Instructor(s): *Reitze/Kumar*

PHYSICS DEPARTMENT

PHY2054 Exam 2 November 8, 2010

Name (print, last first): _____ Signature: _____

On my honor, I have neither given nor received unauthorized aid on this examination.

YOUR TEST NUMBER IS THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE.

(1) **Code your test number on your answer sheet (use lines 76–80 on the answer sheet for the 5-digit number).** Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your UFID number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) Do all scratch work anywhere on this exam that you like. **Circle your answers on the test form.** At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout.
(4) **Blacken the circle of your intended answer completely, using a #2 pencil or blue or black ink**. Do not make any stray marks or some answers may be counted as incorrect.
(5) **The answers are rounded off. Choose the closest to exact. There is no penalty for guessing. If you believe that no listed answer is correct, leave the form blank.**
(6) Hand in the answer sheet separately.

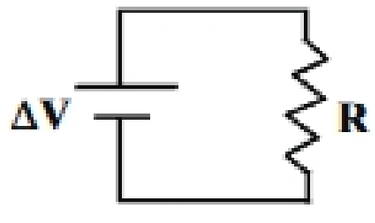
Useful Constants:

$k_e = 8.99 \times 10^9 \mathrm{Nm^2}/C^2$		$\epsilon_0 = 8.85 \times 10^{-12} \mathrm{C^2}/(\mathrm{Nm^2})$		V=volt	N=newton
$\mu_0 = 4\pi \times 10^{-7}$ Tm/A		$k_0 = \mu_0/(4\pi) = 10^{-7}$ Tm/A			$g = 9.8$ m/s^2
electron charge $= -1.6 \times 10^{-19}$C		electron mass $= 9.11 \times 10^{-31}$kg			C=coulomb
"milli"$=10^{-3}$	"micro"$=10^{-6}$	n="nano"$=10^{-9}$	"pico"$=10^{-12}$	J=joule	m=Meter

1. A battery with an internal resistance of 0.5Ω is connected to a 10Ω resistor. If the voltage across the battery (the terminal voltage) is 20 Volts, what is the EMF of the battery (in Volts)?

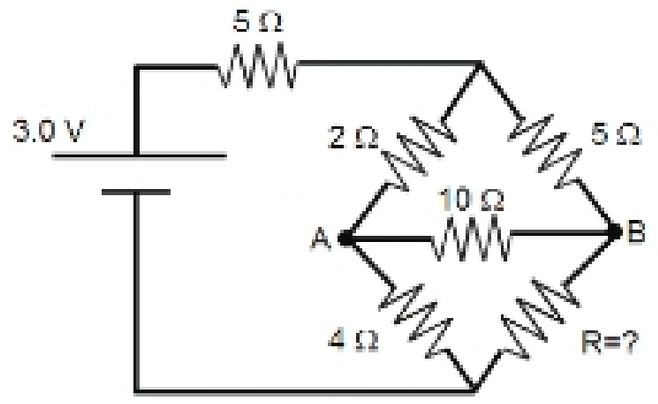
(1) 21 (2) 20 (3) 19 (4) 24 (5) 22

2. If $\Delta V = 6$ V and if the resistor R in the figure dissipates 12 W of power, what is R (in Ω)?



(1) 3 (2) 2 (3) 5 (4) 72 (5) 24

3. For what value of the resistor R will there be no current flowing through the 10Ω resistor shown in the figure? (HINT: If there is no current flowing through the 10Ω resistor, what is the potential difference between points A and B?



(1) 10Ω
(2) 5Ω
(3) 15Ω
(4) 30Ω
(5) 4Ω

4. A negatively charged particle enters a region of uniform magnetic field which points in the positive x-direction. If it experiences a magnetic force in the positive y-direction, its velocity must be:

(1) in the negative z direction
(2) in the positive z direction
(3) in the positive x direction
(4) in the negative x direction
(5) in the positive y direction

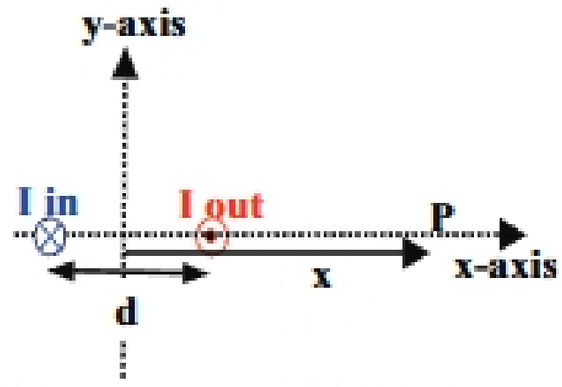
5. An electron (charge $q = -1.6 \times 10^{-19}$C) is undergoing uniform circular motion with a radius $R = 2 \times 10^{-8}$m produces a magnetic field at the center of the circle with a magnitude of 0.8 microTesla. What is the speed of the electron (in km/s)?

