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PHYSICS DEPARTMENT

PHY 2049, Spring 2012 Midterm 2 March 27, 2012

Name (print): ______________________ 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.

DIRECTIONS

(1) **Code your test number on your answer sheet (use 76–80 for the 5-digit number)**. Code your name on your answer sheet. **Darken circles completely (errors can occur if too light)**. Code your student 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. 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 with scratch work.
(4) Work the questions in any order. Incorrect answers are not taken into account in any way; you may guess at answers you don't know.
(5) If you think that none of the answers is correct, please choose the answer given that is closest to your answer.
(6) **Blacken the circle of your intended answer completely, using a number 2 pencil**. Do not make any stray marks or the answer sheet may not read properly. Completely erase all incorrect answers, or take a new answer sheet.
(7) As an aid to the examiner (and yourself), in case of poorly marked answer sheets, please circle your selected answer on the examination sheet. Please remember, however, that in the case of a disagreement, the answers on the bubble sheet count, NOT what you circle here. Good luck!!!

>>>>>>>>**WHEN YOU FINISH** <<<<<<<<
Hand in the answer sheet separately.

Constants		
$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$	$m_p = 1.67 \times 10^{-27}$ kg	$m_e = 9.11 \times 10^{-31}$ kg
$e = 1.6 \times 10^{-19}$ C	$k = 9 \times 10^9$ N m^2/C^2	$\epsilon_0 = 8.85 \times 10^{-12}$ F/m
$\mu_0 = 4\pi \times 10^{-7}\ T \cdot A/m$	$c = 3 \times 10^8$ m/s	$g = 9.8$ m/s^2

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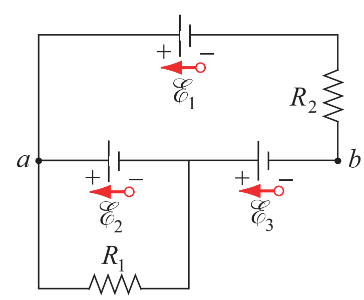
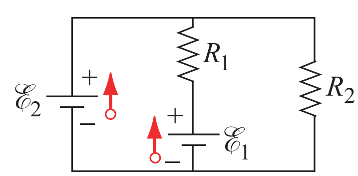
1. In the circuit shown, $R_1 = 100\,\Omega$, $R_2 = 25\,\Omega$, and the ideal batteries have EMFs of $\varepsilon_1 = 6.0$ V, $\varepsilon_2 = 3.0$ V, and $\varepsilon_3 = 1.5$ V. What is the magnitude of the current flowing through resistor R_2?



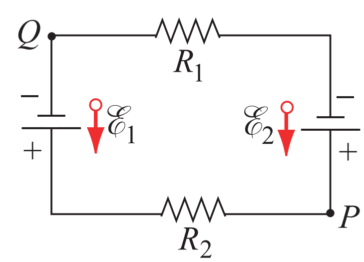
(1) 60 mA
(2) 30 mA
(3) 40 mA
(4) 20 mA
(5) 240 mA

2. In the circuit shown, $R_1 = 15\,\Omega$, $R_2 = 60\,\Omega$, and the ideal batteries have EMFs of $\varepsilon_1 = 4.0$ V and $\varepsilon_2 = 9.0$ V. What is the magnitude of the current flowing through resistor R_1?



(1) 0.3 A (2) 0.15 A (3) 0.5 A (4) 0.9 A (5) 0.08 A

3. In the circuit shown, the ideal batteries have EMFs of $\varepsilon_1 = 12$ V and $\varepsilon_2 = 6$ V and the resistances are $R_1 = 30\,\Omega$ and $R_2 = 10\,\Omega$. If the potential at Q is defined to be 4.5 V, what is the potential at P?



(1) 15.0 V
(2) 10.5 V
(3) 6.0 V
(4) 24.0 V
(5) −10 V

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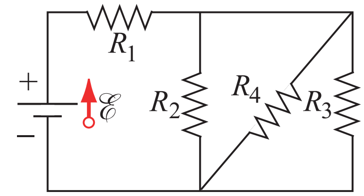
4. In the shown figure, $R_1 = R_2 = R_3 = 50\,\Omega$, $R_4 = 100\,\Omega$, and the ideal battery has EMF $= 6$ V. What is the equivalent resistance of the circuit?

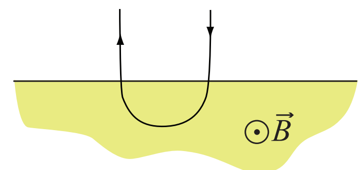


(1) $70\,\Omega$ (2) $120\,\Omega$ (3) $20\,\Omega$ (4) $90\,\Omega$ (5) $250\,\Omega$

5. A capacitor with an initial potential difference of 50 V is discharged through a $10^6\,\Omega$ resistor when a switch between them is closed at $t = 0$. At $t = 2$ s, the potential difference across the capacitor is 25 V. What is the capacitance of the capacitor?

