Current, Its Transmission and Distribution – Vocabulary

DC: This stands for "direct current".
It is produced by cells and batteries.
This type of current always travels in the same direction
The intensity of DC remains constant (I is constant) as long as the cell/battery doesn't "burn out" (become discharged).
DC is used in walkmans, small tape recorders, toys, remote control units, etc. (any time a battery is used).

I_{dc} indicates the current of a DC source.
V_{dc} indicates the voltage of a DC source.

AC: This stands for "alternating current".
Large power systems like Hydro-Québec supply AC (∴ most home and industrial appliances are designed to use this type of current).
AC regularly changes direction.
The voltage of AC regularly changes direction, and it oscillates between a maximum and a minimum value.
Electrons swing back and forth at regular intervals.
The voltage oscillates between a maximum and a minimum value.

f = frequency

$f = \frac{\#\text{ oscillations}}{s}$ or $\frac{\#\text{ cycles}}{s}$

Hydro-Québec provides AC at a frequency of 60Hz.
Electrons move in a wave-like pattern; they travel through 60 cycles every second.

Root Mean Square Values (rms values)

These are used to represent the average current and average voltage supplied by an AC source (since the I and V are constantly changing we need an average).

rms current $(I_{rms}) = 0.707 \times I_{peak}$

rms voltage $(V_{rms}) = 0.707 \times V_{peak}$
$= 0.707 \times (170V)$
$= 120V$ ∴ average voltage is 120V

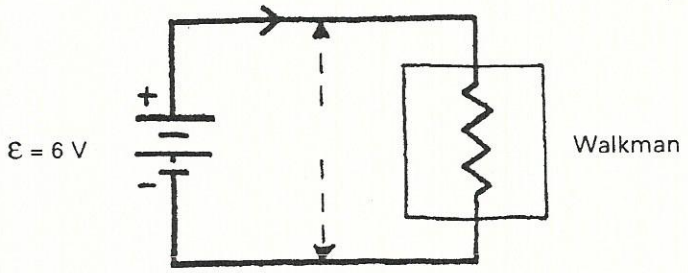
A DC voltage of 120V would provide the same power as the average provided by an AC that oscillates between +170V and –170V.

Hydro-Quèbec supplies us with rms voltages of 120V and 240V.

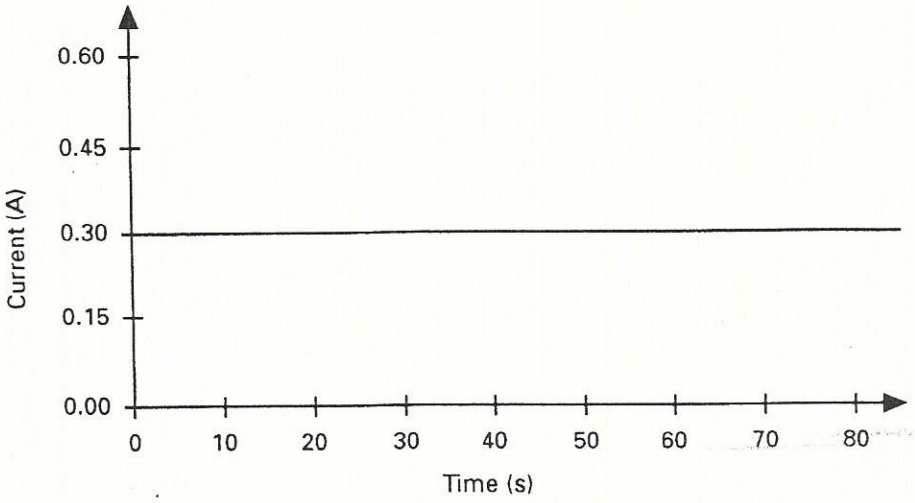
Power drawn by appliances also varies since V and I (from AC source) vary over time. Therefore, average power must be considered.

