Electrical Power

N4

Electrical Power

All electrical appliances convert electrical energy into other forms of energy. Energy has the symbol E and is measured in units of joules, J.

All appliances have a known power rating which can be found on the appliance's rating plate. Power has the symbol P and is measured in units of watts, W. The power rating of an appliance is measured as the number of joules of energy it transforms per second.

The table below shows some household appliances along with their main energy transformation and their typical power rating.

Appliance	Main energy transformation	Power (watts, W)
Lamp	Electrical into light	60
Toaster	Electrical into heat	1100
Food mixer	Electrical into kinetic	120
Radio	Electrical into sound	630

The number of joules of energy an appliance uses depends on two factors:

1. how long the appliance is on
2. the power rating of the appliance

Therefore the longer an appliance is on and the greater its power rating the more electrical energy it will use.

Energy Consumption

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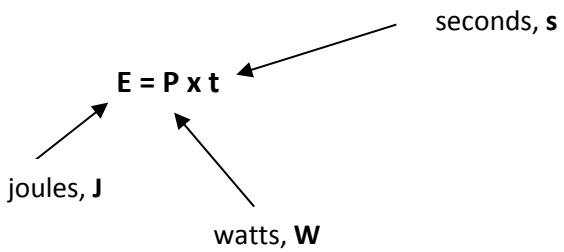
In a world concerned with saving energy, it is necessary to be able to calculate the energy consumption of different appliances in order that we make an informed decision on which appliances we may want to purchase.

This can be calculated using the following equation:

energy = power x time



Example

A typical washing machine is rated 1200W. It is switched on for a washing cycle of 60 minutes how much energy does it consume during this cycle?

P = 1200W

t = 60 x 60 = 3600s

E = ?

E = P x t

E = 1200 x 3600

E = 432 0000 J

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Calculations involving power, energy and time

Example 1

A typical washing machine is rated 1200W. It is switched on for a washing cycle of 60 minutes, how much energy does it consume during this cycle?

P = 1200W

t = 60 minutes (60 x 60 = 3600s)

E = ?

E = P x t

E = 1200 x 3600

E = 432 0000 J

Example 2

A toaster switched on for 5 minutes uses 330,000 J of energy, calculate its power.

P =?

t = 5minutes (5 x 60 =300s)

E = 330,000 J

E = P x t

330,000 = P x 300

$$\frac{330{,}000}{300} = P$$

P = 1100 W

Example 3

The power rating of a lamp is 60 W, during the time it has been on it has used up 10,000 J of electrical energy. For how long was the lamp on?

P = 60 W

t =?

E = 10,000 J

E = P x t

10,000 = 60 x t

$$\frac{10{,}000}{60} = t$$

t = 167 s

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Electrical power equations

The **electrical energy transformed each second** is equal to **P = I x V**

Explain the equivalence of P = I x V and $P = I^2 R$ and $P = V^2 / R$

The power equation P = I x V can be arranged for use with other quantities.

Example 1

V = I x R and **P = I x V**

P = I x (I x R)

$P = I^2 R$

Example 2

$I^2 = V^2 / R^2$ and **$P = I^2 R$**

$P = V^2 / R^2$ (x R)

$P = V^2 / R$

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Carry out calculations involving P, I, V and R

Example 1

A torch bulb has a voltage of 6 V and a current of 0.3 A passing through it. What is its power?

V = 6 V

I = 0.3 A

P =?

P = I x V

P = 0.3 x 6

P = 1.8 W

Example 2

A car headlamp has a power of 24 W and a resistance of 6 Ω. Calculate its voltage supply.

P = 24 W

R = 6 Ω

V =?

$P = V^2/R$

$24 = V^2 / 6$

$24 \times 6 = V^2$

$144 = V^2$

$\sqrt{144} = V$

V = 12 V

Example 3

An electric heater has a voltage supply of 240 V and a power of 960 W. Calculate the current passing through it then the resistance of its elements.

	Step 1		**Step 2**
V = 240 V	**P = I x V**	Then	**$P = I^2 x R$**
P = 960 W	960 = I x 240		960 = (4 x 4) x R
I =?	960 / 240 = I		960/16 = R
R =?	**I = 4 A**		**R = 60 Ω**