(1) 2.9×10^{-6} F (2) 2.0×10^{-6} F (3) 3.5×10^{5} F (4) 3.5×10^{-7} F (5) 0.5 F

6. An ion of charge $q = +2e$ and unknown mass is sent into a region with a uniform magnetic field of magnitude $B = 0.5$ T as shown in the figure. The charged ion makes a U-turn in the region of the magnetic field as a semicircle of radius 1 m and exits after a time $t = 7.8 \times 10^{-6}$ s. What is the mass of the ion in kg?



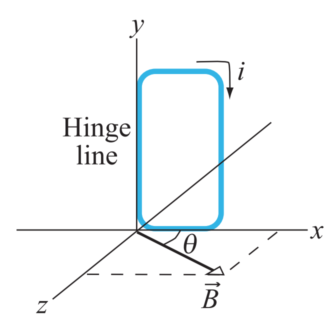
(1) 4.0×10^{-25} (2) 1.6×10^{-19} (3) 2.0×10^{-25} (4) 1.2×10^{-24} (5) 1.0×10^{-25}

7. A beam of electrons ("cathode rays") with a velocity of $\vec{v} = 3.0 \times 10^7\,\hat{\imath}$ m/s is sent into a region where there is a uniform magnetic field of $\vec{B} = 5.0 \times 10^{-4}\,\hat{\jmath}$ T. What electric field $\vec{E}$ is necessary (direction and magnitude) so that the electrons continue traveling in a straight line without deflection by the magnetic field?

(1) $-1.5 \times 10^4\,\hat{k}$ T (2) $1.5 \times 10^4\,\hat{k}$ T (3) $5.0 \times 10^{-4}\,\hat{\jmath}$ T (4) $-5.0 \times 10^{-4}\,\hat{\jmath}$ T (5) $2.4 \times 10^{-15}\,\hat{\imath}$ T

8. The figure shows a rectangular loop of wire of dimensions 10 cm by 5.0 cm. It carries a current of 0.2 A and it is hinged along one long side. It is mounted in the xy plane, and it makes an angle of $\theta = 30°$ to the direction of a uniform magnetic field of 0.25 T. What is the magnitude of the torque acting on the loop about the hinge line?

(1) 2.2×10^{-4} N·m
(2) 1.3×10^{-4} N·m
(3) 5.0×10^{-3} N·m
(4) 1.0×10^{-3} N·m
(5) 0 N·m



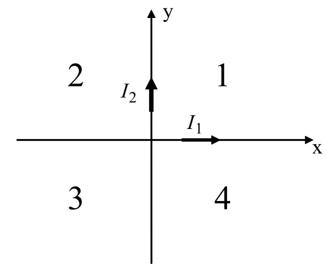
9. A magnetic field CANNOT:

(1) change the kinetic energy of a charge
(2) exert a force on a charge
(3) accelerate a charge
(4) change the momentum of a charge
(5) exist

10. An electron moves in the $-\hat{\imath}$ direction, through a uniform magnetic field in the $-\hat{\jmath}$ direction. The magnetic force on the electron is in the direction:

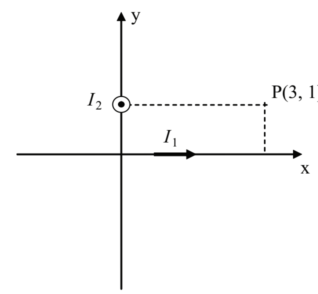
(1) $-\hat{k}$ (2) $\hat{k}$ (3) $-\hat{\jmath}$ (4) $\hat{\jmath}$ (5) $-\hat{\imath}$

11. Two wires are aligned with the x- and y-axes and carry currents I_1 along the x-axis and I_2 along the y-axis as shown. Which of the four quadrants have points in the (x, y)-plane where the magnetic field is zero?



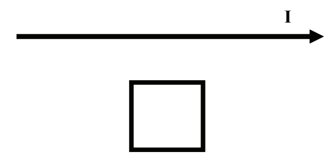
(1) 1 & 3
(2) 2 & 4
(3) all
(4) none
(5) the answer depends on the relative magnitudes of the two currents

12. One wire is aligned with the x-axis and carries current $I_1 = 1A$. Another wire carries current $I_2 = 2A$ out of the page through the point (x, y)=(0 m, 1 m) as shown. What is the magnitude of the magnetic field in Tesla at point P(3 m, 1 m)?



