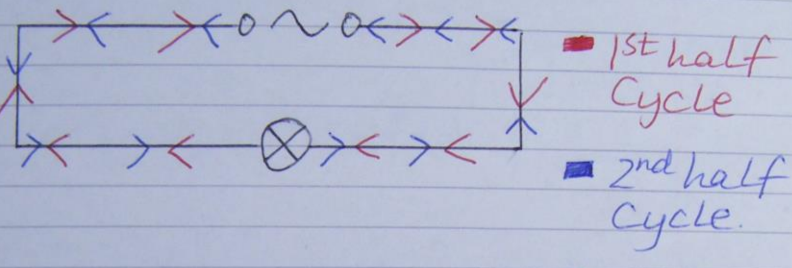
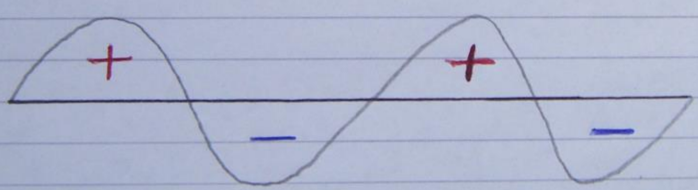
# Alternating Current (AC) - B McMULLEN

AC Supply —o∼o—

There is no + or − at either terminal.



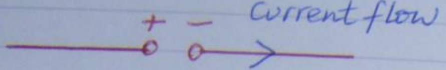

ie The current changes direction every half cycle.




- This wave relates to ac voltage and ac current.
- The magnitude is continually varying and the direction is changing every half cycle for voltage and current.

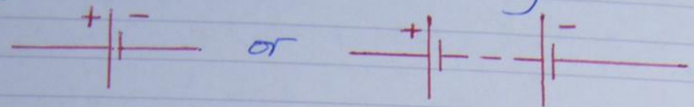
## Direct Current (DC)

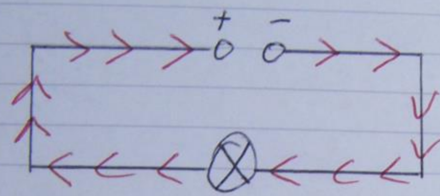





DC Supply

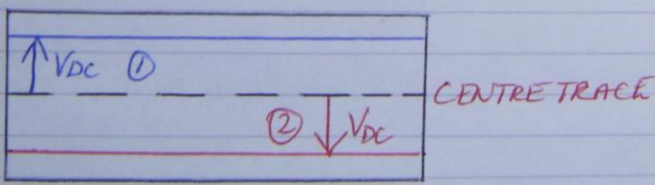
or a cell or a battery




The current flows in one continual loop in a DC circuit ie out of the negative and back to the positive.

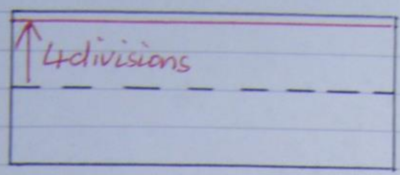
## DC Waveforms




① ⇒ Battery is connected to the oscilloscope +ve to +ve and −ve to −ve.

② ⇒ Battery is connected to the oscilloscope +ve to −ve and −ve to +ve.

## Ex 1




Y-gain setting on the oscilloscope $= 5Vdiv^{-1}$

Q a) Calculate the dc voltage from the wave trace.

b) How is the battery connected to the oscilloscope?

A a) DC VOLTAGE $= 5Vdiv^{-1} \times 4divs = \underline{20V}$

b) Horizontal Trace ↑ ∴ +ve to +ve and −ve to −ve.

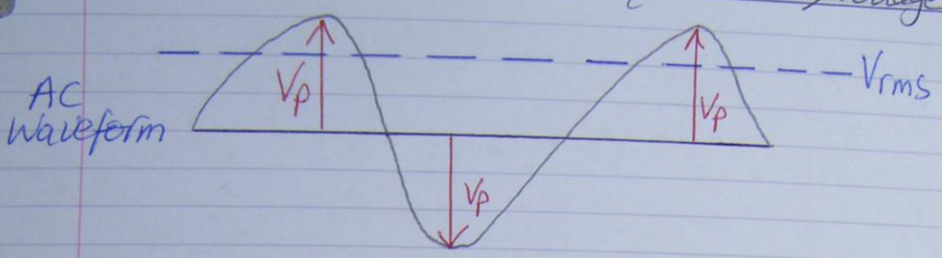
## mains supply in the UK.

Mains supply in the UK involves:

- mains voltage = 230 Volts (ac)
- Mains frequency = 50 Hertz.

* DC supplies have a frequency of 0 Hertz. *

# Peak and Root mean square (rms) Voltage




$V_p$ → Peak Voltage

$V_{rms}$ → Root mean square voltage.

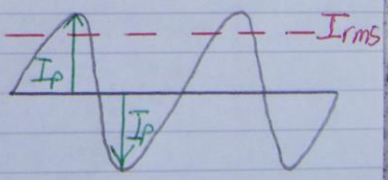
$$V_p = \sqrt{2}\, V_{rms}$$ ⇐ In DB!!

