Phys 112
Spring 2013

General Physics: Class Exam II v2

20 March 2013

Name: Solution. **Total:** /70

Instructions

- There are 8 questions on 5 pages.
- Show your reasoning and calculations and always justify your answers.

Physical constants and useful formulae

Coulomb's constant:	$k = 9.0 \times 10^9\,\mathrm{Nm^2/C^2}$	Permeability constant:	$\mu_0 = 4\pi \times 10^{-7}\,\mathrm{Tm/A}$
Electron charge:	$q_{\mathrm{electron}} = -1.60 \times 10^{-19}\,\mathrm{C}$	Electron mass:	$m_e = 9.11 \times 10^{-31}\,\mathrm{kg}$
Proton charge	$q_{\mathrm{proton}} = +1.60 \times 10^{-19}\,\mathrm{C}$	Proton mass:	$m_p = 1.67 \times 10^{-27}\,\mathrm{kg}$

Question 1

In a procedure to coat an object with copper, copper ions flow through a solution and accumulate on the object. Each copper ion has the same charge as two protons. The current that flows is 0.025 A and it flows for 30 min. Determine the total number of copper ions that accumulate on the object.

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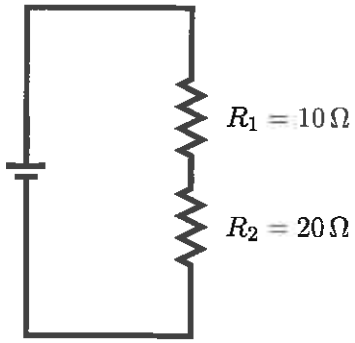
Question 2

Two resistors are connected to a battery as illustrated. Let I_1 and I_2 denote the currents through resistor 1 and resistor 2 respectively. Which of the following (choose one) is true?



a) $I_2 < \frac{1}{2} I_1$

b) $I_2 = \frac{1}{2} I_1$

c) $I_2 = I_1$

d) $I_2 = 2I_1$

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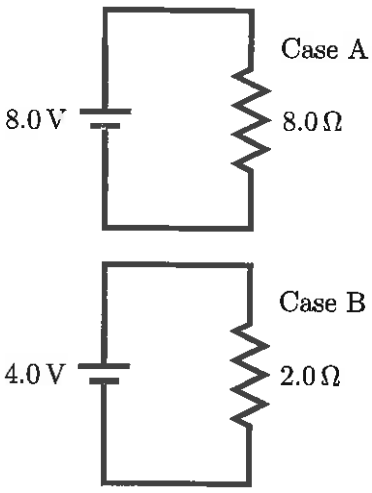
Question 3

A 8.0 V battery is connected to resistor A, which has resistance 8.0 Ω. A 4.0 V battery is connected to resistor B, which has resistance 2.0 Ω. Zog claims that the *power* provided by resistor A is double that provided by B. Geraldine claims that the power delivered for resistor B is double that for resistor A. Is either correct? Explain your answer.



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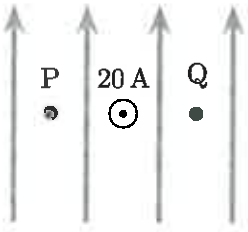
Question 4

A hidden collection of source magnets produces a uniform magnetic field which points vertically up and which has magnitude 5.0×10^{-4} T. A long straight wire points directly out of the page and carries current 20 A.

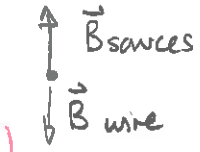


a) Determine the net magnetic field at the point labeled P, which is a distance of 0.010 m directly left of the wire.

$\vec{B} = \vec{B}_{wire} + \vec{B}_{sources}$

$B_{wire} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 20\,A}{2\pi \times 0.010\,m}$

$= 4.0 \times 10^{-4}\,T$



2 + 3

$B = B_{source} - B_{wire} = 5.0 \times 10^{-4}\,T - 4.0 \times 10^{-4}\,T$ } 3

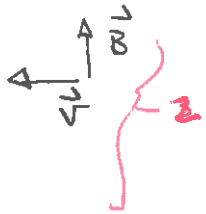
$= 1.0 \times 10^{-4}\,T$ ↑ up } 2

b) At one instant a particle with charge 6.0×10^{-6} C is at point P and is moving directly left with speed 5.0×10^{5} m/s. Determine the force exerted on the particle.

