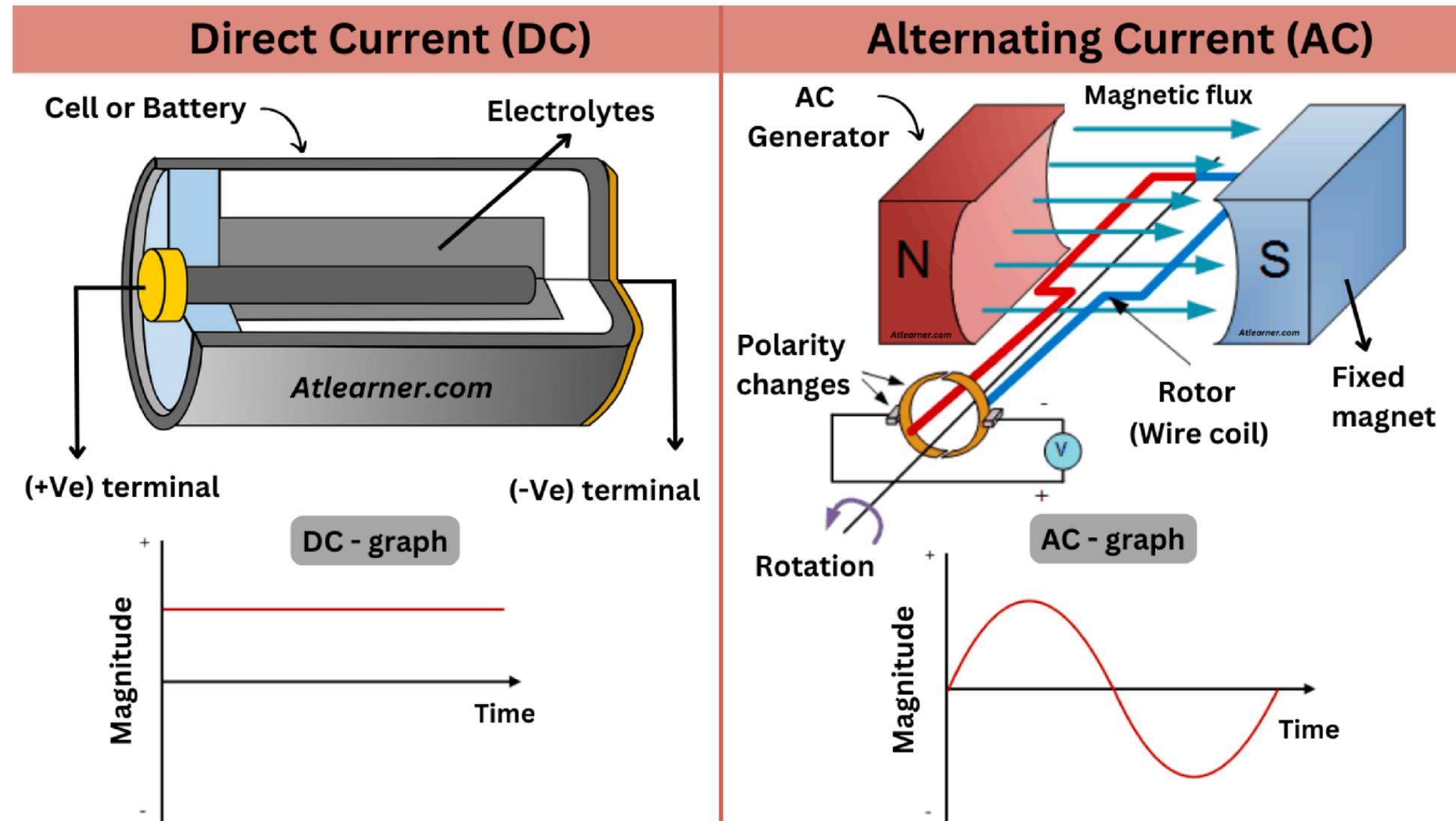


# 9702 C21 Alternating currents



# Properties of AC & Voltage

AC = a current which periodically varies from positive to negative and changes its magnitude continuously with time

