 77777

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

PHYSICS DEPARTMENT

PHY 2049, Spring 2016 | Midterm 2 | March 28, 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.

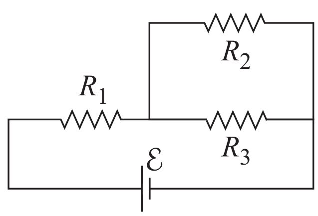
DIRECTIONS

(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.

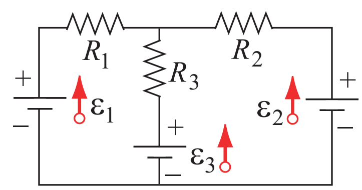
Constants			
$e = 1.6 \times 10^{-19}$ C	$m_p = 1.67 \times 10^{-27}$ kg	$m_e = 9.1 \times 10^{-31}$ kg	$\epsilon_o = 8.85 \times 10^{-12}$ C^2/N·m^2
milli (m) $= 10^{-3}$	micro (μ) $= 10^{-6}$	nano (n) $= 10^{-9}$	pico (p) $= 10^{-12}$
$k = 1/(4\pi\epsilon_o) = 9 \times 10^9$ N·m^2/C^2		$\mu_0 = 4\pi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

1. In the figure, $\mathcal{E} = 18.0$ V, $R_1 = 2.0$ kΩ, $R_2 = 6.0$ kΩ, and $R_3 = 12.0$ kΩ. What is the power dissipated in R_2, in mW?



(1) 24
(2) 56
(3) 74
(4) 12
(5) 35

2. In the figure, $\mathcal{E}_1 = 3.0$ V and $\mathcal{E}_2 = \mathcal{E}_3 = 1.5$ V. All the resistors are 2.0 kΩ. What is the magnitude of the current flowing through resistor 3, in mA?

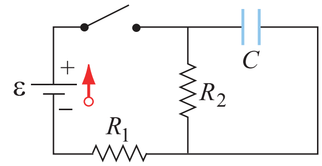


(1) 0.25
(2) 0.40
(3) 0.10
(4) 0.050
(5) 0.025

3. A capacitor with an initial potential difference of 15 V is discharged through a resistor when a switch between them is closed at $t = 0$. At $t = 1.0$ s, the potential difference across the capacitor is 1.5 V. What is the potential difference across the capacitor at $t = 2.0$ s?

(1) 150 mV (2) 120 mV (3) 0 (4) 90 mV (5) 30 mV

4. In the figure, $\mathcal{E} = 6.0$ V, $C = 150\ \mu$F, $R_1 = 1.0$ kΩ, and $R_2 = 2.0$ kΩ. At $t = 0$ the switch is closed. After a long enough time for the capacitor to become fully charged, what will be its final charge, in coulombs?



(1) 6.0×10^{-4} (2) 9.0×10^{-4} (3) 1.5×10^{-1} (4) 3.0×10^{-1} (5) 2.5×10^{-2}

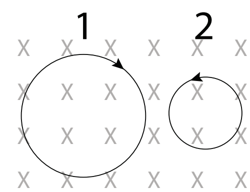
5. A horizontal power line carries a current of 3.0 kA from north to south. Earth's magnetic field of magnitude 60 μT is directed toward the north and is inclined downward from horizontal at an angle of 30°. What is the magnitude of the magnetic force, per unit length, on the power line?

(1) 0.090 N/m (2) 0.18 N/m (3) 0 (4) 0.062 N/m (5) 0.034 N/m

6. In the above problem, what is the direction of the force?

(1) east (2) west (3) up (4) down (5) none of the others

7. A uniform magnetic field is going into the plane of the page. Two charged particles move in circles in the plane of the page, as shown in the figure. The particles have the same speed and the same magnitude of charge, $|q|$, but they move in the opposite directions, as indicated by arrows. Which of the following is true about the charge of particle 1, q_1, and the masses, m_1 of particle 1 and m_2 of particle 2?



(1) $q_1 < 0$, $m_1 > m_2$ (2) $q_1 < 0$, $m_1 < m_2$ (3) $q_1 > 0$, $m_1 > m_2$ (4) $q_1 > 0$, $m_1 < m_2$ (5) $q_1 > 0$, $m_1 = m_2$

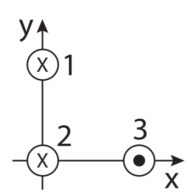
8. A circular loop of radius 0.1 m, carrying a current of 0.2 A, is placed in a uniform magnetic field of 0.8 T. What is the work required to flip the loop from its lowest-energy orientation to its highest-energy orientation?

(1) 10 mJ (2) 0.16 J (3) 20 mJ (4) 80 mJ (5) 0

9. A proton traveling at 23 m/s in the $+y$ direction enters a region of space in which there is a uniform electric field of 41 N/C pointing in the $-x$ direction. To keep the proton moving on a straight line without deflection, how large a magnetic field (in tesla) must be applied and what is its direction?