(1) 20 (2) 10 (3) 40 (4) 5 (5) 5,000

6. Two particles are undergoing circular motion in a uniform magnetic field that is perpendicular to their velocities. Particle 1 has a charge of 0.1 C, a mass of 2 grams, and a radius for its circular motion of 0.5 m. Particle 2 has a charge of 0.2 C, a mass of 4 grams, and a radius for its circular motion of 2 m. If it takes particle 1 one second to make one complete revolution, how long (in s) does it take particle 2 to make one complete revolution?

(1) 1 (2) 2 (3) 0.5 (4) 4 (5) 8

7. Two infinitely long parallel wires lie in the xz-plane and are located at $x = -d/2$ and $x = d/2$ as shown. The left wire ($x = -d/2$) carries a current I (into the page), while the right wire ($x = d/2$) carries a same current I (out of the page). What is the y-component of the magnetic field on the x-axis at $x = d$? (Note that $k_0 = \mu_0/(4\pi)$.)

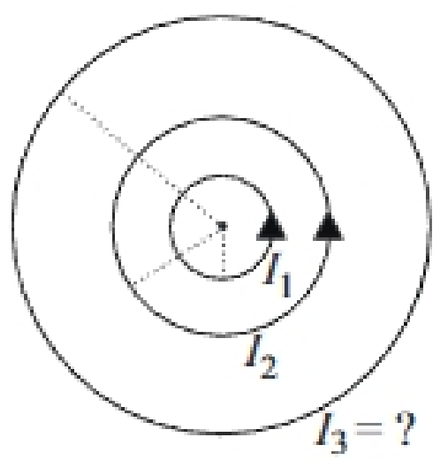


(1) $8k_0I/(3d)$ (2) $-8k_0I/(3d)$ (3) $8k_0I/d$ (4) $-8k_0I/d$ (5) zero

8. In the previous problem, what is the y-component of the magnetic field on the x-axis at $x = 0$?

(1) $-8k_0I/d$ (2) $8k_0I/(3d)$ (3) $-8k_0I/(3d)$ (4) $8k_0I/d$ (5) zero

9. Three circular concentric loops of wire, each having 10 turns, are shown in the figure. The inner loop has a radius of 10 cm, the middle loop has a radius of 20 cm, and the outer loop has a radius of 35 cm. The current in the inner loop is $I_1 = 2.0$ A and the current in the middle loop is $I_2 = 4$ A. Both the inner and middle loop currents are traveling in a counterclockwise direction. What is the current I_3 (magnitude and direction) in the outer loop if the magnetic field at the center is 1.8×10^{-4}T directed into the page?



(1) 24.0 A, clockwise
(2) 8.5 A, clockwise
(3) 14.0 A, counterclockwise
(4) 8.5 A, counterclockwise
(5) 32.0 A, clockwise

10. Two parallel long wires separated by a distance d carry the same current and repel each other with a force F per unit length. If both these currents are doubled and the wire separation is increased to $4d$, the force per unit length is now:

(1) F (2) $4F$ (3) $2F$ (4) $F/2$ (5) $F/4$

11. Compute the self inductance in a coil that experiences a 20 V induced EMF when the current is changing at a rate of 100 A/s.