-->direction of AC varies every **half cycle**

the variation of current(or p.d.) with time can be represented as a **sine curve (i.e. sinusoidal wave // sinusoid)**

-->so e- in a wire carrying AC move back and forth with SHM

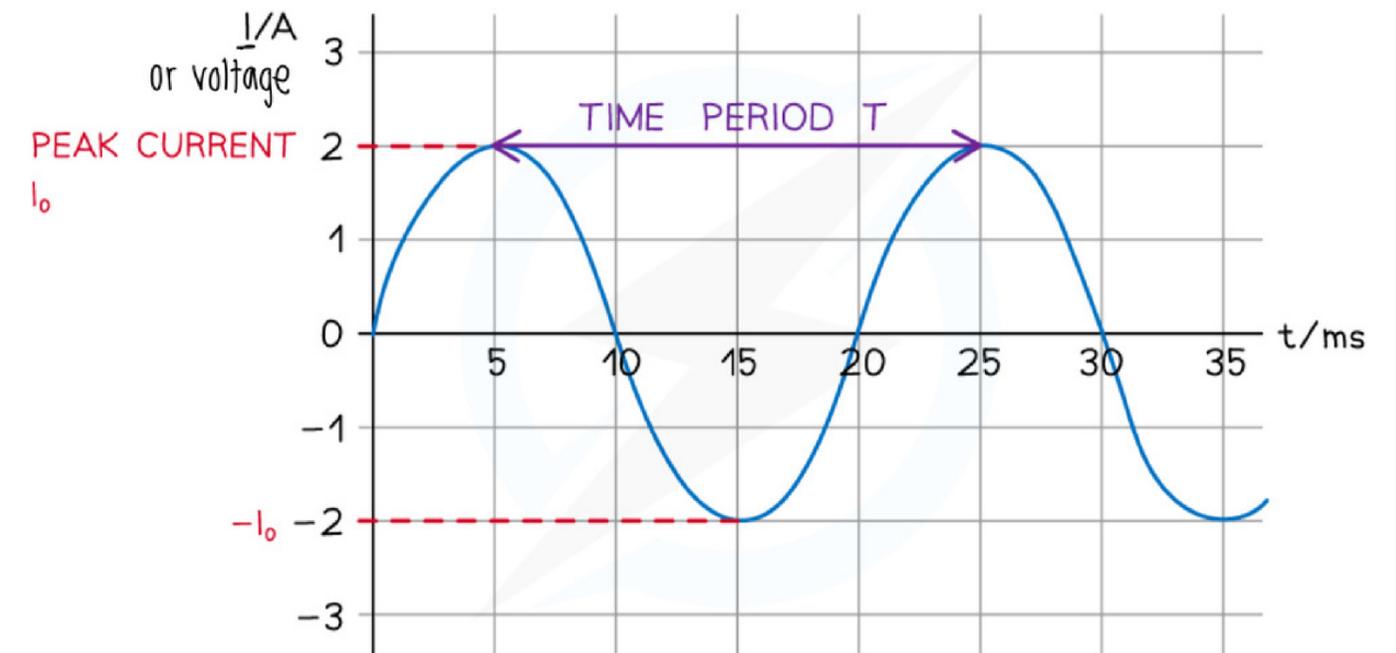
Relationship of AC is :  $T=1/f$

$$T = \frac{1}{f}$$

Peak current ( $I_0$ ), or peak voltage ( $V_0$ ), is defined as:

**The maximum value of the alternating current or voltage**

Peak current, or voltage, can be determined from the **amplitude** of the graph



$$I = I_0 \sin(\omega t)$$

$$V = V_0 \sin(\omega t)$$

$$\omega = \frac{2\pi}{T} = 2\pi f$$

$I$  = current (A)

$I_0$  = peak current (A)

$\omega$  = angular frequency of the supply ( $\text{rad s}^{-1}$ )

$t$  = time (s)

