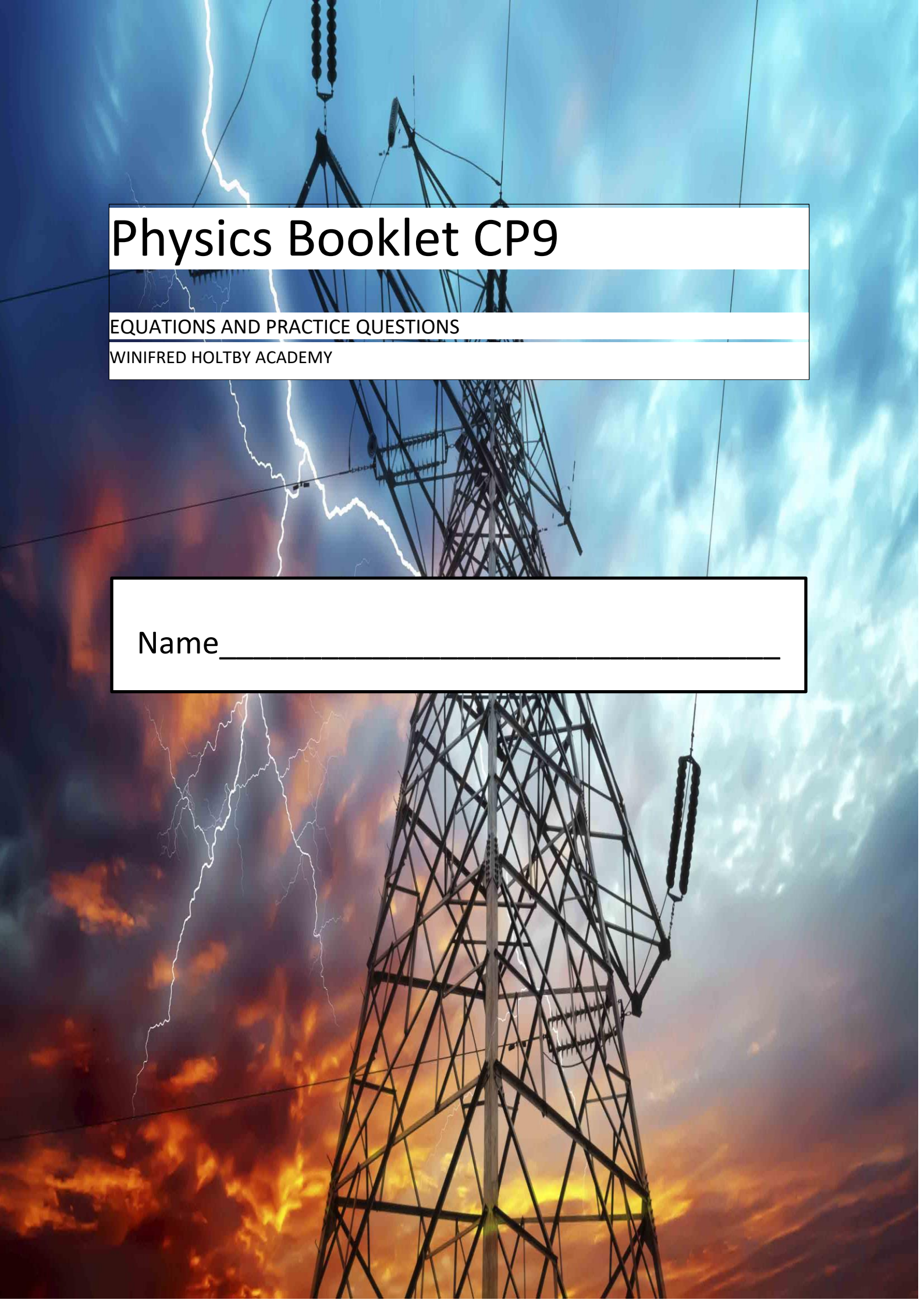


Physics Booklet CP9

EQUATIONS AND PRACTICE QUESTIONS

WINIFRED HOLTBY ACADEMY

Name_____

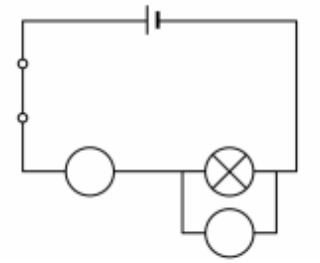
Answer the questions using the F.R.S.A.U format and a calculator.

