Chapter 1
Introduction

Four main categories of circuit analysis

(a) DC Analysis

(b) Transient Analysis

(c) Sinusoidal Analysis

(d) Frequency Analysis

Linear circuit analysis ?

TABLE **1.1** Comparison of a Linear Model for e^x to Exact Value

x	$f(x)$*	$1 + x$	Relative error**
0.0001	1.0001	1.0001	0.0000005%
0.001	1.0010	1.001	0.00005%
0.01	1.0101	1.01	0.005%
0.1	1.1052	1.1	0.5%
1.0	2.7183	2.0	26%

*Quoted to four significant figures.

**Relative error $\triangleq \left| 100 \times \frac{e^x - (1+x)}{e^x} \right|$

Chapter 2
Basic Components and Electric Circuits

2.1 Units and Scales

2.2 Charge, Current, Voltage, and Power

2.3 Voltage and Current Sources

2.4 Ohm's Law

- Basic electrical quantities and associated units.
- Current direction and Voltage polarity
- The passive sign convention for calculation power
- Ideal voltage and current sources
- Dependent sources
- Resistance and Ohm's law

International System of Units

TABLE **2.1** SI Base Units

Base Quantity	Name	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

(a) Work or Energy : Joule (J), kWh

(b) Power : Watt (W)

(c) Calorie is another unit of energy

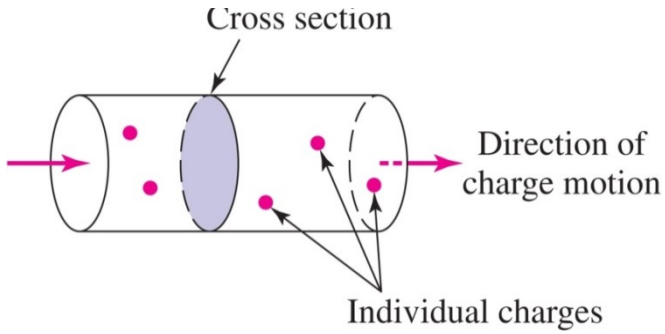
SI Prefixes

TABLE **2.2** SI Prefixes

Factor	Name	Symbol	Factor	Name	Symbol
10^{-24}	yocto	y	10^{24}	yotta	Y
10^{-21}	zepto	z	10^{21}	zetta	Z
10^{-18}	atto	a	10^{18}	exa	E
10^{-15}	femto	f	10^{15}	peta	P
10^{-12}	pico	p	10^{12}	tera	T
10^{-9}	nano	n	10^{9}	giga	G
10^{-6}	micro	μ	10^{6}	mega	M
10^{-3}	milli	m	10^{3}	kilo	k
10^{-2}	centi	c	10^{2}	hecto	h
10^{-1}	deci	d	10^{1}	deka	da

Charge

- Positive or negative charge
- Unit of charge ?
- Charge of an electron ?
- Charge in motion : Current



