General Physics II — Quest 3

Chapters 20–21: Electric Circuits; Magnetic Forces and Magnetic Fields

Useful constants:

$$e = 1.60 \times 10^{-19}\,\text{C}, \qquad \mu_0 = 4\pi \times 10^{-7}\,\text{T}\cdot\text{m/A}$$

Part I: Multiple Choice

1. A resistor is connected across an ideal battery. If the resistance is doubled while the battery voltage remains the same, the current in the resistor

   (A) doubles

   (B) is cut in half

   (C) remains the same

   (D) increases by a factor of 4

2. Three resistors are connected in series to a battery. Which statement is correct?

   (A) The current is different through each resistor

   (B) The voltage across each resistor is the same

   (C) The current is the same through each resistor

   (D) The equivalent resistance is smaller than the smallest resistor

3. Electrical energy delivered to a resistor is converted primarily into

   (A) magnetic field energy only

   (B) kinetic energy of the resistor as a whole

   (C) thermal energy

   (D) gravitational potential energy

4. The magnetic force on a charged particle moving through a magnetic field is greatest when the particle's velocity is

   (A) parallel to the field

   (B) perpendicular to the field

   (C) opposite to the field

   (D) zero

5. A proton moves to the right through a uniform magnetic field directed upward. The magnetic force on the proton points

   (A) into the page

   (B) out of the page

   (C) upward

   (D) to the left

6. Two long straight parallel wires carry currents in the same direction. The wires

   (A) repel each other

   (B) attract each other

   (C) exert no force on each other

   (D) first attract, then repel

Part II: Problems

9. A 12.0 V battery is connected to two resistors, $R_1 = 4.0\,\Omega$ and $R_2 = 8.0\,\Omega$, in series.

   (a) Find the equivalent resistance of the circuit.

   (b) Find the current in the circuit.

   (c) Find the voltage drop across each resistor.

   (d) Find the power dissipated by the $8.0\,\Omega$ resistor.

10. A singly ionized sodium ion ($q = +e$) in a medical instrument moves at speed

$$v = 3.0 \times 10^6\,\text{m/s}$$

through a uniform magnetic field of magnitude

$$B = 0.20\,\text{T}.$$

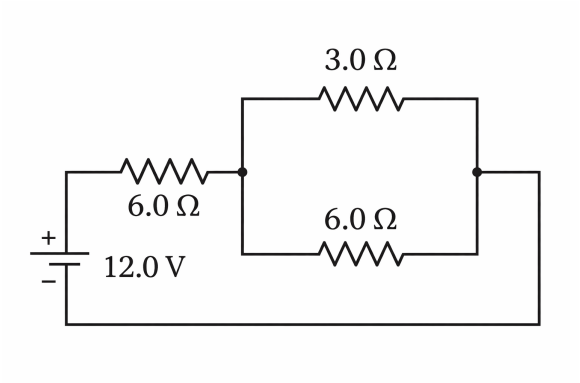
The velocity is perpendicular to the magnetic field.

   (a) Find the magnitude of the magnetic force on the ion.

   (b) If the ion moved parallel to the magnetic field instead, what would the magnetic force be?

11. A wire carries a current of 0.81 A. This wire makes an angle of 49° with respect to a magnetic field of magnitude 7.0×10^{-5} T. The wire experiences a magnetic force of magnitude 9.9×10^{-5} N. What is the length of the wire?

12. In the circuit shown below,



    (a) Find the equivalent resistance of the parallel portion.

    (b) Find the total equivalent resistance of the circuit.

    (c) Find the total current supplied by the battery.

    (d) Find the current through the 3.0 Ω resistor.

13. A proton ($q = +e$, $m = 1.67 \times 10^{-27}$ kg) moves perpendicular to a uniform magnetic field of magnitude 0.50 T with a speed of 2.0×10^{6} m/s.

    (a) Calculate the magnitude of the magnetic force on the proton.

    (b) Find the radius of the circular path.

    (c) If the speed of the proton increases, what happens to the radius?