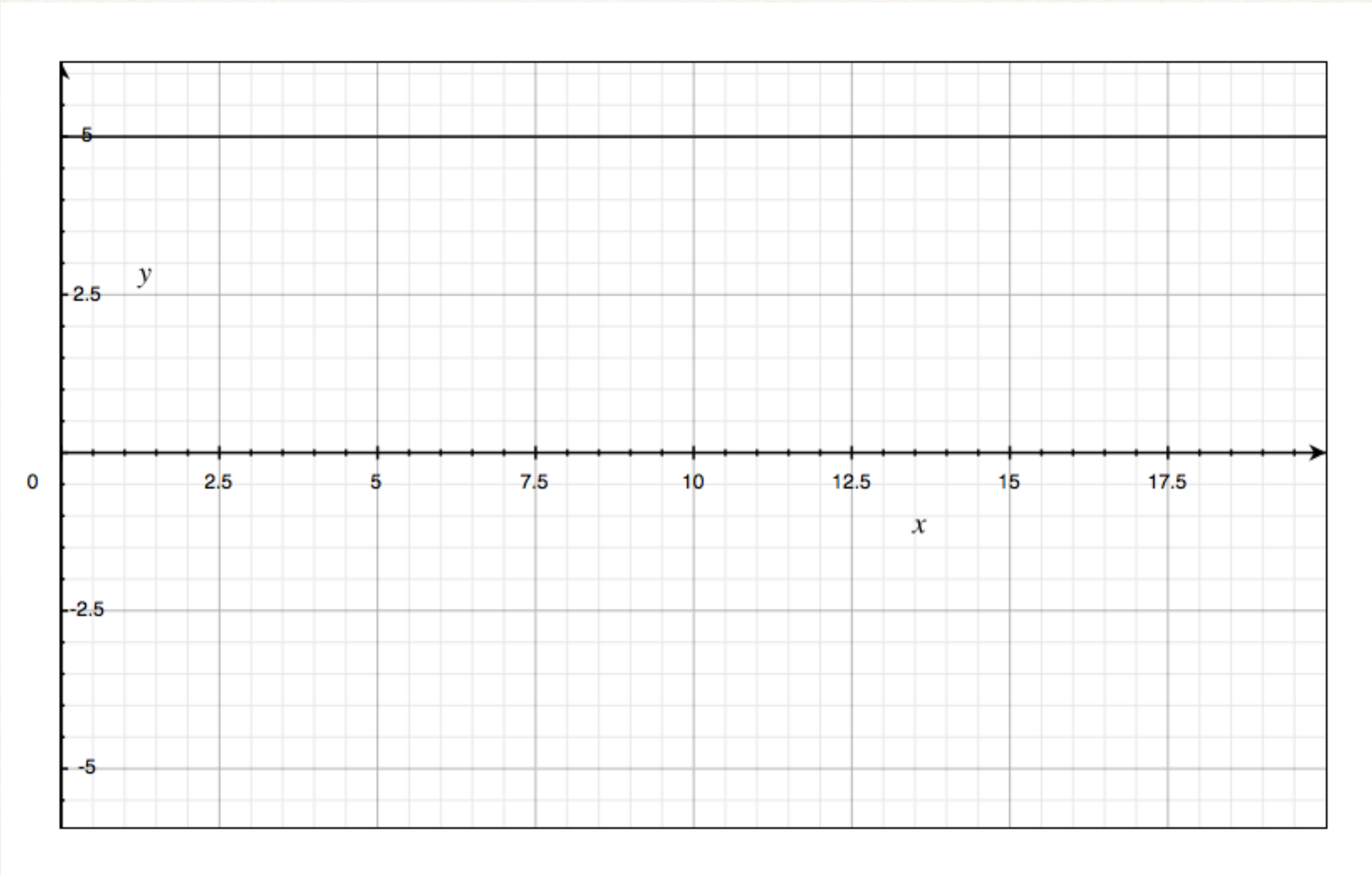
DC - Direct Current



DC - Direct Current

