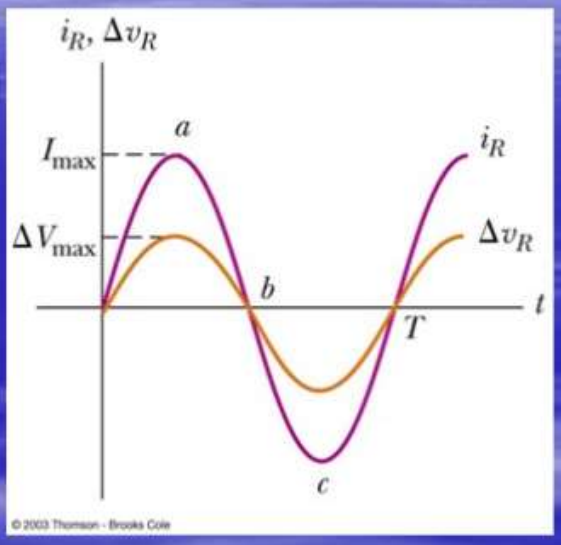
AC Circuit

- An AC circuit consists of a combination of circuit elements and an AC generator or source
- The output of an AC generator is sinusoidal and varies with time according to the following equation
  - $\Delta V = \Delta V_{max} \sin 2\pi f t$
    - Δv is the instantaneous voltage
    - ΔV_{max} is the maximum voltage of the generator
    - f is the frequency at which the voltage changes, in Hz
  - Same thing about the current (if only a resistor)
  - $I = I_{max} \sin 2\pi f t$

Resistor in an AC Circuit

- Consider a circuit consisting of an AC source and a resistor
- The graph shows the current through and the voltage across the resistor
- The current and the voltage reach their maximum values at the same time
- The current and the voltage are said to be *in phase*



Voltage varies as

$\Delta V = \Delta V_{max} \sin 2\pi f t$

Same thing about the current

$I = I_{max} \sin 2\pi f t$

More About Resistors in an AC Circuit

- The direction of the current has no effect on the behavior of the resistor
- The rate at which electrical energy is dissipated in the circuit is given by
  - $P = i^2 R = (I_{max} \sin 2\pi f t)^2 R$
    - where i is the *instantaneous current*
    - the heating effect produced by an AC current with a maximum value of I_{max} is not the same as that of a DC current of the same value
    - The maximum current occurs for a small amount of time
- Averaging the above formula over one cycle we get

$$P = \frac{1}{2} I_{max}^2 R$$

rms Current and Voltage

- The *rms current* is the direct current that would dissipate the same amount of energy in a resistor as is actually dissipated by the AC current

$$I_{rms} = \frac{I_{max}}{\sqrt{2}} = 0.707\, I_{max}$$

- Alternating voltages can also be discussed in terms of rms values

$$\Delta V_{rms} = \frac{\Delta V_{max}}{\sqrt{2}} = 0.707\, \Delta V_{max}$$

Ohm's Law in an AC Circuit

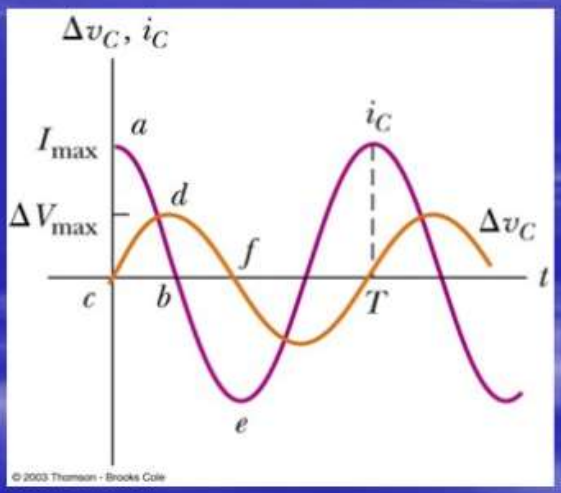
- rms values will be used when discussing AC currents and voltages
  - AC ammeters and voltmeters are designed to read rms values
  - Many of the equations will be in the same form as in DC circuits
- Ohm's Law for a resistor, R, in an AC circuit
  - $\Delta V_{rms} = I_{rms} R$
  - Also applies to the maximum values of v and i

Capacitors in an AC Circuit

- Consider a circuit containing a capacitor and an AC source
- The current starts out at a large value and charges the plates of the capacitor
  - There is initially no resistance to hinder the flow of the current while the plates are not charged
- As the charge on the plates increases, the voltage across the plates increases and the current flowing in the circuit decreases

More About Capacitors in an AC Circuit

- The current reverses direction
- The voltage across the plates decreases as the plates lose the charge they had accumulated
- The voltage across the capacitor lags behind the current by 90°



Capacitive Reactance and Ohm's Law

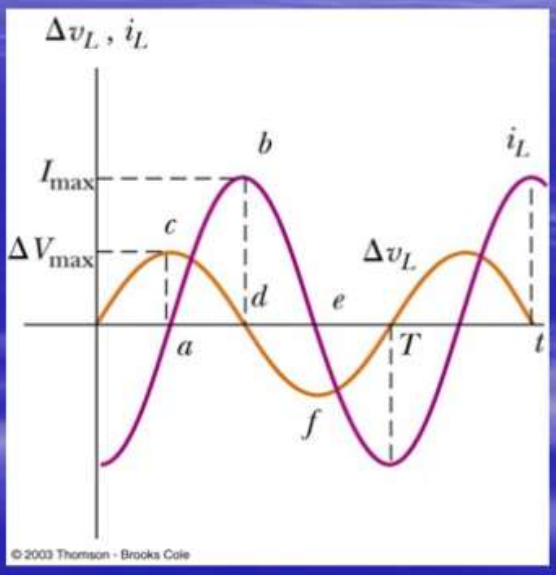
- The impeding effect of a capacitor on the current in an AC circuit is called the *capacitive reactance* and is given by

$$X_C = \frac{1}{2\pi f C}$$

  - When f is in Hz and C is in F, X_C will be in ohms
- Ohm's Law for a capacitor in an AC circuit
  - $\Delta V_{rms} = I_{rms} X_C$

Inductors in an AC Circuit

- Consider an AC circuit with a source and an inductor
- The current in the circuit is impeded by the back emf of the inductor
- The voltage across the inductor always leads the current by 90°



Inductive Reactance and Ohm's Law

- The effective resistance of a coil in an AC circuit is called its *inductive reactance* and is given by
  - $X_L = 2\pi f L$
    - When f is in Hz and L is in H, X_L will be in ohms
- Ohm's Law for the inductor
  - $\Delta V_{rms} = I_{rms} X_L$