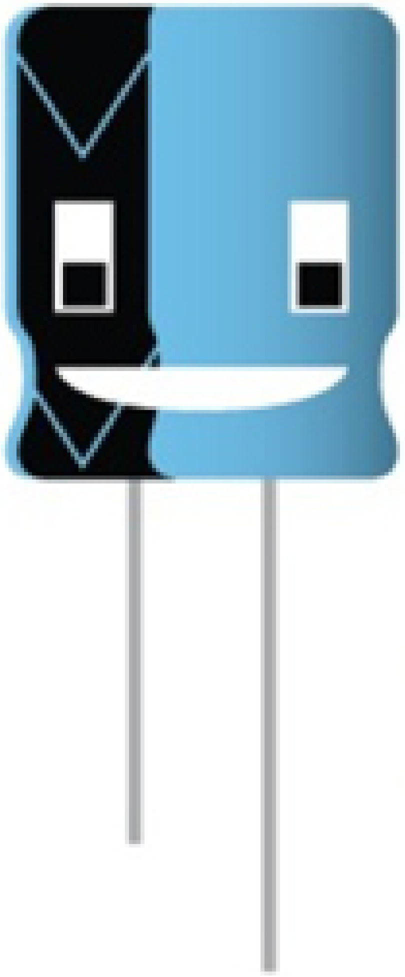
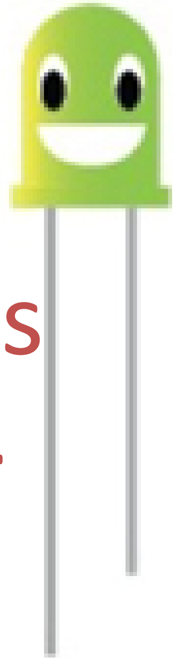
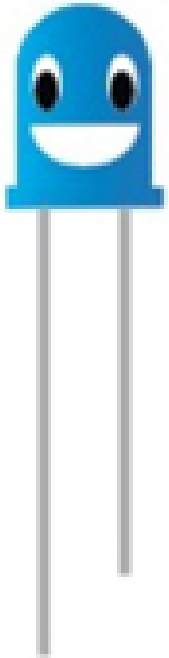
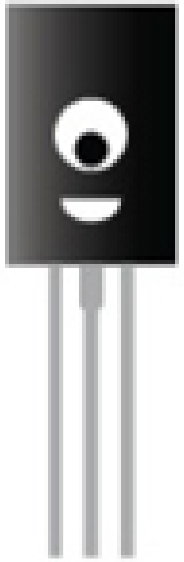
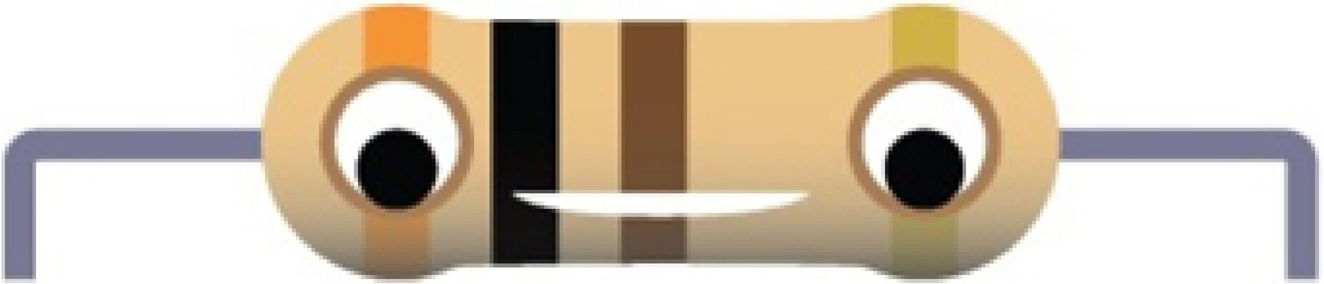








Electronics
Section 01



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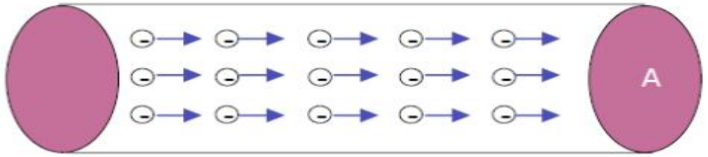
Fundamental Quantities and Their Units

Quantity	SI Unit
Length	meter
Mass	kilogram
Time	second
Temperature	Kelvin
Electric Current	Ampere
Amount of Substance	mole
Luminous Intensity	Candela

Electric current (I)



