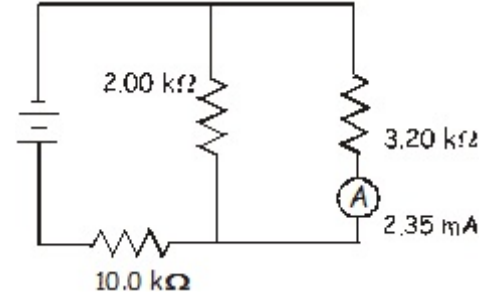


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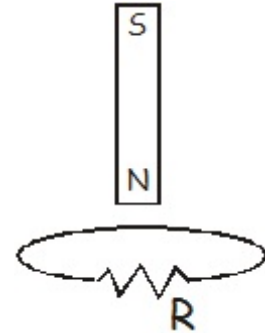
1. Find the voltage provided by the battery in this circuit.

$$\begin{aligned}
 V_T &= R_T \cdot I_T \\
 R_T &= 10.0 \text{ k}\Omega + (2.00^{-1} + 3.20^{-1})^{-1} \text{ k}\Omega \\
 &= 11.23076923 \text{ k}\Omega \\
 I_T &= I_{3.2} + I_2 = (3.2 \text{ k}\Omega \cdot 2.35 \text{ mA}) / 2.00 \text{ k}\Omega + 2.35 \text{ mA} \\
 &= 6.11 \text{ mA} \\
 V_T &= 11.23076923 \text{ k}\Omega \cdot 6.11 \text{ mA} = 68.62 \text{ V} = \boxed{68.6 \text{ V}}
 \end{aligned}$$



2. A bar magnet, north pole down, is dropped through a loop of wire as shown. What is the direction of the current through the resistor (a) While the magnet is falling towards the loop, (b) after the magnet has fallen through the loop and is moving away from it?

- a. As the magnet falls toward the loop, the magnetic flux pointing down through the center of the loop will be increasing, so a current will be created trying to resist that change. So, the current will flow counter-clockwise around the loop (looking from above) in order to create a magnetic field pointing up through the center of the loop.
- b. As the magnet falls out of the bottom of the loop, the magnetic flux pointing down through the loop will be decreasing, so the current will flow to oppose that change by trying to increase the field pointing down through the loop. According to the right-hand rule, this means the current will be flowing clockwise around the loop (viewed from above).

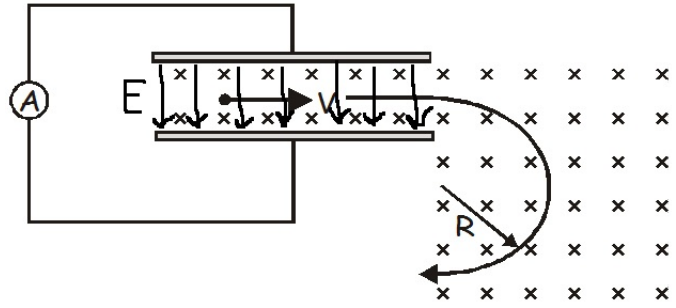


3. Two wires run parallel to each other. They are both 125 cm in length. They are separated by 12.0 cm. The wire on the left is carrying a current of 3.20 A and the wire on the right is carrying a current of 4.15 A. The currents are going in the same direction. (a) What is the force that is acting between them? (b) Is it attractive or repulsive?

a. $F_1 = I_1 \ell_1 B_2 = I_1 \ell_1 (\mu_0 I_2 / 2\pi r) = 3.20 \text{ A} \cdot 1.25 \text{ m} (4\pi \times 10^{-7} \text{ T}\cdot\text{m/A} \cdot 4.15 \text{ A} / (2\pi \cdot 0.120 \text{ m}))$
 $= 2.76666666 \times 10^{-5} \text{ N} = \boxed{2.77 \times 10^{-5} \text{ N or } 27.7 \mu\text{N}}$

- b. Force is attractive. The magnetic field from the second wire would be coming out of the paper at the point of the first wire. By the right hand rule, the first wire (on the left) would then experience a force pushing it toward the right (toward the other wire).

