Phys 112
Spring 2013

General Physics: Class Exam II

v1

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.

Need total charge ΔQ. Then the number of ions is

$\frac{\Delta Q}{\text{charge per ion}}$ → $2 \times 1.6 \times 10^{-19}\mathrm{C} = 3.2 \times 10^{-19}\mathrm{C}$ 2

So $I = \frac{\Delta Q}{\Delta t} \Rightarrow \Delta Q = I\Delta t = 0.025\mathrm{A} \times 30\mathrm{min} \times 60\mathrm{s/min}$

$= 45\mathrm{C}$ 4

So number of ions is

$\frac{45\mathrm{C}}{3.2 \times 10^{-19}\mathrm{C}} = 1.4 \times 10^{20}$ 3

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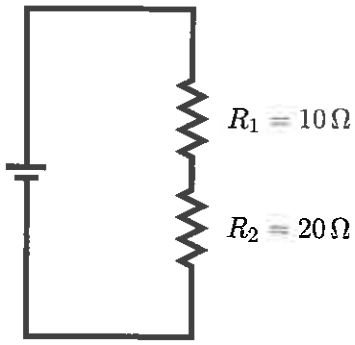
Question 2

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) $I_2 = 2I_1$

Current must be same at every point otherwise charge accumulates.

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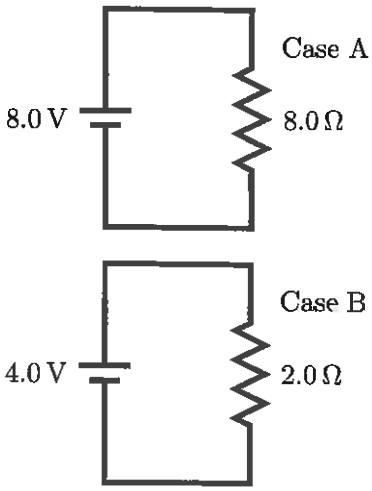
Question 3

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.



$P = \Delta V\, I$ but $I = \Delta V / R$

$\Rightarrow P = (\Delta V)^2 / R$

For A: $P = (8.0\text{V})^2 / 8.0\,\Omega = 8.0\,\text{W}$

For B: $P = (4.0\text{V})^2 / 2.0\,\Omega = 8.0\,\text{W}$

These are the same. Neither is correct.

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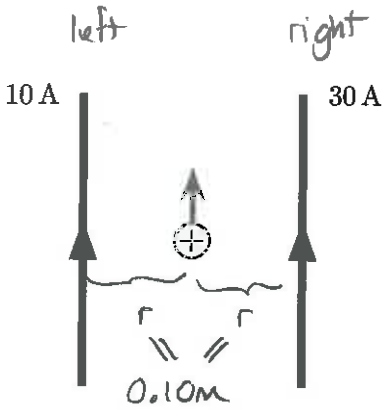
only get I (+3)

Question 4

Two very long parallel wires are 0.20 m apart. The left wire carries a current of 10 A vertically up and the right wire 30 A vertically up. At one instant a particle with charge 6.0×10^{-6} C is midway between the wires and is moving with speed 5.0×10^{3} m/s vertically.



a) Determine the net magnetic field produced by both currents at the location of the charged particle.

$\vec{B} = \vec{B}_{left} + \vec{B}_{right}$

$\vec{B}_{left}$ ⊗ , $\vec{B}_{right}$ ⊙ } 3

$B_{left} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 10\,A}{2\pi \times 0.10\,m} = 2.0 \times 10^{-5}\,T$ ⊗ } 3

$B_{right} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 30\,A}{2\pi \times 0.10\,m} = 6.0 \times 10^{-5}\,T$ ⊙ } 3 dominant

The outward field dominates so

$B = B_{right} - B_{left} = 4.0 \times 10^{-5}\,T$ out ⊙

3 2

b) Determine the magnitude and direction of the net force exerted on the charged particle.

