

AC and DC

Matthew Williams • Physics • May 20, 2026

AC and DC

Direct Current (DC)

Direct current (DC) flows in one direction only and at a constant value. Batteries and cells are DC sources. The current-time graph for a DC source is a horizontal straight line.

Alternating Current (AC)

Alternating current (AC) continuously reverses direction. The current (and voltage) follows a sinusoidal pattern with time. Mains electricity in most countries is AC, in the Caribbean this is typically 50 Hz or 60 Hz.

AC Parameters

Quantity	Symbol	Definition	Unit
Peak voltage	V_0	Maximum voltage in either direction	V
Peak-to-peak voltage	$2V_0$	Total voltage swing from positive to negative peak	V
Period	T	Time for one complete cycle	s
Frequency	f	Number of cycles per second; $f = 1/T$	Hz

<PlotlyGraph

data=[

{

x: [0, 0.0005, 0.001, 0.0015, 0.002, 0.0025, 0.003, 0.0035, 0.004, 0.0045, 0.005, 0.0055, 0.006, 0.0065, 0.007, 0.0075, 0.008, 0.0085, 0.009, 0.0095, 0.01, 0.0105, 0.011, 0.0115, 0.012, 0.0125, 0.013, 0.0135, 0.014, 0.0145, 0.015, 0.0155, 0.016, 0.0165, 0.017, 0.0175, 0.018, 0.0185, 0.019, 0.0195, 0.02, 0.0205, 0.021, 0.0215, 0.022, 0.0225, 0.023, 0.0235, 0.024, 0.0245, 0.025, 0.0255, 0.026, 0.0265, 0.027, 0.0275, 0.028, 0.0285, 0.029, 0.0295, 0.03, 0.0305, 0.031, 0.0315, 0.032,

```

0.0325, 0.033, 0.0335, 0.034, 0.0345, 0.035, 0.0355, 0.036, 0.0365, 0.037, 0.0375, 0.038, 0.0385,
0.039, 0.0395, 0.04],
y: [0, 50.7, 100.4, 147.6, 191.1, 229.8, 262.9, 289.6, 309.1, 321.1, 325.0, 321.1, 309.1, 289.6, 262.9,
229.8, 191.1, 147.6, 100.4, 50.7, 0, -50.7, -100.4, -147.6, -191.1, -229.8, -262.9, -289.6, -309.1,
-321.1, -325.0, -321.1, -309.1, -289.6, -262.9, -229.8, -191.1, -147.6, -100.4, -50.7, 0, 50.7, 100.4,
147.6, 191.1, 229.8, 262.9, 289.6, 309.1, 321.1, 325.0, 321.1, 309.1, 289.6, 262.9, 229.8, 191.1,
147.6, 100.4, 50.7, 0, -50.7, -100.4, -147.6, -191.1, -229.8, -262.9, -289.6, -309.1, -321.1, -325.0,
-321.1, -309.1, -289.6, -262.9, -229.8, -191.1, -147.6, -100.4, -50.7, 0],
type: 'scatter',
mode: 'lines',
name: 'AC voltage',
line: {color: '#2563eb', width: 2.5, shape: 'spline'},
},
]]
layout={{
xaxis: {title: {text: 'Time / s'}},
yaxis: {title: {text: 'Voltage / V'}},
annotations: [
{x: 0.005, y: 350, text: 'Peak V = 325 V', showarrow: false, font: {size: 10}},
{x: 0.025, y: -350, text: 'T = 0.02 s ' f = 50 Hz', showarrow: false, font: {size: 10}},
],
shapes: [
{type: 'line', x0: 0, y0: 0, x1: 0.02, y1: 0, line: {color: '#dc2626', width: 1.5, dash: 'dot'}},
],
}}
caption="Alternating voltage from a 50 Hz AC supply: period T = 0.02 s, peak voltage 325 V. The
root-mean-square (RMS) voltage is  $325/\sqrt{2}$  V, this is what appliances are rated at."
height={260}
/>

```



```

},
]]
layout={{
xaxis: {title: {text: 'Time / s'}},
yaxis: {title: {text: 'Voltage / V'}},
annotations: [
{x: 0.015, y: -60, text: 'Negative half-cycles blocked (zero output)', showarrow: false, font: {size: 10}},
],
}}
caption="Half-wave rectified output: only positive half-cycles pass through the diode. The output is always positive (DC direction) but pulsating, not smooth like a battery."
height={240}
/>

```

Comparison of waveforms:

Waveform	Description
DC (battery)	Constant, flat line, no variation
AC	Smooth sine wave, alternates positive and negative
Half-wave rectified AC	Positive half-cycles only; gaps where negative half-cycles were blocked

To smooth the output of a rectifier, a large capacitor is connected in parallel, it charges during peaks and discharges during gaps, reducing the variation.

Exam Tip

The period is read from the graph as the time for one complete cycle (crest to crest, or the distance from one zero crossing to the next on the same side). Frequency is $f = 1/T$, not $T/1$.

For AC generator questions: doubling the rotation speed doubles the frequency, halves the period, and increases the peak voltage (more EMF generated per revolution).