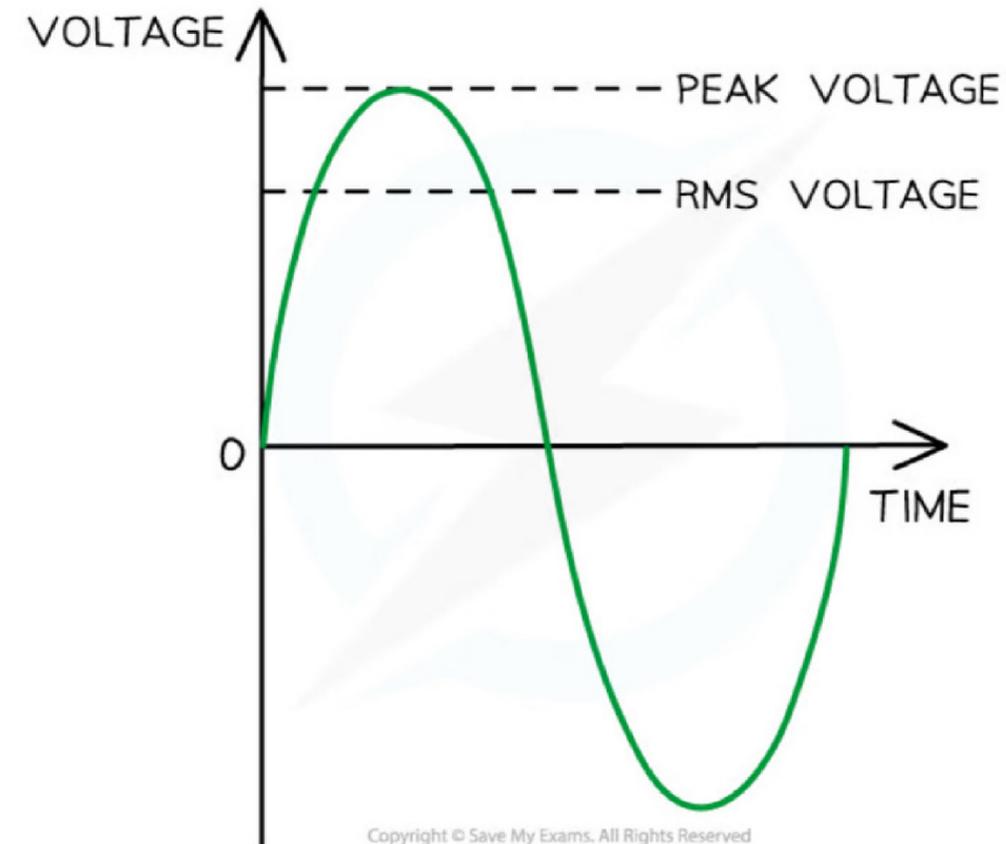
# Root-Mean-Square(r.m.s) Current & Voltage

r.m.s values represent the DC, or voltage values that will produce the same heating effect//power dissipation as the AC, or voltage

r.m.s value = the steady DC, or voltage, that delivers the same **average** power in a resistor as the AC, or voltage