$F = |q| v B \sin\theta$ ($\theta = 90°$)

$= 6.0 \times 10^{-6}\,C \times 5.0 \times 10^{3}\,m/s \times 4.0 \times 10^{-5}\,T$

$= 1.2 \times 10^{-6}\,N \longrightarrow$

4

by right hand rule } 2

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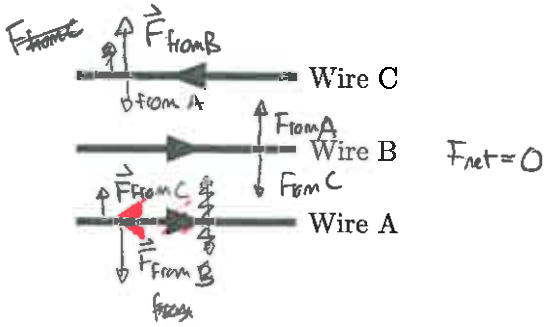
Question 5

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) $F_C < F_B < F_A$

$F_B=0$ +2

$F_A=F_C \neq 0$

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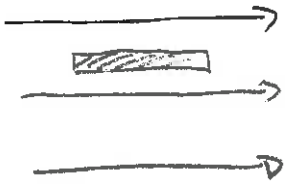
Question 6

A collection of source magnets produces a uniform magnetic field that points directly right. A straight wire carries a current and this wire can be oriented in any direction. In which direction the wire be oriented to give the smallest possible force exerted by the magnetic field? Explain your answer.



need this (+5)

$F = ILB\sin\alpha$

Need $\sin\alpha = 0$

$\Rightarrow \alpha = 0$

Wire must be parallel to field.

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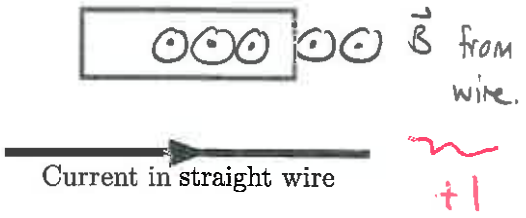
Question 7

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?



+1

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.

Flux out increases $\Rightarrow$ induced field in $\Rightarrow$ current clockwise

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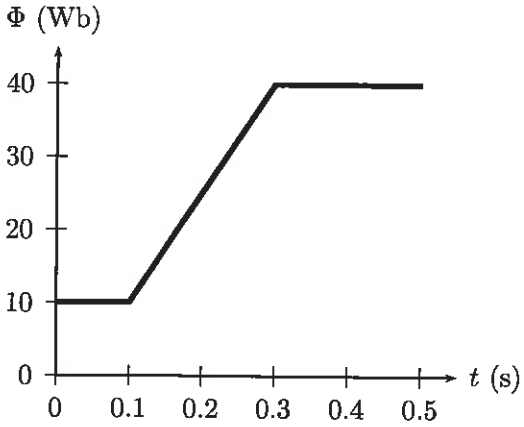
Question 8

The flux through a loop of fixed area varies with time as illustrated. Indicate the time(s) or period of time when the EMF induced in the loop is largest and determine the maximum value of the EMF induced in the loop.



Need $\mathcal{E} = \left|\frac{\Delta\Phi}{\Delta t}\right|$ +2

So $\mathcal{E} \neq 0$ only when flux changes.

$\Rightarrow$ 0.1s → 0.3s gives $\mathcal{E} \neq 0$

else give $\mathcal{E} = 0$ } +3

In 0.1s → 0.3s period

$\Delta\Phi = \Phi_f - \Phi_i$

$= 40\ \text{Wb} - 10\ \text{Wb}$

$= 30\ \text{Wb}$

$\Delta t = 0.2\text{s}$

$\mathcal{E} = \left|\frac{30\ \text{Wb}}{0.2\text{s}}\right| = 150\text{V}$ (+3)

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