CP9b.4

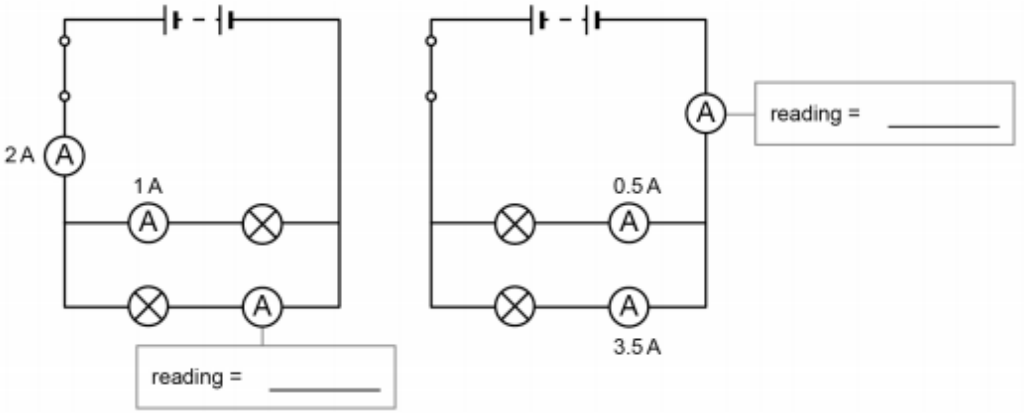
1 **a** What does an **ammeter** measure? _____

b What does a **voltmeter** measure? _____

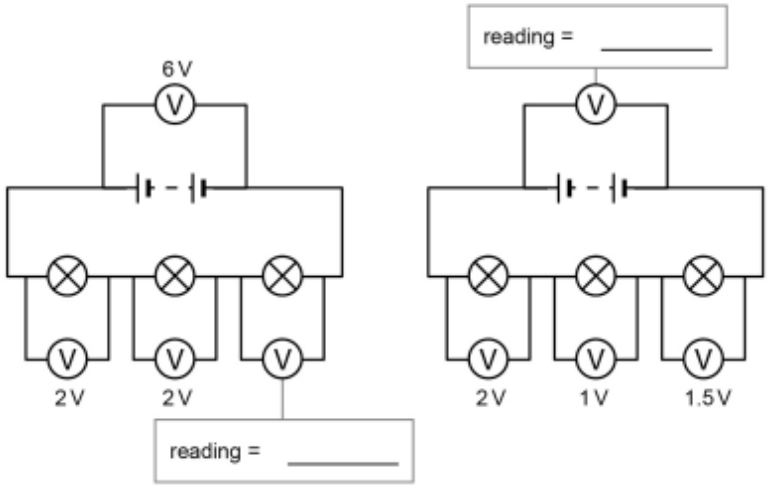
c Complete this circuit diagram to show how you would connect an ammeter to measure the current through the lamp and a voltmeter to measure the **potential difference** across the lamp.



2 In the following circuits, what are the missing current readings on the ammeters?



3 In the following circuits, what are the missing potential differences on the voltmeters?



Answer the questions using the F.R.S.A.U format and a calculator.

CP9b.5

1 A student connects a lamp in a circuit with a **cell** and a switch. She wants to measure the current through the lamp and the **potential difference** across it.

a Draw a circuit including meters to measure the current and the potential difference.

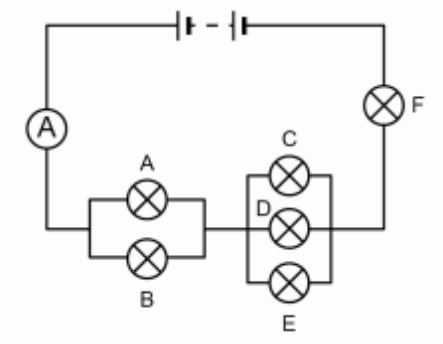
b State the name of the meter used to measure current.

c State the name of the meter used to measure potential difference.

