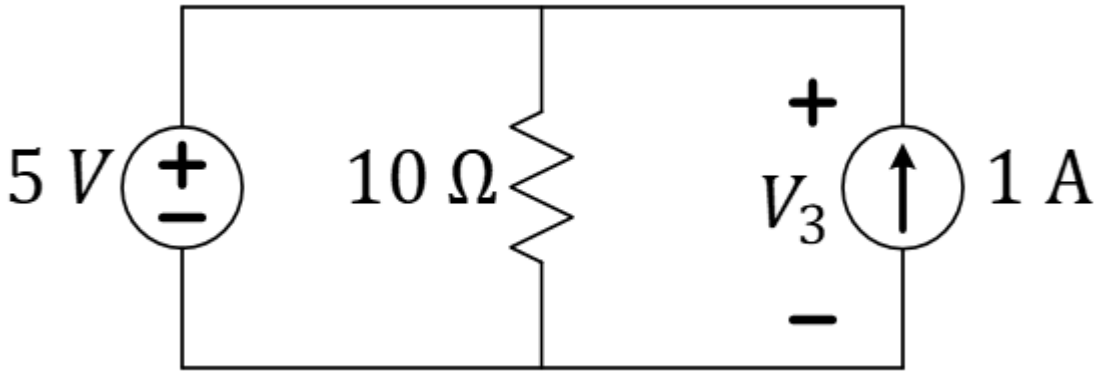
Lecture 10: Signed Power and Design

- The purpose of a signed power convention
- Exercises under constraints on components

Which of the sources are delivering power?

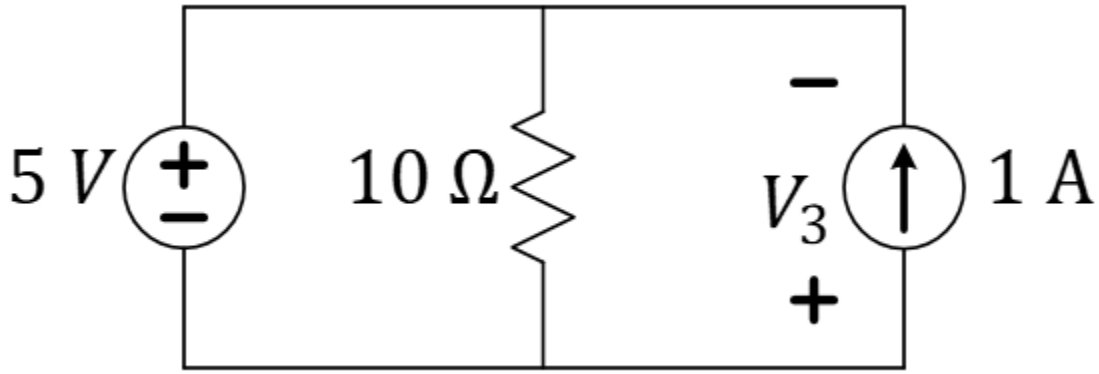
A. The voltage source only
B. The current source only
C. Both
D. Neither
E. Not enough information to tell

Polarity labels for Kirchhoff are Arbitrary



Q: Find the value of V_3.

Q: Find the power of the current source.

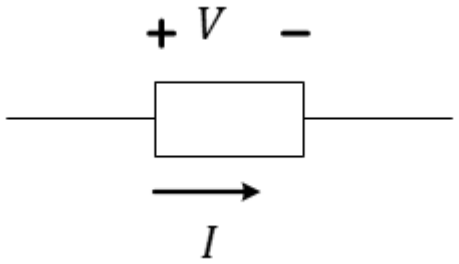


Q: Find the value of V_3.

Q: Find the power of the current source.

Q: Does the sign of $P_3 = V_3 I_3$ have any meaning?