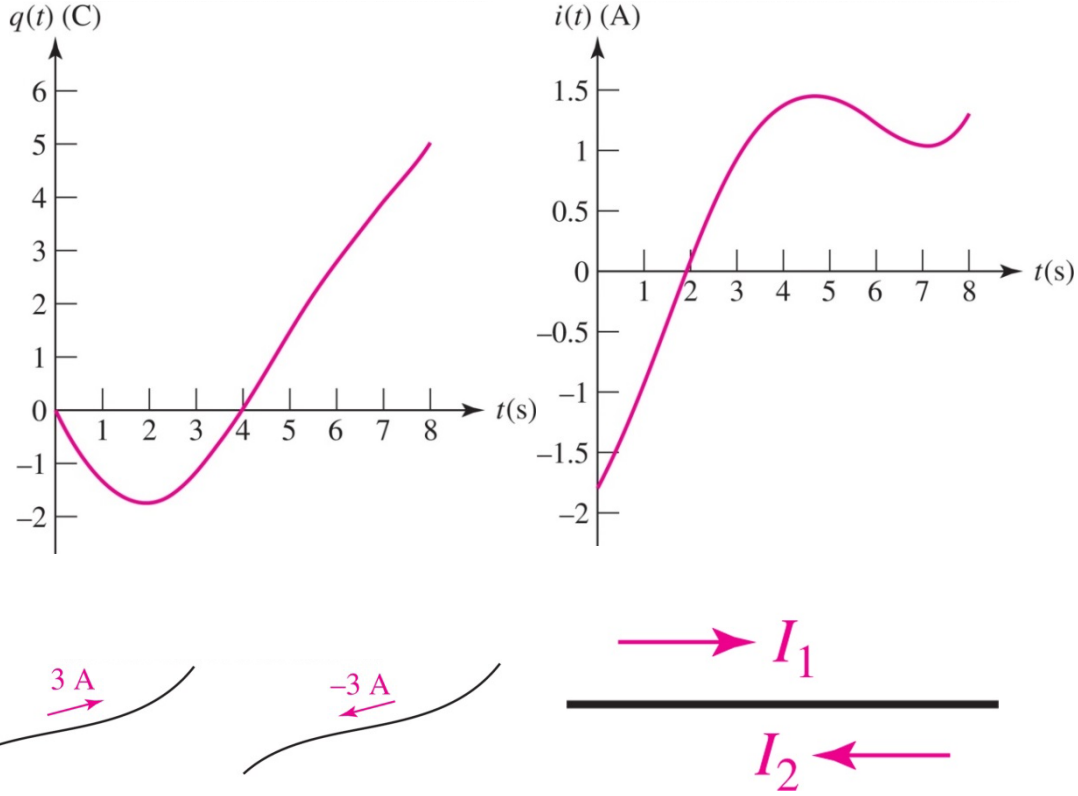
Current

- Transfer of charge : transfer of Energy
- Controlled transfer of charge : Key factor of Electrical Engineering
- Vector quantity : amount and direction
- Reference direction of current
- Definition of 1 A :

$$i(t) = \frac{dq}{dt}$$

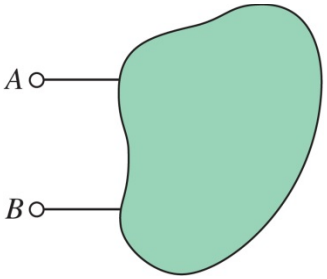
$$\int_{q(t_0)}^{q(t)} dq = \int_{t_0}^{t} i\, dt'$$

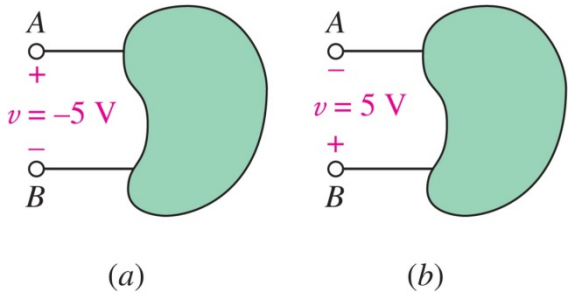
$$q(t) = \int_{t_0}^{t} i\, dt' + q(t_0)$$

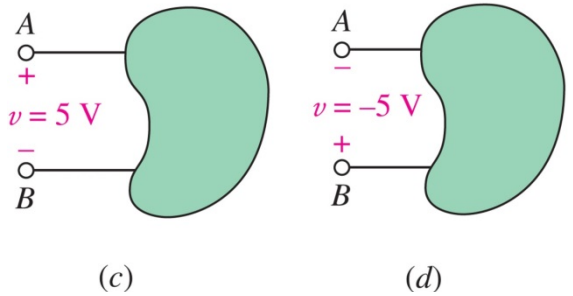


Voltage

- Potential difference bet. two terminal : Can move charges
- Expenditure of Energy
- Unit of Voltage ? Volt and J/C
- Polarity convention







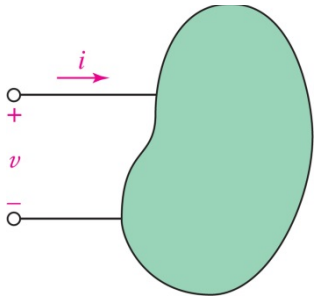
Power

- 1 Watt (J/s) : one joule of energy expenditure through transfer of one coulomb of charge in one second.

- Passive sign convention :

