EE202 – Electric Circuits I
Lecture 1 – Introductory Concepts

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Topics

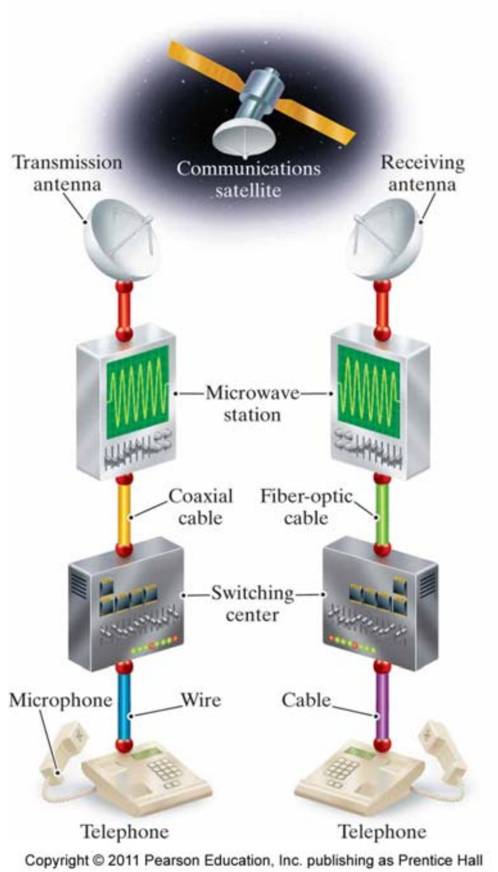
- Introduction
- Various Applications

Objectives

- Recognize the various applications of electric Circuits

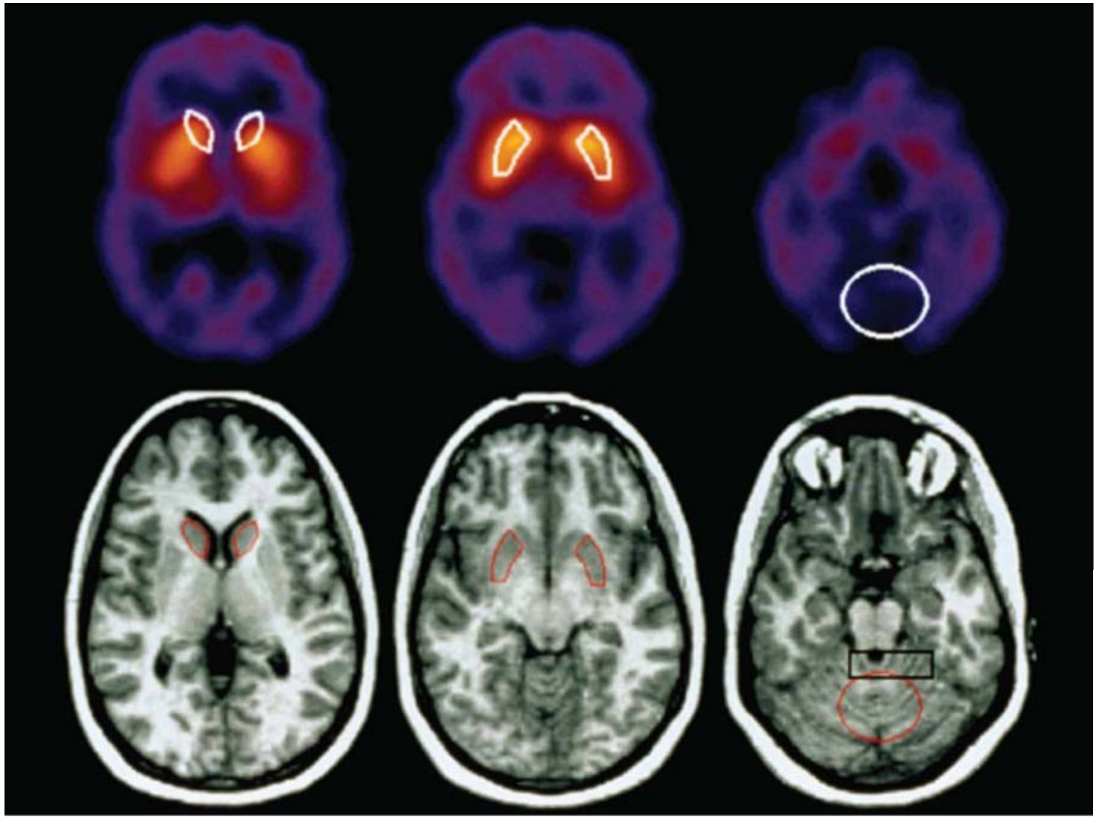
Examples of Electric Systems

A telephone system



A telephone system.