(1) 1.8, $+z$ direction (2) 1.8, $+x$ direction (3) 940, $+z$ direction (4) 940, $-y$ direction (5) 940, $+x$ direction

10. Three long straight wires run perpendicular to the plane of the page and carry currents in the directions indicated in the figure. Wire 1 passes the y axis of the plane at $y = 2.0$ m, wire 2 goes through the origin, and wire 3 passes the x axis at $x = 2.0$ m. If the magnitudes of the currents in wires 1, 2, and 3 are $i_1 = 1.0$ A, $i_2 = 2.0$ A, and $i_3 = 3.0$ A, respectively, what is the magnitude of the force per unit length on wire 2 due to the other two wires?



(1) 6.3×10^{-7} N/m (2) 8.0×10^{-7} N/m (3) 5.1×10^{-7} N/m (4) 4.0×10^{-7} N/m (5) 2.7×10^{-7} N/m

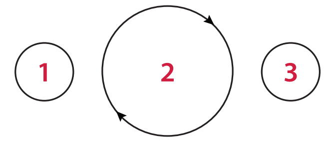
11. To create a magnetic field of 2.0 T inside a solenoid of length 50 cm and radius 1.0 cm, how many windings are required if the current in the wire is 100 A?

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

12. A uniform current flows through a straight wire with circular cross section of radius R. At what distance from the center of the wire is the magnitude of the magnetic field one half of the magnetic field at the surface of the wire?

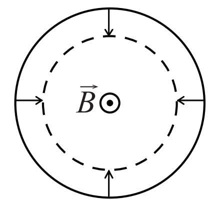
(1) $R/2$ and $2R$ (2) $R/2$ and $\sqrt{2}R$ (3) only $2R$ (4) only $\sqrt{2}R$ (5) only $4R$

13. 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?



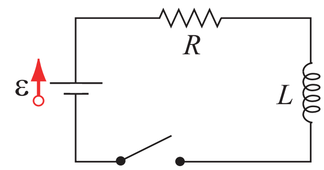
(1) clockwise, clockwise
(2) clockwise, counterclockwise
(3) counterclockwise, counterclockwise
(4) counterclockwise, clockwise
(5) no induced current

14. A circular conducting loop is placed in a uniform 1.0-tesla magnetic field pointing out of the page, as shown. If the loop suddenly contracts from its initial radius of 0.3 m with a radial velocity of $dr/dt = -0.2$ m/s, what is the magnitude and direction of the induced current immediately after the loop starts contracting? Assume that the resistance of the loop, 0.1 Ω, is not affected by the contraction.



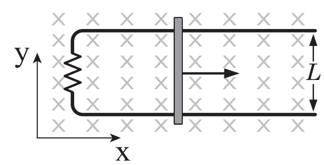
(1) 3.8 A counterclockwise (2) 3.8 A clockwise (3) 1.9 A counterclockwise (4) 1.9 A clockwise (5) 0

15. In the RL circuit shown, the component values are $R = 5.0\ \Omega$, $L = 10.0$ mH, and $\mathcal{E} = 9.0$ V. If the switch is closed at $t = 0$, what is the magnitude of the self-induced emf in the inductor at 3.0 ms?



(1) 2.0 V (2) 12.0 V (3) 9.0 V (4) 5.0 V (5) 0

16. The figure shows a rod that is forced to move at constant speed $v = 2.0$ m/s along the horizontal rails, which are separated by distance $L = 10$ cm. The rod, rails, and connecting resistor at the left form a conducting loop. The resistor has a resistance $R = 0.5\ \Omega$; the rest of the loop has negligible resistance. The entire apparatus is placed in a uniform 0.80 T magnetic field pointing into the page. What is the direction (the $+y$ or $-y$ direction) and value of the induced current *through the resistor*?



(1) $-y$, 0.32 A (2) $+y$, 0.32 A (3) $-y$, 32 A (4) $+y$, 32 A (5) no current

17. A capacitor in an LC oscillator has a maximum potential difference of 17 V and a maximum energy of 160 μJ. When the capacitor has a potential difference of 5 V, what is the energy stored in the magnetic field of the inductor, in μJ?

(1) 146 (2) 113 (3) 80 (4) 56 (5) 31

18. An alternating emf with an amplitude of 10 V and a frequency (not angular frequency!) of 60 Hz is applied across a 300 μF capacitor. What is the amplitude of the current through the emf source?

(1) 1.1 A (2) 65 A (3) 3.3 kA (4) 27 mA (5) 3.0 mA

19. Consider an RLC circuit with driving emf amplitude $\mathcal{E}_m = 12$ V, resistance $R = 4.0\ \Omega$, inductance $L = 20$ mH, and capacitance $C = 120\ \mu$F. Find the amplitude of the potential difference across the resistor *at resonance*.

(1) 12 V (2) 3.0 V (3) 60 V (4) 240 V (5) 600 V

20. An ideal transformer provides an output emf whose magnitude is 7 V and frequency 60 Hz, when the amplitude of the input is 175 V. If there are 700 primary windings around the transformer core, what is the number of secondary windings?

(1) 28 (2) 76 (3) 175 (4) 240 (5) 700

THE FOLLOWING QUESTIONS, NUMBERED IN THE ORDER OF THEIR APPEARANCE ON THE ABOVE LIST, HAVE BEEN FLAGGED AS CONTINUATION QUESTIONS: 6