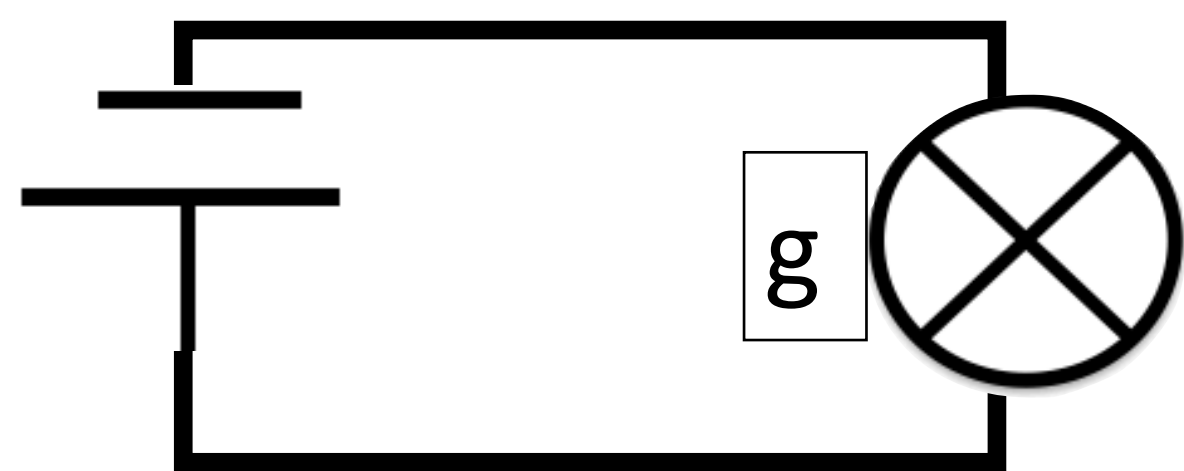
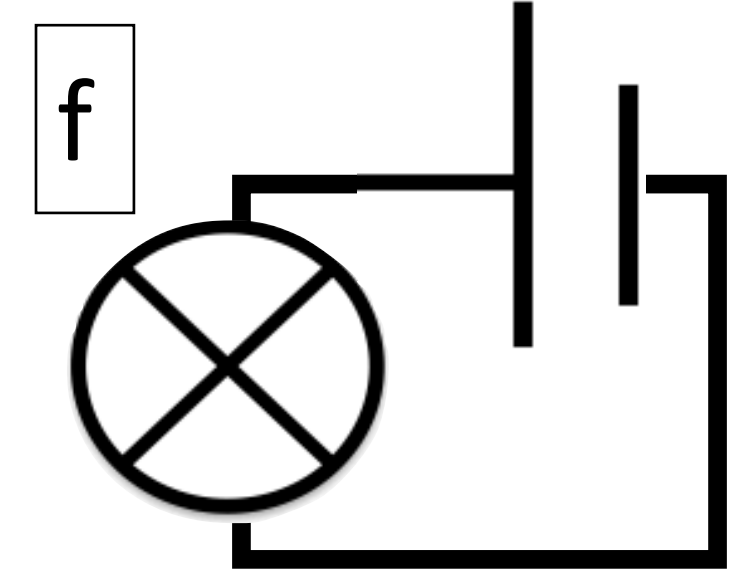