Applications, Electrical Engineering
CAT Scan



Applications, Electrical Engineering
Aviation

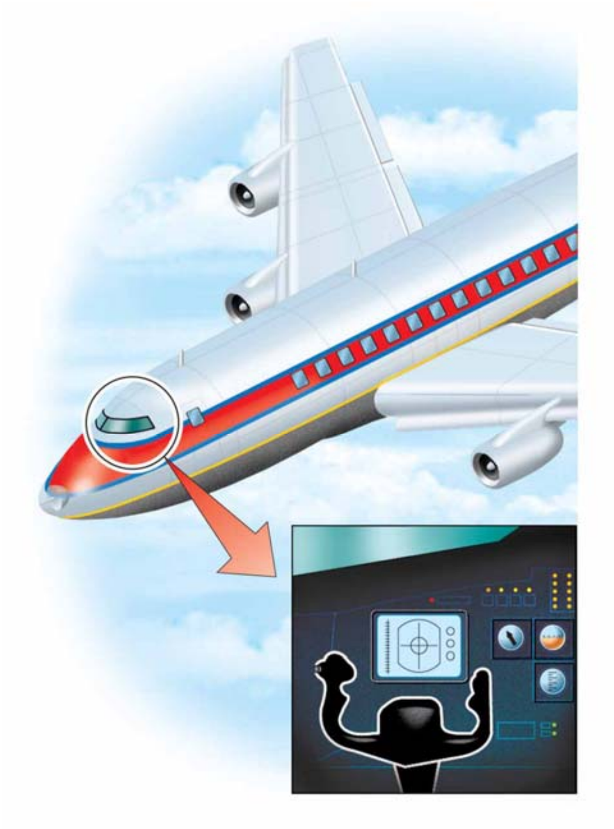


TABLE 1.1 The International System of Units (SI)

Quantity	Basic Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	degree kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

TABLE 1.2 Derived Units in SI

Quantity	Unit Name (Symbol)	Formula
Frequency	hertz (Hz)	s^{-1}
Force	newton (N)	$kg \cdot m/s^2$
Energy or work	joule (J)	$N \cdot m$
Power	watt (W)	J/s
Electric charge	coulomb (C)	$A \cdot s$
Electric potential	volt (V)	J/C
Electric resistance	ohm (Ω)	V/A
Electric conductance	siemens (S)	A/V
Electric capacitance	farad (F)	C/V
Magnetic flux	weber (Wb)	$V \cdot s$
Inductance	henry (H)	Wb/A

TABLE 1.3 Standardized Prefixes to Signify Powers of 10

Prefix	Symbol	Power
atto	a	10^{-18}
femto	f	10^{-15}
pico	p	10^{-12}
nano	n	10^{-9}
micro	μ	10^{-6}
milli	m	10^{-3}
centi	c	10^{-2}
deci	d	10^{-1}
deka	da	10
hecto	h	10^{2}
kilo	k	10^{3}
mega	M	10^{6}
giga	G	10^{9}
tera	T	10^{12}

A conceptual model for electrical engineering design.

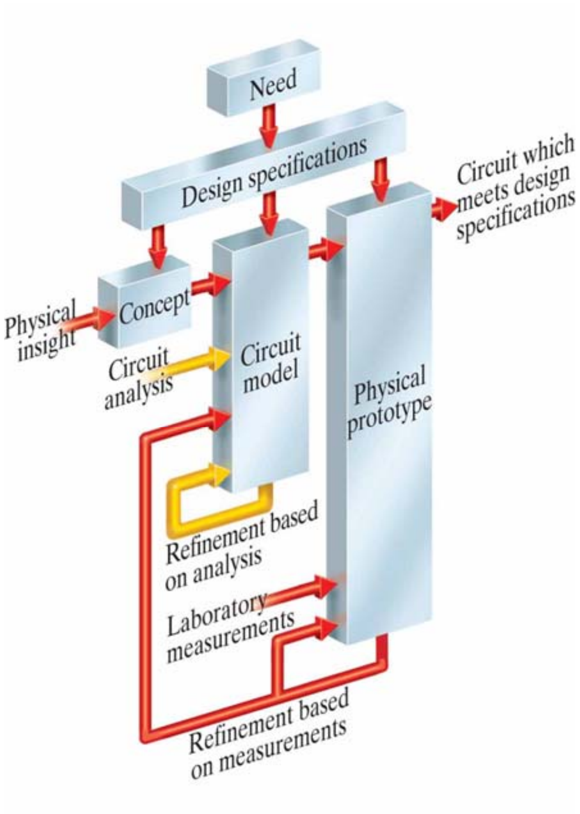
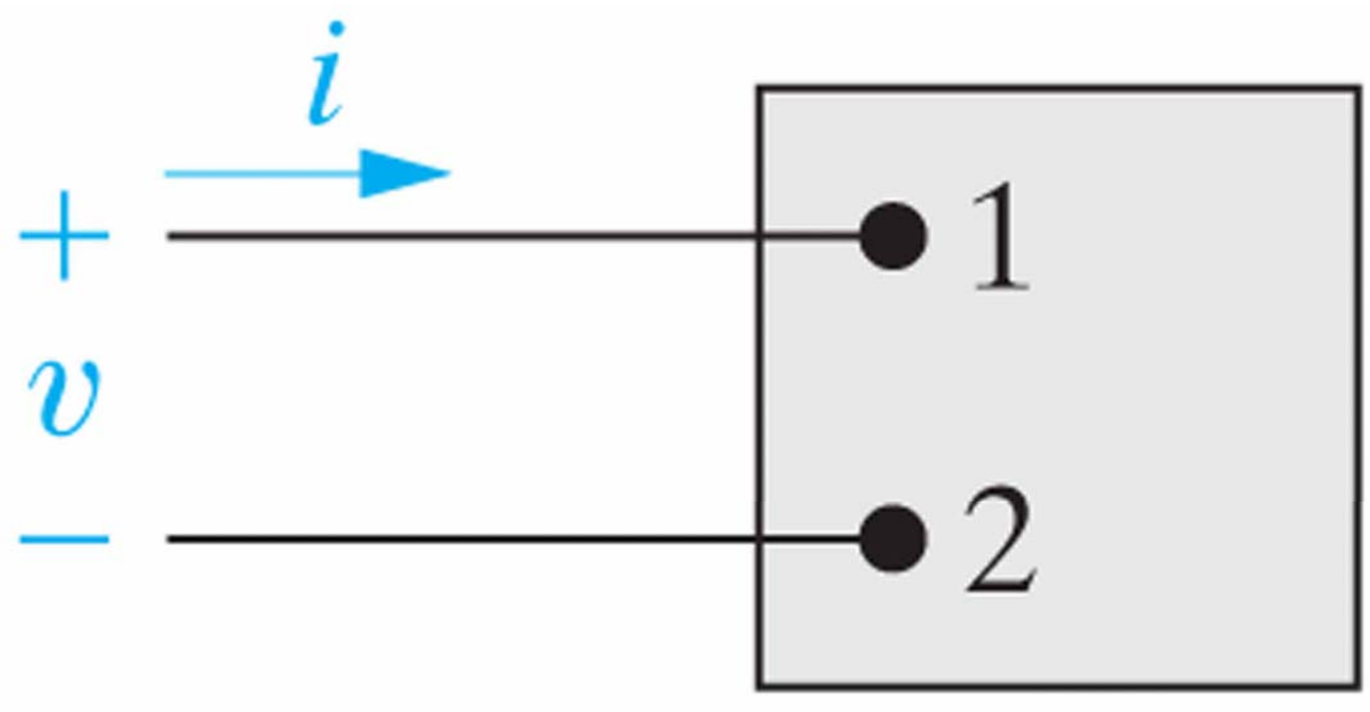