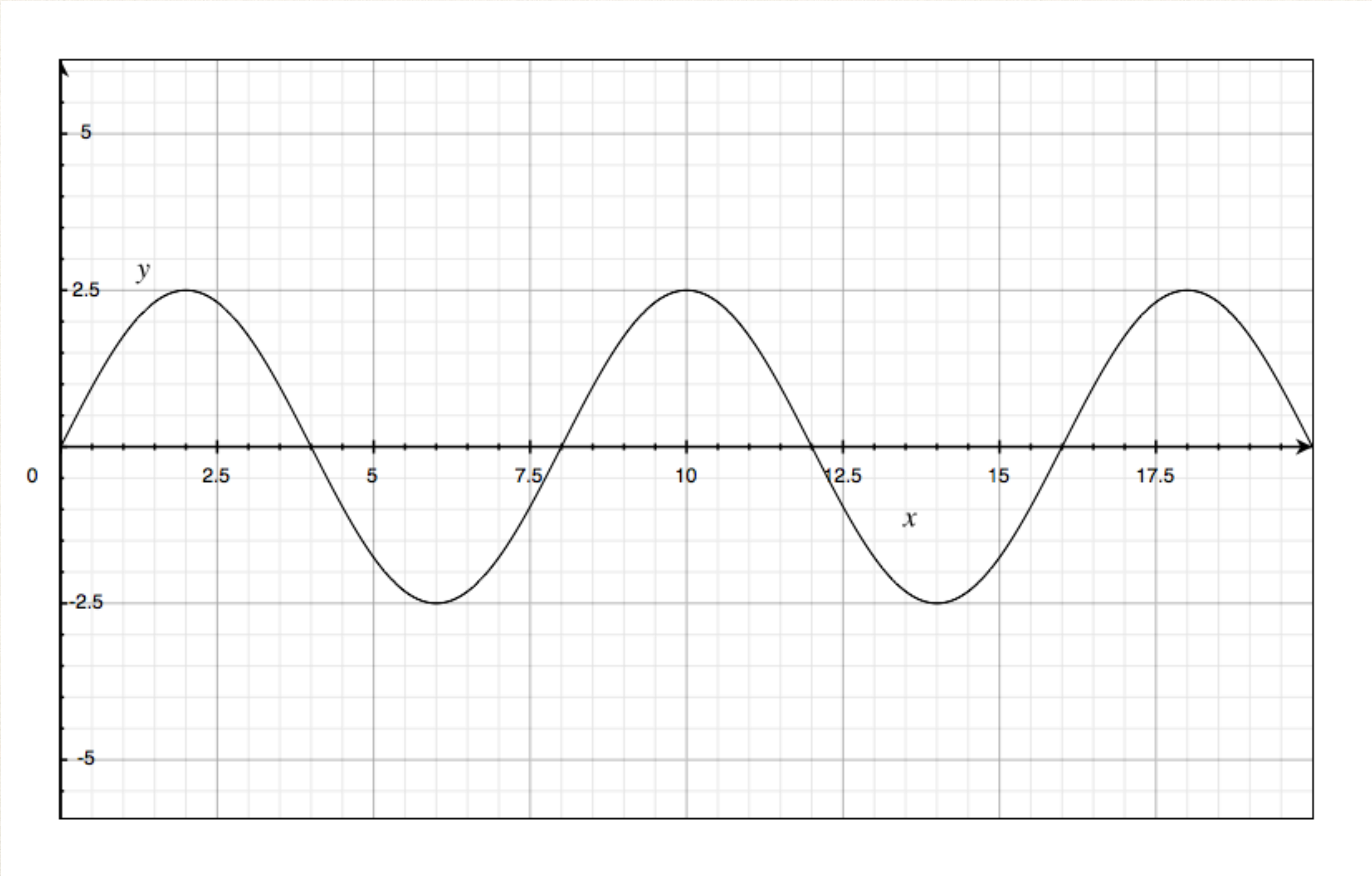
- What is the current through a 72 Ω resistor if connected to a 3.6 V battery?