$$V_{\text{r.m.s}} = \frac{V_0}{\sqrt{2}}$$

$$I_{\text{r.m.s}} = \frac{I_0}{\sqrt{2}}$$



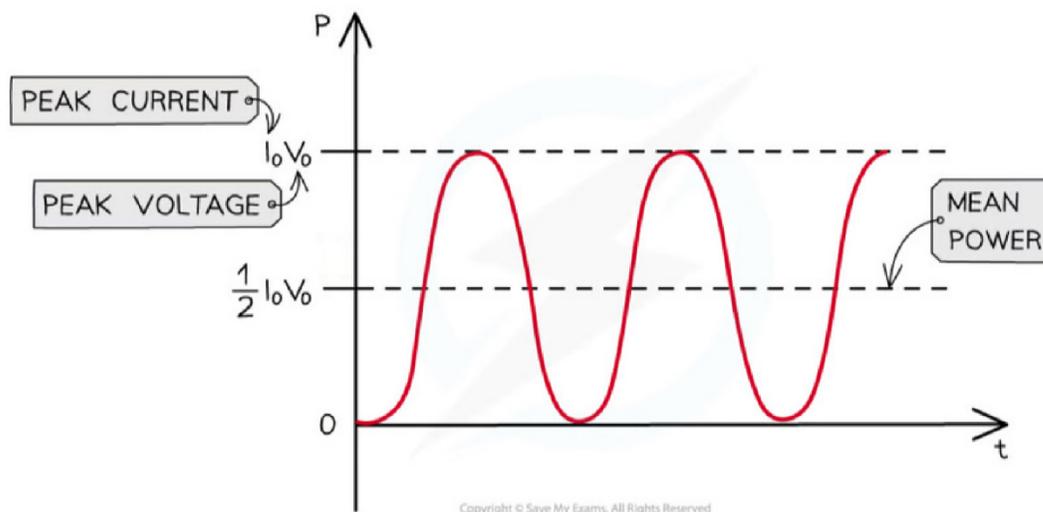
# Mean Power

$$P = IV = I^2R = \frac{V^2}{R}$$

I = **direct** current (A)

V = **direct** voltage (V)

R = resistance ( $\Omega$ )



Recall the equation for peak current:

$$I_0 = \sqrt{2} I_{r.m.s}$$

The peak (maximum) power and the mean (average) power are given by:

$$P_{mean} = (I_{r.m.s})^2 R$$

$$P_{peak} = I_0^2 R$$

Peak power can be written in terms of r.m.s current as

$$P_{peak} = (\sqrt{2} I_{r.m.s})^2 R$$

Therefore, peak power is related to mean power by:

$$2(I_{r.m.s})^2 R = 2P_{mean}$$

$$P_{mean} = \frac{P_{peak}}{2}$$

--> **Mean power in a resistive load is half the maximum power for sinusoidal AC or voltage**

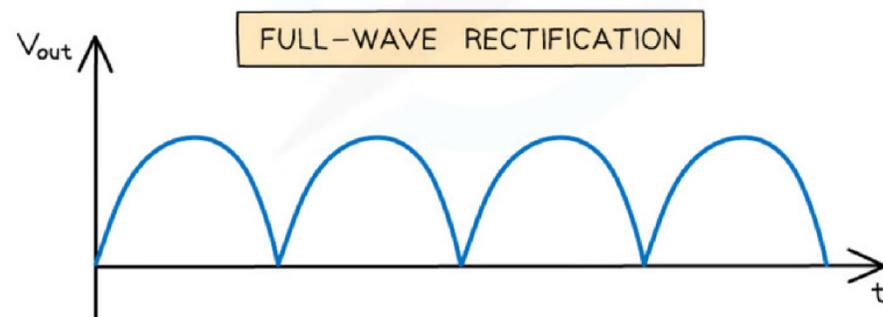
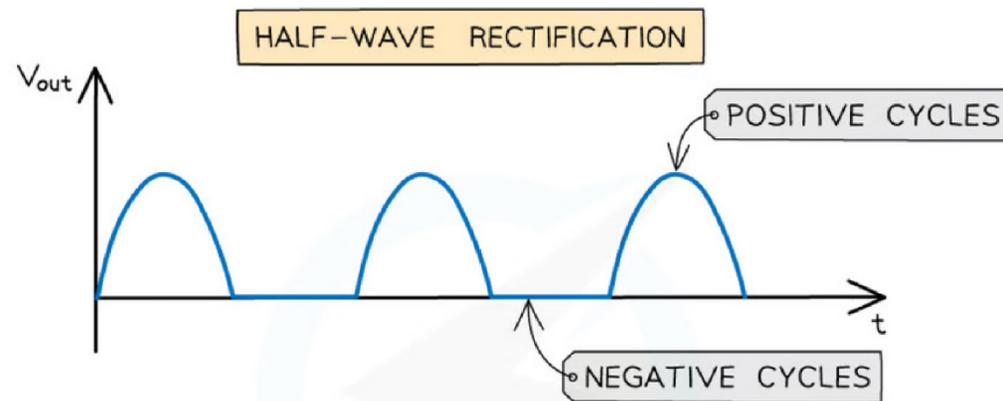
# Rectification

