Instructor(s): *Acosta/Woodard*

PHYSICS DEPARTMENT

PHY 2049, Fall 2015 Midterm 2 November 3, 2015

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			
$\epsilon_0 = 8.85 \times 10^{-12}$ F/m	$m_e = 9.11 \times 10^{-31}$ kg	$m_p = m_n = 1.67 \times 10^{-27}$ kg	$e = 1.6 \times 10^{-19}$ C
$k = 9 \times 10^9$ N m^2/C^2	$\mu_0 = 4\pi \times 10^{-7}$ T m/A	$N_A = 6.02 \times 10^{23}$ atoms/mole	$c = 3 \times 10^8$ m/s
m = milli = 10^{-3}	μ = micro = 10^{-6}	n = nano = 10^{-9}	p = pico = 10^{-12}

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1. Two light bulbs have resistances of 100Ω and 300Ω. They are connected in parallel across a 120 V line. What is the total power dissipated by the two bulbs?

(1) 192 W (2) 144 W (3) 48 W (4) 36 W (5) 75 W

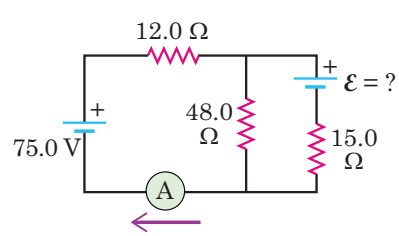
2. Two light bulbs have resistances of 100Ω and 300Ω. They are connected in parallel across a 120 V line. What is the power dissipated by the 100Ω bulb?

(1) 144 W (2) 192 W (3) 48 W (4) 36 W (5) 75 W

3. Two light bulbs have resistances of 100Ω and 300Ω. They are connected in parallel across a 120 V line. What is the total power dissipated by the 300Ω bulb?

(1) 48 W (2) 144 W (3) 192 W (4) 36 W (5) 75 W

4. In the circuit shown in the figure both batteries have insignificant internal resistance and the idealized ammeter reads 4.0 A in the direction shown. Find the emf of the battery (a negative answer indicates that the emf polarity is opposite to what is shown).

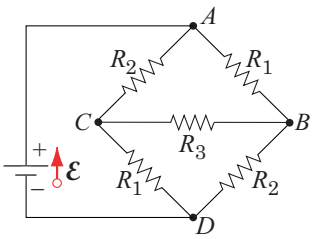


(1) −25 V (2) 68 V (3) −79 V (4) 79 V (5) 25 V

5. A capacitor with an initial potential difference of 150 V is discharged through a resistor when a switch between them is closed at $t = 0$ s. At $t = 10.0$ s, the potential difference across the capacitor is 1.5 V. What is the potential difference across the capacitor at $t = 20$ s?

(1) 15 mV (2) 60 mV (3) 2.2 mV (4) 0.1 mV (5) 750 mV

6. In the figure $\varepsilon = 14$ V, $R_1 = R_3 = 1\,\Omega$, and $R_2 = 2\,\Omega$. What is the potential difference $V_A - V_B$?

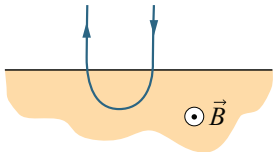


(1) 6 V
(2) 4 V
(3) 2 V
(4) 10 V
(5) 14 V

7. A proton travels through uniform magnetic and electric fields. The magnetic field is $\vec{B} = -2.50\hat{\imath}$ mT. At one instant the velocity of the proton is $\vec{v} = 2000\hat{\jmath}$ m/s. At that instant what is the net force acting on the proton if the electric field is $4.00\hat{k}$ V/m?

(1) $+14 \times 10^{-19}\hat{k}$ N (2) $-8.0 \times 10^{-19}\hat{k}$ N (3) $+6.6 \times 10^{-19}\hat{k}$ N (4) $-1.6 \times 10^{-19}\hat{k}$ N (5) zero

8. In the figure a charged particle moves into a region of uniform magnetic field $\vec{B}$, goes through half a circle, and then exits that region. The particle is either a proton or an electron (you must decide which). It spends 130 ns in the region. What is the magnitude of $\vec{B}$?

