3-7: Electric Power

- The basic unit of power is the watt (W).
  - Multiple units of power are:
    - **kilowatt (kW):**
      1000 watts or 10^3 W
    - **megawatt (MW):**
      1 million watts or 10^6 W
  - Submultiple units of power are:
    - **milliwatt (mW):**
      1-thousandth of a watt or 10^{-3} W
    - **microwatt (μW):**
      1-millionth of a watt or 10^{-6} W

3-7: Electric Power

- Work and energy are basically the same, with identical units.

- Power is different. It is the <u>time rate</u> of doing work.
  - Power = work / time.
  - Work = power × time.

3-7: Electric Power

- Practical Units of Power and Work:
  - The rate at which work is done (power) equals the product of voltage and current. This is derived as follows:
  - First, recall that:

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}} \quad \text{and} \quad 1 \text{ ampere} = \frac{1 \text{ coulomb}}{1 \text{ second}}$$

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Power = Volts × Amps, or

$$P = V \times I$$

$$\text{Power (1 watt)} = \frac{1\ \text{joule}}{1\ \cancel{\text{coulomb}}} \times \frac{1\ \cancel{\text{coulomb}}}{1\ \text{second}} = \frac{1\ \text{joule}}{1\ \text{second}}$$

3-7: Electric Power

- Kilowatt Hours
  - The kilowatt hour (kWh) is a unit commonly used for large amounts of electrical work or energy.
  - For example, electric bills are calculated in kilowatt hours. The kilowatt hour is the billing unit.
  - The amount of work (energy) can be found by multiplying power (in kilowatts) × time in hours.

3-7: Electric Power

To calculate electric cost, start with the power:

- An air conditioner operates at 240 volts and 20 amperes.
- The power is $P = V \times I = 240 \times 20 = 4800$ watts.
  - Convert to kilowatts:

    4800 watts = 4.8 kilowatts
  - Multiply by hours: (Assume it runs half the day)

    energy = 4.8 kW × 12 hours = 57.6 kWh
  - Multiply by rate: (Assume a rate of $0.08/ kWh)

    cost = 57.6 × $0.08 = $4.61 per day

Problem

- How much is the output voltage of a power supply if it supplies 75 W of power while delivering a current of 5 A?

- How much does it cost to light a 300-W light bulb for 30 days if the cost of the electricity is 7¢/kWh.

3-8: Power Dissipation in Resistance

- When current flows in a resistance, heat is produced from the friction between the moving free electrons and the atoms obstructing their path.
- Heat is evidence that power is used in producing current.

3-8: Power Dissipation in Resistance

- The amount of power dissipated in a resistance may be calculated using any one of three formulas, depending on which factors are known:
  - $P = I^2 \times R$
  - $P = V^2 / R$
  - $P = V \times I$

Problem

- Solve for the power, P, dissipated by the resistance, R
  a. I = 1 A, R = 100Ω , P = ?
  b. I = 20 mA, R = 1 kΩ , P = ?
  c. V = 5 V, R = 150Ω , P = ?
  d. V = 22.36 V, R = 1 kΩ , P = ?

- How much power is dissipated by an 8-Ω load if the current in the load is 200 mA?