We can assume that all electrons travel with constant drift velocity

- The current is defined as the net charge (dq) that passes (perpendicular) through a given area per unit time.

$$I = \frac{dq}{dt}$$

Scalar quantity

$$[I] = \frac{[q]}{[t]} = \frac{C}{Sec} = A$$

Prefixes

Table 1-1 Prefixes for Powers of 10*

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

The power ***P*** is defined as the rate at which the charge loses energy

$$P = \frac{\Delta U}{\Delta t}$$

$$P = I\,\Delta V = \frac{\Delta V^2}{R} = I^2 R$$

Q1. **In the Bohr model of the hydrogen atom, an electron in the lowest energy state moves at a speed of 2.19×10^{6} m/s in a circular path of radius 5.29×10^{-11} m. What is the effective current associated with this orbiting electron?**

Solution

The period of the electron in its orbit is $T = 2\pi r/v$, and the current represented by the orbiting electron is

$$I = \frac{\Delta Q}{\Delta t} = \frac{|e|}{T} = \frac{v|e|}{2\pi r}$$

$$= \frac{(2.19 \times 10^{6}\ \text{m/s})(1.60 \times 10^{-19}\ \text{C})}{2\pi(5.29 \times 10^{-11}\ \text{m})}$$

$$= 1.05 \times 10^{-3}\ \text{C/s} = \boxed{1.05\ \text{mA}}$$

Q2. A rechargeable flashlight battery is capable of delivering 90 mA for about 12 h. How much charge can it release at that rate? If its terminal voltage is 1.5 V, how much energy can the battery deliver?

Solution

$q = it = 90 \times 10^{-3} \times 12 \times 60 \times 60 = \mathbf{3.888\ kC}$

$E = pt = ivt = qv = 3888 \times 1.5 = \mathbf{5.832\ kJ}$

Q3.

Calculate the amount of charge represented by six million protons.

Answer: $+9.612 \times 10^{-13}$ C.

Q4.

How many coulombs are represented by these amounts of electrons?

(a) 6.482×10^{17} (b) 1.24×10^{18}

(c) 2.46×10^{19} (d) 1.628×10^{20}

Solution

(a) $q = 6.482\text{x}10^{17} \text{ x } [-1.602\text{x}10^{-19} \text{ C}] = \mathbf{-103.84 \text{ mC}}$

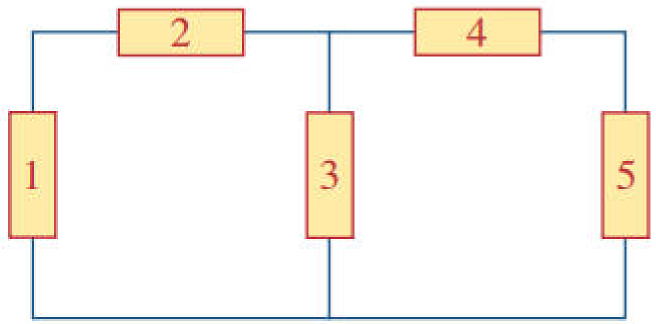
(b) $q = 1.24\text{x}10^{18} \text{ x } [-1.602\text{x}10^{-19} \text{ C}] = \mathbf{-198.65 \text{ mC}}$

(c) $q = 2.46\text{x}10^{19} \text{ x } [-1.602\text{x}10^{-19} \text{ C}] = \mathbf{-3.941 \text{ C}}$

(d) $q = 1.628\text{x}10^{20} \text{ x } [-1.602\text{x}10^{-19} \text{ C}] = \mathbf{-26.08 \text{ C}}$

Q5.

Figure shows a circuit with five elements. If $p_1 = -205$ W, $p_2 = 60$ W, $p_4 = 45$ W, $p_5 = 30$ W, calculate the power p_3 received or delivered by element 3.