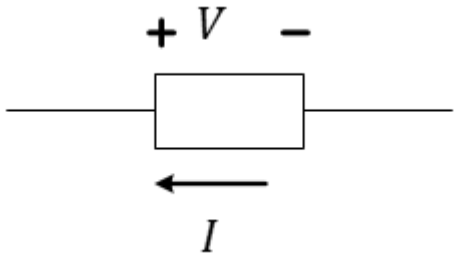
Standard Reference



$$V = IR$$

$$P = IV$$

Non-Standard Reference

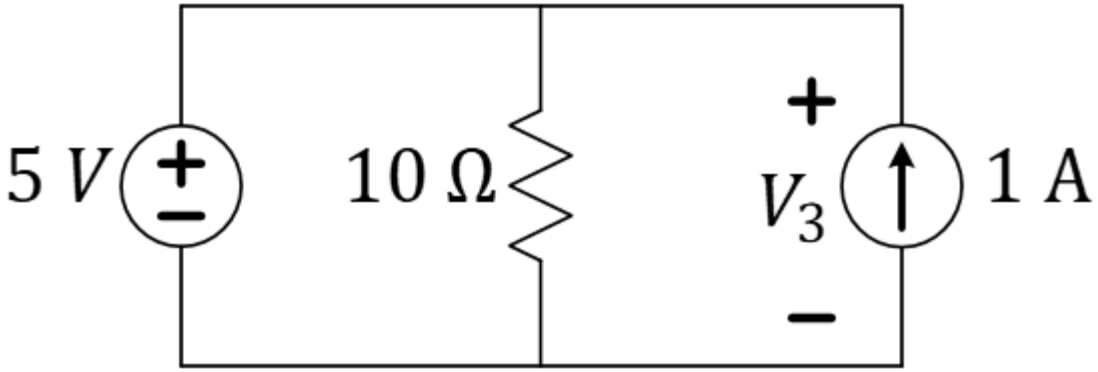


$$V = -IR$$

$$P = -IV$$

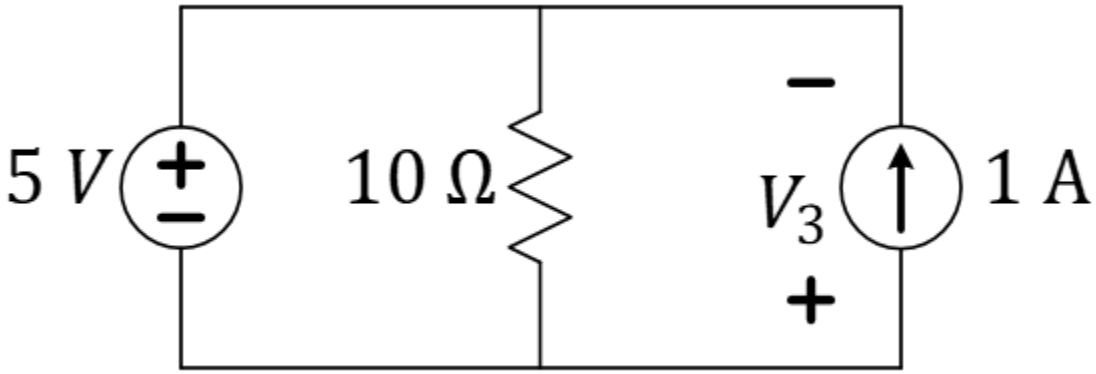
Note: Standard convention is also called “passive” convention.

Polarity for *Power* MATTERS!