4. A particle with an unknown mass and charge moves with a constant speed of $v = 1.9 \times 10^6$ m/s as it passes undeflected through a pair of parallel plates as shown. The plates are separated by a distance of $d = 6.0 \times 10^{-3}$ m, and a constant potential difference V is maintained between them. A uniform magnetic field of $B = 0.20$ T directed into the page exists between the plates and to the right of them as shown. After the particle passes into the region to the right of the plates where only the magnetic field exists, its trajectory is circular with radius $r = 0.10$ m.



- a. What is the sign of the particle's charge?

Explain your answer.

- b. On the drawing, indicate the direction of the electric field provided by the plates.
 c. Determine the magnitude of the potential difference between the plates.
 d. Determine the ratio of charge to mass (q/m) of the particle.

- a. After leaving the plates, the right hand rule says that a positive particle would be deflected upward by the magnetic field, therefore the particle has a negative charge.
 b. The electric field between the plates is forcing the particle upward the exact same amount that the magnetic field is forcing it downward. A positive particle would be forced upward by an upward directed electric field, but since the particle is negative, the electric field must point downward (see diagram).

c. $F = qE = qvB\sin\theta$

so $E = vB = 1.9 \times 10^6 \text{ m/s} \cdot 0.20 \text{ T} = 3.8 \times 10^5 \text{ V/m}$

$V = E \cdot d = 3.8 \times 10^5 \text{ V/m} \cdot 6.0 \times 10^{-3} \text{ m} = \boxed{2280 \text{ V or } 2.28 \text{ kV}}$

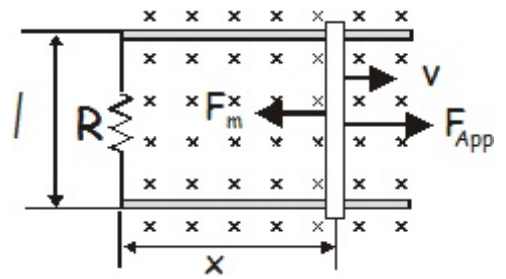
d. $F_c = F_B$

$mv^2/r = qvB\sin\theta$

$q/m = v^2/rvB\sin\theta = v/rB = 1.9 \times 10^6 \text{ m/s} / (0.10 \text{ m} \cdot 0.20 \text{ T})$

$= \boxed{95\,000\,000 \text{ C/kg or } 95\,000\,000 :1}$

5. A force is applied to a conducting rod so that it slides across a pair of conducting rails. A uniform magnetic field of 1.25 T is directed into the page. The rails are separated by 25.0 cm. The rod is moving at a constant velocity of 12.2 m/s. The resistance of the system is 2.50 Ω . Find the following:
- The induced emf in the moving rod,
 - the direction of the current through R ,
 - the current through R ,
 - The magnitude of the applied force needed to keep the rod moving at constant velocity,
 - The power dissipated by the resistor.



- $\mathcal{E} = Blv = 1.25 \text{ T} \cdot 0.25 \text{ m} \cdot 12.2 \text{ m/s} = 3.8125 \text{ V} = \boxed{3.81 \text{ V}}$
- Current will flow upward through R . Right-hand rule for the electrons in the conducting rod: they're moving to the right, the magnetic field is into the page, therefore a positive charge would move up through the conducting rod (and an electron would move down).
- $I = V/R = 3.8125 \text{ V}/2.50 \Omega = 1.525 \text{ A} = \boxed{1.53 \text{ A}}$

First solutions to d & e:

- $P = VI = 3.8125 \text{ V} \cdot 1.525 \text{ A} = 5.8140625 \text{ W} = \boxed{5.81 \text{ W}}$
- $P \cdot t = F \cdot d$ (both are equal to work),
so $F = P/v = 5.81 \text{ W}/12.2 \text{ m/s} = 0.4765625 \text{ N} = \boxed{0.477 \text{ N}}$

Second solutions to d & e:

- $F = IlB\sin\theta = 1.525 \text{ A} \cdot 0.250 \text{ m} \cdot 1.25 \text{ T} = 0.4765625 \text{ N} = \boxed{0.477 \text{ N}}$
- $P = W/t = F \cdot d/t = F \cdot v = 0.4765625 \text{ N} \cdot 12.2 \text{ m/s} = 5.8140625 \text{ W} = \boxed{5.81 \text{ W}}$

I'm sure there are other methods as well! :)