Chapter 2 Solutions

Section 2.1 Introduction

2.1 Current source

2.2 Voltage source

2.3 Resistor

2.4 Capacitor

2.5 Inductor

Section 2.2 Charge and Current

2.6 b)

The current direction is designated as the direction of the movement of positive charges.

2.7 The relationship of charge and current is

$$q(t) = \int_{t_0}^{t} i(t)dt + q(t_0)$$

so

$$q(t) = \int_{t_0}^{t} 2\sin(10\pi t)dt + q(t_0)$$

$$q(t) = \Big|_{t_0}^{t} \left[\frac{-2}{10\pi}\cos(10\pi t)\right] + q(t_0)$$

2.8 The coulomb of one electron is denoted by e and

$$q(t) = \int_{t_0}^{t} i(t)dt + q(t_0)$$

So

$$n(t) = q(t)/e = \frac{1}{e}\int_{t_0}^{t} 12t\ dt + q(t_0)$$

If $t_0 = 0$ and $q(t_0) = 0$,

$$n(t) = \frac{6}{e}t^2$$

2.9

$$q(t) = \int i\,dt$$

$$q(t) = \int_0^t 5\,dt$$

$$q(t) = 5t$$

2.10

$$q(t) = {}_0^5[5t] = 5(5) - 5(0) = 25\,\text{Coulombs}$$

2.11 Using the definition of current-charge relationship, the equation can be rewritten as:

$$i = \frac{dq}{dt} = \frac{\Delta n}{\Delta t} e$$

Thus, the current flow within t_1 and t_2 time interval is,

$$i = \frac{(5.75 - 2) \times 10^{19}}{2} (-1.6 \times 10^{-19}) = -3A$$

The negative sign shows the current flow in the opposite direction with respect to the electric charge.

2.12 Assuming the area of the metal surface is S, The mass of the nickel with depth d = 0.15mm is

$$m = \rho \times d \times S$$

Meanwhile, using the electro-chemical equivalent, the mass of the nickel can be expressed as

$$m = k \times I \times t$$

where $I = \sigma \times S$.

Equating the two expressions of the mass, the coating time is found:

$$t = \rho \times d / \sigma = 1.24 \times 10^5 \text{ s} \approx 34.4 \text{ hour}$$

Section 2.3 Voltage

2.13 By the definition of voltage, when a positive charge moves from high voltage to low voltage, its potential energy decreases.

So a is "+", b is "-". In other words, u_{ab}=1V.

2.14 The current $i(t)$ is defined as:

$$i(t) = \begin{Bmatrix} 3 & 0 < t \le 1 \\ 0 & elsewhere \end{Bmatrix}$$

Therefore, the charge is

$$g = \int_0^1 3dt = 3\text{C}$$

The energy in Joules is given by:

$$J = V \times C = 5 \times 3 = 15J$$

2.15

$$1 \text{ electron} = -1.6 \times 10^{-19} \text{ Coulombs.}$$

Therefore, there are 6.25×10^{18} electrons in a coulomb.

$$\text{Coulombs of } 5 \times 10^{16} \text{electrons} = \frac{5 \times 10^{16}}{6.25 \times 10^{18}} = 8 \times 10^{-3}$$

Therefore, the voltage is

$$V = \frac{J}{C} = \frac{15}{8 \times 10^{-3}} = 1875\text{V}$$

2.16

$$q(t) = \int_0^1 2\sin\left(\frac{3}{2}\pi t\right)dt$$

$$= \left[\frac{-4}{3\pi}\cos\left(\frac{3}{2}\pi t\right)\right]_0^1 = 0.4244\text{C}$$

$$J = V \times C = 5 \times 0.4244 = 2.122\text{J}$$

2.17

$$q = \frac{20J}{2V} = 10C$$

$$i = \frac{dq}{dt} = \frac{10C}{4s} = 2.5A$$

Section 2.4 Respective Direction of Voltage and Current

2.18 True

2.19 False

2.20 True

Section 2.5 Kirchoff's Current Law

2.21 According to KCL

$$0 = 7 - i_2 - 3$$

Therefore,

$$i_2 = 4A$$

2.22 Notice that

$$0 = 3 - 2 + i_4$$

Therefore,

$$i_4 = -1A$$

It can be seen that

$$i_5 = -2A$$

i_6 can now be found.

$$0 = 5 + 2 + 1 - i_6$$

$$i_6 = 8A$$

2.23

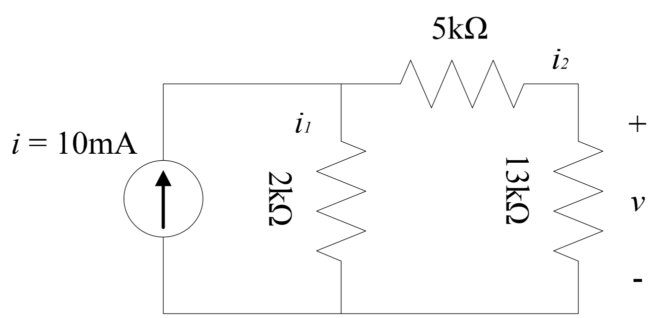

Figure S2.23: Circuit for Problem 2.23.

According to KCL,

$$10mA = i_1 + i_2$$

and

$$2ki_1 = 18ki_2$$

Therefore,

$$i_1 = 9mA, i_2 = 1mA$$
$$V = I \times R = 13k \times 1mA = 13V$$

2.24 Using the KCL method, we have,