

General Physics II — Practice Quest 3

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

Useful constants:

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

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
7. A light bulb is connected to a battery. If the voltage across the bulb is doubled, the power dissipated by the bulb (assuming constant resistance)
- (A) doubles
 - (B) increases by a factor of 4
 - (C) is cut in half
 - (D) remains the same
8. A charged particle moves through a region where both electric and magnetic fields are present. If the particle moves in a straight line at constant velocity, which statement must be true?
- (A) Only the electric force is acting
 - (B) Only the magnetic force is acting
 - (C) The electric and magnetic forces cancel each other
 - (D) The magnetic force is zero
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Part II: Problems

9. Basic Circuit Analysis

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. Parallel Circuits and Household Current

A biology lab bench contains two devices connected in parallel across a 120 V outlet. One device has resistance $240\ \Omega$, and the other has resistance $160\ \Omega$.

- (a) Find the equivalent resistance of the two-device combination.
- (b) Find the current through each device.
- (c) Find the total current supplied by the outlet.
- (d) Which device uses more power? Justify your answer with a calculation.

11. Magnetic Force on a Moving Charge

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's speed were doubled, what would happen to the magnetic force?
- (c) If the ion moved parallel to the magnetic field instead, what would the magnetic force be?
- (d) State whether the magnetic force can change the speed of the particle. Briefly explain.

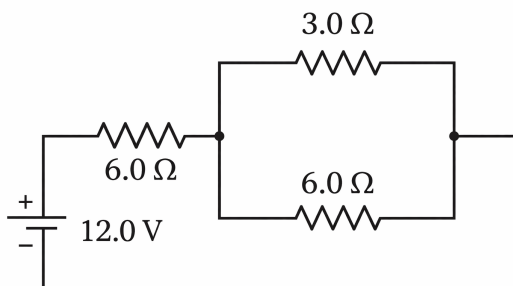
12. Magnetic Field of a Long Straight Wire

A long straight wire carries a current of 8.0 A.

- (a) Find the magnitude of the magnetic field at a point 3.0 cm from the wire.
- (b) Find the magnitude of the magnetic field at a point 6.0 cm from the wire.
- (c) Compare your answers from parts (a) and (b). What happens to the magnetic field when the distance from the wire doubles?
- (d) A second long straight wire is placed parallel to the first wire, 3.0 cm away. If the currents are in the same direction, do the wires attract or repel?

13. Series-Parallel Circuit

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 $3.0\ \Omega$ resistor.

14. Circular Motion in a Magnetic Field

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) Explain why the proton follows a circular path.
- (c) Find the radius of the circular path.
- (d) If the speed of the proton increases, what happens to the radius?