**rectification = the process of converting AC and voltage into DC and voltage**

-->used in electronic equipment which requires DC (e.g. mains voltage must be rectified from the alternating voltage produced at power stations)

2 types of rectification:

- 1.half-wave rectification: Graph  $V_{out}$  against time is a sine curve with positive cycles and a flat line ( $V_{out}=0V$ ) on the negative cycle. This is because the diode only conducts in the positive direction
- 2.full-wave rectification: Graph  $V_{out}$  against time is a sine curve where the positive cycles and the negative cycles are both curved bumps



# Half-Wave Rectification

Half-wave rectification consists of a **single diode**

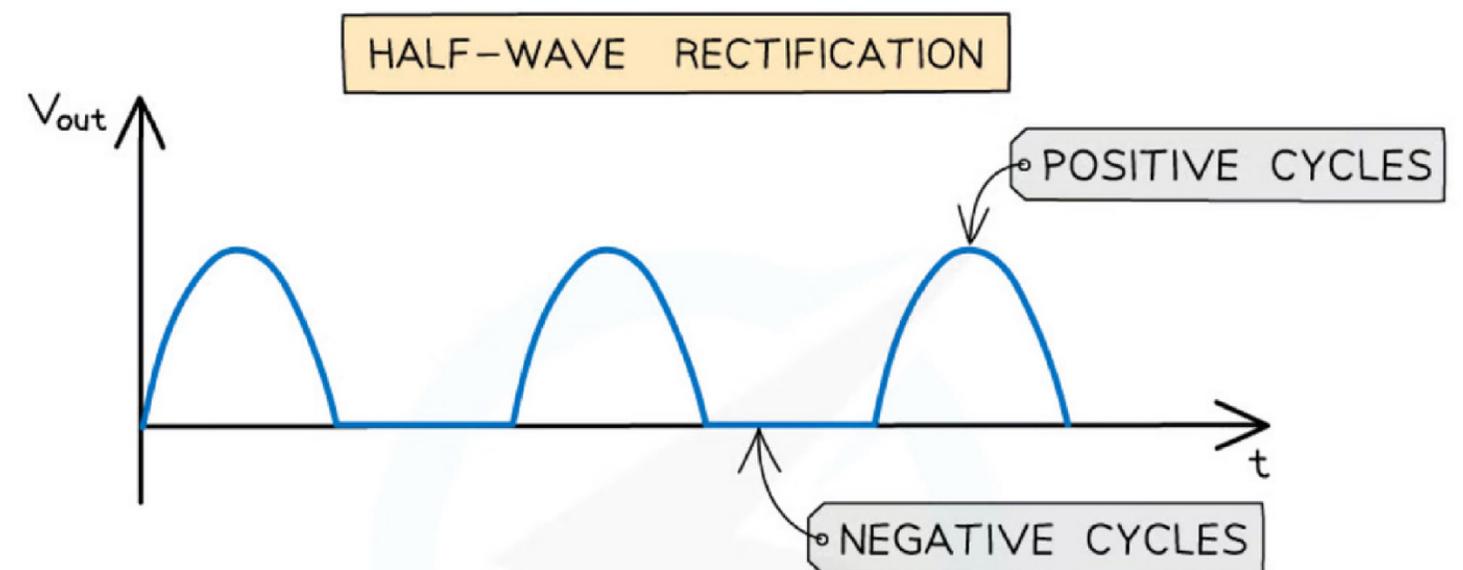
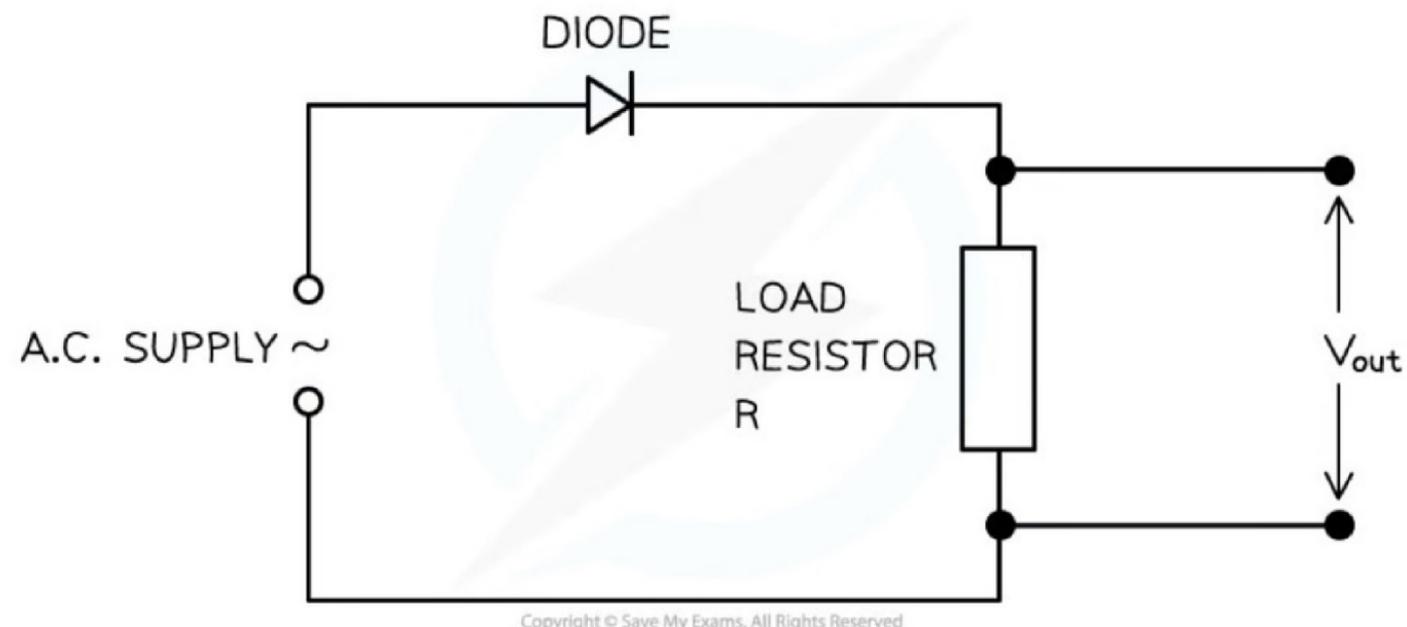
-An alternating input voltage is connected to a circuit with a load resistor and diode in series