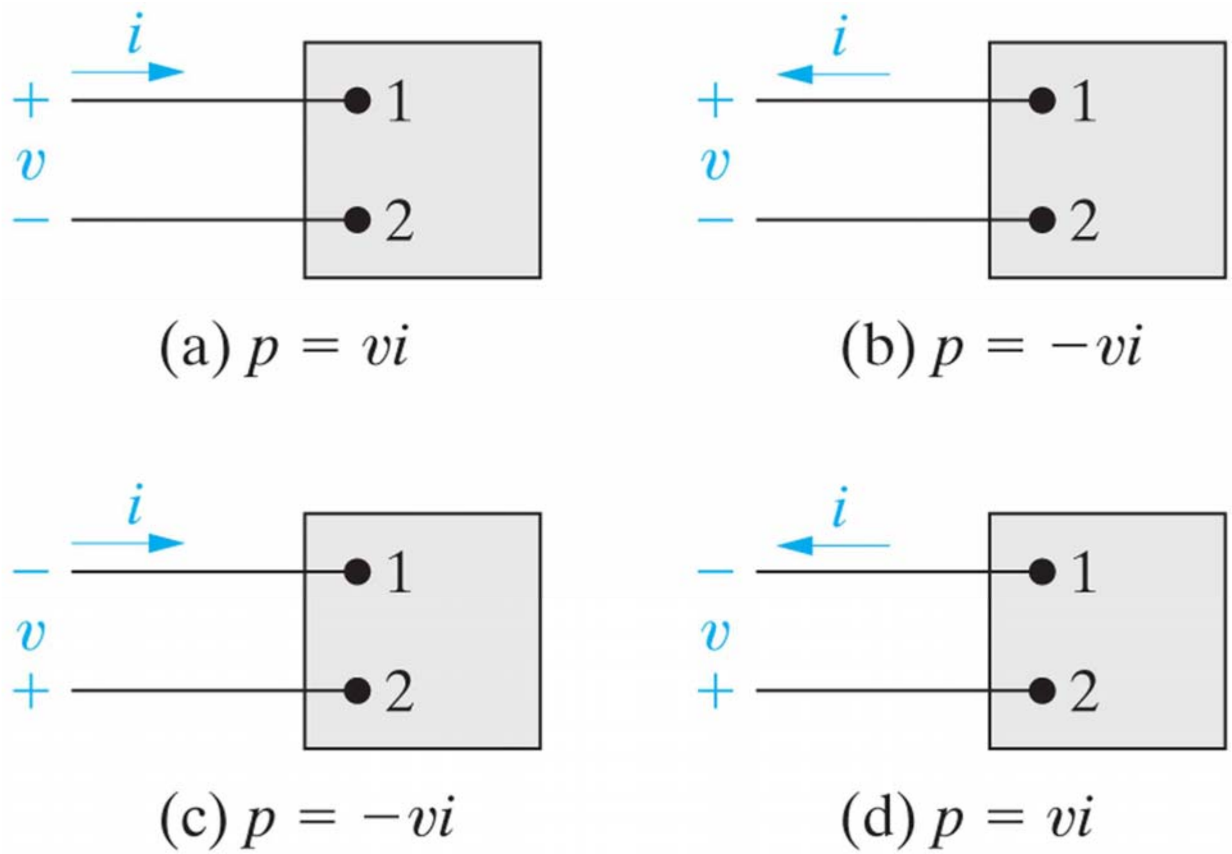
TABLE 1.4 Interpretation of Reference Directions in Fig. 1.5

