

ELECTRIC POWER

As we learned in the Energy part of the previous unit, power is how fast energy is being converted from one form to another, i.e. how fast useful energy is converted into something else.

Recall that power = energy \div time.

$$P = E/t \quad \text{Units: Watts, W.}$$

We have two electrical equations that involve Q: $V = E/Q$ $I = Q / t$

Can we combine them somehow to eliminate Q ?

Yes, multiply them : $V * I = E / t$ This is the formula for Power (on the right hand side)!

Therefore we have another equation for power $\boxed{P = I V}$ \leftarrow important equation.

Power (in Watts) = current (amps) * voltage (volts)

– Do some sample problems –

1) How much current is used by a 200W toaster? (assume that it is plugged into a 120V outlet).

Formula: $I = P/V$

$$I = 200W / 120 V = 1.67 A.$$

2) A certain 1.5V battery can supply 350mA. What power does it output?

$$P = I V$$

$$P = (0.35A)(1.5V) = 0.525 W \text{ or } 525mW.$$

3) How many Joules does a 100W light bulb use in a minute?

Joules are energy. $E = P \times t$

$$E = 100W \times 60s = 6000J \text{ (or } 6kJ)$$

4) How long could the energy in a 225 Calorie chocolate bar power a 60W light bulb?
(1 Calorie = 4200 J)

5) A DVD player uses 45 W of power. How much current does it use?

** If the device is something that plugs into an outlet, use $V = 120V$.*

① given: $P = 45W$

$$V = 120V$$

② Do any units need to be converted? No

③ formula: $I = P/V$

④ solve: $I = 45W / 120V = 0.375A = 375mA$

Kilowatt hours

★ Ontario Hydro does not charge you for how much power or voltage or current or charge that you use, but how much energy you use.

★ However, instead of using Joules (or megaJoules), they use a unit called kilowatt–hours (*that's not a minus sign*).

What do you get when you multiple power * time? Energy !

$$1 \text{ kW} \cdot \text{hr} = 1000 \text{ W} * 3600 \text{ sec} = 3600000 \text{ J} = 3.6 \text{ MJ}$$

It is really easy to calculate how many kilowatt hours you use:

- Put the power in kilowatts.
- Put the time in hours.
- Multiply the two.

Example: If you leave a **30W** light bulb on for **2 days** how many kilowatt hours do did you use? How much would you have to pay for the electricity?

$$\text{Power} = 300\text{W} = 0.3 \text{ kW}$$

$$\text{Time} = 2 \text{ days} = 48 \text{ hours.}$$

$$\text{Energy used (in kWh)} = 0.3\text{kW} \times 48 \text{ hrs} = 14.4 \text{ kWh.}$$

London Hydro charges about 11.8 ¢ / kWh (depending what time of day you use it),

∴ Cost = how many kWh x price per kWh

$$\text{Cost} = 14.4\text{kWh} * 11.8 \text{ ¢ / kWh} = 169.9 \text{ ¢ or } \$1.70$$

Even though this isn't much it adds up when you consider all of the lights, etc. My electrical bill is normally around \$160 per month.

Practice:

How much does it cost to leave a 100W light bulb on for 5 days if the cost of electricity is 5.2 ¢/kWh ?

Answer: 62.4 cents.

Here are some other practice if you want (but there's a worksheet that you need to complete that may be marked, so make sure to do that.) Nelson 11: p 465 #6-8, p 466 #2, 9,10,12,14