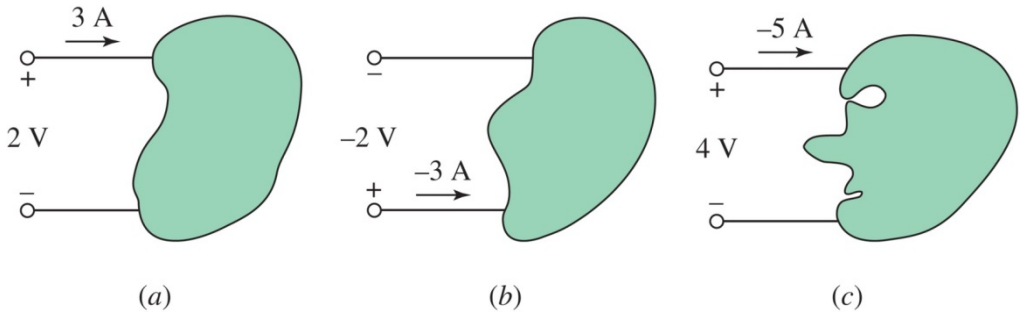
$$p = \upsilon i$$

The power absorbed by the element



Example 2.1

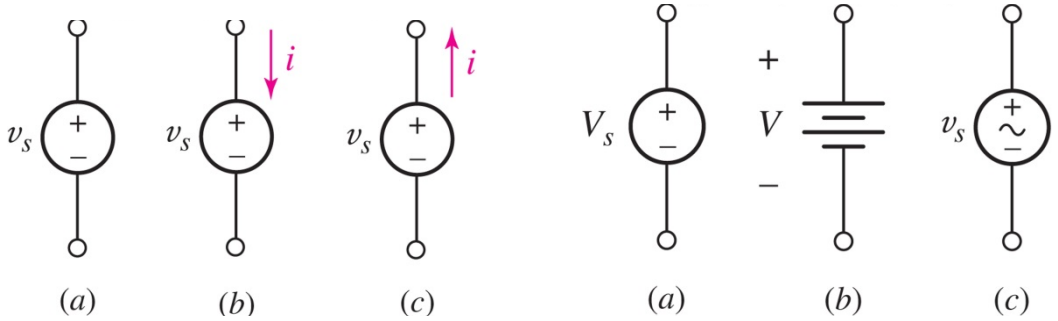
The power absorbed by each element ?



- Simple Lumped circuit element model :
- Circuit element can be classified according to the relationship of the current through the element to the voltage across the element
- Voltage is proportional to the current : Resistor
- Voltage is proportional to the derivative of the current with respect to time : Inductor
- Voltage is proportional to the integral of the current with respect to time : Capacitor
- Voltage/current source is completely independent of the current/voltage through/across it : Independent voltage/current sources
- Voltage or current sources that depends upon a current or voltage elsewhere in the circuit : Dependent sources

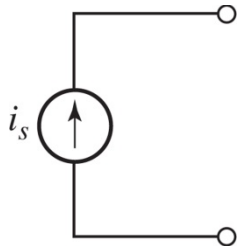
Independent voltage sources

- A terminal voltage which is completely independent of the current through it
- Ideal sources are assumed



Independent voltage sources

- A terminal current which is completely independent of the voltage across it
- What voltage across an independent current source ?

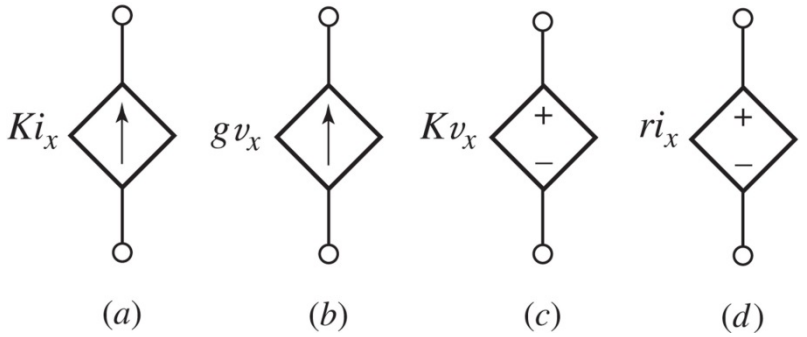


Dependent (controlled) sources

- Useful for modeling some electronic elements

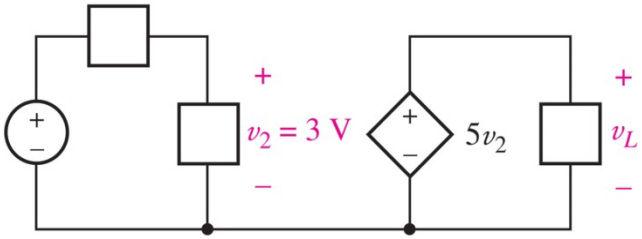
- (a) current-controlled current source
- (b) voltage-controlled current source
- (c) voltage-controlled voltage source
- (d) current-controlled voltage source

- Unit of K, g, and r ?