The diode will only conduct during the positive cycles of the input alternating voltage

-->Hence there is only current in the load resistor during these positive cycles

The  $V_{out}$  across the resistor will fluctuate against time in the same way as the input alternating voltage except there are no negative cycles

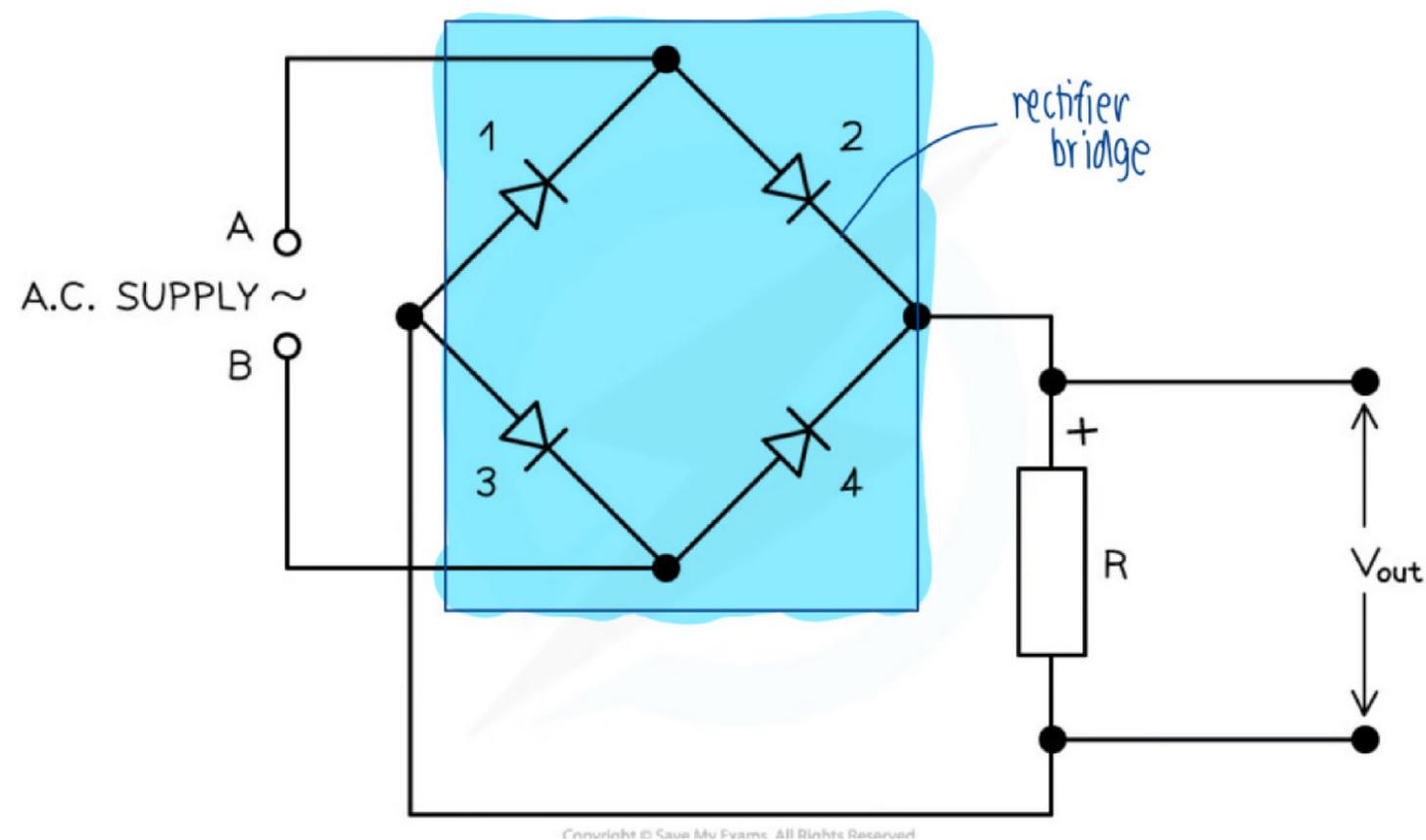
-->half of the time the voltage is zero => so power available from half-wave rectified supply is reduced



# Full-Wave Rectification

Full-wave rectification requires a **bridge rectifier circuit**

This consists of **four diodes** connected across an input alternating voltage supply



positive cycles:

-2 forward bias diodes conduct

-2 reverse bias diodes not conduct

-current flow to load resistor with positive terminal at the top of the resistor

negative cycles:

-2 forward bias diodes become reverse bias and not conduct

-2 reverse bias diodes become forward bias and conduct

-current in the load resistor flow in the same direction

current in the load resistor is the same in positive & negative cycles

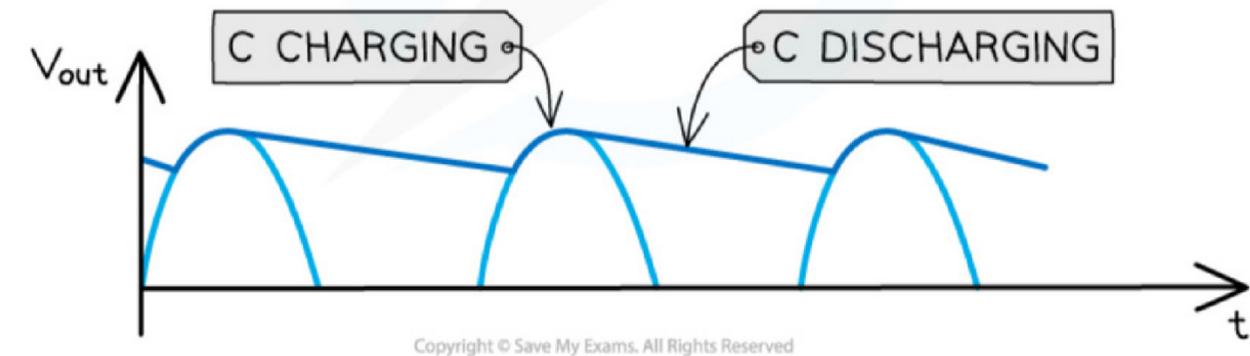
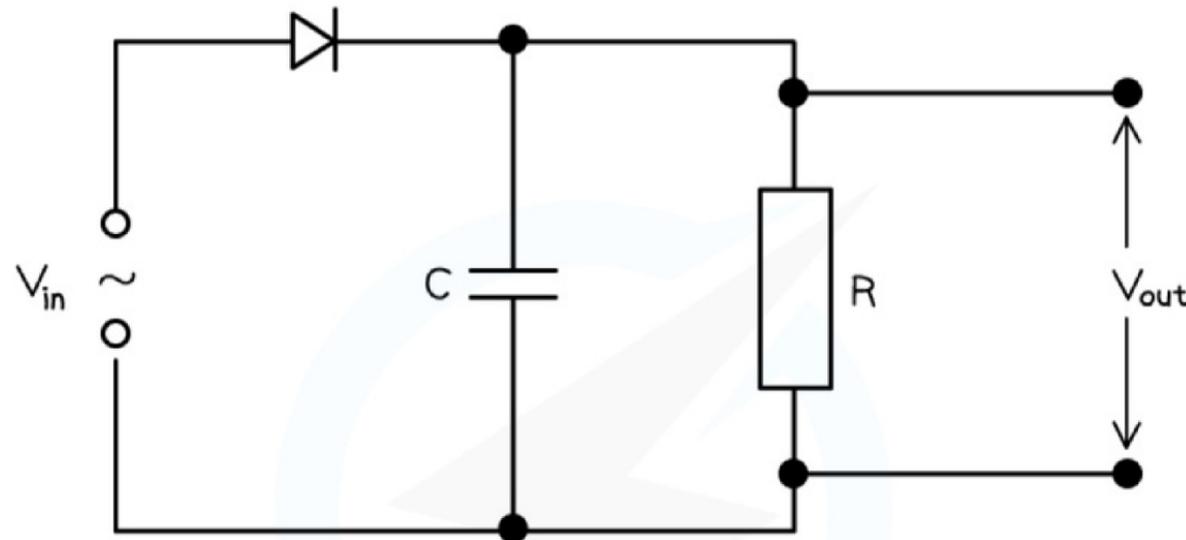
each diode pair have the same half-wave rectification --> so 2 pairs = full wave rectification

advantage of full-wave compared to half-wave rectification:  
-greater power --> **greater power is supplied on every half cycle**

# Smoothing

In rectification, to produce a steady DC or voltage from AC or voltage, a **smoothing capacitor** is needed

**smoothing = the reduction in the variation of the output voltage or current**



Smoothing work by:

1. a single capacitor with capacitance is connected in **parallel** with a load resistor
2. the capacitor charges up from the input voltage and maintains the voltage at high level
3. then it discharges gradually through the resistor when the rectified voltage drops but the voltage rises again and the capacitor charges up again.



*A smooth, rectified current graph creates a 'rippling' shape against time*

**Slower capacitor discharges = Smaller ripples = More smoothing**

To increase smoothing:

-a capacitor with **greater capacitance C**

-a resistance with **large resistor R**

time constant of capacitor  $>$  time interval between adjacent peaks of the output signal