	Positive Value	Negative Value
v	voltage drop from terminal 1 to terminal 2	voltage rise from terminal 1 to terminal 2
	or	*or*
	voltage rise from terminal 2 to terminal 1	voltage drop from terminal 2 to terminal 1
i	positive charge flowing from terminal 1 to terminal 2	positive charge flowing from terminal 2 to terminal 1
	or	*or*
	negative charge flowing from terminal 2 to terminal 1	negative charge flowing from terminal 1 to terminal 2

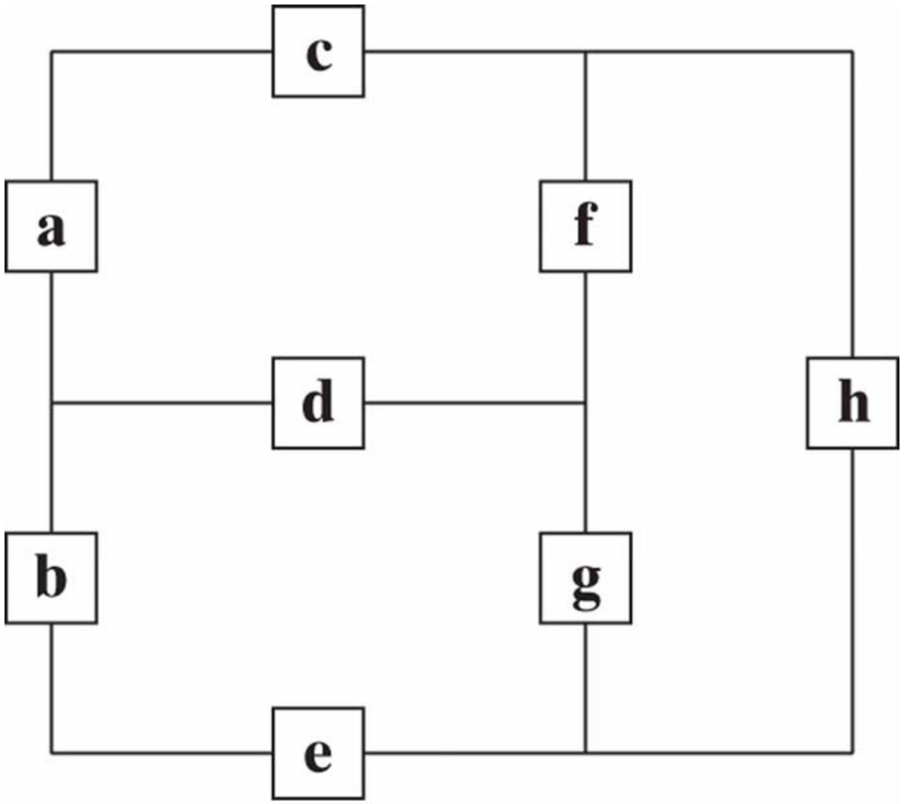
An ideal basic circuit element.



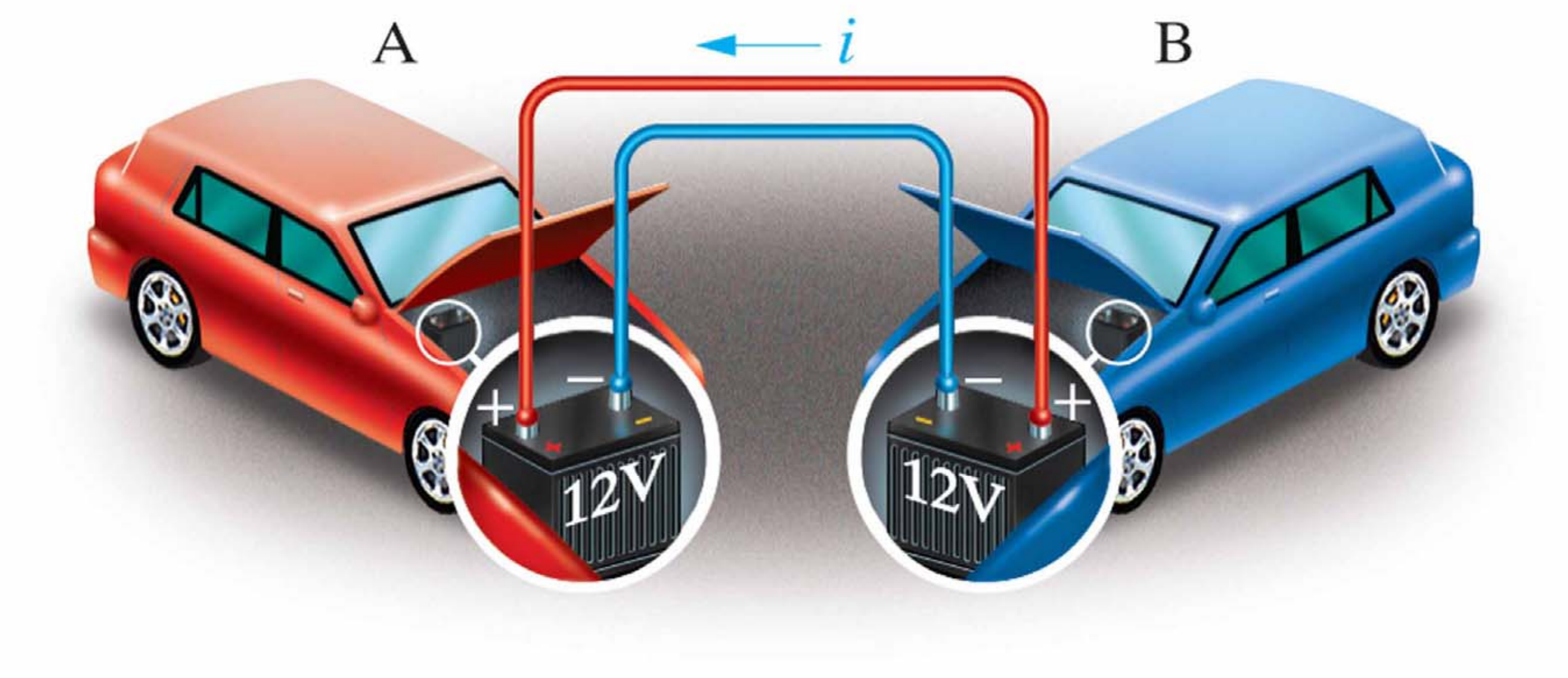
Polarity references and the expression or power.