Peak Voltage ($V_p$); Root mean square voltage ($V_{rms}$).

- AC current is treated exactly the same with

$$I_p = \sqrt{2}\, I_{rms}$$

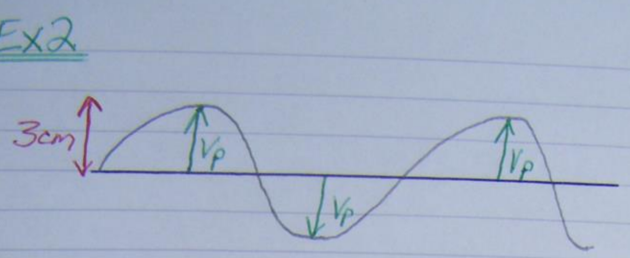
Peak current ($I_p$); Root mean square current ($I_{rms}$).




- $V_{rms}$ is the 'sort of average' ac voltage but $V_{ac(average)} = 0V$.

- $I_{rms}$ is the 'sort of average' ac current but $I_{ac(average)} = 0A$.

## Ex2




Q Calculate or find:

a) Peak voltage of the waveform.

b) $V_{rms}$ of the waveform.

A a) $V_p = 0.2Vcm^{-1} \times 3cm = \underline{0.6V}$

b) $V_p = \sqrt{2}\,V_{rms} \Rightarrow V_{rms} = \frac{V_p}{\sqrt{2}} = \frac{0.6}{\sqrt{2}} = \underline{0.42V}$

## Ex3

Q Calculate the peak voltage of the mains supply in the UK.

A $V_p = ?$ $\quad V_p = \sqrt{2}\,V_{rms}$

$V_{rms} = 230V$ $\quad \Rightarrow V_p = \sqrt{2} \times 230V = \underline{325V}$

## Power in AC Circuits

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

In an AC circuit you would always use the rms values of voltage and current in any calculation.

## Ex4

**Q** Calculate the power dissipated through a 30Ω light filament lamp if a peak current of 2·58A passes through it.

**A** $P = ?$
$I_p = 2{\cdot}58A$
$R = 30\Omega$

• Step 1 $I_p = \sqrt{2}\, I_{rms}$

$\Rightarrow I_{rms} = \frac{I_p}{\sqrt{2}} = \frac{2{\cdot}58}{\sqrt{2}} = 1{\cdot}82A$

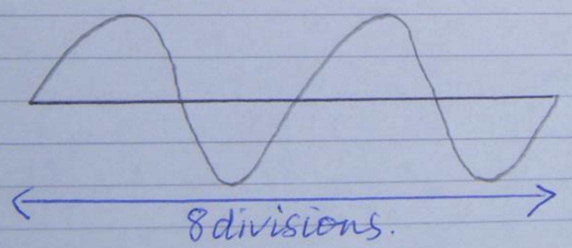
• Step 2 $P = I_{rms}^2 R$

$\Rightarrow P = (1{\cdot}82)^2 \times 30$

$\Rightarrow P = 100W$

## Calculating the frequency of an ac supply

### Ex5




OSCILLOSCOPE SETTING
To measure frequency we look at the time-base setting
eg $20\,ms\,div^{-1}$

**Q** Calculate the frequency of the ac supply which produced the waveform above.

**A** 2 waves ⇒ 2 periods (T)

$$2T = \text{Time-base setting} \times \text{No. of divisions}$$

$$\Rightarrow 2T = 20\,\text{ms div}^{-1} \times 8\,\text{divs} = 160\,\text{ms}$$

$$\Rightarrow T = \frac{160\,\text{ms}}{2} = 80\,\text{ms} = 80 \times 10^{-3}\,\text{s}$$

From $f = \frac{1}{T}$ then $f = \frac{1}{80 \times 10^{-3}} = 12.5\,\text{Hz}$

## Definitions

$f$ • Frequency is the number of waves that pass a point per second. (Hz)

$T$ • Period is the time to complete one wave or the time taken for a wave to repeat itself. (s)

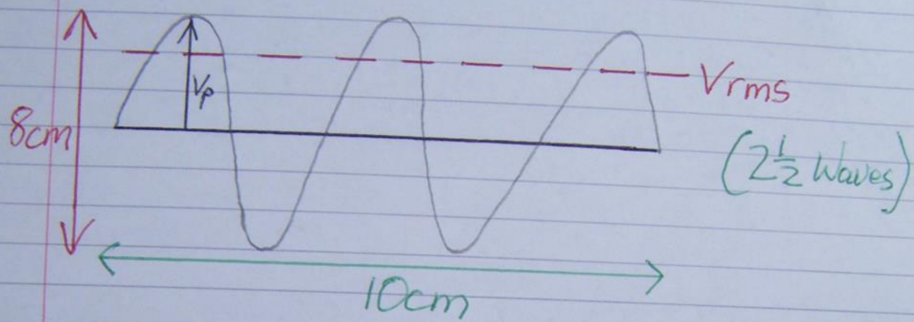
$f = \frac{N}{t}$ but if $N = 1 \therefore t = T$

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

# Ex6

## OSCILLOSCOPE SETTINGS

- Y-gain setting $= 0.25\,V\,cm^{-1}$
- Time-base setting $= 5\,ms\,cm^{-1}$




**Q** Calculate or find:

a) $V_p$ → Peak Voltage
b) $V_{rms}$ → Root mean square voltage.
c) Period of the waveform.
d) Frequency of the waveform.

