Physics II **Exam 2 - Chs. 18A,19,20 - Electric Current, Magnetic Field** **Feb. 23, 2009**

Name Rec. Instr. Rec. Time

For full credit, make your work clear to the grader. Show the formulas you use, all the essential steps, and results with correct units and correct number of significant figures. Point values are given in parenthesis. For TF or MC questions, choose the best answer. Coulomb's Law constant $k = 8.988$ GN·m^2/C^2, permittivity of free space $\epsilon_0 = 8.854$ pF/m, permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ T·m/A, elementary charge $e = 1.602 \times 10^{-19}$ C, electron mass $m_e = 9.11 \times 10^{-31}$ kg, 1 electron-volt = 1.0 eV = 1.602×10^{-19} J, 1 gauss = 1 G = 1.0×10^{-4} T.

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1. (14) A fully charged 12.0-volt car battery rated at 850 amp-hours is connected to a spotlight rated at 150. watts for 12.0 volts.

a) (2) Based on the units of amp-hours, the quantity 850 amp-hours must be

a. power. b. energy. c. current. d. charge.

b) (4) Give 850 amp-hours in SI units.

c) (4) What current does the spotlight operate on?

d) (4) How long (in hours) will the battery last while powering the spotlight?

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2. (10) Aluminum wiring rated at 30.0 A maximum current is to be installed in a home. For safety reasons, it should produce no more heat than 15 watts per meter of length. (aluminum resistivity is $\rho = 2.65 \times 10^{-8}$ Ω·m).

a) (4) What resistance should a 1.00 meter length of the wire have, to safely carry 30.0 A?

b) (6) How thick (diameter) does the wire have to be?

3. (4) A battery is supplying a power of 32.0 W to a circuit, while a current of 1.25 A flows from the battery. How large is the terminal voltage of the battery?

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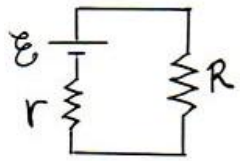
4. (8) A real 90.0 V battery (one with internal resistance) has a terminal voltage of 80.0 V when a motor with a resistance of 8.00 Ω is connected to it.



a) (4) What amount of current is the battery supplying to the motor?

b) (4) How large is the battery's internal resistance?

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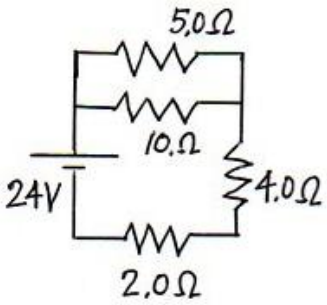
5. (16) The circuit contains an arrangement of resistors connected to an ideal 24-volt battery that has no internal resistance.



a) (2) Which pair of resistors is in series (if any)? _____

b) (2) Which pair of resistors is in parallel (if any)? _____

c) (6) What is the equivalent resistance connected to the battery?

d) (6) What is the voltage drop across the 4.0 Ω resistor?

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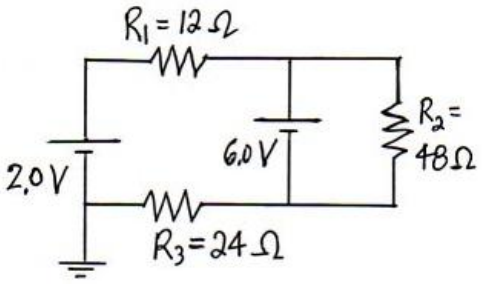
6. (10) Consider this circuit.



a) (4) How large is the current flowing through R_2? Which direction?

b) (6) How large is the current flowing through R_1? Which direction?

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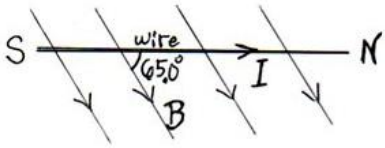
7. (6) At some location, Earth's magnetic field is $B_{\text{Earth}} = 0.70$ gauss and points North, at 65.0° below horizontal as shown. A 1.00 km long power line carries 88 A due north. Find the net force on this segment of power line, giving its magnitude and direction.



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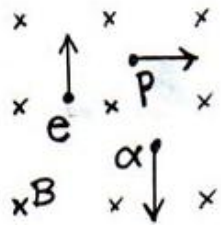
8. (6) A uniform magnetic field points into the page as shown. The diagram shows the instantaneous velocities of a proton (p), an electron (e) , and an alpha-particle (α, He^{2+} ion).



a) (2) The magnetic force on the proton points
a. ↑ b. ↓ c. ← d. → e. ⊗ f. ⊙

b) (2) The magnetic force on the electron points
a. ↑ b. ↓ c. ← d. → e. ⊗ f. ⊙

c) (2) The magnetic force on the alpha-particle points
a. ↑ b. ↓ c. ← d. → e. ⊗ f. ⊙

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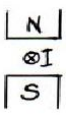
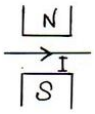
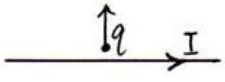
9. (2) The magnetic force on a current-carrying wire between the poles of a magnet as shown points
a. ↑ b. ↓ c. ← d. → e. ⊗ f. ⊙



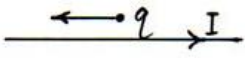
10. (2) The magnetic force on a current-carrying wire between the poles of a magnet as shown points
a. ↑ b. ↓ c. ← d. → e. ⊗ f. ⊙



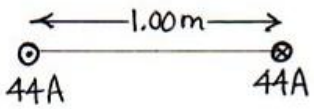
11. (2) The magnetic force on *an electron* moving near a current-carrying wire as shown points
a. ↑ b. ↓ c. ← d. → e. ⊗ f. ⊙



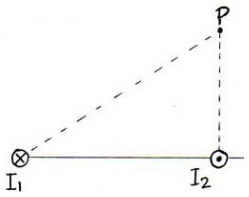
12. (2) The magnetic force on *a proton* moving near a current-carrying wire as shown points
a. ↑ b. ↓ c. ← d. → e. ⊗ f. ⊙



13. (8) Two long wires separated by 1.00 m carry equal but opposite 44.0 A currents. Find the magnitude and direction of the net magnetic field they produce at a point halfway between the wires.



14. (4) The diagram shows the currents of two long wires, I_1 and I_2. For the magnetic field they produce at point P, sketch arrows $\vec{B}_1$ and $\vec{B}_2$ that represent the correct directions of the magnetic fields produced by each current at P.

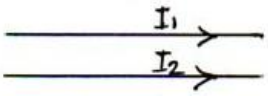


15. (2) Two long wires with parallel currents

a. attract each other b. repel each other c. do not affect each other.

16. (2) The net magnetic field below the two wires shown points

a. ↑ b. ↓ c. ← d. → e. ⊗ f. ⊙



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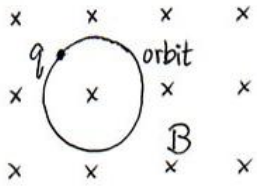
17. (10) A uniform magnetic field B cause protons ($m = 1.67 \times 10^{-27}$ kg) to move in cyclotron orbits of radius 12.0 cm at a frequency of 250. MHz (i.e., $250. \times 10^6$ revolutions per second).



a) (2) In the diagram, the protons circulate a. clockwise b. counterclockwsie.

b) (4) At what speed v are the protons moving?

c) (4) How strong is the magnetic field B, in tesla?