

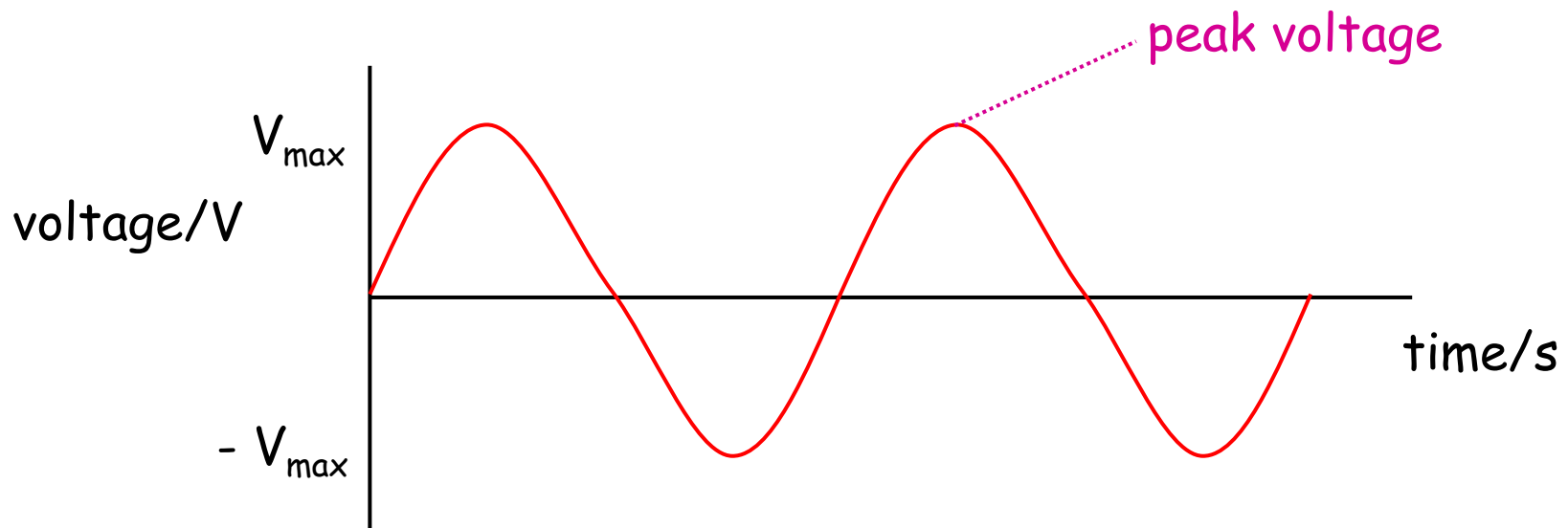


Higher Physics - Unit 2

2.2 Alternating Current and Voltage

AC Voltage Supply

The size of an AC voltage supply is constantly changing.



The maximum voltage is called the peak voltage, V_p .

Since the size of the voltage is changing, we use an average value when doing calculations.

The average value used is the "root mean square" or rms voltage.

It is calculated using:

$$V_{\text{rms}} = \frac{V_{\text{peak}}}{\sqrt{2}}$$

The rms voltage equals the equivalent dc voltage.

Example 1

The rms voltage in the UK is quoted as 230 V.

Calculate the peak voltage.

$$V_{\text{rms}} = 230 \text{ V}$$

$$V_{\text{p}} = ?$$

$$\begin{aligned} V_{\text{peak}} &= \sqrt{2} \times V_{\text{rms}} \\ &= \sqrt{2} \times 230 \\ V_{\text{peak}} &= 325 \text{ V} \end{aligned}$$



AC Current

An AC current also has a peak and rms value.

To calculate the rms current:

$$I_{\text{rms}} = \frac{I_{\text{peak}}}{\sqrt{2}}$$

The rms current equals the equivalent dc current.

Components in AC circuits however, must be able to withstand the peak voltage.



AC and Ohm's Law

The peak or rms values can be applied to Ohm's Law.

$$V_{\text{peak}} = I_{\text{peak}} \times R$$

$$V_{\text{rms}} = I_{\text{rms}} \times R$$

Example 1

Calculate the peak current for a 100Ω resistor connected to a mains supply.

$$V_{\text{rms}} = 230 \text{ V}$$

$$R = 100 \Omega$$

$$I_{\text{peak}} = ?$$

$$V_{\text{peak}} = \sqrt{2} \times V_{\text{rms}}$$

$$= \sqrt{2} \times 230$$

$$\underline{\underline{V_{\text{peak}} = 325 \text{ V}}}$$

$$V_{\text{peak}} = I_{\text{peak}} R$$

$$I_{\text{peak}} = \frac{V_{\text{peak}}}{R}$$

$$= \frac{325}{100}$$

$$\underline{\underline{I_{\text{peak}} = 3.3 \text{ A}}}$$

Must use ALL peak values or ALL rms values.