$$V = IR$$

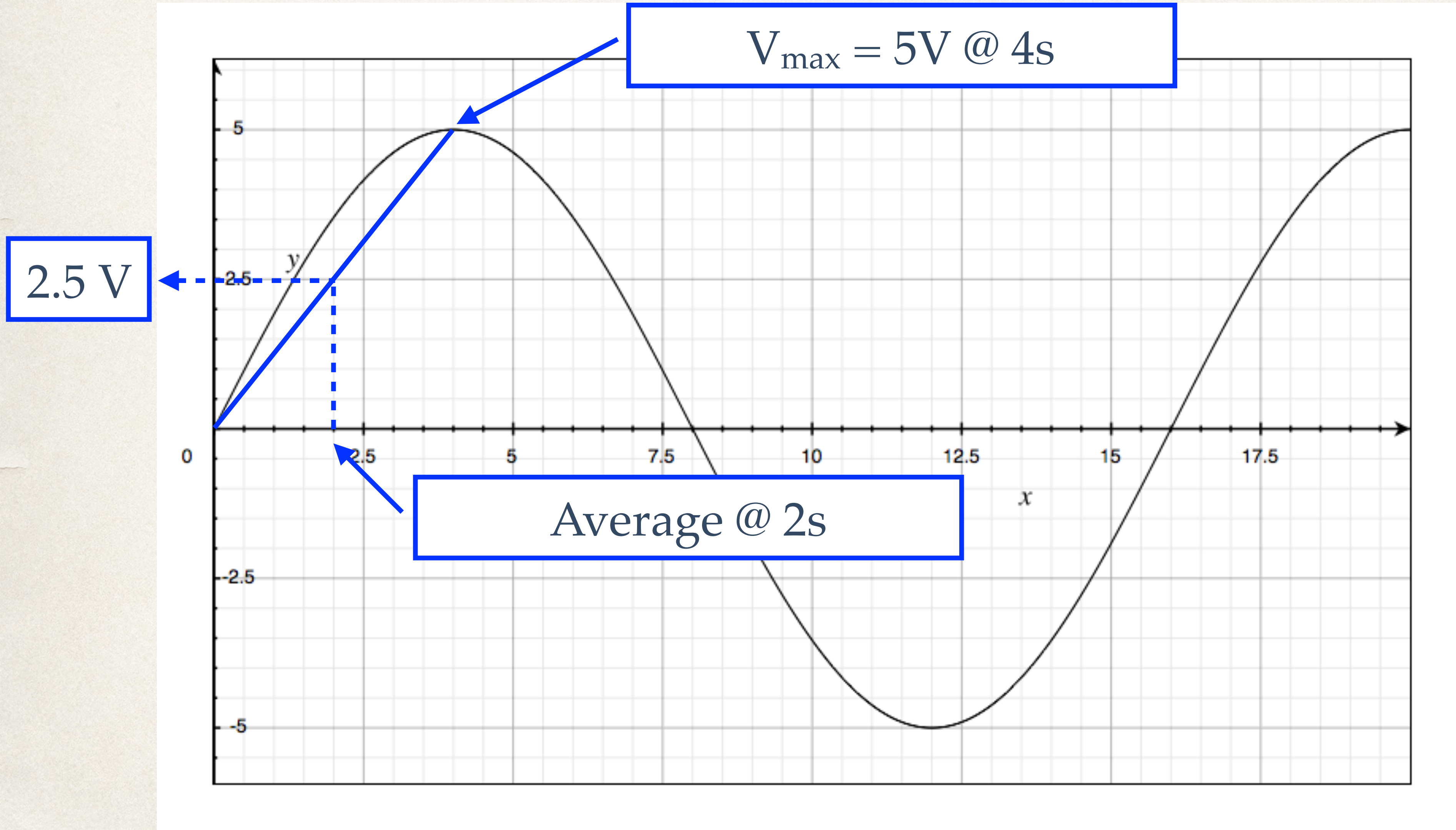
$$I = \frac{V}{R} = \frac{3.6\ \text{V}}{72\ \Omega}$$