Non-Standard Reference

$$P = -IV = -(1)(V_3)$$

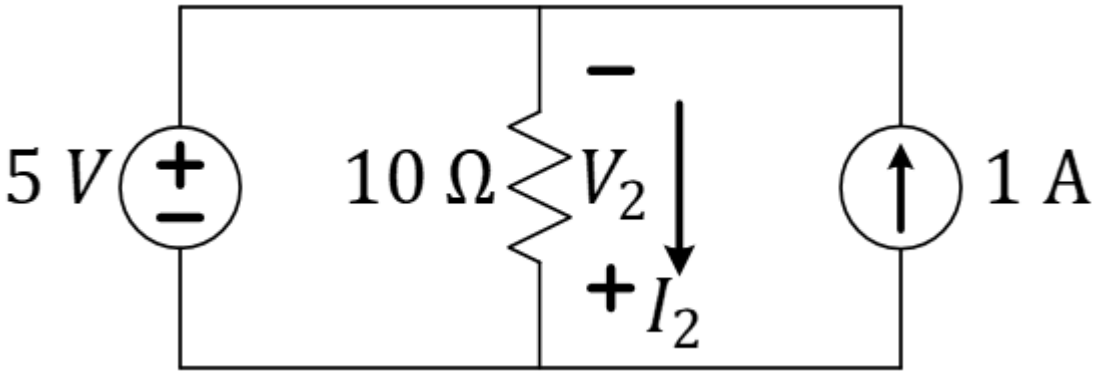


Standard Reference

$$P = IV = +(1)(V_3)$$

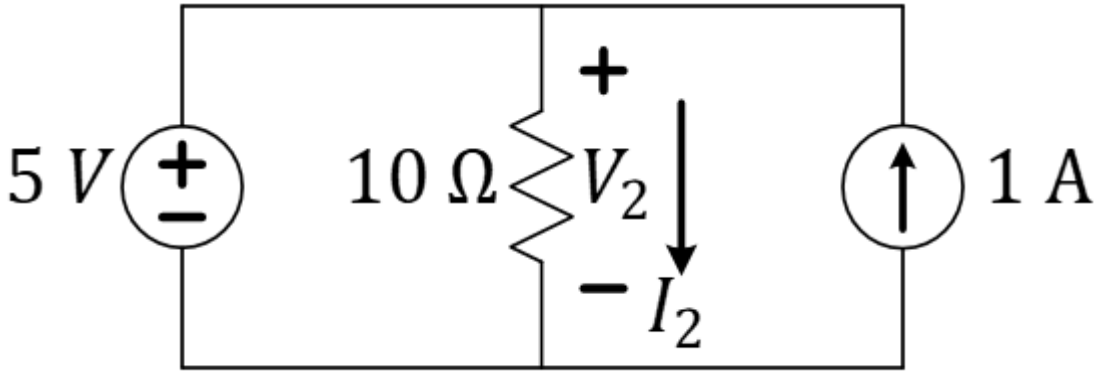
$$P = -5\ W$$

Polarity for *Ohm's Law* MATTERS!



Non-Standard Reference

$$I_2 = -\frac{V_2}{R}$$



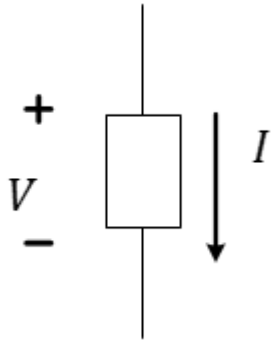
Standard Reference

$$I_2 = \frac{V_2}{R}$$

$$I_2 = 0.5\ A$$

The Equation P=IV Assumes Standard

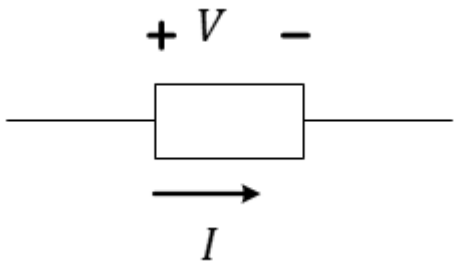
Using the standard polarity labeling: $P = V\ I_{+\rightarrow -}$



$P < 0 \Rightarrow Element\ delivers\ power\ to\ the\ circuit$

$P > 0 \Rightarrow Element\ absorbs\ power\ from\ the\ circuit$

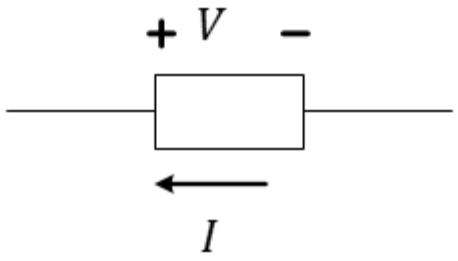
Recap of labeling implication



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

$$P = VI$$

"Standard Reference"



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

$$P = -VI$$

"Non-Standard Reference"

This way, power is defined such that it is negative when it is supplied (sourced) and positive when it is absorbed (sinked).