2 Describe two conditions needed to produce an electric current.

3 Define potential difference.

4 In the circuit below, all the lamps are identical.



a Calculate the current passing through each of the lamps A–E when the reading on the **ammeter** is 4.8 A.

b The potential difference across the single lamp F is 6.6 V. The potential difference across the two lamps A and B in parallel is 3.3 V. The potential difference across the three lamps in parallel C, D, E is 2.2 V. Calculate the total potential difference of the **battery**.

Extra challenge

5 Three identical 1.5 V cells can be connected in parallel or series to make a battery.

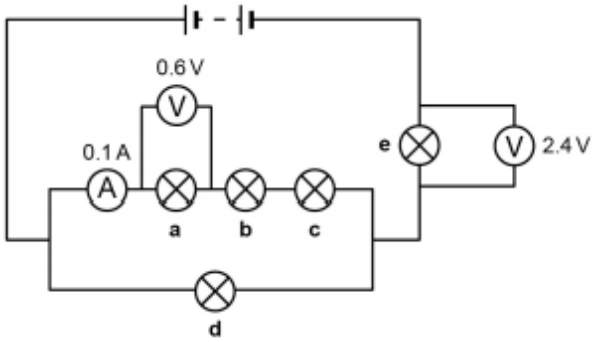
Compare and contrast the effect on the total potential difference and the time the battery will last when the cells are connected in parallel or in series part of question above need to align with above.

6 Look at the circuit diagram below. Calculate:

a the current in each lamp

b the potential difference across each lamp

c the potential difference supplied by the battery.



Answer the questions using the F.R.S.A.U format and a calculator.

CP9c.6

You will be expected to recall the equation linking electric charge, current and time in your examination, and also the one linking energy transferred, charge and potential difference. You will need to choose the correct equation to answer the question, and you should also be able to change the subjects of the equations and to use the correct units.

1 The table shows the **charge** that flows when a current passes for a certain time. What are the missing values for **a**–**e**?

Charge (C)	Current (A)	Time (s)
a	3	60
1250	**b**	100
3600	5	**c**
9	**d**	18
2160	0.6	**e**

2 The current in a torch bulb is 0.3 A.

a The torch is switched on for 600 s. How much charge flows through the bulb?

b The battery has a charge of 900 C. How many *minutes* will it take to discharge the battery completely?

3 The charging current from a phone charger is 1.1 A.

a How much charge flows to the battery in 200 s?

b It takes 4 hours to fully charge the flat battery. What charge does the battery hold? (*Hint:* remember to convert hours to seconds.)

4 Different batteries contain different amounts of charge and energy. What are the missing values for **a**–**e** in the table?

Battery	Energy (J)	Charge (C)	Potential difference (V)
AA alkaline long-life	**a**	7600	1.5
Lithium camera	1350	450	**b**
Zinc air hearing-aid	420	**c**	1.4
PP3 alkaline long-life	18 000	**d**	9
Lead acid car battery	2 592 000	216 000	**e**

5 A student has a power bank external battery pack for his phone. The charge is given in units of milliampere hours (mAh). When fully charged, the battery stores 6000 mAh.

a Use the equation that relates charge, time and current to answer the following questions.

i Calculate the charge if a current of 1 milliamp flows for 1 hour.

ii Calculate the charge in **coulombs** in the battery pack when it is fully charged.

iii The charging current is 2 A. Calculate how long it takes to fully charge the battery when it is flat.

b The potential difference of the battery is 5 V.

i Calculate the energy stored when it is fully charged.

ii Calculate the energy transferred to the phone battery when a student uses the charger and 1000 C of charge flows to the phone battery.

Answer the questions using the F.R.S.A.U format and a calculator.

CP9d.5

1 Write down:

a the unit and symbol for **resistance**

b the equation connecting potential difference, current and resistance.

2 **a** Describe what happens to the current in a circuit when the resistance is increased and potential difference is unchanged.

b Explain why this happens.

3 A 9 V cell is connected across a 36 Ω resistor. Calculate the current.

4 The 230 V mains supply is connected to a kettle and a current of 12 A passes. Calculate the resistance of the kettle element.