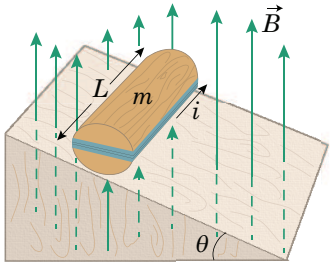


(1) 2.5×10^{-1} T (2) 2.8×10^{-4} T (3) 8.0×10^{-2} T (4) 4.4×10^{-5} T (5) Must have radius

9. In a certain cyclotron a proton moves in a circle of radius 0.5 m. The magnitude of the magnetic field is 1.2 T. What is the kinetic energy of the proton in million electron-volts (MeV)?

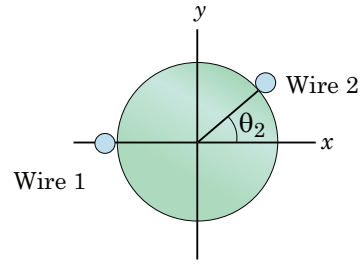
(1) 17 (2) 0.51 (3) 100 (4) 940 (5) 35

10. The figure shows a wood cylinder of mass $m = 0.250$ kg and length $L = 0.100$ m, with $N = 10$ turns of wire wrapped around it longitudinally, so that the plane of the wire contains the long central axis of the cylinder. The cylinder is released on a plane inclined at an angle θ to the horizontal, with the plane of the coil parallel to the incline plane. If there is a vertical uniform magnetic field of magnitude 0.500 T, what is the least current i through the coil that keeps the cylinder from rolling down the plane?



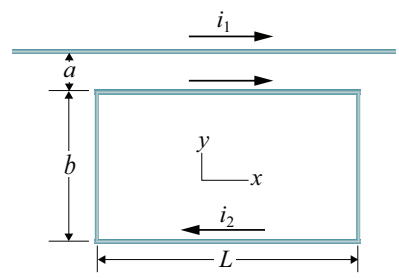
(1) 2.45 A (2) 24.5 A (3) Need to know θ (4) 4.90 A (5) 12.3 A

11. The figure shows, in cross section, two long straight wires held against a plastic cylinder of radius 20 cm. Wire 1 carries current $i_1 = 60$ mA out of the page and is fixed in place at the left side of the cylinder. Wire 2 carries current $i_2 = 40$ mA out of the page and can be moved around the cylinder. At what (positive) angle θ_2 should wire 2 be positioned such that, at the origin, the net magnetic field due to the two currents has magnitude 80 nT?



(1) 104 degrees (2) 76 degrees (3) 62 degrees (4) 48 degrees (5) 14 degrees

12. In the figure a long straight wire carries a current $i_1 = 30$ A and a rectangular loop carries current $1_2 = 20$ A. Take the dimensions to be $a = 1$ cm, $b = 8$ cm, and $L = 30$ cm. In unit vector notation, what is the force on the loop due to 1_1?



(1) $+3.2$ mN $\hat{j}$
(2) -0.4 mN $\hat{j}$
(3) $+3.6$ mN $\hat{j}$
(4) -3.2 mN $\hat{j}$
(5) -3.6 mN $\hat{j}$

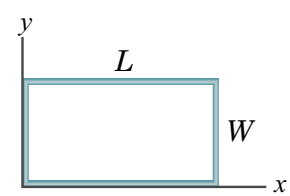
13. The current density $\vec{J}$ inside a long, solid, cylindrical wire of radius $a = 3.1$ mm is in the direction of the central axis, and its magnitude varies linearly with radial distance r from the axis according to $J = J_0 r/a$, where $J_0 = 310$ A/m^2. What is the magnitude of the magnetic field at $r = a/2$? You may need the Jacobian term $r\,dr\,d\theta$ for integration in polar coordinates.

(1) 100 nT (2) 8 nT (3) 300 nT (4) 24 nT (5) 400 nT

14. A solenoid that is 95 cm long has a radius 2.0 cm and a winding of 1200 turns; it carries a current of 3.6 A. What is the magnitude of the magnetic field inside the solenoid?

