Instructor(s): *Profs. Korytov, Takano*

PHYSICS DEPARTMENT

PHY 2049, Fall 2016 Midterm 2 November 8, 2016

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

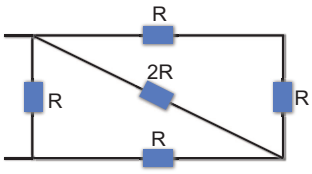
(1) **Code your test number on your answer sheet (use 76–80 for the 5-digit number)**. Code your name on your answer sheet. **Darken circles completely (errors can occur if too light)**. Code your student number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) Do all scratch 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.

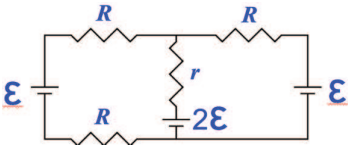
Constants			
$e = 1.6 \times 10^{-19}$ C	$m_p = 1.67 \times 10^{-27}$ kg	$m_e = 9.1 \times 10^{-31}$ kg	$\epsilon_o = 8.85 \times 10^{-12}$ C^2/N·m^2
milli (m) $= 10^{-3}$	micro (μ) $= 10^{-6}$	nano (n) $= 10^{-9}$	pico (p) $= 10^{-12}$
$k = 1/(4\pi\epsilon_o) = 9 \times 10^9$ N·m^2/C^2		$\mu_0 = 4\pi \times 10^{-7}$ T·m/A	
Sphere: $A = 4\pi R^2$ $V = \frac{4\pi}{3}R^3$			

1. Find the equivalent resistance of the five resistors, connected as shown in the figure.



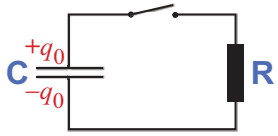
(1) 2R/3 (2) R/2 (3) 3R/4 (4) R/3 (5) R/4

2. Find the current through resistor r in the circuit shown in the figure ($\mathcal{E} = 5$ V, $R = 5\ \Omega$, $r = 5\ \Omega$).



(1) 0.6 A (2) 0.2 A (3) 0.4 A (4) 0.8 A (5) 0

3. In the RC circuit shown in the figure, the switch is closed at time $t = 0$. At what time does the power dissipated in the resistor become half the power dissipated right after closing the switch? $C = 1\ \mu$F, $R = 1$ kΩ, $q_0 = 1\ \mu$C.

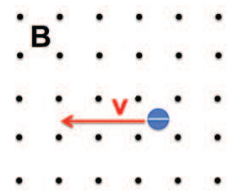


(1) 0.35 ms (2) 0.70 ms (3) 0.50 ms (4) 1.00 ms (5) 0.25 ms

4. A battery with a 5 V emf and an internal resistance of $1\,\Omega$ is connected to a resistor with resistance $5\,\Omega$. What is the power dissipated in the *battery*?

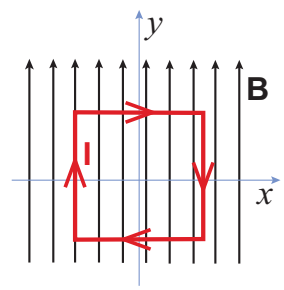
(1) 0.7 W (2) 3.5 W (3) 0.13 W (4) 25 W (5) 5.0 W

5. An electron (negative charge!) moves to the left in magnetic field B pointing out of the page, as shown in the figure. What is the direction of the force experienced by the electron?



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

6. A square loop with current I flowing clockwise is placed in magnetic field B pointing up, as shown in the figure. How would the loop "want" to turn?



(1) around the x axis
(2) around the y axis
(3) clockwise in the (x, y) plane
(4) counterclockwise in the (x, y) plane
(5) the loop is in equilibrium

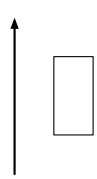
7. In a certain mass spectrometer, an ion beam is accelerated in a gap with electric field. The potential difference across the gap is kept at V. After passing the gap, ions enter a space of uniform magnetic field B oriented normal to the beam direction. The radius of curvature of the ion trajectory in the magnetic field is proportional to:

(1) $\frac{\sqrt{V}}{B}$ (2) $\sqrt{\frac{V}{B}}$ (3) $\frac{V}{\sqrt{B}}$ (4) $\sqrt{VB}$ (5) $\frac{B}{\sqrt{V}}$

8. A magnetic dipole is in a uniform magnetic field. The dipole experiences a torque of 20×10^{-24} Nm. The potential energy of the dipole is 15×10^{-24} J. What is the angle between the dipole and the magnetic field (in degrees)?

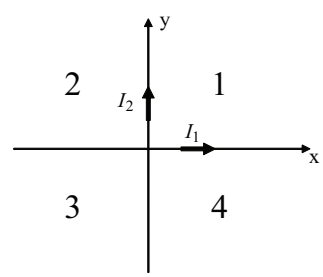
(1) 127 (2) 37 (3) not enough information (4) 143 (5) 61

9. As shown in the figure, a long wire carries a current of 12 A in the direction shown. What is the net force acting on the rectangular wire loop having dimensions 4 cm × 8 cm, current 2A, and whose closest distance to the wire is 4 cm (in μN)?