5 Describe and explain what happens to the total resistance of a circuit with a resistor when:

a a second resistor is added in series.

b a second resistor is added in parallel with the first resistor.

6 A 24 V power supply is connected in series with a 3 kΩ resistor.

a What is the current in the circuit?

b A 5 kΩ resistor is added in series. What is the total resistance of the circuit?

c What is the new current in the circuit?

d What is the new potential difference across:

i the 3 kΩ resistor **ii** the 5 kΩ resistor?

7 **a** Draw the circuit diagram of a circuit that can be used to find the resistance of an unknown resistor. Include a variable resistor to change the current in your circuit.

b Describe how to do the test. Include:

i the two quantities to be measured

ii how to calculate the resistance

iii how to repeat the experiment using a larger current.

Extra challenge

8 A cable contains five different coloured wires: black, yellow, blue, red and green. One of the wires is broken.

a Explain how you could find out which wire is broken.

In fact the black wire was broken. At one end of the cable a student connects:

- the yellow wire to the blue wire with a 47 Ω resistor
- the red wire to the green wire with a 3 Ω resistor.

At the other end of the cable the student connects:

- the blue wire to the red wire with a 10 Ω resistor
- the yellow wire to an ammeter, a 12 V battery and the green wire.

b Draw a circuit diagram to show the set-up. Label or use colour to show the coloured wires.

c Calculate the resistance of the circuit.

d Calculate the current you would expect to see on the ammeter.

e The ammeter reads 0.16 A. Use this information to calculate the total resistance of the circuit.

f The four wires all have the same resistance. Use your answers to parts **d** and **e** to calculate the resistance of each wire.

Answer the questions using the F.R.S.A.U format and a calculator.

CP9d.6

In your examination you will be expected to recall the equation linking potential difference, current and **resistance**. You will need to choose the correct equation to answer the question. You should also be able to change the subject of the equations and to use the correct units.

1 The table below links the potential difference across a component, circuit or part of a circuit with its resistance and the current passing through it. Fill in the missing values.

Potential difference (V)	Current (A)	Resistance (Ω)
	2.3	100
100		25
9	0.005	
	0.02	600
1000		10 000
230	13	

2 A current of 5 mA passes through a resistor of 1 kΩ. Calculate the potential difference across the resistor.

3 A 9 V battery is connected to a resistor.

a The current is 3 A. Calculate the value of the resistance.

b The same resistance is connected to a 12 V battery. Calculate the current.

4 To find the remains of a wall buried under the ground an archaeologist can do a resistance survey. The resistance of the ground is measured. Stone and brick have a higher resistance than soil. Here are the measurements for three sites.

Site	Potential difference (V)	Current (A)
A	12	0.030
B	6	0.012
C	12	0.015

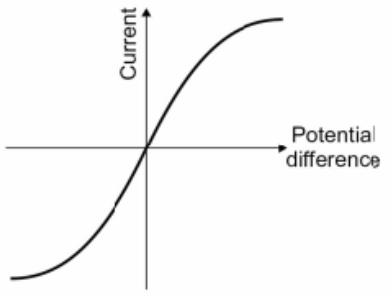
a Calculate the resistance at each site.

b Which site is the most likely to be the site of the wall?

Answer the questions using the F.R.S.A.U format and a calculator.

CP9e.5

1 Look at this graph of current against potential difference for a filament lamp.



Explain how the current changes when the potential difference across the filament lamp is increased.

2 Explain what happens to the current when the potential difference across a fixed resistor is doubled.

3 **a** Sketch a graph of current against potential difference for a **diode**.

b Explain how and why the graph looks different for negative values of potential difference.

c Explain what happens to the current and the resistance as the potential difference is increased in the positive direction.

d Give an example of the use of a diode.

e What is a diode that gives out light called?

4 A **light-dependent resistor** (LDR) has a resistance of 100 Ω.

a Calculate the current through the LDR when the potential difference is 5 V.

b You shine a light on the LDR. What will happen to its resistance?

c What will happen to the current in part **b** if the potential difference stays the same?

d Describe a use for an LDR.