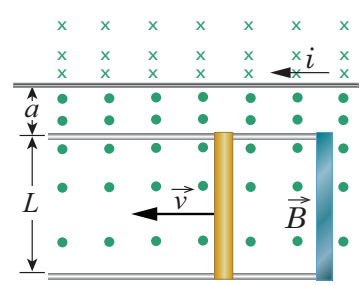
(1) 5.7 mT (2) 5.4 mT (3) 270 mT (4) 43 mT (5) 45 mT

15. A wire loop of lengths $L = 40$ cm and $W = 25$ cm lies in a magnetic field $\vec{B} = (0.08\ \text{T/m s})(y\,t)\,\hat{k}$. What are the magnitude and direction of the induced emf?



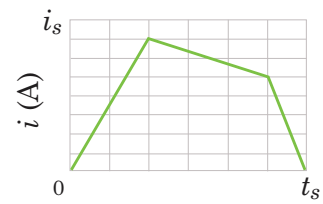
(1) 1 mV, clockwise (2) 1 mV, counter-clockwise (3) zero (4) 2 mV, clockwise (5) 2 mV, counter-clockwise

16. The figure shows a rod of length $L = 10$ cm that is forced to move at constant speed $v = 5$ m/s along the horizontal rails. The rod, rails and connecting strip at the right form a conducting loop. The rod has a resistance $R = 0.4\ \Omega$; the rest of the loop has negligible resistance. A current $i = 100$ A through the long straight wire at a distance $a = 10$ mm from the loop sets up a nonuniform magnetic field through the loop. At what rate (in μW) is thermal energy generated in the rod?



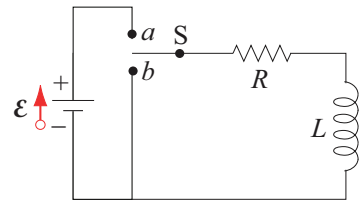
(1) 0.14 (2) 0.060 (3) 0.025 (4) 0.57 (5) 0.24

17. The current i through a 4.6 H inductor varies with time t as shown in the graph, where the vertical axis scale is set by $i_s = 8$ A and the horizontal axis scale is set by $t_s = 6$ ms. The inductor has a resistance of 12 Ω. What is the magnitude of the induced emf during the time interval 2 ms $< t <$ 5 ms?



(1) 3100 Volts (2) 72 Volts (3) 6100 Volts (4) 96 Volts (5) 3.1 Volts

18. The switch in the figure is closed on a at time $t = 0$. What fraction of the total voltage drop $\mathcal{E}$ occurs across the inductor at time $t = 2L/R$?



(1) 0.14
(2) 0.37
(3) 0.61
(4) 0.50
(5) 0.25

19. An LC circuit has a capacitance of 20 μF and an inductance of 10 mH. At time $t = 0$ the charge on the capacitor is 27 μC and the current is 80 mA. The maximum possible charge in μC is:

(1) 45 (2) 27 (3) 100 (4) 63 (5) 36

20. An LC circuit has a capacitance of 20 μF and an inductance of 10 mH. At time $t = 0$ the charge on the capacitor is 27 μC and the current is 80 mA. The maximum possible current in mA is:

(1) 100 (2) 27 (3) 45 (4) 63 (5) 36

21. A sinusoidally varying source of emf with an amplitude of 10 V and a cyclic frequency of 5 GHz is applied across a 100 μH inductor. What is the current amplitude through the inductor?

(1) 3.2×10^{-6} A (2) 2.0×10^{-5} A (3) 3.1×10^{7} A (4) 3.1×10^{5} A (5) 1×10^{5} A

22. A 218 Ω resistor, a 0.775 H inductor, and a 6.50 μF capacitor are connected in series across a sinusoidally varying source of emf that has voltage amplitude 31.0 V and a cyclic frequency of 37.5 Hz. What is the magnitude of the phase difference between the current in the resistor and the emf?

(1) 65° (2) 90° (3) 25° (4) 2.2° (5) 0°

23. A transformer connected to a 120 V (rms) AC line is to supply 12,000 V (rms) for a neon sign. To reduce shock hazard, a fuse is to be inserted in the primary circuit; the fuse is to blow when the rms current in the secondary circuit exceeds 3.0 mA. What current rating should the fuse in the primary circuit have?

(1) 300 mA (2) 3 mA (3) 30 μA (4) 36 mA (5) 900 mA

FOLLOWING GROUPS OF QUESTIONS WILL BE SELECTED AS ONE GROUP FROM EACH TYPE
TYPE 1
Q# S 1
Q# S 2
Q# S 3
TYPE 2
Q# S 19
Q# S 20