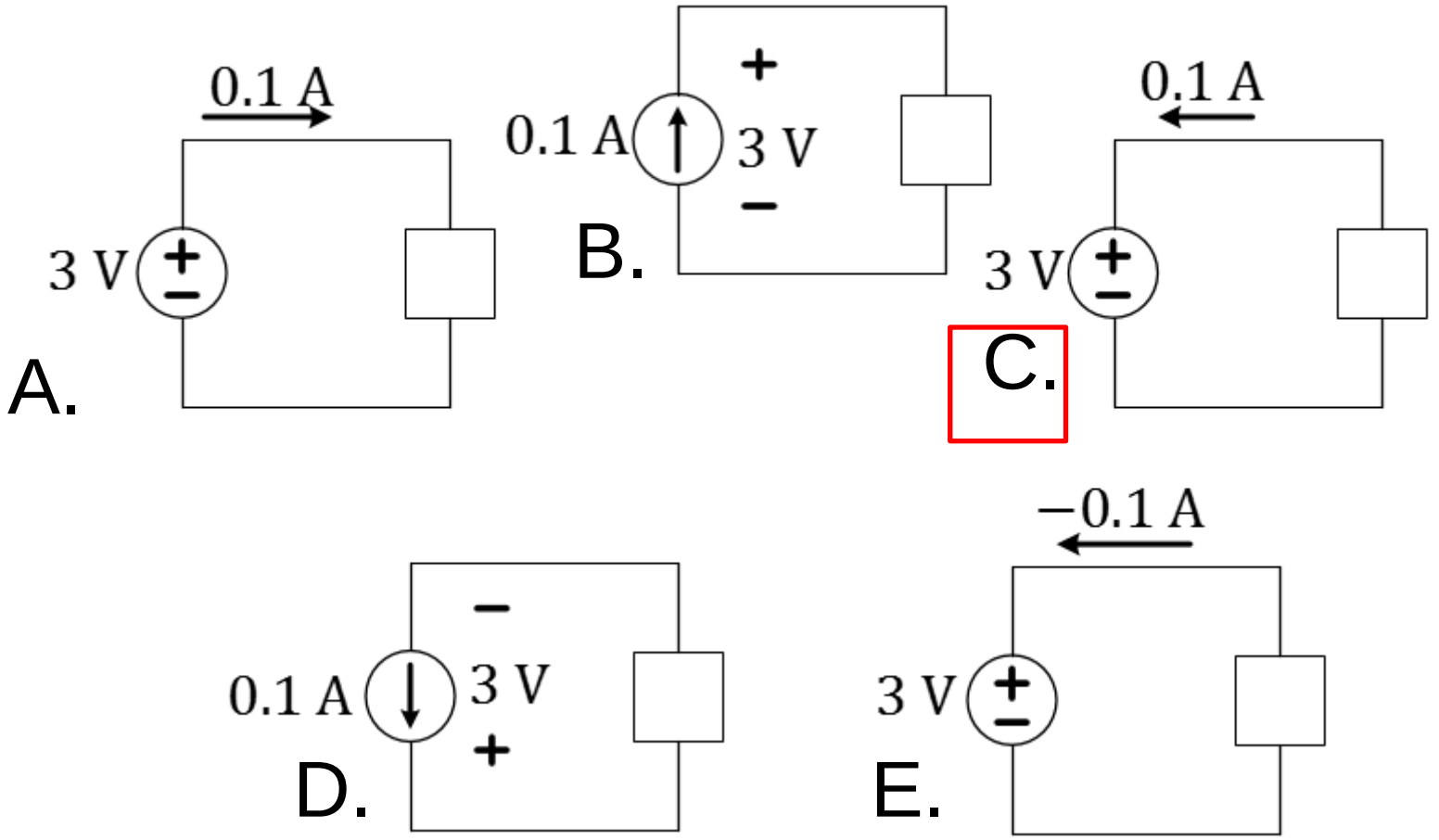
Universal:

Ohm's Law: $I_{+\to-} = \frac{V}{R}$

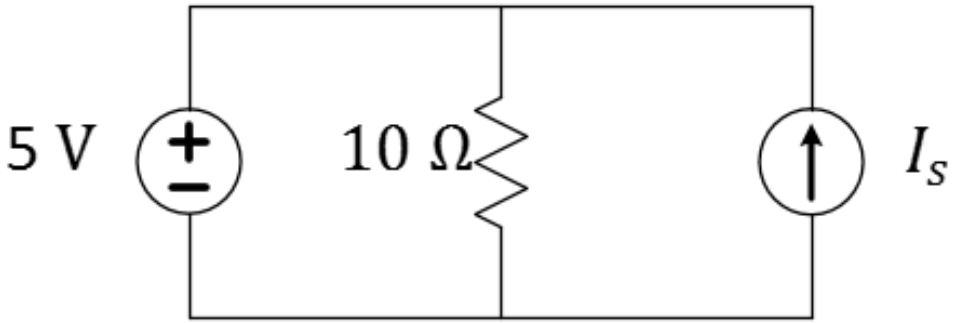
Power Eqn: $P = VI_{+\to-}$

Q: With power defined as above,
what is the sum of powers for all circuit elements?

Which of the sources below absorbs power?



Using the Power Equation



Q: For what values of I_S does the current source supply power?

L10 Learning Objectives

a. Assign polarity of current and voltage
b. Properly apply Ohm's Law to conditions of standard and non-standard polarities
c. Properly apply the signed-Power formula to conditions of standard and non-standard polarities
d. Design a circuit for specified power constraints.