Physics 241
Exam 2
March 31, 2004

One (both sides) 8 1/2" x 11" crib sheet is allowed. It must be of your own creation.

$$k = \frac{1}{4\pi\varepsilon_0} = 9\times10^9\ \frac{\mathrm{N\cdot m^2}}{\mathrm{C^2}}$$

$$\varepsilon_0 = 8.85\times10^{-12}\ \frac{\mathrm{C^2}}{\mathrm{N\cdot m^2}}$$

$$\mu_0 = 4\pi\times10^{-7}\ \frac{\mathrm{N}}{\mathrm{A^2}}$$

$$e = 1.602\times10^{-19}\ \mathrm{C}$$

$c = 2.99792458\times10^8$ m/s (speed of light)

$N_{Avogadro} = 6.022\times10^{23}$ (number of atoms in 12 g of ^{12}C)

m 10^{-3} μ 10^{-6} n 10^{-9} p 10^{-12} f 10^{-15}

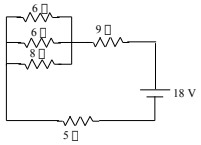
k 10^{3} M 10^{6} G 10^{9} T 10^{12} P 10^{15}

For $ax^2 + bx + c = 0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

1. Please sign the opscan sheet and print your name on it.
2. Use a #2 pencil to fill in your full name, your student identification number (old one), and finally the answers for problems 1–12.
3. Please be prepared to show your Purdue ID when you hand in your opscan sheet.

1. Consider the circuit shown below. What is the current flowing through the 8 Ω resistor?

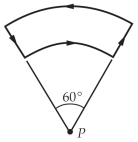


(a) 0.68 A
(b) 6.2 A
(c) 0.30 A
(d) 2.4 A
(e) none of the above

2. Consider an air-filled capacitor with plate area A = 100 cm^2 and plate separation d = 5 mm. The capacitor is charged with a 24 V battery and then disconnected. A slab of dielectric with dielectric constant κ = 14 is then introduced and fills the capacitor. What is the final voltage on the capacitor?

(a) 1.7 V
(b) 336 V
(c) 24 V
(d) 1.6 V
(e) none of the above

3. The closed loop shown below carries a current of 8 amperes in the counterclockwise direction. What is the magnetic field at point P? The radius of the outer arc is 10 cm and the radius of the inner arc is 7 cm.

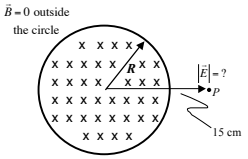


(a) 2.5 x 10^{-6} T
(b) 3.6 x 10^{-6} T
(c) 2.2 x 10^{-5} T
(d) 2.1 x 10^{-4} T
(e) none of the above

4. The radiation in a microwave oven comes from electrons rotating in a circular orbit. If the frequency of the circular motion is 2.85 GHz, what is the magnitude of the magnetic field that causes the circular orbit? The mass and charge of an electron are 9.11×10^{-31} kg and $-e = -1.60 \times 10^{-19}$ C.

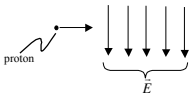
(a) 0.016 T
(b) 0.10 T
(c) 10 T
(d) 0.63 T
(e) none of the above

5. A magnetic field $\vec{B}$ is uniform, but changing in time, throughout a circular region of radius $R = 10$ cm as shown below. Outside the circular region $\vec{B} = 0$. The magnetic field in the circular region is given by $B = (7t - 0.5)$ T, where t is expressed in seconds. What is the magnitude of the induced electric field at point P at a radius of 15 cm at $t = 3$ ms?



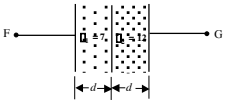
(a) 0.53 V/m
(b) 0.23 V/m
(c) 0.0070 V/m
(d) 0 V/m
(e) none of the above

6. Suppose that protons with a velocity of 5×10^6 m/s are to be selected by subjecting the protons to a combination of an electric field and a magnetic field that results in no deflection of the protons. If the electric field is 5,000 V/m, pointed downward, what is the magnitude and direction of the magnetic field that will result in zero deflection of the moving protons. The protons are moving to the right as shown below. The charge and mass of a proton are $+e = 1.60 \times 10^{-19}$ C and $m = 1.67 \times 10^{-27}$ kg, respectively.



