Tutorial and Solution 2z-02

Q1. Find the charge in coulombs of (a) 5.31×10^{20} electrons, and (b) 2.9×10^{22} protons.

(*a*) Since the charge of an electron is -1.602×10^{-19} C, the total charge is

$$5.31 \times 10^{20} \cancel{\text{electrons}} \times \frac{-1.602 \times 10^{-19}\ \text{C}}{1\ \cancel{\text{electron}}} = -85.1\ \text{C}$$

(*b*) Similarly, the total charge is

$$2.9 \times 10^{22} \cancel{\text{protons}} \times \frac{1.602 \times 10^{-19}\ \text{C}}{1\ \cancel{\text{proton}}} = 4.65\ \text{kC}$$

Q2. How many protons have a combined charge of 6.8 pC?

Because the combined charge of 6.241×10^{18} protons is 1 C, the number of protons is

$$6.8 \times 10^{-12}\ \cancel{\text{C}} \times \frac{6.241 \times 10^{18}\ \text{protons}}{1\ \cancel{\text{C}}} = 4.24 \times 10^{7}\ \text{protons}$$

Q3. Find the current flow through a light bulb from a steady movement of (a) 60 C in 4 s, (b) 15 C in 2 min, and (c) 10^{22} electrons in 1 h.

Current is the rate of charge movement in coulombs per second. So,

(*a*) $I = \frac{Q}{t} = \frac{60\ \text{C}}{4\ \text{s}} = 15\ \text{C/s} = 15\ \text{A}$

(*b*) $I = \frac{15\ \text{C}}{2\ \cancel{\text{min}}} \times \frac{1\ \cancel{\text{min}}}{60\ \text{s}} = 0.125\ \text{C/s} = 0.125\ \text{A}$

(*c*) $I = \frac{10^{22}\ \cancel{\text{electrons}}}{1\ \cancel{\text{h}}} \times \frac{1\ \cancel{\text{h}}}{3600\ \text{s}} \times \frac{-1.602 \times 10^{-19}\ \text{C}}{1\ \cancel{\text{electron}}} = -0.445\ \text{C/s} = -0.445\ \text{A}$

The negative sign in the answer indicates that the current flows in a direction opposite that of electron movement. But this sign is unimportant here and can be omitted because the problem statement does not specify the direction of electron movement.

Q4. Electrons pass to the right through a wire cross section at the rate of 6.4×10^{21} electrons per minute. What is the current in the wire?

Because current is the rate of charge movement in coulombs per second,

$$I = \frac{6.4 \times 10^{21}\ \cancel{\text{electrons}}}{1\ \cancel{\text{min}}} \times \frac{-1\ \text{C}}{6.241 \times 10^{18}\ \cancel{\text{electrons}}} \times \frac{1\ \cancel{\text{min}}}{60\ \text{s}} = -17.1\ \text{C/s} = -17.1\ \text{A}$$

The negative sign in the answer indicates that the current is to the left, opposite the direction of electron movement.

Q5. Figure 1-8 shows a circuit diagram of a voltage source of *V* volts connected to a current source of *I* amperes. Find the power absorbed by the voltage source for

(a) *V* = 2 V, / = 4 A
(b) *V* = 3 V, / = -2 A
(c) *V = -6 V, 7= -8 A*

Fig. 1-8

Because the reference arrow for I is into the positively referenced terminal for V, the current and voltage references for the voltage source are associated. This means that there is a positive sign (or the absence of a negative sign) in the relation between power absorbed and the product of voltage and current: $P = VI$. With the given values inserted,

(*a*) $P = VI = 2 \times 4 = 8$ W

(*b*) $P = VI = 3 \times (-2) = -6$ W

The negative sign for the power indicates that the voltage source delivers rather than absorbs power.

(*c*) $P = VI = -6 \times (-8) = 48$ W