5 A **thermistor** is in a circuit with a potential difference of 12 V. The current is 3 A.

a What is the resistance of the thermistor?

b The circuit is put in a freezer. What will happen to the resistance of the thermistor?

c What will happen to the current in part **b** if the potential difference stays the same?

d Describe a use of a thermistor.

Extra challenge

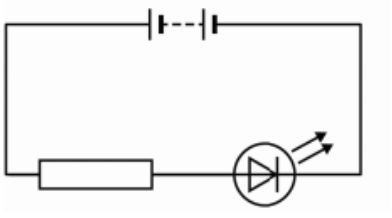
6 A **light-emitting diode** (LED) has very low resistance when the potential difference across it is higher than 2 V.

a If the potential difference across a diode is greater than 2 V what will happen to the current through it?

Suggest what effect this may have on the LED.

b Suggest why a light-emitting diode usually has a fixed resistor connected in series with it.

c The series circuit has a 5 V battery and a fixed resistor in series with the LED. Calculate the value of resistance needed to make sure the potential difference across the LED is not greater than 2 V and the current through it is not greater than 10 mA.



d If this value of resistor is not available, explain whether a resistor with a higher or a lower value should be used.

Answer the questions using the F.R.S.A.U format and a calculator.

CP9f.3

> You will be expected to use the equation linking energy transferred, current, potential difference and time in your examination. You should also be able to change the subject of the equation and to use the correct units.

energy transferred = current × potential difference × time

(J) (A) (V) (s)

This equation can also be written as

$E = I \times V \times t$

Worked example

A 12 V battery supplies a current of 0.3 A to a heater for 8 minutes. Calculate the energy that is transferred in heating up the heater and the surroundings.

$E = I \times V \times t$

$E = (0.3\ \text{A}) \times (12\ \text{V}) \times (8\ \text{minutes})$

Note that time has to be in seconds, so minutes need to be converted to seconds here.

$E = (0.3\ \text{A}) \times (12\ \text{V}) \times (8 \times 60\ \text{s})$

$E = 0.3 \times 12 \times 480\ \text{J}$

$E = 1728\ \text{J}$

Mains voltage in the UK is 230 V. Use this value in questions about mains voltage.

1 The table below links the energy transferred in an appliance with the current, potential difference and the time it is switched on for. Calculate the missing values.

Appliance	Energy transferred (J)	Current (A)	Potential difference (V)	Time (s)
a kettle		12	230	180
b filament lamp		2	12	3 600
c water heater	28 800		12	600
d torch	3 600	2		300
e cordless vacuum cleaner	99 000	5	22	
f television	966 000	1.4	230	

2 A lamp uses the mains voltage and has a current of 2 A. The lamp is switched on for 1 minute. How much energy does it transfer?

3 A 12 V battery passes a current of 0.5 A through a charger, transferring 2880 J of energy. How many minutes does this take?

4 A fan heater uses the mains voltage and takes a current of 13 A. The heater is on for 1 hour. How much energy does it transfer? Give your answer to the nearest megajoule.

5 A laptop uses a charger that connects to the mains voltage. The current is 0.3 A. The energy transferred is 82 800 J. Calculate the time that the charger was switched on for. Give your answer in minutes.

6 Two electric kettles, A and B, both use the mains voltage. Kettle A takes a current of 13 A and kettle B takes a current of 10 A. If kettle A takes 5 minutes to boil some water, how long will kettle B take to boil the same amount of water? (Assume that the energy transferred in heating the surroundings is the same for both kettles.)

Answer the questions using the F.R.S.A.U format and a calculator.

CP9f.6

You may find this information helpful for these questions:

The mains voltage in the UK is 230 V.

energy transferred = current × potential difference × time *or* $E = I \times V \times t$

You are not expected to remember this equation.

1 Name an appliance where the heating effect of an electric current is useful. Describe how and why it is useful.

2 Describe a situation in which the heating effect of an electric current is dangerous.

3 The central processor unit (CPU) of a computer has a lot of circuits in a very small computer chip. It has a cooling fan. Explain why it needs a cooling fan.

4 **a** A student uses a three-way adapter to plug three electrical appliances into one socket. She connects a phone charger (current = 0.16 A), a laptop (current = 0.3 A) and a lamp (current = 0.4 A). A cable connects the adaptor to the socket for the mains electricity supply. Calculate the current in the cable when all three appliances are connected.

b The student then decides to use the adaptor in the kitchen to connect an electric kettle, a toaster and a deep fat fryer. Suggest why this is not a good idea.