(a) 1.0×10^{-3} T, into the page
(b) 1.0×10^{3} T, upward (opposite the direction of the electric field)
(c) 1.0×10^{3} T, out of the page
(d) 1.0×10^{-3} T, out of the page
(e) none of the above

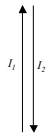
7. Consider the following compound capacitor with plate area $A = 15$ cm^2 and $d = 2$ mm.



What is the capacitance of C_{FG}?

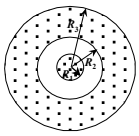
(a) 349 fF
(b) 29.3 pF
(c) 1.54 pF
(d) 126 pF
(e) none of the above

8. Two parallel wires are each carrying a current of 1000 A in opposite directions. If the wires are 2 cm apart and 15 cm long, what is the force exerted on one wire by the other. Is the force attractive or repulsive?



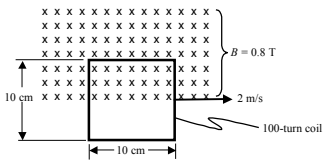
(a) 1.5 N, attractive
(b) 1.5 N, repulsive
(c) 10 N, attractive
(d) 10 N, repulsive
(e) none of the above

9. Two very long coaxial cylindrical conductors are shown in cross-section below. The inner cylinder has radius R_1 = 1 cm and caries a total current of I_1= 120 A in the positive z-direction (pointing out of the page). The outer cylinder has an inner radius R_2= 3 cm, outer radius R_3= 6 cm and carries a current of I_2= 300 A in the negative z-direction (pointing into the page). Assume that the current is uniformly distributed over the cross-sectional area of the conductors. What is the magnetic field at a radius of 0.5 cm?



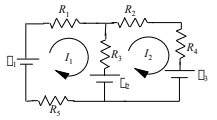
(a) 0 T
(b) 7.2 x 10^{-3} T
(c) 4.8 x 10^{-3} T
(d) 1.2 x 10^{-3} T
(e) none of the above

10. An 100-turn square coil with 10 cm sides is located in a magnetic field of 0.8 T directed into the page as shown. Only half of the coil is in the region of the magnetic field. The resistance of the coil is 20 Ω. What is the magnitude and direction of the induced current if the coil is moved with a speed of 2 m/s to the right?



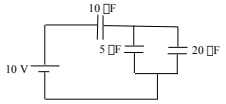
(a) 0.4 A, counterclockwise
(b) 0.8 A, counterclockwise
(c) 0 A
(d) 0.4 A, clockwise
(e) none of the above

11. Consider the circuit with loop currents I_1 and I_2 shown below. What equation does the application of the Kirchoff loop rule on the left loop yield?



(a) $+\mathcal{E}_1 - I_1R_1 - I_1R_3 + \mathcal{E}_2 - I_1R_5 + I_2R_3 = 0$
(b) $-\mathcal{E}_1 - I_1R_1 - I_1R_3 + \mathcal{E}_2 - I_1R_5 - I_2R_3 = 0$
(c) $+\mathcal{E}_1 - I_1R_1 - I_1R_3 - \mathcal{E}_2 - I_1R_5 + I_2R_3 = 0$
(d) $-\mathcal{E}_1 - I_1R_1 - I_1R_3 - \mathcal{E}_2 - I_1R_5 + I_2R_3 = 0$
(e) none of the above

12. Consider the circuit shown below. What is the charge stored on the 20 □F capacitor?



(a) 14 □C
(b) 57 □C
(c) 71 □C
(d) 19 □C
(e) none of the above

Physics 241
Answer key for blue Exam 2
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1. (c) 0.30 A
2. (a) 1.7 V
3. (b) 3.6×10^{-6} T
4. (b) 0.10 T
5. (b) 0.23 V/m
6. (a) 1.0×10^{-3} T, into the page
7. (b) 29.3 pF
8. (b) 1.5 N, repulsive
9. (d) 1.2×10^{-3} T
10. (c) 0 A
11. (c) $+\mathcal{E}_1 - I_1 R_1 - I_1 R_3 - \mathcal{E}_2 - I_1 R_5 + I_2 R_3 = 0$
12. (b) 57 μC