**A** a) $V_p$ = Y-gain setting × no. of cm's $= 0.25\,V\,cm^{-1} \times 4\,cm$
$V_p = 1V$

b) $V_p = \sqrt{2}\,V_{rms} \Rightarrow V_{rms} = \frac{V_p}{\sqrt{2}} = \frac{1V}{\sqrt{2}} = 0.71V$

c) $2\frac{1}{2}$ Waves $= 2.5T$ = Time-base setting × no. of cm's

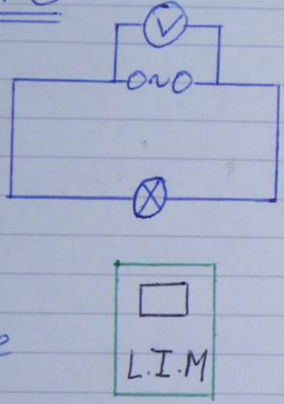
$\Rightarrow 2.5T = 5\,ms\,cm^{-1} \times 10\,cm = 50\,ms = 50\times10^{-3}s$

$\Rightarrow T = \frac{50\times10^{-3}}{2.5} = 20\times10^{-3}s$

d) $f = \frac{1}{T} = \frac{1}{20 \times 10^{-3}} = 50\,Hz$

## Experiment to compare AC with DC.

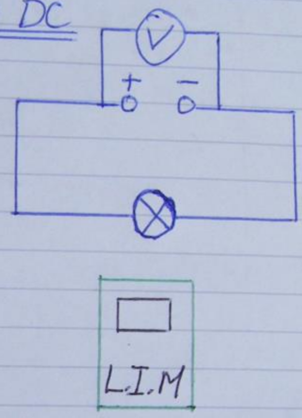
### ① AC




L.I.M ⇒ Light Irradiance Meter.

Set the AC Supply voltage to a set voltage and then record the reading on the L.I.M.

### ② DC




Vary the DC Supply voltage until the reading on the L.I.M is the same as observed with the AC Supply experiment.

* Reading on the AC Voltmeter measures the Vrms in ac. *

## Conclusion

| |
|---|
| Vrms in ac = Vdc |

## Definition of Vrms

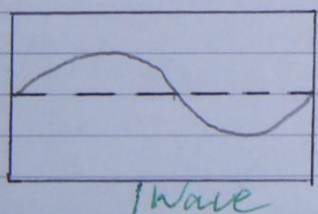
This is the AC Voltage which gives the same heating effect in a circuit to the equivalent DC Voltage.

## Time-base setting

If the time-base setting on an oscilloscope is increased then the number of waves viewed on the screen will increase.
However, the amplitude of the waves will stay constant. (The y-gain setting can increase or decrease the amplitude of the waves.)

## Ex 7.

Q//

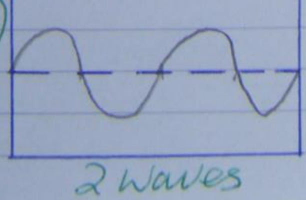



Time-base setting $= 5\,ms\,cm^{-1}$

a) Draw the waveform when the time-base setting is adjusted to $10\,ms\,cm^{-1}$.

b) How does the amplitude of the waves compare.

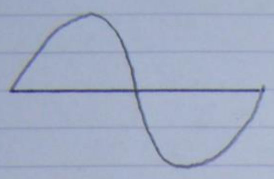
A// a)



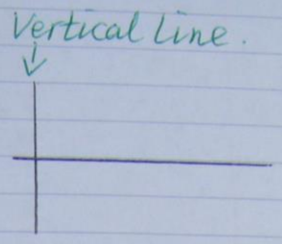

b) The amplitude stays constant.

# A wee extra!!

## AC

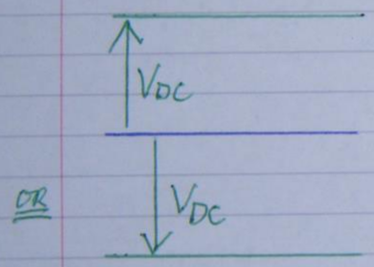


Time-base on

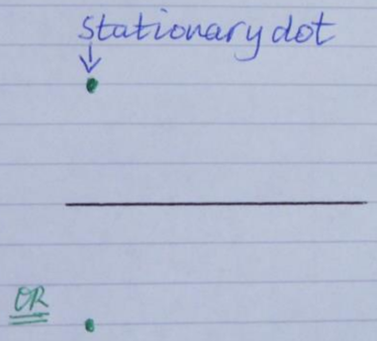



Time-base off

## DC




Time-base on




Time-base off