Solution

$$\Sigma\, p = 0 \rightarrow -205 + 60 + 45 + 30 + p_3 = 0$$

$$p_3 = 205 - 135 = 70 \text{ W}$$

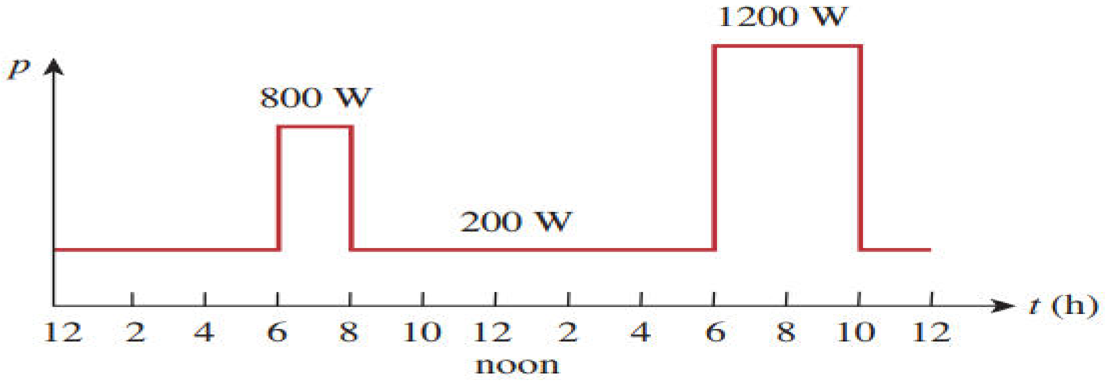
Thus element 3 receives **70 W.**

Q6.

Figure shows the power consumption of a certain household in 1 day. Calculate:

(a) the total energy consumed in kWh,

(b) the average power per hour over the total 24 hour period.



Solution

(a) Energy $= \sum pt = 200 \text{ x } 6 + 800 \text{ x } 2 + 200 \text{ x } 10 + 1200 \text{ x } 4 + 200 \text{ x } 2$

$= \mathbf{10\ kWh}$

(b) Average power $= 10{,}000/24 = \mathbf{416.7\ W}$

Q7. **Batteries are rated in terms of ampere-hours (A . h). For example, a battery that can produce a current of 2.00 A for 3.00 h is rated at 6.00 A . h. (a) What is the total energy, in kilowatt-hours, stored in a 12.0 V battery rated at 55.0 A . h? (b) At $0.110 per kilowatt-hour, what is the value of the electricity at dollar that produced by this battery?**

Solution

(a) The total energy stored in the battery is

$$\Delta U_E = q(\Delta V) = It(\Delta V)$$

$$= (55.0\ \mathrm{A\cdot h})(12.0\ \mathrm{V})\left(\frac{1\ \mathrm{C}}{1\ \mathrm{A\cdot s}}\right)\left(\frac{1\ \mathrm{J}}{1\ \mathrm{V\cdot C}}\right)\left(\frac{1\ \mathrm{W\cdot s}}{1\ \mathrm{J}}\right)$$

$$= 660\ \mathrm{W\cdot h} = \boxed{0.660\ \mathrm{kWh}}$$

(b) The value of the electricity is

$$\text{Cost} = (0.660\ \mathrm{kWh})\left(\frac{\$0.110}{1\ \mathrm{kWh}}\right) = \boxed{\$0.072\ 6}$$

MSQ

(1) A nanosecond is:

A. 10^{9} s
B. 10^{-9} s
C. 10^{-10} s
D. 10^{-10} s
E. 10^{-12}

(2) One millivolt is one millionth of a volt.

(a) True (b) False

(3) The prefix *micro* stands for:

(a) 10^{6} (b) 10^{3} (c) 10^{-3} (d) 10^{-6}

(4) A cook plugs a 500 W crockpot and a 1000 W kettle into a 240 V power supply, all operating on direct current. When we compare the two, we find that

a. $I_{crockpot} < I_{kettle}$ and $R_{crockpot} < R_{kettle}$.

b. $I_{crockpot} < I_{kettle}$ and $R_{crockpot} > R_{kettle}$.

c. $I_{crockpot} = I_{kettle}$ and $R_{crockpot} = R_{kettle}$.

d. $I_{crockpot} > I_{kettle}$ and $R_{crockpot} < R_{kettle}$.

e. $I_{crockpot} > I_{kettle}$ and $R_{crockpot} > R_{kettle}$.

(5) Which of these is not an electrical quantity?

(a) charge (b) time (c) voltage

(d) current (e) power

(6) A 4-A current charging a dielectric material will accumulate a charge of 24 C after 6 s.

(a) True (b) False

(7) The unit of current is:

(a) coulomb (b) ampere

(c) volt (d) joule

(8) Voltage is measured in:

(a) watts (b) amperes

(c) volts (d) joules per second

(9) A charge of 2 C flowing past a given point each second is a current of 2 A.

(a) True (b) False

(10) The voltage 2,000,000 V can be expressed in powers of 10 as:

(a) 2 mV (b) 2 kV (c) 2 MV (d) 2 GV

(11) The voltage across a 1.1-kW toaster that produces a current of 10 A is:

(a) 11 kV (b) 1100 V (c) 110 V (d) 11 V

(12) The dependent source in Fig. 1.22 is:

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