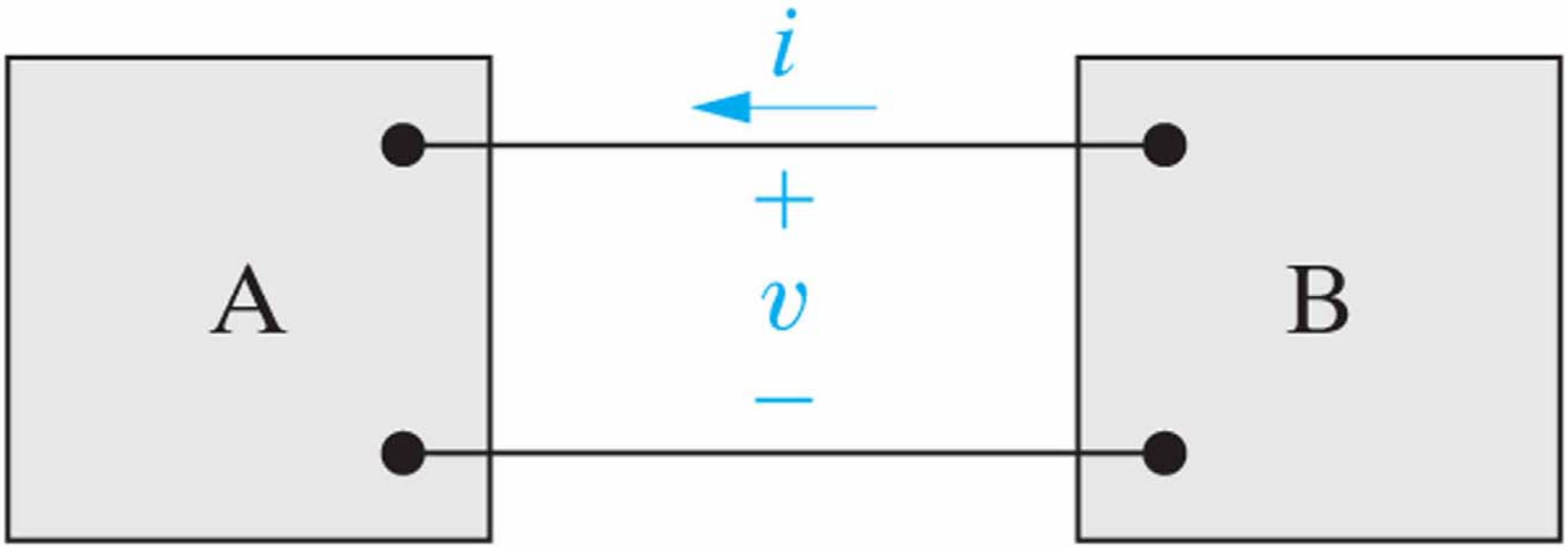
Circuit model for power distribution in a home, with voltages and currents defined.



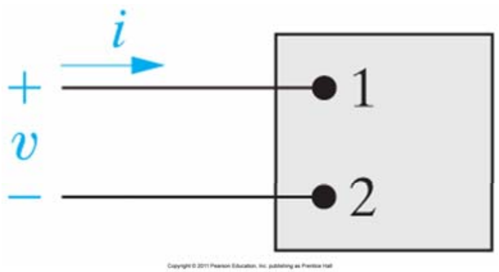
Application Example



Application Example Schematic



Problem P1.18



[a] $p = vi = 0.25e^{-3200t} - 0.5e^{-2000t} + 0.25e^{-800t}$

$p(625\,\mu\text{s}) = 42.2\ \text{mW}$

[b]
$$\begin{aligned} w(t) &= \int_0^t (0.25e^{-3200t} - 0.5e^{-2000t} + 0.25e^{-800t}) \\ &= 140.625 - 78.125e^{-3200t} + 250e^{-2000t} - 312.5e^{-800t}\,\mu\text{J} \\ w(625\,\mu\text{s}) &= 12.14\,\mu\text{J} \end{aligned}$$

