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:

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

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

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.

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

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

i.e.

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

Multiplying these quantities together gives:

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

The Qs 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:

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

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 µA	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?