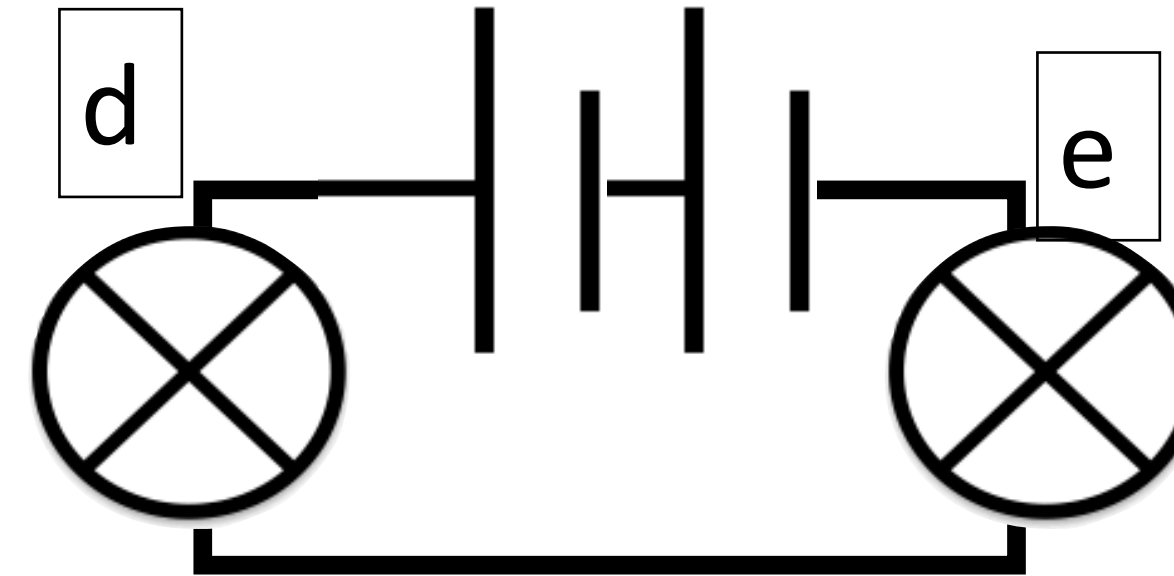
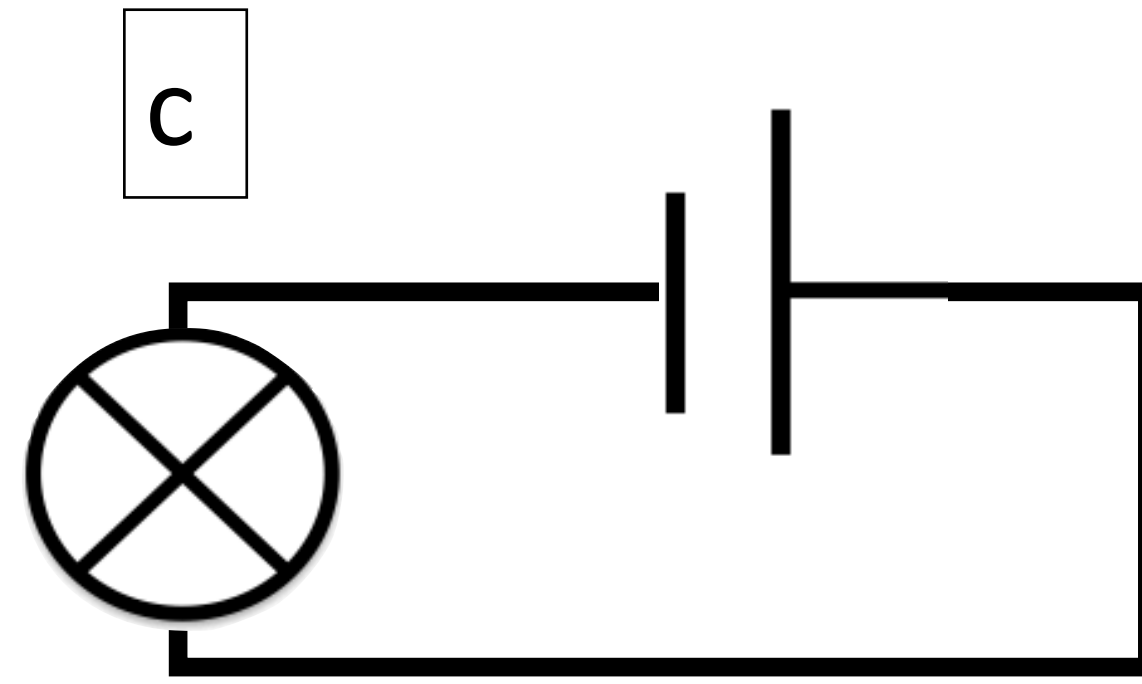