[c] $w_{\text{total}} = 140.625\,\mu\text{J}$

Problem P1.19

[a] $0\text{ s} \le t < 1\text{ s}$:

$v = 5\text{ V}$; $i = 20t\text{ A}$; $p = 100t\text{ W}$

$1\text{ s} < t \le 3\text{ s}$:

$v = 0\text{ V}$; $i = 20\text{ A}$; $p = 0\text{ W}$

$3\text{ s} \le t < 5\text{ s}$:

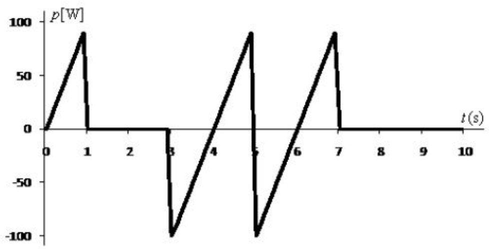
$v = -5\text{ V}$; $i = 80 - 20t\text{ A}$; $p = 100t - 400\text{ W}$

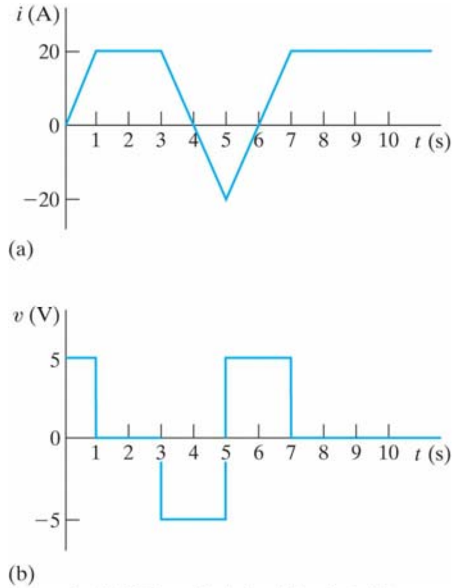
$5\text{ s} < t \le 7\text{ s}$:

$v = 5\text{ V}$; $i = 20t - 120\text{ A}$; $p = 100t - 600\text{ W}$

$t > 7\text{ s}$:

$v = 0\text{ V}$; $i = 20\text{ A}$; $p = 0\text{ W}$





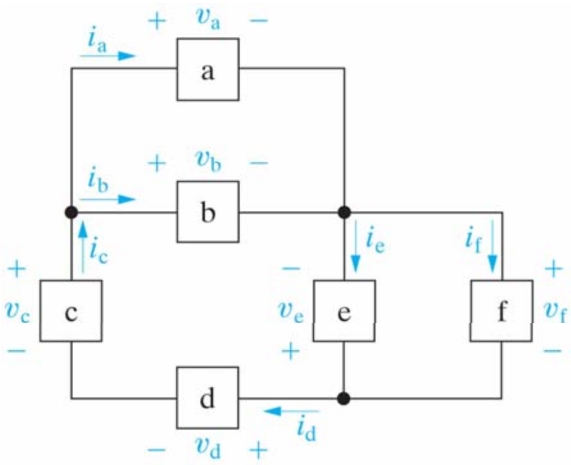
Calculate the area under the curve from zero up to the desired time:

$$w(1) = \tfrac{1}{2}(1)(100) = 50\text{ J}$$

$$w(6) = \tfrac{1}{2}(1)(100) - \tfrac{1}{2}(1)(100) + \tfrac{1}{2}(1)(100) - \tfrac{1}{2}(1)(100) = 0\text{ J}$$

$$w(10) = w(6) + \tfrac{1}{2}(1)(100) = 50\text{ J}$$

Problem P1.26



P 1.26 We use the passive sign convention to determine whether the power equation is $p = vi$ or $p = -vi$ and substitute into the power equation the values for v and i, as shown below:

$$p_a = v_a i_a = (150 \times 10^3)(0.6 \times 10^{-3}) = 90 \text{ W}$$
$$p_b = v_b i_b = (150 \times 10^3)(-1.4 \times 10^{-3}) = -210 \text{ W}$$
$$p_c = -v_c i_c = -(100 \times 10^3)(-0.8 \times 10^{-3}) = 80 \text{ W}$$
$$p_d = v_d i_d = (250 \times 10^3)(-0.8 \times 10^{-3}) = -200 \text{ W}$$
$$p_e = -v_e i_e = -(300 \times 10^3)(-2 \times 10^{-3}) = 600 \text{ W}$$
$$p_f = v_f i_f = (-300 \times 10^3)(1.2 \times 10^{-3}) = -360 \text{ W}$$

Remember that if the power is positive, the circuit element is absorbing power, whereas is the power is negative, the circuit element is developing power. We can add the positive powers together and the negative powers together — if the power balances, these power sums should be equal:
$\sum P_{dev} = 210 + 200 + 360 = 770$ W;
$\sum P_{abs} = 90 + 80 + 600 = 770$ W
Thus, the power balances and the total power developed in the circuit is 770 W.

