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General Physics II, Quiz 8
PHYS100AA, Class year 102
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SN:_______________, Name:_______________

Chapter 28-31, Serway; ABSOLUTELY NO CHEATING!

Please write the answers on the blank space or on the back of this paper to save resources.

1.

Label the currents in the branches as shown in the first figure. Reduce the circuit by combining the two parallel resistors as shown in the second figure.

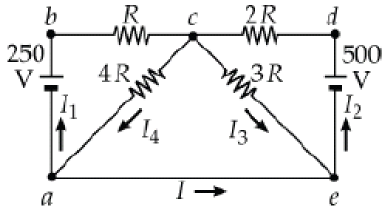

Figure (a)

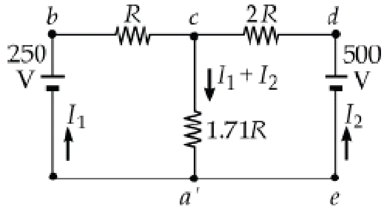

Figure (b)

ANS FIG.1

Apply Kirchhoff's loop rule to both loops in Figure (b) to obtain:

$$(2.71R)I_1 + (1.71R)I_2 = 250$$

and $$(1.71R)I_1 + (3.71R)I_2 = 500$$

With $R = 1\ 000\ \Omega$, simultaneous solution of these equations yields:

$$I_1 = 10.0 \text{ mA}$$

and $$I_2 = 130.0 \text{ mA}$$

From Figure (b), $V_c - V_a = (I_1 + I_2)(1.71\text{R}) = 240 \text{ V}$

Thus, from Figure (a), $I_4 = \dfrac{V_c - V_a}{4R} = \dfrac{240 \text{ V}}{4\ 000\ \Omega} = 60.0 \text{ mA}$

Finally, applying Kirchhoff's point rule at point A in Figure (a) gives:

$$I = I_4 - I_1 = 60.0 \text{ mA} - 10.0 \text{ mA} = +50.0 \text{ mA}$$

or I = 50.0 mA from point A to point E

2.

The emfs induced in the rods are proportional to the lengths of the sections of the rods between the rails. The emfs are $\varepsilon_1 = B\ell v_1$ with positive end downward, and $\varepsilon_2 = B\ell v_2$ with positive end upward, where $\ell = d = 10.0$ cm is the distance between the rails.

Apply Kirchhoff's laws. We assume current I_1 travels downward in the left rod, current I_2 travels upward in the right rod, and current I_3 travels upward in the resisitor R_3.

Left loop: $$+B\ell v_1 - I_1R_1 - I_3R_3 = 0 \quad (1)$$

Right loop: $$+B\ell v_2 - I_2R_2 + I_3R_3 = 0 \quad (2)$$

At the top junction: $I_1 = I_2 + I_3$ (3)

Substituting (3) into (1): $B\ell v_1 - I_1R_1 - I_3R_3 = 0$

$$B\ell v_1 - (I_2 + I_3)R_1 - I_3R_3 = 0$$
$$I_2R_1 + I_3(R_1 + R_3) = B\ell v_1 \quad (4)$$

Use (2) and (4) to solve for I_2, then equate:

$$I_2 = \frac{B\ell v_2 + I_3R_3}{R_2} = \frac{B\ell v_1 - I_3(R_1 + R_3)}{R_1}$$

$$(B\ell v_2 + I_3R_3)R_1 = [B\ell v_1 - I_3(R_1 + R_3)]R_2$$
$$I_3[R_3R_1 + (R_1 + R_3)R_2] = B\ell v_1R_2 - B\ell v_2R_1$$

$$I_3 = B\ell\frac{(v_1R_2 - v_2R_1)}{R_1R_2 + R_1R_3 + R_2R_3}$$

$$I_3 = (0.0100\text{ T})(0.100\text{ m})\frac{[(4.00\text{ m/s})(15.0\ \Omega) - (2.00\text{ m/s})(10.0\ \Omega)]}{(10.0\ \Omega)(15.0\ \Omega) + (10.0\ \Omega)(5.00\ \Omega) + (15.0\ \Omega)(5.00\ \Omega)}$$

$$= 1.45\times10^{-4}\text{ A}$$

Therefore, $I_3 = \boxed{145\ \mu\text{A upward in the picture}}$, as was originally chosen.