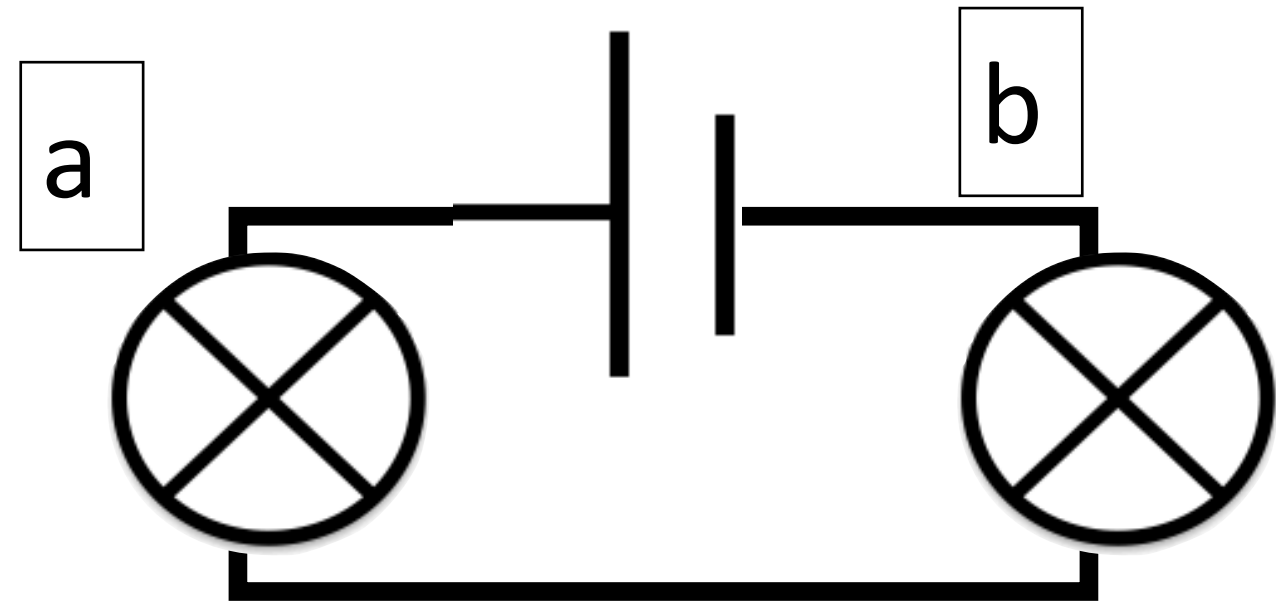
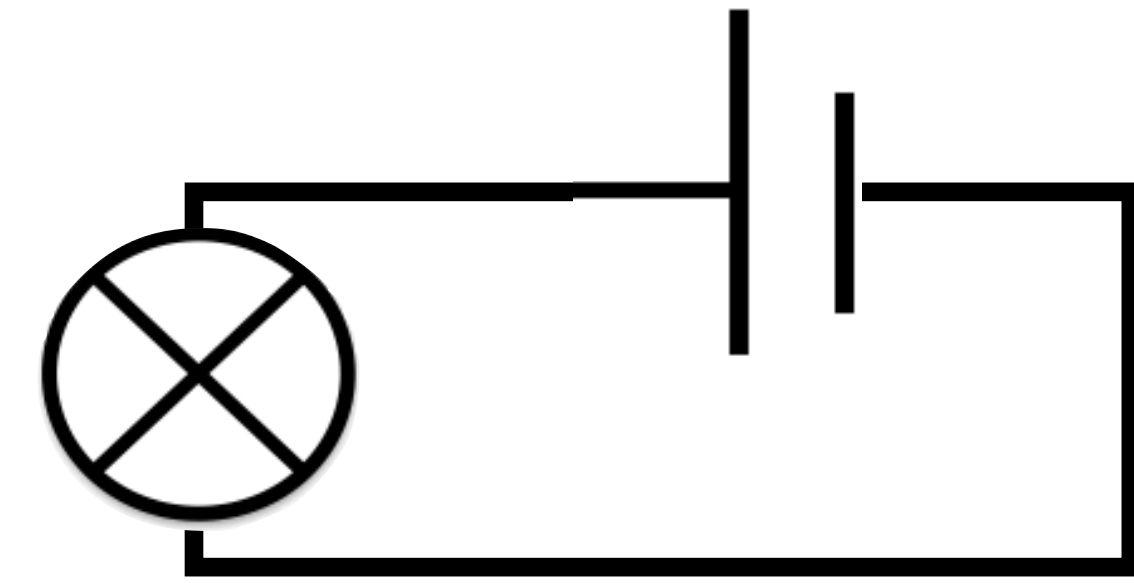