Problem P1.27

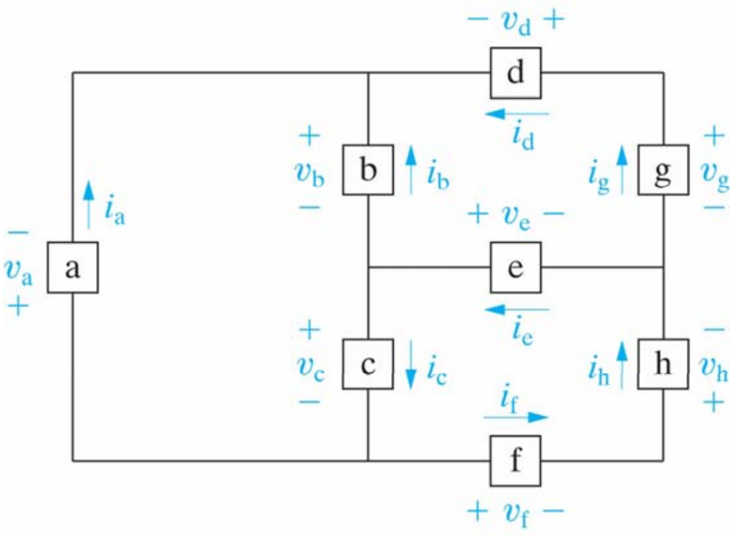


TABLE P1.27

Element	Voltage (V)	Current (mA)
a	990	−22.5
b	600	−30
c	300	60
d	105	52.5
e	−120	30
f	165	82.5
g	585	52.5
h	−585	82.5

P 1.27

$$p_a = -v_a i_a = -(990)(-0.0225) = 22.275 \text{ W}$$
$$p_b = -v_b i_b = -(600)(-0.03) = 18 \text{ W}$$
$$p_c = v_c i_c = (300)(0.06) = 18 \text{ W}$$
$$p_d = v_d i_d = (105)(0.0525) = 5.5125 \text{ W}$$
$$p_e = -v_e i_e = -(-120)(0.03) = 3.6 \text{ W}$$
$$p_f = v_f i_f = (165)(0.0825) = 13.6125 \text{ W}$$
$$p_g = -v_g i_g = -(585)(0.0525) = -30.7125 \text{ W}$$
$$p_h = v_h i_h = (-585)(0.0825) = -48.2625 \text{ W}$$

Therefore,

$$\sum P_{abs} = 22.275 + 18 + 18 + 5.5125 + 3.6 + 13.6125 = 81 \text{ W}$$

$$\sum P_{del} = 30.7125 + 48.2625 = 78.975 \text{ W}$$

$$\sum P_{abs} \neq \sum P_{del}$$

Thus, the interconnection does not satisfy the power check.