$P_{av} = V_{rms} \times I_{rms}$

Direct-current circuit



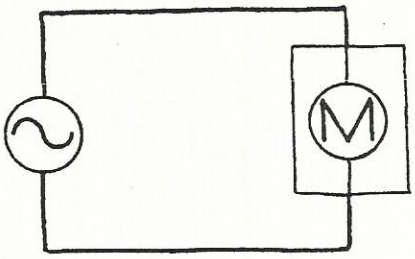
a) Walkman's direct-current circuit



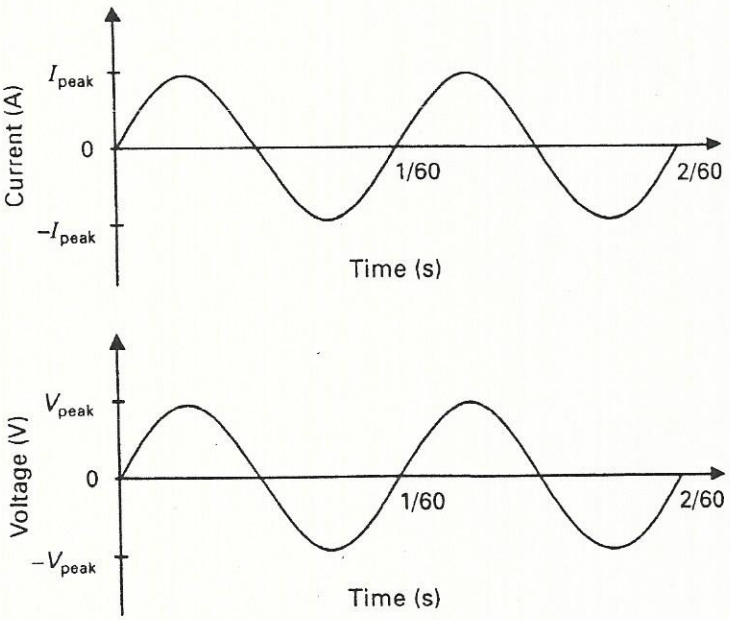
b) Graph of current over time: I = 0.30 A at t = 10 s, 20 s or 50 s

2. This is true as long as the cell or battery is not discharged.

Alternating-current circuit



a) Electric-drill circuit powered by the power system. Note that the symbol for Hydro-Québec has been replaced by the more general one for a source of alternating current. The direction of the current does not appear on the diagram because it is continually alternating.



b) Graph of current (*I*) and voltage (*V*) over time. Note that their values are constantly changing. Above the axis (positive values), current circulates in one direction and below the axis (negative values), it is reversed.

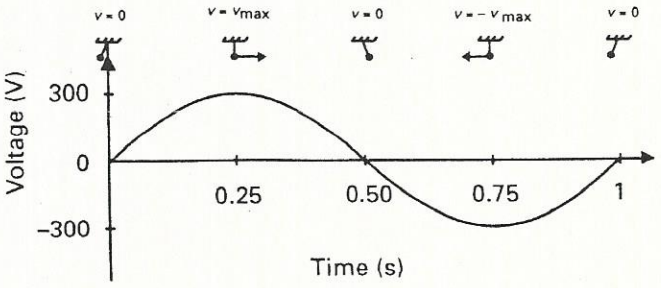
Heinrich Hertz

Heinrich Hertz (1857-94) was born in Hamburg, Germany, to wealthy parents. His parents enroled him in private school and, at a very young age, he showed an exceptional talent for all subjects, except music and song. He hesitated for a long time between a career as an engineer and one as a scientist. His marked interest for the pure sciences finally won. He attended university in Hamburg, Munich and Berlin.