# Theatre of Science IGCSE Physics: Electricity 11: Recap etc!

Will the bulbs in these circuits light up? (The long leg of an LED is the positive end; assume no diodes are melting!)



The bulb in this circuit is shining normally. Say how bright the other bulbs are: Bright, Normal, Dim, or Out.



What units make up a volt?

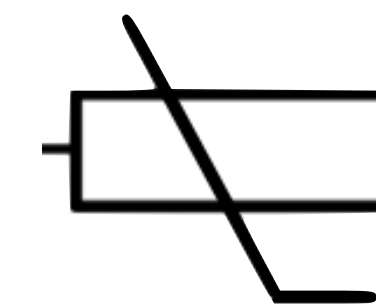
- a) J/s
- b) J/C
- c) C/s
- d) C/J

What units make up a watt?

- a) J/s
- b) J/C
- c) C/s
- d) C/J

What is this?!

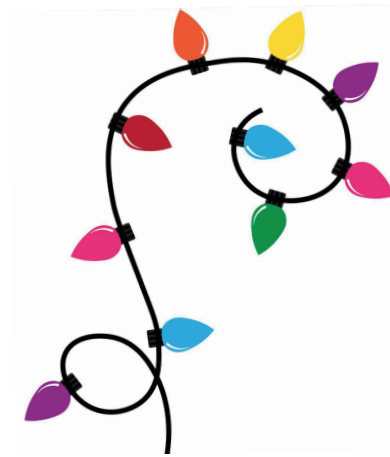
- a) Variable resistor
- b) LED
- c) Thermistor
- d) Fuse



What about a thermistor changes when it heats up?

- a) Voltage
- b) Resistance
- c) About of light emitted

1) A set of ten Christmas lights is plugged into the mains electricity supply in the UK.



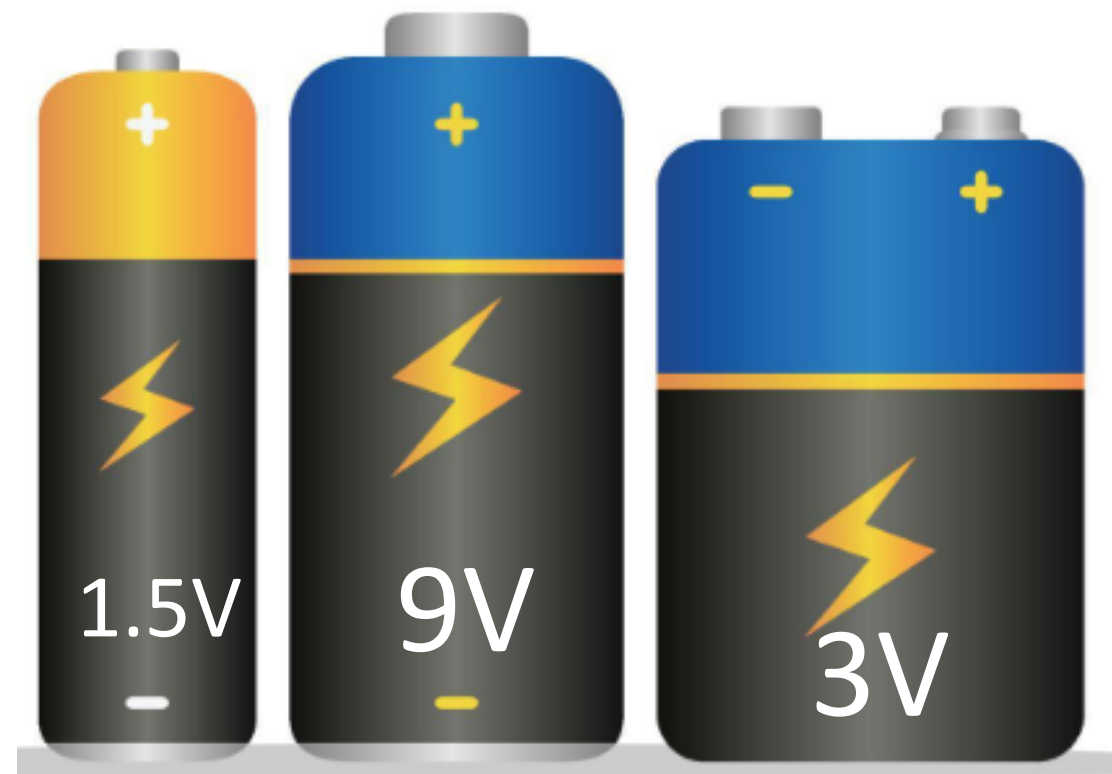
0.2A flows through each bulb.

a) How much current flows through the circuit altogether?  
\_\_\_\_\_

b) What is the resistance of each bulb?  
\_\_\_\_\_

c) What is the total resistance of the circuit?  
\_\_\_\_\_

2) These batteries are each connected to identical bulbs. Which battery makes the bulb shine brightest? Explain your answer.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



3) Sketch the following:

Fuse

Resistor

Diode

Power Supply

4) What components might these graphs represent? Finish labelling them.