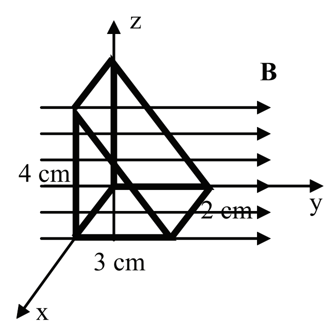
(1) 2.4×10^{-7}
(2) 3.3×10^{-7}
(3) 6.7×10^{-8}
(4) 1.5×10^{-6}
(5) 4.2×10^{-7}

13. A current I through an infinitely long wire increases. A square loop made of a conductor is placed next to the wire carrying the current as shown (the loop and the wire are in the plane of the sheet). What is the direction of a net force exerted on the loop?



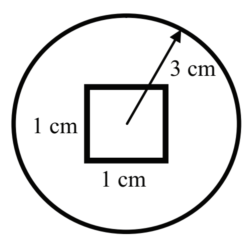
(1) down (2) up (3) out of the page (4) into the page (5) zero

14. A prism with sides 2, 3, 4 cm is placed in uniform magnetic field of 1 T pointing along the y-direction (see drawing). Find the magnetic field flux (in Webbers) through the entire surface area of the prism.



(1) 0
(2) 10×10^{-4}
(3) 8×10^{-4}
(4) 18×10^{-4}
(5) 16×10^{-4}

15. A square, single-turn wire loop 1 cm on a side is placed inside a solenoid that has a circular cross section of radius 3 cm, as shown. The solenoid is 20 cm long and wound with 1000 turns of wire carrying a current of 3 A. If the current in the solenoid is reduced to zero in 0.3 s, find the magnitude of the average induced emf in the loop.

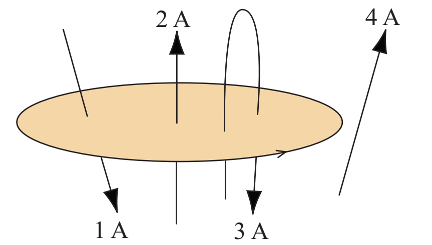


(1) 6.3μV (2) 0.63μV (3) 35μV (4) 18μV (5) 1.3μV

16. A 25-turn circular coil of wire has a diameter of 1 m. It is placed with its axis along the direction of Earth's magnetic field of 50μT. Then, the coil is flipped 180° in 0.2 s. An average emf of what magnitude is generated in the coil?

(1) 9.8 mV (2) 4.9 mV (3) 0.39 mV (4) 0.20 mV (5) 1.6 mV

17. There are a number of wires in space carrying different currents (see figure). What is the result of integrating the **B**-field along a circular path of radius $r = 1$ m in the direction as shown in figure?



(1) 1.3×10^{-6} Tm
(2) -1.3×10^{-6} Tm
(3) 1.2×10^{-7} Tm
(4) -1.2×10^{-7} Tm
(5) -6.5×10^{-8} Tm

18. A uniform magnetic field $\vec{B}$ is perpendicular to the plane of a N-turn circular wire loop of radius r. The magnitude of the field varies with time according to $B = B_0\, e^{-t/\tau}$, where B_0 and τ are constants. Find an expression for the EMF magnitude in the loop as a function of time.

(1) $\dfrac{\pi r^2 B_0 N}{\tau}\, e^{-t/\tau}$ (2) $\dfrac{\pi r^2 B_0 N}{\tau}\,(1 - e^{-t/\tau})$ (3) $\pi r^2 B_0 N \tau\, e^{-t/\tau}$ (4) $\pi r^2 B_0 N \tau\,(1 - e^{-t/\tau})$ (5) $\pi r^2 B_0 N \tau$

19. One of the experiments at the Large Hadron Collider is using a superconducting solenoid of 6 m in diameter and 12 m in length. Once energized, the solenoid has a 4-T magnetic field inside. Calculate total the stored energy in the magnetic field inside the solenoid.

(1) 2 GJ (2) 300 MJ (3) 10 MJ (4) 500 kJ (5) 40 kJ

20. A fuse of zero resistance, an inductor with inductance L=5 H, a battery with *emf* $\mathcal{E}$=10 V, and a switch are connected in series and make one loop. If the current through the fuse reaches the maximum allowed $I_{\max} = 3$ A, the fuse "blows" and thereafter has infinite resistance. The switch is initially open and closes at time $t = 0$ s. How long will it take since closing the switch till the fuse blows?

(1) 1.5 s (2) 0.06 s (3) 17 s (4) 6 s (5) 0.17 s