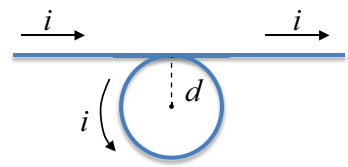
(1) 4.8 (2) 2.4 (3) 14.4 (4) 7.2 (5) 0

10. 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 at which 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

11. Part of a long, straight insulated wire carrying current i is bent into a circular section of radius d as shown in the figure. What is the magnitude of the magnetic field at the center of the circular section if both straight and curved sections lie in the plane of the page as shown?



(1) $\frac{\mu_0 i}{2\pi d}(\pi - 1)$ (2) $\frac{\mu_0 i}{2\pi d}(\pi + 1)$ (3) $\frac{\mu_0 i}{2\pi d}$ (4) $\frac{\mu_0 i}{2d}$ (5) 0

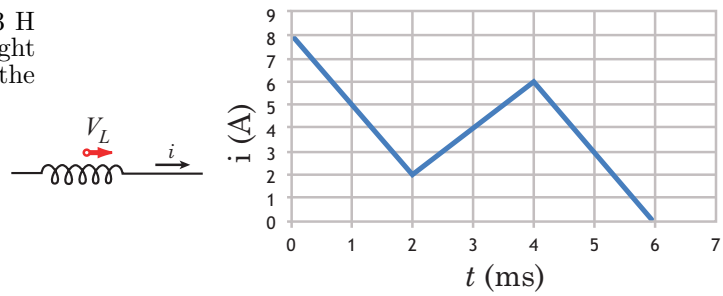
12. To create a magnetic field of 2.0 T inside a solenoid of length 50 cm and radius 1.0 cm, how many windings are required if the current in the wire is 100 A?

(1) 8,000 (2) 1,600 (3) 16,000 (4) 80,000 (5) 160,000

13. The number of turns is tripled for an ideal solenoid, and its length is doubled, while holding its cross-sectional area constant. If the old inductance is L, what is the new inductance?

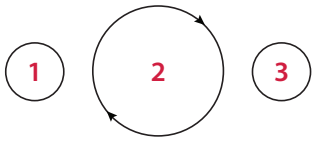
(1) $9L/2$ (2) $3L/2$ (3) $2L/3$ (4) $9L/4$ (5) $3L/4$

14. The current through an inductor with inductance $L = 0.3$ H is shown by the graph, with the direction from left to right through the inductor as shown. What is the emf across the inductor ($V_L = V_{\text{right}} - V_{\text{left}}$), including sign, at $t = 1$ ms?



(1) 900 V (2) −900 V (3) 1500 V (4) −750 V (5) −2 V

15. Three circular loops of conductors are placed on the page, as shown in the figure. The current in the large loop, loop 2, is in the clockwise direction and increasing. What is the direction of the induced current in loop 1 and in loop 3, respectively?



(1) clockwise, clockwise
(2) clockwise, counterclockwise
(3) counterclockwise, counterclockwise
(4) counterclockwise, clockwise
(5) no induced current

16. A tightly wound circular coil of 8 turns has a radius of 6 cm. The coil rotates around an axis along the diameter at frequency $f = 55$ Hz inside a solenoid of radius 18 cm. The magnetic field produced by the solenoid is 4.2 T. If the coil has a resistance of $0.067\,\Omega$, what is the rms current induced in the coil in amps?

(1) 1,390 (2) 330 (3) 173 (4) 12,500 (5) 560

17. An LC circuit has a capacitance of $100\,\mu$F and an inductance of 10 mH. At time $t = 0$ the charge on the capacitor is $1\,\mu$C and the current in the circuit is 1 mA. What is the maximum charge on the capacitor at a later time, in μC?

(1) 1.4 (2) 2.1 (3) 2.8 (4) 3.5 (5) 4.2

18. The amplitudes of oscillations in an RLC circuit decrease by a factor of two in 1 ms. If one doubles the resistance R, inductance L, and capacitance C at the same time, how long will it take now for the amplitudes of oscillations in the new circuit to decrease by a factor of two?

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

19. An RLC circuit ($R = 50\,\Omega$, $L = 100$ mH, $C = 20$ μF) is connected to alternating emf $\mathcal{E}(t) = \mathcal{E}_m \sin(\omega_d t)$, where $\mathcal{E}_m = 300\,\mathrm{V}$ and $\omega_d = 1000\ \mathrm{s}^{-1}$. What is the amplitude of the oscillating current in the circuit?

(1) 4.2 A (2) 6.0 A (3) 3.3 A (4) 2.1 A (5) 1.4 A

20. A capacitor of capacitance $C = 10$ μF is connected to a power outlet in the U.S. ($V_{rms} = 110$ V, $f = 60$ Hz) and the resulting rms current i_{rms}^{US} is measured. When the same capacitor is connected to a power outlet in UK ($V_{rms} = 220$ V, $f = 50$ Hz), the resulting rms current is i_{rms}^{UK}. What is the ratio of the two rms currents, $i_{rms}^{\mathrm{US}}/i_{rms}^{\mathrm{UK}}$?

(1) 0.6 (2) 0.5 (3) 1.0 (4) 1.2 (5) 1.7