# Electrical power and energy

Worked solutions

**GCSE science calculations**

This topic online

**1** A desk lamp is connected to the 230 V mains supply. The current in the lamp is 0.25 A.

Calculate the power of the lamp. (2 marks)

Power = potential difference × current

$P = 230 \times 0.25$

**57.5 W**

**2** The heating element in a hand warmer has a resistance of 15 Ω. The current in the element is 4.0 A.

Calculate the power of the heating element. (2 marks)

Power = (current)$^2$ × resistance

$P = 4.0^2 \times 15$

$P = 16 \times 15$

**240 W**

**3** A charge of 60 C flows through a 12 V car headlight bulb.

Calculate the energy transferred to the bulb. (2 marks)

Energy transferred = charge flow × potential difference

$E = 60 \times 12$

**720 J**

**4** Amara boils water in a 2.8 kW kettle. The kettle is switched on for 3 minutes.

Calculate the energy transferred by the kettle in joules. (3 marks)

Energy transferred = power × time

Convert to watts and seconds

$2.8\ kW = 2.8 \times 1000 = 2800\ W$

$3\ minutes = 3 \times 60 = 180\ s$

$E = 2800 \times 180$

**504 000 J**


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**5** A phone charger supplies a potential difference of 5.0 V. The current in the charging cable is 800 mA.
Calculate the power supplied to the phone. (2 marks)

Power = potential difference x current

800 mA = 800 ÷ 1000 = 0.800 A

P = 5.0 x 0.800

**4.0 W**

**6** A television has a power of 120 W. Callum watches it for 2.5 hours.
Calculate the energy transferred by the television in joules.
Give your answer in standard form. (3 marks)

Energy transferred = power x time

2.5 hours = 2.5 x 3600 = 9000 s

E = 120 x 9000

E = 1 080 000 J

**$1.08 \times 10^6$ J**

**7** A hairdryer has a power of 2000 W. It is connected to the 230 V mains supply.
Calculate the current in the hairdryer.
Give your answer to 2 significant figures. (3 marks)

Power = potential difference x current

2000 = 230 x I

I = 2000 ÷ 230

I = 8.695... A

**8.7 A**

**8** In a Year 10 practical, 1500 J of energy is transferred when a charge of 125 C flows through a motor.
Calculate the potential difference across the motor. (3 marks)

Energy transferred = charge flow x potential difference

1500 = 125 x V

V = 1500 ÷ 125

**12 V**


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**9** A resistor in a circuit transfers energy at a rate of 36 W when the current in it is 3.0 A.

Calculate the resistance of the resistor. (3 marks)

Power = (current)$^2$ x resistance

$36 = 3.0^2 \times R$

$36 = 9 \times R$

$R = 36 \div 9$

$\boxed{4.0\ \Omega}$

**10** The motor of an e-scooter is connected to a 36 V battery. The current in the motor is 6.0 A for a journey of 20 minutes.

a. Calculate the charge that flows through the motor during the journey.

b. Calculate the energy transferred by the battery during the journey. Give your answer in standard form to 2 significant figures. Show your working. (4 marks)

a)

Charge flow = current x time

20 minutes = 20 x 60 = 1200 s

$Q = 6.0 \times 1200$

$\boxed{7200\ C}$

b)

Energy transferred = charge flow x potential difference

$E = 7200 \times 36$

$E = 259\,200\ J$

$\boxed{2.6 \times 10^5\ J}$


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**11** A kettle is connected to the 230 V mains supply. The current in the kettle is 11 A. The kettle is switched on for 4 minutes.

Calculate the energy transferred by the kettle in kilojoules (kJ).

Give your answer to 3 significant figures. Show your working.

(4 marks)

Power = potential difference x current

$P = 230 \times 11$

$P = 2530\ W$

Energy transferred = power x time

4 minutes $= 4 \times 60 = 240\ s$

$E = 2530 \times 240$

$E = 607\,200\ J$

$E = 607\,200 \div 1000 = 607.2\ kJ$

**607 kJ**

**12** **Higher tier**

A step-down transformer in a phone charger has a primary potential difference of 230 V and a primary current of 0.020 A. The secondary potential difference is 5.0 V.

The transformer is 100% efficient.

Calculate the current in the secondary coil. Show your working.

(3 marks)

$V_p \times I_p = V_s \times I_s$

$230 \times 0.020 = 5.0 \times I_s$

$4.6 = 5.0 \times I_s$

$I_s = 4.6 \div 5.0$

**0.92 A**


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**13** **Higher tier**

A power station generates electricity at a potential difference of 25 kV and a current of 400 A. A step-up transformer increases the potential difference to 400 kV before the electricity is sent along the National Grid.

The transformer is 100% efficient.

a. Calculate the current in the transmission cables after the step-up transformer.

b. The transmission cables have a total resistance of 40 Ω. Calculate the power transferred to the surroundings by heating the cables. Show your working.

(5 marks)

a)

$V_p \times I_p = V_s \times I_s$

$25\ kV = 25\ 000\ V$

$400\ kV = 400\ 000\ V$

$25\ 000 \times 400 = 400\ 000 \times I_s$

$10\ 000\ 000 = 400\ 000 \times I_s$

$I_s = 10\ 000\ 000 \div 400\ 000$

**25 A**

b)

Power = (current)$^2$ x resistance

$P = 25^2 \times 40$

$P = 625 \times 40$

**25 000 W**

**14** Two lamps, A and B, are connected in series to a 12 V battery. The potential difference across lamp A is 7.5 V. The current in the circuit is 0.40 A.

Calculate the power of lamp A.

(2 marks)

Use the p.d. across lamp A (7.5 V), not the battery p.d. (12 V)

Power = potential difference x current

$P = 7.5 \times 0.40$

**3 W**


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**15** A phone charger has an output potential difference of 5.0 V. The charging cable has a resistance of 0.25 Ω. The current in the cable is 2.0 A.

Calculate the power wasted heating the cable. (3 marks)

The 5.0 V is across the charger, not the cable, so use the current and the cable resistance

Power = (current)$^2$ x resistance

$P = 2.0^2 \times 0.25$

$P = 4.0 \times 0.25$

1 W


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