Unit 1
Particles, Quantum Phenomena and Electricity

6.1 Alternating current and power

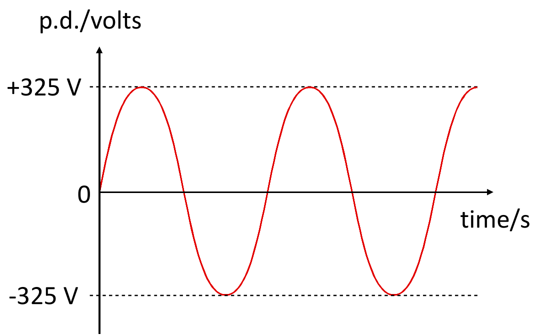
AS28

6.1 Alternating Current and Power

Maximum current and p.d.

- An alternating current (a.c.) reverses its direction repeatedly.
- The graph opposite shows how an alternating potential difference varies with time. The number of cycles the p.d. passes through each second is known as the **frequency** of the alternating supply, (measured in hertz, Hz).
- The maximum p.d. is known as the **peak** p.d., V_0.
- The peak value shown on the graph is for the UK mains electricity supply.
- In a circuit of resistance R, carrying an alternating current of peak value I_0, the current and p.d. are related by the equation:

$$V_0 = I_0 R$$



Power supplied by an alternating current

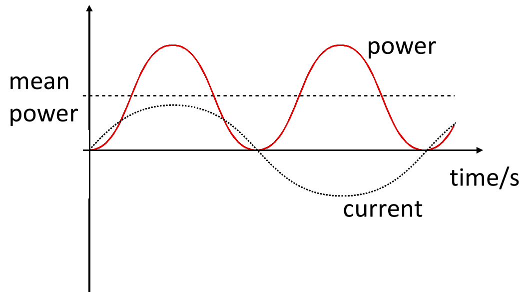
The maximum power supplied by an alternating current is given by the expression

$$P_{max} = V_0 I_0$$

The maximum power dissipated as heat in a resistance R is

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

Note that the mean power supplied is P_{max} / 2.



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Root mean square (rms) values

An alternating current with a peak value of 3.0 A will not deliver the same power to an appliance as a direct current (d.c.) of 3.0 A. This is because the alternating supply only reaches 3.0 A twice every cycle whereas the direct supply is at 3.0 A all the time.

The value of the alternating current which would deliver the same power as a direct supply of the same size is known as the **root mean square** (rms) current. It is the alternating current that would deliver the average power, so

$$I_{rms}{}^{2}R = \frac{1}{2}I_0R$$

Therefore

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

The peak and rms p.d.s are also related by the equation

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

The mean power supplied to a resistance R can be expressed as

$$P_{mean} = \frac{V_{rms}{}^{2}}{R} = I_{rms}{}^{2}R = I_{rms}V_{rms}$$