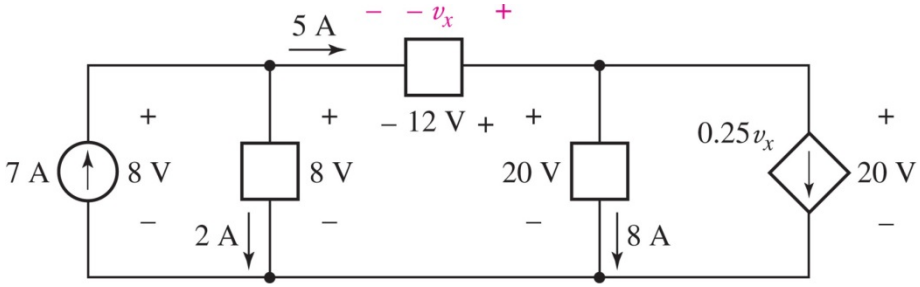
Example 2.2

$$v_L = 5v_2 = 15\ V$$



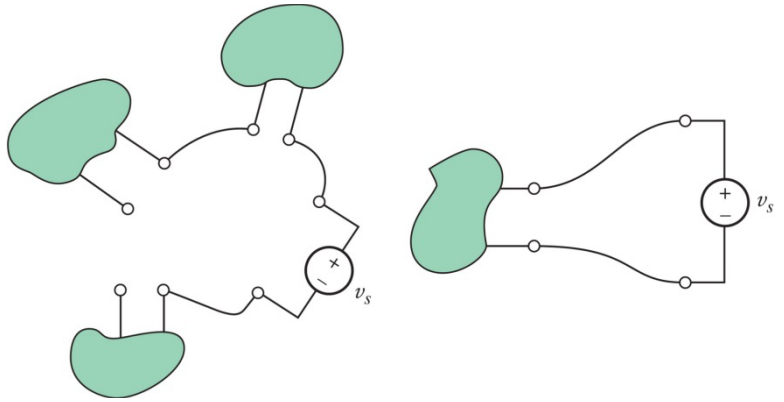
Practice 2.9

Find the power absorbed by each element.



Networks and Circuits

- (electrical) Network : interconnection of two or more circuit elements
- (electric) Circuit : A network with at least one closed path



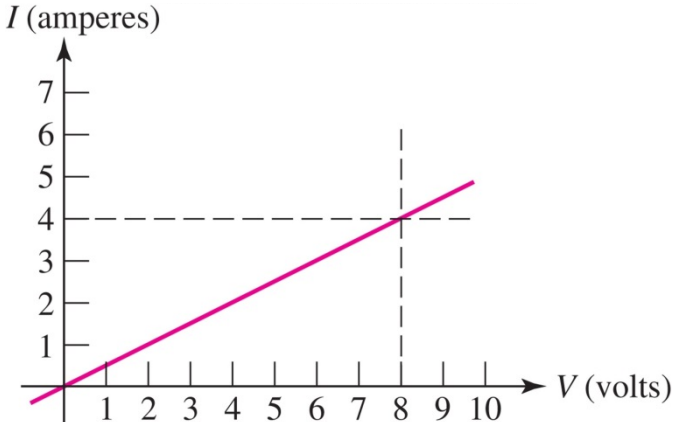
Resistance

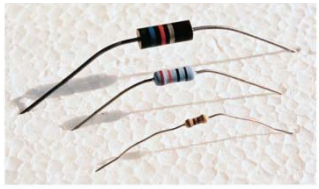
- Idealized passive elements: resistor, inductor, capacitor
- Ohm's law : voltage across conducting material is directly proportional to the current through the material

$$\upsilon = Ri$$

- Proportionality factor R : Resistance
- Unit of resistance : ohm (Ω) = V/A
- Linear resistor : constant within certain range of current and voltage or power
- Nonlinear resistor : active element such as diode, transistor
- The absorbed power :

$$p = \upsilon i = i^2 R = \upsilon^2 / R$$

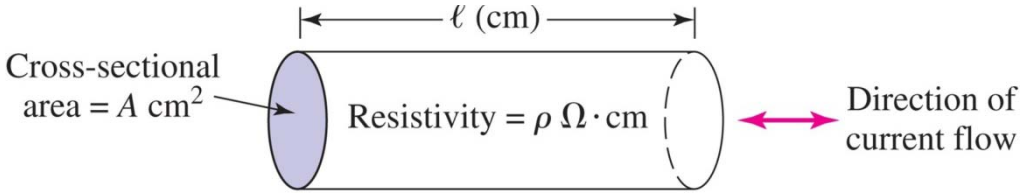


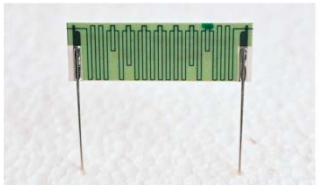


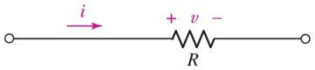
(a)

(b)

Resistivity







$$R = \rho \frac{l}{A}$$

- Resistivity is an inherent property of a material

Conductance

- Reciprocal of Resistance

$$G = \frac{i}{\upsilon} = \frac{1}{R}$$

- Unit of conductance : siemens (S) = mho = A/V

- Instantaneous voltage, current, and power
- Short or open circuit for zero or infinite resistance

Homework : 2장 Exercises 4의 배수 문제 (48번까지만)

- Due day : 2장 수업 끝나고 일주일 후 수업시작 전까지 제출.

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