$F = |q| v B \sin\alpha$

$= 6.0 \times 10^{-6}\,C \times 5.0 \times 10^{5}\,m/s \times 1.0 \times 10^{-4}\,T \sin 90^{\circ}$

$= 3.0 \times 10^{-4}\,N$ } 3 $\vec{F}$ into page ⊗



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c) Suppose that the same particle were moving in with the same velocity at point Q, which is a distance of 0.010 m directly left of the wire. How would the magnitude of the force compare (larger, smaller, same) to that exerted on the particle at P? Explain your answer.

At Q ↑ $\vec{B}_{wire}$ ↑ $\vec{B}_{sources}$ fields add. } 3

⇒ B larger ⇒ F larger.

1 2

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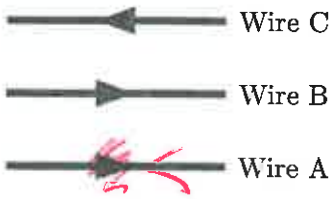
Question 5

Three wires carry currents as illustrated. The magnitudes of the currents are equal. The distances between *adjacent* wires are equal. Let F_A denote the *magnitude of the net force* on wire A, etc,.... Which of the following (choose one) is true?



a) $F_A = F_B = F_C$
b) $F_A = F_C < F_B$
c) $F_A = F_C > F_B$
d) $F_C < F_B < F_A$

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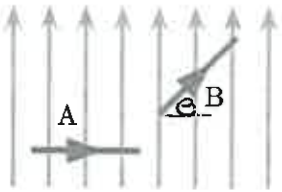
Question 6

Two wires that have the same length and carry the same current are in the same uniform magnetic field. These are oriented as illustrated. How does the magnitude of the force exerted by the magnetic field on A compare (larger, smaller, same) to that exerted on B? Explain your answer.



$F = ILB \sin\alpha$

For A: $F = ILB \sin 90^\circ$
$= ILB$

For B: $F = ILB \sin\theta$ (less than 1)
$F < ILB$

larger for A.

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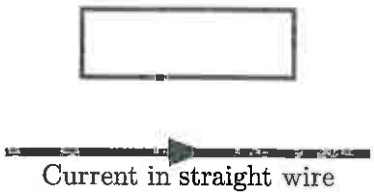
Question 7

A current flows through an infinitely long straight wire as illustrated. A rectangular loop held fixed as illustrated. Which of the following (choose one) is true while current through the straight wire is increased?



a) There is no current in the rectangular loop
b) There is a counterclockwise current in the rectangular loop.
c) There is a clockwise current in the rectangular loop.
d) There is a current (in the rectangular loop) which repeatedly changes direction.

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Question 8

A circular metal ring has radius 0.040 m. The ring is perpendicular to a uniform magnetic field. During an initial period of duration 0.050 s, the field strength increases from 0.0 T to 8.0 T. During a final period of duration 0.020 s, the field strength decreases from 8.0 T to 0.0 T.

a) During which of these two periods is the induced EMF largest? Explain your answer.

$\mathcal{E} = \left| \frac{\Delta \Phi}{\Delta t} \right|$

$\Delta \Phi$ is same

Δt smaller in final period

$\Rightarrow$ $\mathcal{E}$ larger in final period +2

b) Determine the value of the induced EMF during the final period.

$\mathcal{E} = \left| \frac{\Delta \Phi}{\Delta t} \right|$ +1

$\Phi = BA\cos\theta$ +2

$= B\pi r^2 \cos 0$

$= B\pi \times (0.040\text{m})^2$ +3

$\Phi_f = 0$ since $B = 0$

$\Phi_i = 8.0\text{T} \times \pi \times (0.040\text{m})^2 = 0.040\ \text{Wb}$

$\Delta t = 0.020\text{s}$

$\mathcal{E} = \left| \frac{0.040\ \text{Wb}}{0.020\ \text{s}} \right| = 2.0\text{V}$ +2

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