$$\boxed{I = 0.05\ \text{A (or) } 50\ \text{mA}}$$

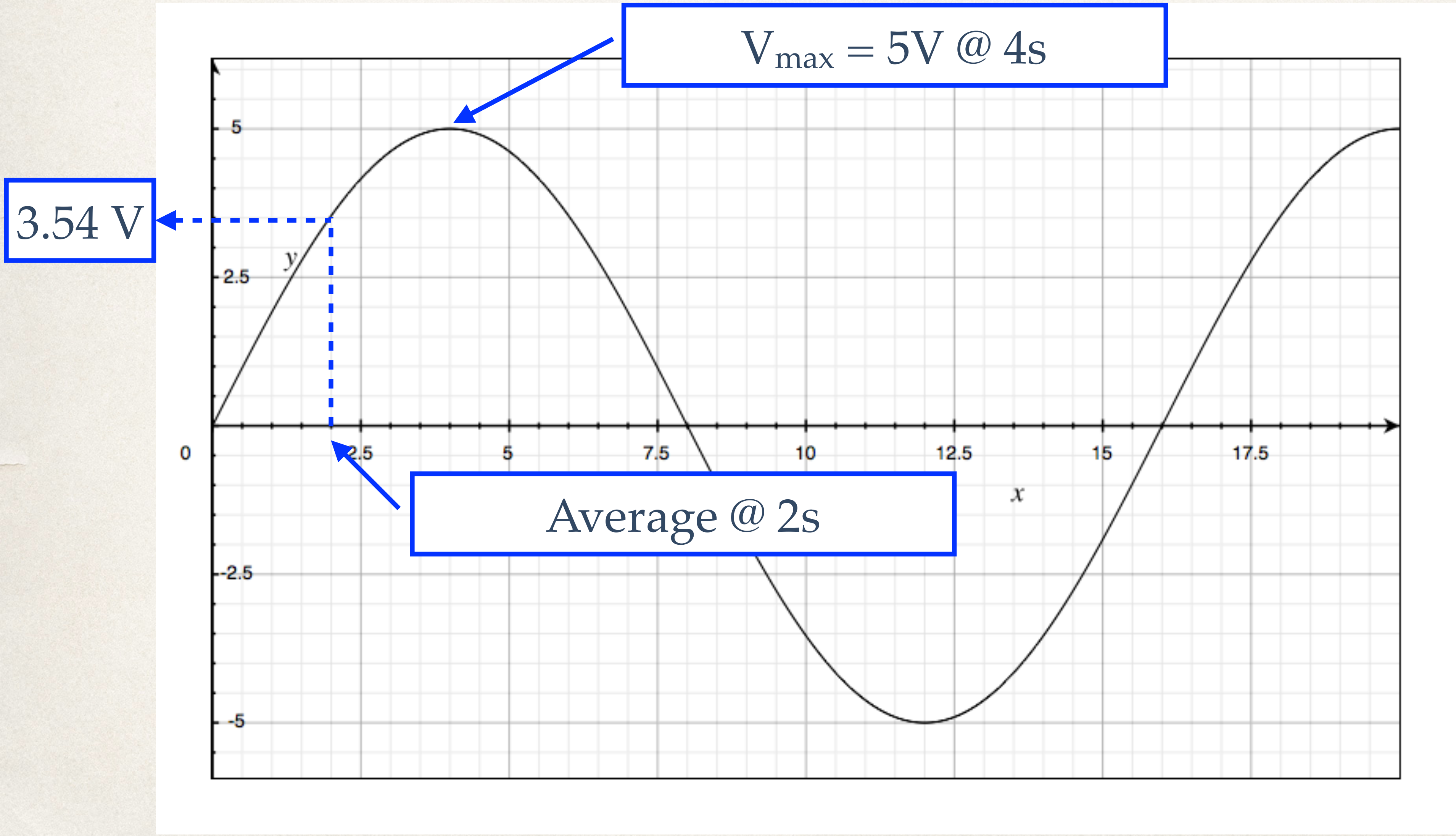
AC - Alternating Current



AC - Alternating Current



AC - Alternating Current



AC - Direct Current

- What is the ratio of the average voltage to the maximum voltage in an AC circuit?

$$\frac{V_{average}}{V_{\max}} = \frac{3.54\ \text{V}}{5\ \text{V}} = 0.707$$

$$V_{average} = 0.707\left(V_{\max}\right)$$

$$V_{\max} = 1.414\left(V_{average}\right)$$

AC - Direct Current

- What is the ratio of the average voltage to the maximum voltage in an AC circuit?

$$V_{\max} = \sqrt{2}\left(V_{average}\right)$$

$$\boxed{V_o = \sqrt{2}\left(V_{rms}\right)}$$

AC - Direct Current

- How does this effect Ohm's Law?

$$V = IR$$

$$I_{rms} = \frac{I_o}{\sqrt{2}} \quad ?$$

$$V_o = I_o R$$

$$\boxed{I_o = \sqrt{2}\left(I_{rms}\right)}$$

$$\sqrt{2}\left(V_{rms}\right) = I_o R$$

$$V_{rms} = \frac{I_o}{\sqrt{2}} R$$

$$\boxed{V_o = \sqrt{2}\left(V_{rms}\right)}$$

Ohm's Law and the Power Eqn.

$$V = IR$$

$$I = \frac{V}{R}$$

$$R = \frac{V}{I}$$

$$P = I\left(IR\right)$$

$$P = \left(\frac{V}{R}\right)V$$

$$P = IV$$

$$P = I^2 R$$

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

Max vs. RMS

$$V_o = I_o R \qquad V_{rms} = I_{rms} R \qquad P = I_o V_o \qquad \bar{P} = I_{rms} V_{rms}$$

$$I_o = \frac{V_o}{R} \qquad I_{rms} = \frac{V_{rms}}{R} \qquad P = I_o{}^2 R \qquad \bar{P} = I_{rms}{}^2 R$$

$$R = \frac{V_o}{I_o} \qquad R = \frac{V_{rms}}{I_{rms}} \qquad P = \frac{V_o{}^2}{R} \qquad \bar{P} = \frac{V_{rms}{}^2}{R}$$

