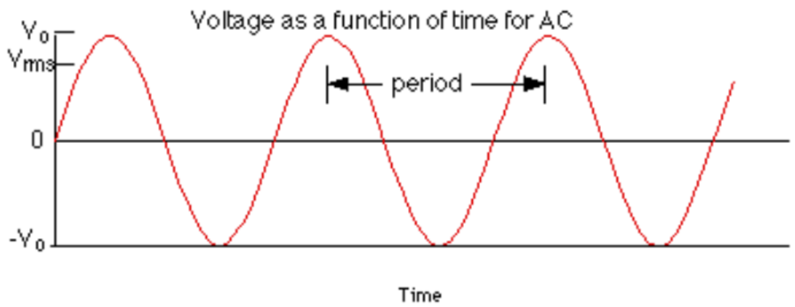
21 Alternating currents An understanding of the practical and economic advantages of transmission of power by electricity from Cambridge IGCSE /O Level Physics or equivalent is assumed.

21.1 Characteristics of alternating currents

Candidates should be able to:

1. understand and use the terms period, frequency and peak value as applied to an alternating current or voltage
2. use equations of the form $x = x_0 \sin \omega t$ representing a sinusoidally alternating current or voltage
3. recall and use the fact that the mean power in a resistive load is half the maximum power for a sinusoidal alternating current
4. distinguish between root-mean-square (r.m.s.) and peak values and recall and use $I_{r.m.s.} = I_0 / \sqrt{2}$ and $V_{r.m.s.} = V_0 / \sqrt{2}$ for a sinusoidal alternating current

- ***AC current*** is defined as **a periodically varying current that changes from positive to negative and has a magnitude that changes with time**.



- To find the frequency of an AC current just use

$$T = 1/f$$

- The peak current (I_0) or peak voltage (V_0) is the maximum value of the AC or alternating voltage.
- The equations that can be used to represent AC or voltage are

$$I = I_0 \sin(\omega t)$$
$$V = V_0 \sin(\omega t)$$

- The **rms value** of an AC or voltage is defined as **the value of a constant current/ voltage that produces the same power in a resistor as the alternating current/ voltage**.
- The rms value represent the dc value producing the same heating effect or power dissipation as the AC value.
- RMS can be calculated from

$$I_{rms} = \frac{I_0}{\sqrt{2}}$$

$$V_{rms} = \frac{V_0}{\sqrt{2}}$$

- For mean power (P_{mean}) in AC, the maximum power is related to the I_{rms} by

$$P_{mean} = I_{rms}R$$

Recall that

$$P = I_0^2R$$

Therefore

$$P = 2I_{rms}R = 2P_{mean}$$

$$P_{mean} = P/2$$

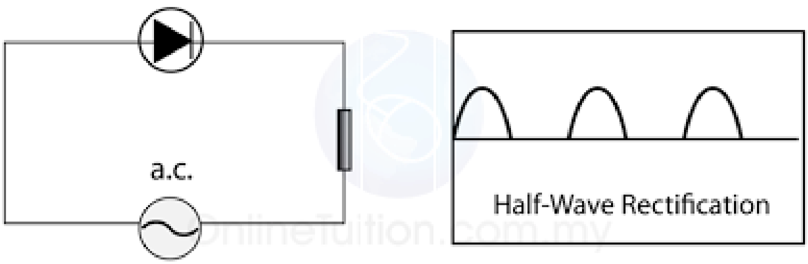
- The mean power in a resistive load is only half the max power for AC

21.2 Rectification and smoothing

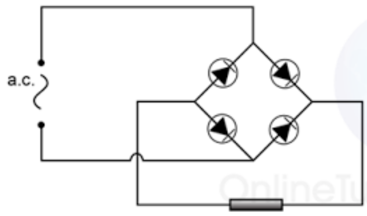
Candidates should be able to:

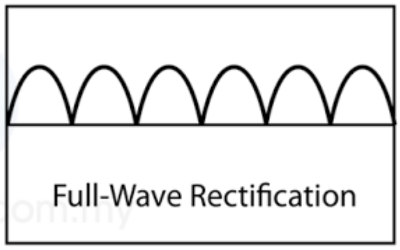
1 distinguish graphically between half-wave and full-wave rectification
2 explain the use of a single diode for the half-wave rectification of an alternating current
3 explain the use of four diodes (bridge rectifier) for the full-wave rectification of an alternating current
4 analyse the effect of a single capacitor in smoothing, including the effect of the values of capacitance and the load resistance

- **Rectification** is **the process of converting AC into DC**.
- There are two types of rectification
  -**half-wave rectification**

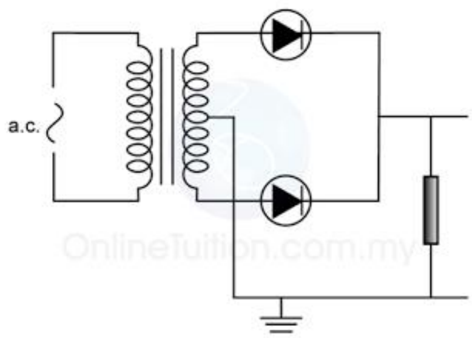


-**full-wave rectification**





- Smoothing can be done with a capacitor to reduce the variation of the output voltage and current.



- A single capacitor is connected in parallel with a load resistor.
- The capacitor is charged from the input voltage and maintains the voltage at a high level.
- When the rectified voltage drops, the capacitor discharges.
- When the voltage rises again the capacitor is charged again.
- The amount of smoothing is controlled by the capacitance (C) of the capacitor and the resistor (R).
- The slower the capacitor discharges, the more smoothing that occurs.
- Recall $\tau = RC$.
- You can increase the discharge time by increasing **C** or **R**.
- This means that τ of the capacitor must be greater than the time interval between **adjacent peaks** of the AC or voltage.