(1) 200 mH (2) 0.2 mH (3) 50 mH (4) 5.0 H (5) 32 mH

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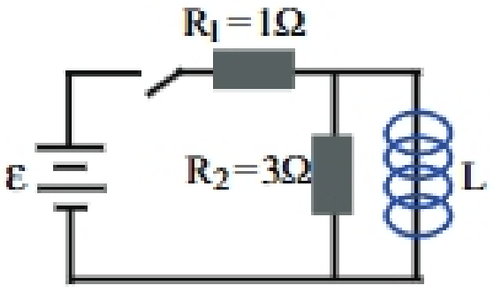
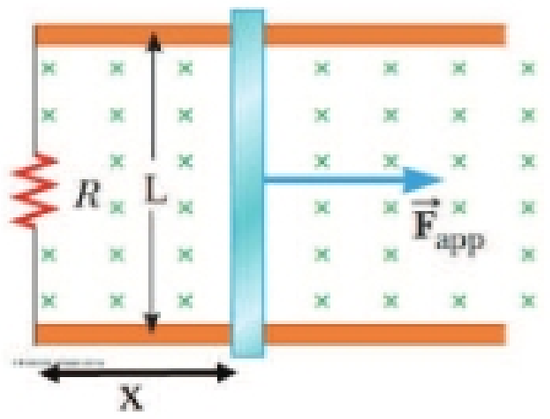
12. Consider the RL circuit shown in the figure. The switch is closed at time $t = 0$? A current, I_{short}, passes through resistor R_1 immediately after the switch is closed (*i.e.*, $t \ll \tau$) and a current, I_{long}, passes through resistor R_1 a long time after the switch is closed (*i.e.*, $t \gg \tau$). What is the ratio $I_{\text{long}}/I_{\text{short}}$?



(1) 4 (2) 3 (3) 2 (4) 0.25 (5) 0.5

13. A conducting bar with mass $M = 10$ kg can slide with no friction along two conducting rails separated by distance $L = 0.5$ m, as shown in the figure. A uniform 5 Tesla magnetic field points into the page, as indicated by crosses. An external force F_{app} pulls the bar to the right with a constant acceleration $a = 2$ m/s^2. The bar starts from rest at $x = 0$ at $t = 0$. What is the magnitude and direction of the induced current in the $R = 0.5$ Ohm resistor at time $t = 2$ seconds?



(1) 20 Amps counter-clockwise
(2) 20 Amps clockwise
(3) 10 Amps clockwise
(4) 10 Amps counter-clockwise
(5) 40 Amps counter-clockwise

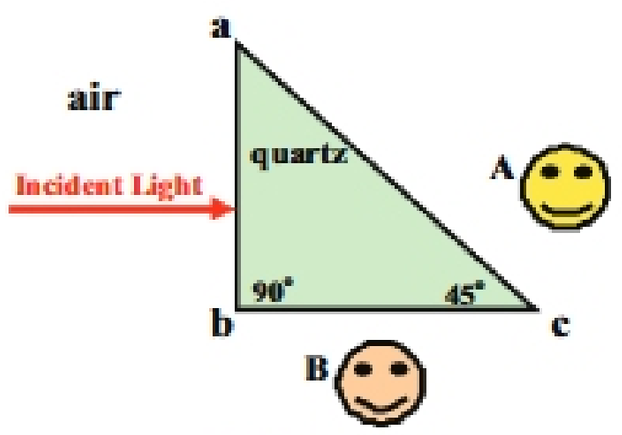
14. In the previous problem, what is the magnitude of the external force F_{app} (in N) at time $t = 2$ seconds?

(1) 70 (2) 50 (3) 20 (4) 30 (5) 45

15. The sun has a mass of 1.99×10^{30}kg, a radius of 6.96×10^{8}m, and a radiation power of 3.90×10^{26}W. What is the intensity of the electromagnetic radiation (in kW/m^2) at the surface of the sun?

(1) 6.4×10^4 (2) 1,020 (3) 1.6×10^4 (4) 6,400 (5) 1.6×10^5

16. In general the index of refraction of quartz depends on the wavelength of the light. Suppose that a ray of light is incident normally of face ab of a quartz prism in the shape of an equilateral right triangle as shown with an index of refraction of the quartz that is inversely proportional to the wavelength, λ, of the light as given by the formula $n = a/\lambda$, with $a = 735$ nm. If the incident light is blue with wavelength $\lambda_{\text{blue}} = 400$ nm, will the light be seen by observer A or observer B and what is the angle (in degrees) between the light ray entering the quartz and the light ray that exits the quartz?



(1) B, 90 (2) A, 90 (3) B, 15 (4) A, 15 (5) B, 45

17. In the previous problem, if the incident light is red with wavelength $\lambda_{\text{red}} = 600$ nm, will the light be seen by observer A or observer B and what is the angle (in degrees) between the light ray entering the quartz and the light ray that exits the quartz?

(1) A, 15 (2) A, 60 (3) B, 15 (4) B, 90 (5) A, 90