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26 Power Calculations

Power is the **rate at which energy is transferred**, or the **rate at which work is done**.

It is calculated using the equation:

$$\text{power} = \text{work done} / \text{time} \quad P = \frac{W}{t}$$

$$\text{or } \text{power} = \text{energy transferred} / \text{time} \quad P = \frac{E}{t}$$

The unit of power is the watt (W).

$$1 \text{ watt} = 1 \text{ joule per second}$$

$$1 \text{ W} = 1 \text{ J/s}$$

26.1 Calculate the missing quantities in the table below.

Power	Energy transferred	Time
(a)	15.5 J	25.0 s
250 W	(b)	60.0 s
150 W	5 250 J	(c)
(d)	105 J	3 min 40 s
250 mW	(e)	100 ms
0.125 kW	96.0 μJ	(f)

Electrical power

Potential difference, or voltage, across a component is the amount of **work done** per **unit charge moving through that component**, i.e.

$$\text{potential difference} = \text{work done} / \text{charge} \quad V = \frac{W}{Q}$$

Electric current is the amount of **charge that flows past a point** per **second**,

i.e.

$$\text{current} = \text{charge/time} \quad I = \frac{Q}{t}$$

Multiplying these quantities together gives:

$$I \times V = \left(\frac{Q}{t} \right) \times \left(\frac{W}{Q} \right)$$

The Q s cancel, giving:

$$I \times V = \frac{W}{t} = P$$

which is equal to power (first equation on the page). So, the equation for electrical power is:

$$\text{power} = \text{current} \times \text{potential difference} \quad P = I \times V$$

26.2 Calculate the missing quantities in the table below.

Power	Current	Potential difference
(a)	0.250 A	1.50 V
22.2 W	(b)	6.00 V
1 200 W	80.0 A	(c)
(d)	68.0 μ A	5.00 kV
8.16 kW	(e)	8.50 kV
4.05 MW	54.0 mA	(f)
(g)	5.0 A	12 V
2.64×10^6 W	(h)	132 000 V
0.366 W	0.060 A	(i)
(j)	10 A	230 V
1 000 W	(k)	230 V
72 W	6.0 A	(l)

- 26.3 How much current does a 2.0 kW electric fire draw from the 230 V mains?
- 26.4 What is the power rating of a lamp which draws 0.26 A from the 230 V mains?
- 26.5 A torch bulb has 2.5 V, 0.18 A stamped on it. What is its power rating?
- 26.6 What is the potential difference across a heater which develops power of 42 W when a current of 3.5 A flows through it?
- 26.7 The power of the heater element of a toilet hand dryer is 2 100 W. It operates from the 230 V mains. Calculate the current drawn from the mains.
- 26.8 What current is carried in the element of a 2.4 kW kettle connected to the 230 V mains?
- 26.9 An MRI scanner has a peak power of 35.0 kW. It is connected to a power supply at 415 V.
- (a) What is the peak current drawn by the MRI scanner?
 - (b) If a scan takes 30 minutes to complete, how much charge has flowed through the scanner in total? Assume the current is constant and equal to Part (a)
- 26.10 On building sites, 115 V mains is used to reduce the risk of electric shock. A drill made for normal household (230 V) use requires a current of 5.60 A. The manufacturer makes a model of the same power rating for use on building sites. What current will the builders' version need?