Problem P1.28

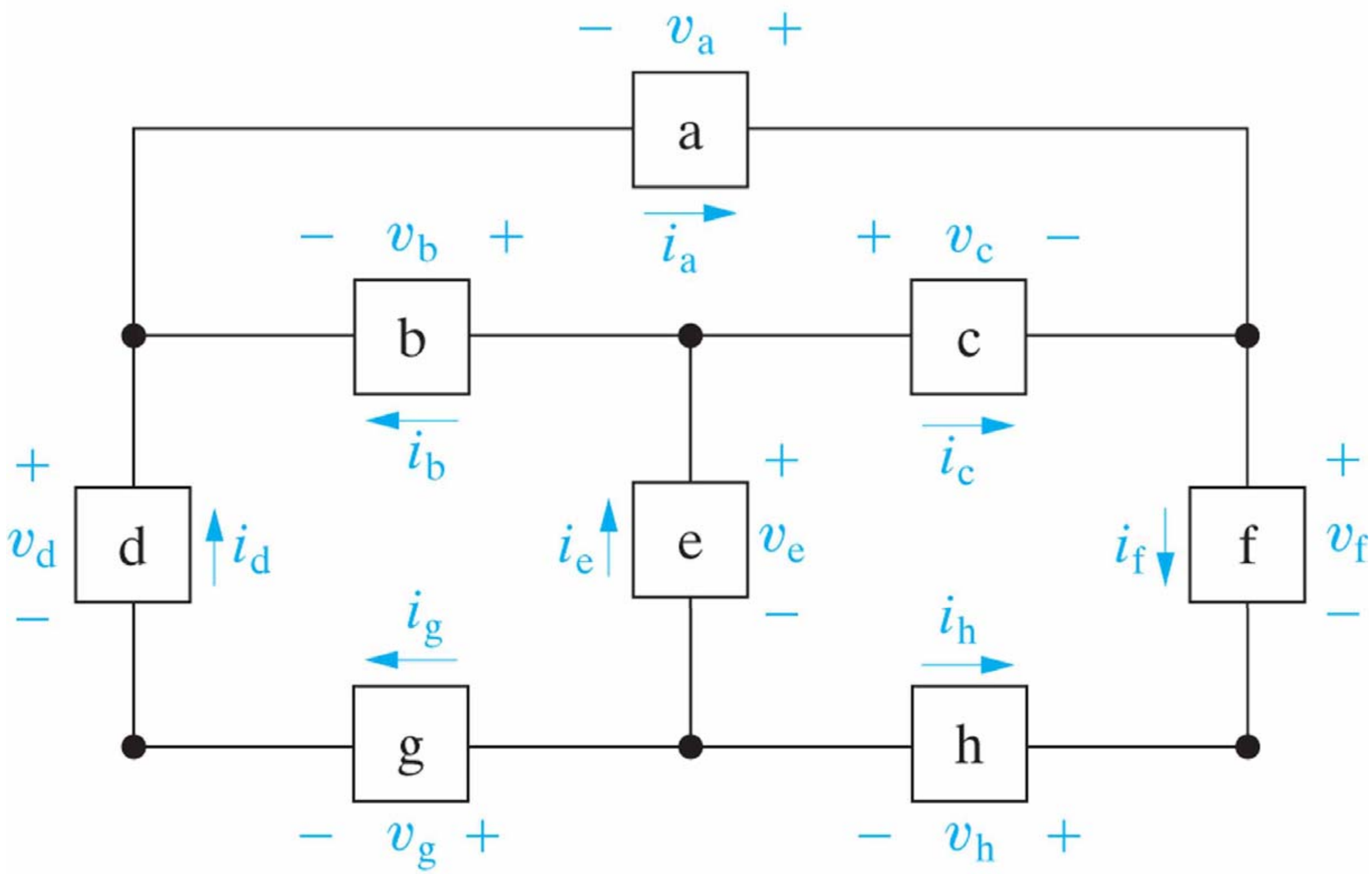


TABLE P1.28

Element	Voltage (V)	Current (A)
a	46.16	6.0
b	14.16	4.72
c	−32.0	−6.4
d	22.0	1.28
e	33.6	1.68
f	66.0	−0.4
g	2.56	1.28
h	−0.4	0.4

Problem P1.29

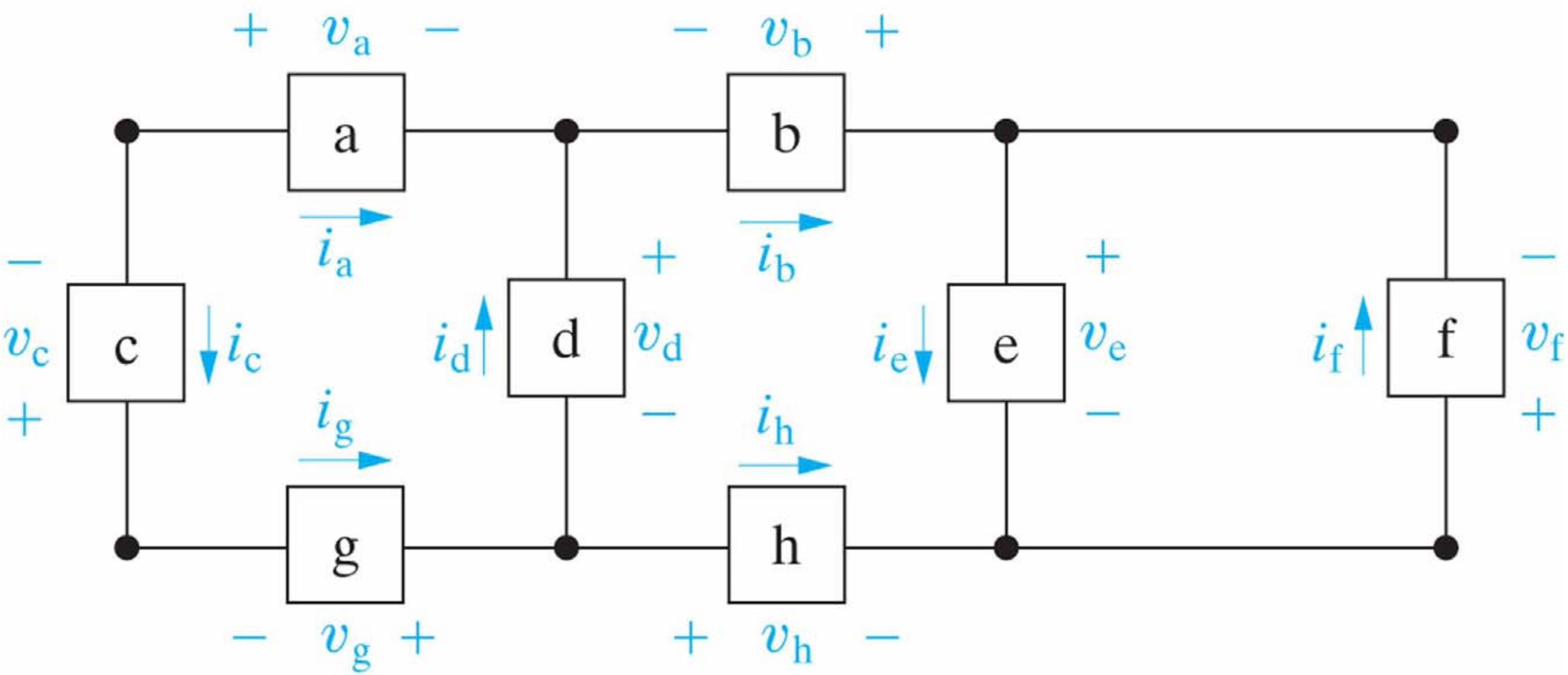


TABLE P1.29

Element	Voltage (V)	Current (mA)
a	5	2
b	1	3
c	7	−2
d	−9	1
e	−20	5
f	20	2
g	−3	−2
h	−12	−3

(a) A human body with a voltage difference between one arm and one leg. (b) A simplified model of the human body with a voltage difference between one arm and one leg.