Between MAX and rms

$$\overline{P} = I_{rms} V_{rms}$$

$$I_o = \sqrt{2} I_{rms}$$

$$V_o = \sqrt{2} V_{rms}$$

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

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

$$\overline{P} = I_{rms} V_{rms} = \frac{I_o}{\sqrt{2}} \frac{V_o}{\sqrt{2}} = \frac{1}{\sqrt{4}} I_o V_o$$

$$\overline{P} = \frac{1}{2} I_o V_o$$

Complete Picture

$$V = IR$$

$$I = \frac{V}{R}$$

$$R = \frac{V}{I}$$

$$P = IV$$

$$P = I^2 R$$

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

$$\bar{P} = \frac{1}{2} I_o V_o$$

$$\bar{P} = \frac{1}{2} I_o^{\,2} R$$

$$\bar{P} = \frac{1}{2} \frac{V_o^{\,2}}{R}$$

Household Electricity

- Standard = AC, 110-120V
- Air Conditioning, Electric Furnace, etc = 220V or 440V
- Circuit Breakers = Ensure current doesn't get too high.
  - Too High Current = Heat = BAD!

$$V_{\max} = 1.414\left(V_{average}\right)$$

Household Electricity

- 1 Kilowatt = power
- 1 Kilowatt-Hour = Energy

$$\text{Power} = \frac{\text{Energy}}{\text{Time}}$$

$$\text{Watts} = \frac{\text{Joules}}{\text{second}}$$

Household Electricity

- How many Joules are in 1 Kilowatt-Hour?

Example Questions

- A battery is made of two silver wires stuck into a lemon. Which of the following is the expected result?

  A. The battery works, but not well because the lemon is a weak electrolyte.

  B. The battery works well because citric acid reacts well with silver

  C. The battery doesn't work because the metals are the same

  D. The battery doesn't work because citric acid is not an electrolyte

  E. The battery has a voltage of 0.78 V, it's what Volta used is his research.

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Example Questions

- A circuit is connected to a 9.0V battery. If the current is 0.3 Amperes, what is the resistance?

A. 0.03 Ω

B. 3.0 Ω

C. 9.3 Ω

D. 30 Ω

E. Answer not provided

Example Questions

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D. 30 Ω

E. Answer not provided

Example Questions

- If the length of a wire is doubled which of the following is true?

  A. The resistivity doubles

  B. The resistance doubles

  C. The resistivity halves

  D. The resistance halves

  E. More information required

Example Questions

- If the length of a wire is doubled which of the following is true?

  A. The resistivity doubles

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  C. The resistivity halves

  D. The resistance halves

  E. More information required

Example Questions

- What is the power of the battery in problem 2?

  (V = 9V, I = 3.0 A, R = 30 Ω)

  A. 0.81 W

  B. 0.81 J

  C. 2.7 W

  D. 2.7 J

  E. 270 W

Example Questions

- What is the power of the battery in problem 2?

  $(V = 9V, I = 3.0\ A, R = 30\ \Omega)$

  A. 0.81 W

  B. 0.81 J

  C. 2.7 W

  D. 2.7 J

  E. 270 W

Example Questions

- What effect does an increase in temperature have on a semi-conductor?

    A. It increases the resistance

    B. It increases the resistivity

    C. It depends on the type of semi-conductor

    D. it decreases the resistance

    E. It decreases the resistivity

Example Questions

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Example Questions

- What effect does an increase in temperature have on a semi-conductor?

$$\rho_T = \rho_o\left[1+\alpha\left(T_f - T_o\right)\right]$$

  - p.508-509 discusses this formula. Notice for a small section of materials that are semi-conductors α is **negative** so as temperature increases then ρ_T will actually decrease. As a result the resistance will also decrease. (so the answer is both D and E)

Batteries

- If I want to greatly increase the voltage in a circuit how could I accomplish that goal?

  A. Change the materials used for the cathode and anode

  B. Change the chemical used for the electrolyte

  C. Connect multiple batteries in parallel

  D. Connect multiple batteries in series

Batteries

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  A. Change the materials used for the cathode and anode

  B. Change the chemical used for the electrolyte

  C. Connect multiple batteries in parallel

  D. Connect multiple batteries in series

Series

- Batteries connected from cathode of one battery to anode of the next

- Increases voltage of the combined batteries.

$$V_t = nV_{battery}$$

Batteries

- What effect does connecting batteries in parallel have?

  A. It makes the battery last longer

  B. It increases the voltage of the battery

  C. It increases the current from the battery

  D. More than one of the above

Batteries

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  A. It makes the battery last longer

  B. It increases the voltage of the battery

  C. It increases the current from the battery

  D. More than one of the above (A & C with limits)

Parallel

- Batteries connected with all cathodes together and all anodes together
- Increases current from the combined batteries **OR** increases the longevity of the combined batteries.