5 **a** Draw a labelled diagram showing the structure of a resistor, with a potential difference across it.

b Explain how electrical resistance inside materials is caused. Use your diagram to help you.

c Suggest how a material with high resistance might differ from a material with low resistance.

d Explain how, in this model, increasing temperature leads to higher resistance.

e Explain how, in this model, increasing current leads to higher temperature.

6 An electric circuit is designed in which it is important to have a low resistance.

List three ways in which the resistance can be reduced.

7 Calculate the energy transferred by a mains electric fire with a current of 13 A when it is on for 3 hours.

Give your answer to the nearest megajoule (MJ). (Mains voltage = 230 V)

8 Calculate the time required for a mains filament lamp with a current of 0.4 A to transfer 2.4 MJ of energy.

Give your answer in hours and minutes, to the nearest minute.

Extra challenge

9 **a** An immersion heater connected to the mains electricity supply takes a current of 13 A. Experiments show that to raise the temperature of a full tank of water by 1 °C this immersion heater requires 5.1×10^5 J of energy. Calculate the time required to heat a full tank of hot water from 15 °C to 49 °C. Give your answer in hours and minutes, to the nearest minute.

b A student calculates how much time is required, using the mass of the water in the tank, the temperature rise and the energy from the mains supply. Explain why the actual time required to heat the full tank of water is slightly more than the student's calculated time.

c The circuit has a safety switch to break the circuit if there is no water in the tank. Explain why this is necessary.

Answer the questions using the F.R.S.A.U format and a calculator.

CP9g.2

This table lists the energy use of some mains appliances. The mains voltage is 230 V.

Appliance	Energy transferred (J)	Time switched on	Power (W)	Current (A)	Resistance (Σ)
fan heater	7 200 000	1 hour = 3600 s			
filament bulb	2 880 000	8 hours = 28 800 s			
iron	1 800 000	30 minutes = 1800 s			
hairdryer	1 320 000	10 minutes = 600 s			
television	1 080 000	2 hours = 7200 s			
kettle	840 000	5 minutes = 300 s			
toaster	288 000	4 minutes = 240 s			
LED light	259 200	24 hours = 86 400 s			
electric drill	108 000	3 minutes = 180 s			
blender	36 000	2 minutes = 120 s			

You may wish to discuss these questions and work as a group to answer them.

1 Predict which appliance has the highest **power rating** and which has the lowest.

highest _____ lowest _____

2 **a** Calculate all the power ratings and enter them in the table.

b Which appliances have the highest and lowest power ratings?

highest _____ lowest _____

3 All the appliances use the same voltage. Predict which appliance has the highest current and which has the lowest.

highest _____ lowest _____

4 **a** Calculate all the currents and enter them in the table.

b Which appliances have the highest and lowest current?

highest _____ lowest _____

5 Write down a general rule for using power ratings to find the appliance that will take the highest current.

_____

6 Using the voltage and the value of current you have calculated, predict which appliance has the highest resistance and which has the lowest.

Highest _____ Lowest _____

7 **a** Calculate all the resistances and enter them in the table.

b Which appliances have the highest and lowest resistances?

Highest _____ Lowest _____

8 Write down a general rule for using power ratings to find the appliance that has the highest resistance.

_____

Answer the questions using the F.R.S.A.U format and a calculator.

CP9g.5

Use mains voltage = 230 V for questions about appliances that use mains electricity.

1 **a** What are the units and symbol for **power**?

b Describe what is meant by power.

2 Write down the equation relating power to energy transfer.

3 If the energy transfer is not known, write down two other equations that may be used to calculate the power transfer in an electric circuit.

4 Calculate the following:

a the energy transferred in a 400 W food blender that is switched on for 2 minutes

b the power of a mains washing machine that takes a current of 2.2 A

c the current in a 1.4 kW mains coffee maker.

5 A shopper has the choice of buying a 3 kW fast boil kettle or a 1.8 kW kettle. Both use mains electricity. The 3 kW kettle takes 5 minutes to boil some water. How long will the 1.8 kW kettle take to boil the same amount of water? Assume that the energy transferred heating the kettle and surroundings is the same and can be ignored.

