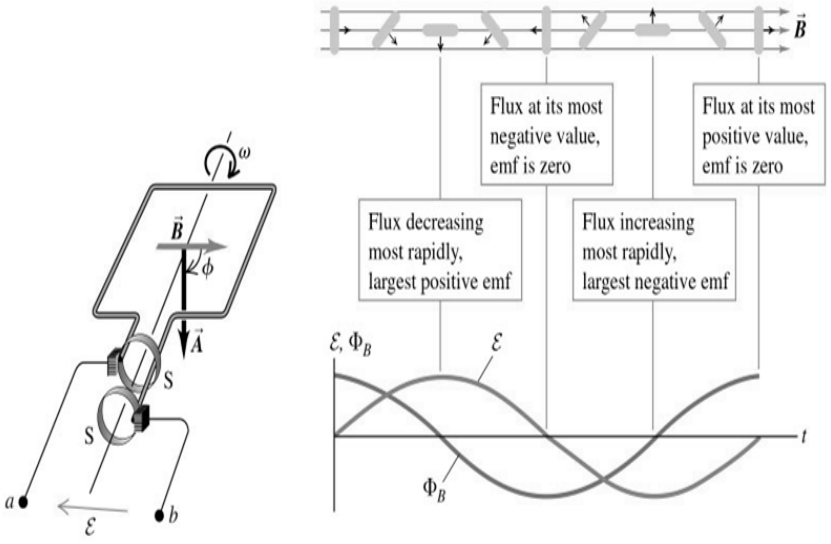
General Physics II

AC Circuits

The AC Source

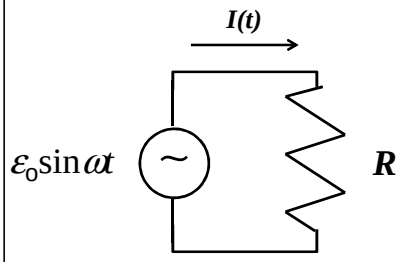


Oscillating Current and Voltage

Output voltage appears at the terminals and is sinusoidal in time with an angular frequency ω.

$$V(t) = V_{\max} \sin(\omega t)$$

- Recall that, $\omega = 2\pi f$ where f is the frequency in Hertz (Hz)
- In the US and the rest of the Western Hemisphere, the frequency is 60 Hz.

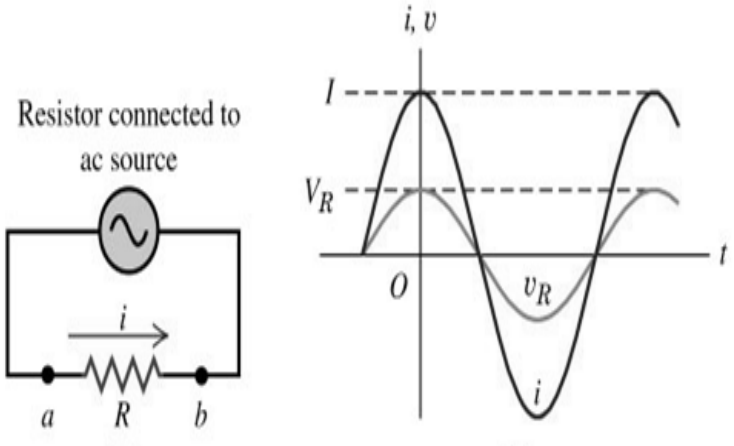


Oscillating circuits have both AC voltage and current.

For resistors this is:

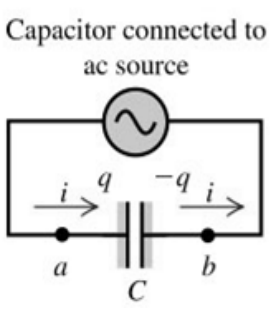
$$I(t) = \frac{\varepsilon_o}{R} \sin(\omega t)$$

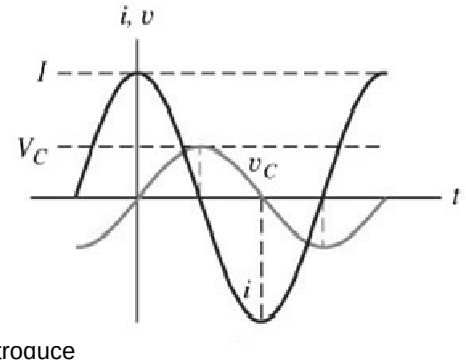
Simple AC Circuits -- Resistor



This is sometimes called a “resistive load” on the circuit

Simple AC Circuits -- Capacitor





For symmetry reasons, we introduce "capacitive reactance", X_C:

$$X_C = \frac{1}{\omega C}$$

$V_{max}=I_C X_C$

Capacitive reactance has units of ohms

Impedance, Z

- The impedance of the circuit is the effective resistance
  - ←Has units of ohms
  - ←Consists of
    - » Total resistance, R
    - » Total capacitance, C
- V=IZ, amplitude of voltage across AC circuit

$$V^2 = V_C^2 + V_R^2$$

$$V^2 = I^2\left[X_C^2 + R^2\right]$$

$$I = \frac{V}{\sqrt{X_C^2 + R^2}}$$

$$Z = \sqrt{X_C^2 + R^2}$$

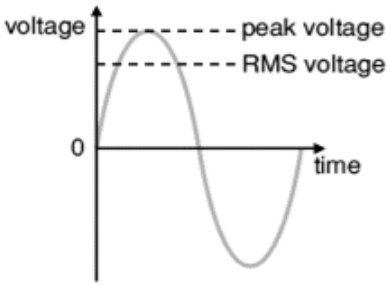
Root Mean Square (RMS)

- The value of an AC voltage is continually changing from zero up to the positive peak, through zero to the negative peak and back to zero again.
- Instead we use the **root mean square voltage (V_{RMS})**:

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

- These equations also apply to **current**:

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



- **The RMS value is the effective value of a varying voltage or current. It is the equivalent steady DC (constant) value which gives the same effect.**

End of

AC Circuits

Lecture