You may need to use the following equations from standard grade:

$$V = IR$$

$$P = \frac{E}{t}$$

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

$$P = IV$$

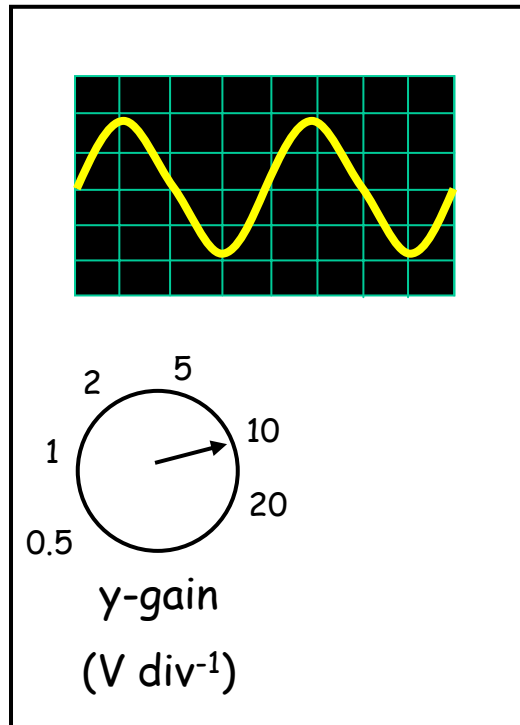
$$P = I^2 R$$

When asked to calculate the **output power**, or **heat produced** (energy), you must **use rms values**.

Worksheet - 2.2 Alternating Current and Voltage

Q1 - Q6

Peak Voltage on Oscilloscope



y-gain = 10 V per division

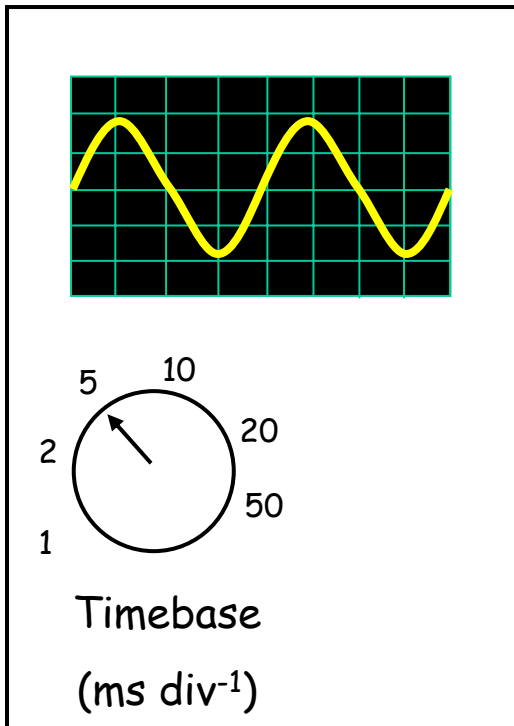
amplitude = 2 divisions

$$\begin{aligned}\text{peak voltage} &= 2 \times 10 \\ &= \underline{\underline{20 \text{ V}}}\end{aligned}$$

Once the peak voltage is known, the rms voltage can be calculated.

$$V_{\text{rms}} = \frac{V_{\text{peak}}}{\sqrt{2}} = \frac{20}{\sqrt{2}} = \underline{\underline{14.1 \text{ V}}}$$

AC Frequency on Oscilloscope



The timebase control tells you how long it takes the spot to move 1 division along the screen.

The time taken for **one complete wave** to pass a point is the **PERIOD**.

period

(s)

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

frequency

(Hz)

The wave on the oscilloscope is 8 divisions long.

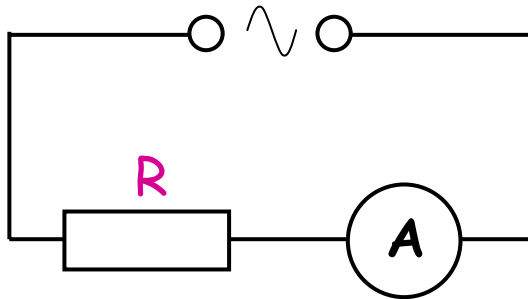
$$\begin{aligned} T &= 8 \times (5 \times 10^{-3}) \\ &= 0.04 \text{ s} \end{aligned}$$

The frequency is calculated to be:

$$\begin{aligned} f &= \frac{1}{T} \\ &= \frac{1}{0.04} \\ &= \underline{\underline{25 \text{ Hz}}} \end{aligned}$$

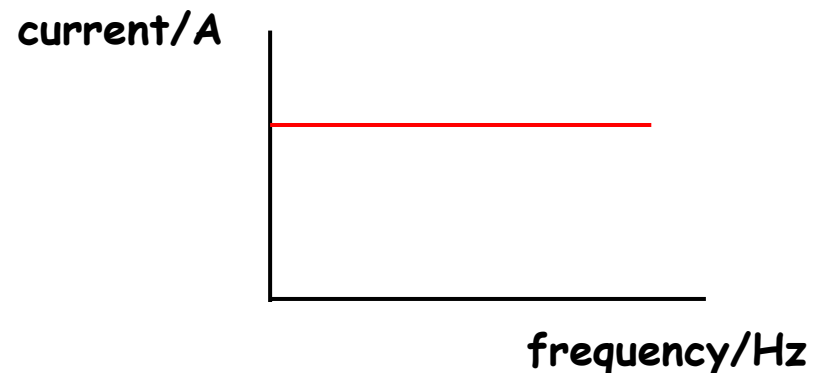
Resistors and AC

A resistor is connected to an AC voltage supply as shown.



As the **frequency** of the AC voltage is **increased**, the **current** in the circuit is **unchanged**.

A graph of current against frequency in a resistor circuit is:



Worksheet - 2.2 Alternating Current and Voltage

Q7 - Q9