6 An electric bicycle has a 36 V battery for a motor that transfers 78 000 J of energy in 5 minutes. Calculate:

a the power of the motor

b the current in the motor circuit

c the electrical resistance of the motor circuit.

7 Calculate the resistance of a 200 W electric blanket that has a current of 870 mA.

Extra challenge

8 3 kW of electrical power is transmitted across the country on the overhead power lines of the 400 kV 'supergrid' and then using the 230 V mains system.

a Calculate the current required to deliver this power in the 400 kV cables and the 230 V cables.

b Compare the power transferred in heating a cable with a resistance of 10 Ω when the power is transmitted at 400 kV and when it is transmitted at 230 V.

c Use your answers to parts **a** and **b** to write an explanation of why a 'supergrid' of 400 kV is used to transmit electric power across large distances.

Answer the questions using the F.R.S.A.U format and a calculator.

CP9g.6

You will be expected to recall the equations linking the following quantities in your examination:

- **power**, energy transferred and time
- power, current and potential difference
- power, current and electrical resistance.

You will need to choose the correct equation to answer the questions. You should also be able to change the subjects of the equations and to use the correct units.

1 The table shows the **power rating** of each appliance and the energy transferred in a certain time.

Calculate the missing values.

Appliance	Power (W)	Energy transferred (J)	Time (s)
kettle	**a**	810 000	300
torch	1.3	**b**	600
motor	8	14400	**c**

2 The table shows the power rating of each appliance, the current through it and the potential difference across it.

Calculate the missing values.

Appliance	Power (W)	Current (A)	Potential difference (V)
electric car	**a**	90	156
washing machine	100	**b**	230
electric screwdriver	300	16.7	**c**

3 The table shows the power rating of an appliance, the current through it and its resistance.

Calculate the missing values.

Appliance	Power (W)	Current (A)	Resistance (Ω)
filament bulb	**a**	0.4	625
hair dryer	1920	**b**	30
vacuum cleaner	460	2	**c**

4 For each of the following questions, write down the equation you are using and then calculate the answer.

a A kettle connected to the 230 V mains supply has a current of 10 A. Calculate:

i the power rating

ii the energy transferred in 30 s

iii the resistance of the kettle element.

b A 9 W lamp is connected to the 230 V mains supply. Calculate:

i the current

ii the resistance of the filament

iii the energy transferred in 10 minutes.

c What is the resistance of the filament of a 50 W 12 V projector light bulb?

	distance travelled = average speed × time	
	acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$	$a = \frac{(v-u)}{t}$
	force = mass × acceleration	$F = m \times a$
	weight = mass × gravitational field strength	$W = m \times g$
	efficiency = $\frac{\text{(useful energy transferred by the device)}}{\text{(total energy supplied to the device)}}$	
HT	**momentum = mass × velocity**	$p = m \times v$
	wave speed = frequency × wavelength	$v = f \times \lambda$
	wave speed = distance ÷ time	$v = \frac{x}{t}$
	density = mass ÷ volume	$\rho = \frac{m}{V}$
	work done = force × distance moved in direction of force	$E = F \times d$
	change in gravitational potential energy = mass × gravitational field strength × change in vertical height	$\Delta GPE = m \times g \times \Delta h$
	kinetic energy = ½ × mass × (speed)²	$KE = ½ \times m \times v^2$
	power = work done ÷ time taken	$P = \frac{E}{t}$
	energy transferred = charge moved × potential difference	$E = Q \times V$
	charge = current × time	$Q = I \times t$
	potential difference = current × resistance	$V = I \times R$
	power = energy transferred ÷ time taken	$P = \frac{E}{t}$
	electrical power = current × potential difference	$P = I \times V$
	electrical power = current squared × resistance	$P = I^2 \times R$
	force exerted on a spring = spring constant × extension	$F = k \times x$

GCSE (9–1) Physics, you also need to learn these extra equations:

	moment of a force = force × distance normal to the direction of the force	
	pressure = force normal to surface ÷ area of that surface	$P = \frac{F}{A}$