Physics 161: Exam 3
Nov. 19, 2012

Directions: Complete the 16 multiple choice problems and transfer your answers to the computer-scored forms. Next, complete the two work-out problems. Show your work for these. Be sure to put your name on the exam and on the computer-scored form.

Useful information:
mass of an electron: 9.1×10^{-31} kg
mass of a proton: 1.67×10^{-27} kg
charge of a proton: 1.6×10^{-19} C.
$\epsilon_0 = 8.85 \times 10^{-12}\ \frac{\mathrm{C}^2}{\mathrm{Nm}^2}$
$\mu_0 = 4\pi \times 10^{-7}$ Tm/A

Part 1 (85 points total) : Multiple Choice.

1. The SI unit for resistance is the
(a) ohm
(b) amp
(c) volt
(d) farad
(e) liter

2. One ohm is equal to one
(a) joule-sec/coulomb^2
(b) amp/volt
(c) joule/coulomb
(d) joule-coulomb
(e) farad/coulomb

3. At room temperature, the electrical resistivity of a typical metal
(a) decreases with increasing temperature.
(b) increases with increasing temperature.
(c) does not depend on temperature.

4. The rate at which heat is produced in a circuit with resistance R is
(a) equal to I^2/R, where I is the current in the resistor.
(b) equal to I^2R, where I is the current in the resistor.
(c) equal to V^2R, where V is the voltage across the resistor.
(d) equal to V/R, where V is the voltage across the resistor.
(e) proportional to the ideal gas constant.

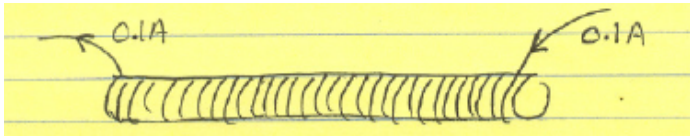
5. The current in a wire with cross-sectional area of 0.6 mm^2 is 1.5 A. If the density of mobile electrons 1.5 $\times 10^{29}$ electrons per cubic meter, what is their drift velocity?

(a) 1.0×10^{-1} m/s
(b) 1.0×10^{-2} m/s
(c) 1.0×10^{-3} m/s
(d) 1.0×10^{-4} m/s
(e) 1.0×10^{-5} m/s

6. The resistivity of Cu is $1.7 \times 10^{-7} \Omega$m. The resistance of a Cu wire of length 10.0 cm and uniform cross sectional area 2 mm^2 is

(a) 3.4×10^{-14} Ω
(b) 8.5×10^{-3} Ω
(c) 92 Ω
(d) 3.0×10^{2} Ω
(e) 1.2×10^{8} Ω

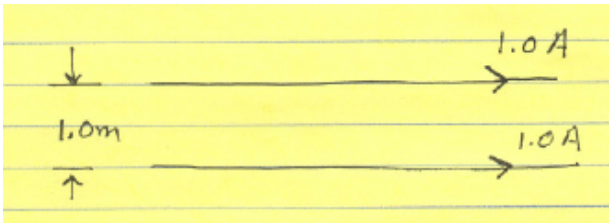
A long solenoid has a radius of 0.5 cm, *and a winding density of 1000 turns per cm. It carries a current of 0.1 Amperes.*



7. The magnetic field inside the solenoid is

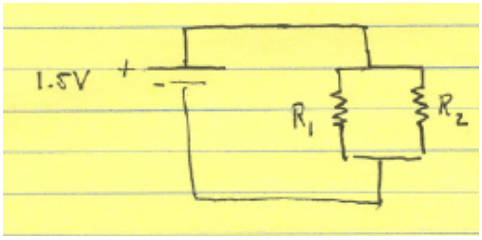
(a) 0.28 μT
(b) 12.6 mT
(c) 0.35 T
(d) 1.5 T
(e) 9.7 T

Two long parallel wires both carry a 1.0 A current in the same direction. The wires are separated from one another by 1 meter.



8. What is the force between the two, per meter of wire?
(a) 4.0×10^{-7} N (repulsive)
(b) 3.0×10^{-7} N (repulsive)
(c) 2.0×10^{-7} N (attractive)
(d) 1.0×10^{-7} N (attractive)
(e) 0.5×10^{-7} N (attractive)

An electrical circuit consists of an ideal 1.5 *V battery connected to two resistors* $R_1 = 5.0\ \Omega$ *and* $R_2 = 10\ \Omega$ *in parallel.*



9. At steady state the current through resistor R_1 is
(a) half as large as the current through R_2.
(b) twice as large as the current through resistor R_2.
(c) three times as large as the current through resistor R_2.
(d) half as large as the current through the battery.
(e) twice as large as the current through the battery.

10. At steady state the current I through the battery is
(a) 5.0 A
(b) 0.30 A
(c) 0.15 A
(d) 0.10 A
(e) 0.45 A

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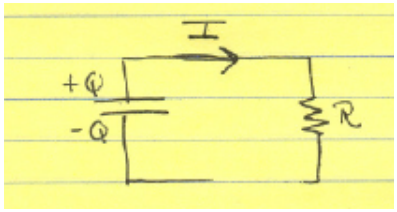
11. Approximately how long does it take charge to leave an initially charged capacitor C which is place in a series closed loop circuit with a resistor R?
(a) Q/C
(b) C/R
(c) RC
(d) $Q/(RC)$
(e) $R/(QC)$



12. What is the resistance between two parallel metal plates of area A and plate separation d, the space between the plates filled with a poorly conducting substance having a resistivity ρ?