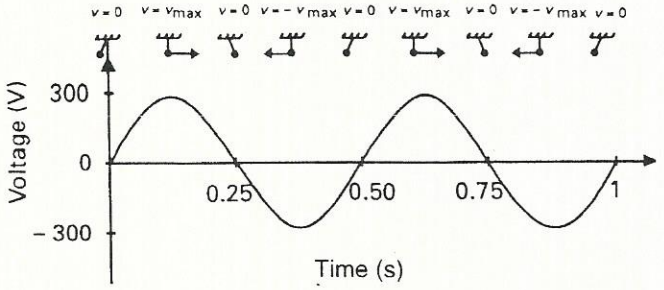
Hertz's first success was the invention of an oscillator, today called a "Hertz oscillator," a device that could produce alternating current at high frequencies, i.e. at hundreds of "megaHertz." The device emitted electromagnetic waves and a receiver detected them. Hertz showed the similarity between these waves and light. In 1887, his discoveries definitively confirmed Maxwell's theory, which, a number of years before, had predicted the existence of "Hertzian waves." The unit of measurement of frequency, the Hertz, was named in his honour.

Hertz was always full of ideas and sometimes he felt overwhelmed: "What patience one must have, even in one's own work! In one day, one can think of more experiments than one could possibly complete in an entire year!"

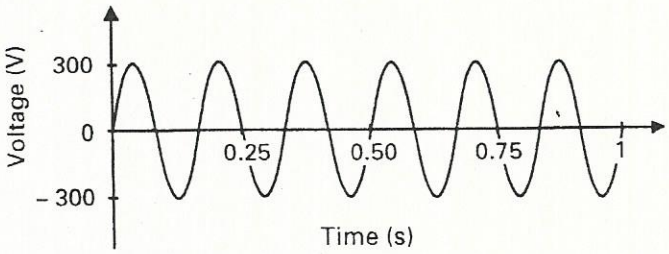
Different frequencies



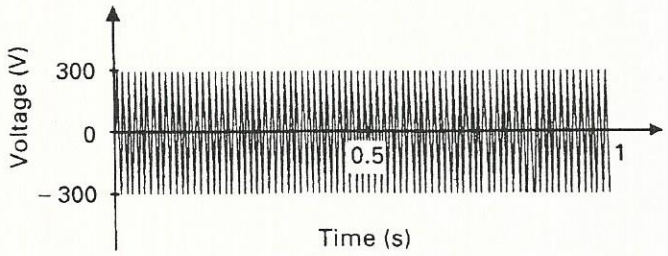
a) Curve of a pendulum oscillating at a frequency of 1 Hz: its speed, represented by *v*, is positive if it is moving toward the right and negative if it is moving toward the left.



b) Curve of a 2-Hz oscillation: the pendulum swings back and forth twice every second.



c) Curve of a 6-Hz cycle



d) Oscillation at 60 Hz: a smaller scale would be needed to see a detailed curve.

Adapting Voltage

transformer: This lowers or raises the voltage of AC.

some uses:
1. Electricity is carried in high voltage lines at 300 000 V – 735 000 V. Near your home, transformers lower this voltage to 120 V and 240 V so that the electricity can enter your home at this voltage and be used in your household appliances.
2. Adapters have transformers. e.g. Your walkman/discman uses a 6V battery. If you use an adapter instead, the adapter's transformer will lower the voltage from 120V (in the outlet) to the 6V that can be used by the walkman.

rectifier: This converts AC into DC. Home appliances that use DC must have rectifiers to convert the AC supplied by outlets into DC. e.g. the walkman adapter would also have a rectifier, since the walkman uses DC.

inverter: This converts DC into AC.

Place an AC (for alternating current) or a DC (for direct current) next to each of the following statements:

_____ a) It is used to operate walkmans and some toys.

_____ b) The rms of its voltage and current is used to calculate energy consumption.

_____ c) Its voltage can be increased or decreased using a transformer.

_____ d) Its I value remains constant.

_____ e) A rectifier can be used to convert it.

_____ f) The voltage oscillates.

_____ g) It is produced by batteries.

_____ h) Its current changes direction regularly.

_____ i) Most home appliances operate on it.

_____ j) Its value is constant.

_____ k) Its current always travels in the same direction.

_____ l) It is produced by cells.

_____ m) It is carried in high voltage aerial lines or underground cables.

_____ n) Its frequency is 60 Hz in the Hydro-Quebec network.

_____ o) The effective value of its intensity is used when making calculations.

_____ p) It is used to operate remote control units.

_____ q) Electrons swing back and forth at regular intervals.