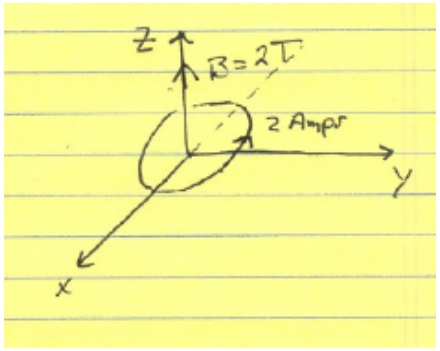
(a) $\rho A/d$
(b) $\rho d/A$
(c) ρAd
(d) $d/\left(\rho A\right)$
(e) $A/\left(\rho d\right)$

13. A particle with charge q moves with a velocity $\vec{v} = v_0\ \left(\hat{x} + \hat{y}\right)$ in a uniform magnetic field $\vec{B} = B_0\ \hat{\mathrm{y}}$. What is the magnetic force on the particle?

(a) $qv_0B_0\ \hat{\mathrm{x}}$
(b) $qv_0B_0\ \hat{\mathrm{y}}$
(c) $qv_0B_0\ \hat{\mathrm{z}}$
(d) $qv_0B_0\ \left(\hat{x} + \hat{y}\right)$
(e) $qv_0B_0\ \left(\hat{x} + \hat{z}\right)$

14. A circular loop of wire lies in the xy plane. The radius of the loop is 1.0 m, and it carries a current of 2.0 A, in a direction shown in the figure. A uniform magnetic field of magnitude 2.0 T is in the $+\hat{\mathrm{z}}$ direction. What is the torque on the current loop?

(a) 4.0 π Nm $\hat{\mathrm{z}}$
(b) -4.0 π Nm $\hat{\mathrm{z}}$
(c) 4.0 π Nm $\hat{\mathrm{x}}$
(d) -4.0 π Nm $\hat{\mathrm{y}}$
(e) 0.0 Nm



15. An electron moves in a circle at a speed of 4000 m/s in a uniform magnetic field of strength 1×10^{-2} T. What is the radius of the circle?

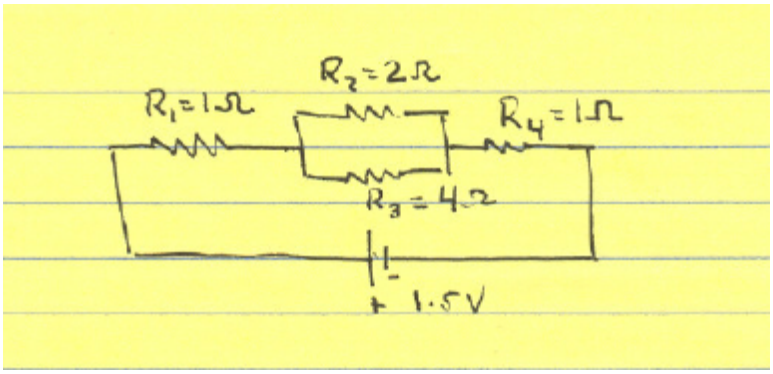
(a) 0.35 $\times 10^{-6}$ m
(b) 1.4 $\times 10^{-6}$ m
(c) 2.3 $\times 10^{-6}$ m
(d) 3.3 $\times 10^{-6}$ m
(e) 5.7 $\times 10^{-6}$ m

16. A straight wire segment of length 1.0 m carries a current of 10 A in the presence of a uniform magnetic field of 3.0×10^{-2} T. The current is moving in the $\hat{z}$ direction and the magnetic field is directed in the $\hat{x}$ direction. What is the force on the wire?

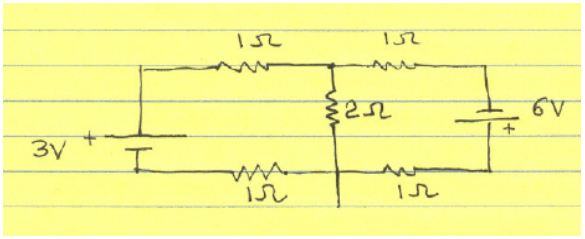
(a) 0.6 N $\hat{\text{x}}$
(b) -0.3 N $\hat{\text{x}}$
(c) 0.2 N $\hat{\text{y}}$
(d) 0.4 N $\hat{\text{z}}$
(e) 0.3 N $\hat{\text{y}}$

Part 2: (15 points total) (Show your work!)

1. (**10 points**) Consider the circuit shown below. The battery has a voltage of 1.5 V. The resistances are labeled. What is the current through resistor R_1?



2. (**5 points**) The circuit shown below has two batteries. One produces a voltage of 3 V, and the other has a voltage of 6 V. The resistances are as labeled. What is the rate at which the 3 V battery does work?



Bonus (5 points): Two long insulated wires lie in the plane of the page as shown. The first wire is horizontal, and the second wire is laid across the first at an angle of 30 degrees. They both carry a current of 1 A. What is the magnitude and direction of the net magnetic force on the second wire by the first? What is the torque (per meter of length) on the second wire?