PHYSICS

PHY 2054 Exam 2

Name (PRINT, last, first): ______________________ Signature: ______________________

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	$\mu_0 = 12.56 \times 10^{-7}$ H/m	$N_A = 6.02 \times 10^{23}$ atoms/mole	$c = 3 \times 10^8$ m/s
$n_{H_2O} = 1.333$	k="kilo"$=10^3$	M="mega"$=10^6$	$g = 9.8$ m/s^2
m="milli"$=10^{-3}$	μ="micro"$=10^{-6}$	n="nano"$=10^{-9}$	p="pico"$=10^{-12}$

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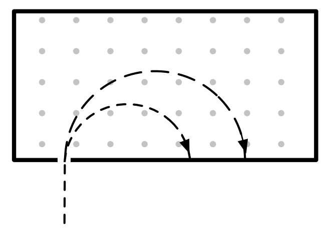
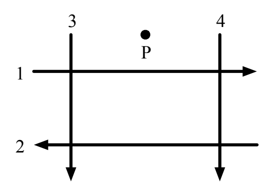
1. The figure shows a mass spectrometer in which charged particles of different masses enter a region through a slit and move perpendicular to a uniform magnetic field permeating the region (the gray dots represent the magnetic field pointing out of the page). For each particle, the detector measures the distance between the entrance point to the place where it strikes the bottom of the region. Assume ^{12}C and ^{16}O singly charged ions are accelerated to the *same* velocity before entering the spectrometer. If the ^{16}O ions strike the detector 5.0 m from the slit, at one point will the ^{12}C ions hit it?



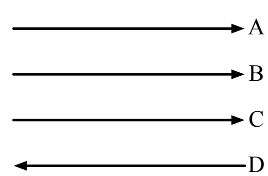
(1) 3.75 m (2) 6.67 m (3) 4.33 m (4) 4.00 m (5) 5.77 m

2. Four long straight wires, each with current 12 A, overlap to form a 12 cm × 24 cm rectangle, as shown. What is the magnitude of the magnetic field at the point P, midway between the vertical wires and 6 cm above the upper wire?



(1) 2.7×10^{-5} T (2) 4.0×10^{-5} T (3) 1.2×10^{-4} T (4) 8.0×10^{-5} T (5) 6.0×10^{-5} T

3. Four long parallel wires are arranged on a plane, as shown in the figure, with 2.0 cm gaps between them. Each wire carries a 12.0 A current in the direction indicated by the arrow. On the wire labeled C, what is the magnetic force per meter?



(1) 3.6×10^{-3} N/m (2) 2.2×10^{-3} N/m (3) 1.2×10^{-4} N/m (4) 3.0×10^{-4} N/m (5) 7.2×10^{-4} N/m

4. Two long parallel wires 20 cm apart carry currents of 5.0 A and 8.0 A in the same direction. Is there any point between the two wires where the magnetic field is zero?

(1) yes, 7.7 cm from the 5-A wire
(2) yes, 12 cm from the 5-A wire
(3) yes, midway between the wires
(4) no
(5) yes, 9.5 cm from the 5-A wire

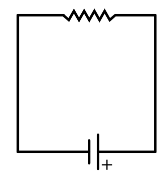
5. Two circular current loops have their centers at the origin (*i.e.*, $x = y = z = 0$). Loop 1 lies in the xy-plane and has radius R and carries current $3I$. Loop 2 lies in the yz-plane and has radius $2R$ and carries current $8I$. What is the magnitude of the net magnetic field at the origin?

(1) $\frac{5\mu_0 I}{2R}$ (2) $\frac{5\mu_0 I}{R}$ (3) $\frac{15\mu_0 I}{2R}$ (4) $\frac{2\mu_0 I}{R}$ (5) $\frac{4\mu_0 I}{R}$

6. The south end of a bar magnet is pushed downward toward a wire loop in the plane of the paper. In which direction is the induced current, and which way is the induced magnetic field?

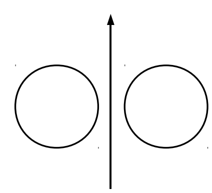
(1) clockwise, into the paper
(2) clockwise, out of the paper
(3) counter-clockwise, into the paper
(4) counter-clockwise, out of the paper
(5) there is no induced current

7. The circuit shown has a 4 V battery in series with a 10 Ω resistor and is in the shape of a square with sides 12 cm. It lies within a uniform magnetic field pointing into the page. If the current in the circuit is 0.80 A counterclockwise, at what rate is the magnitude of the magnetic field changing and is it increasing or decreasing?



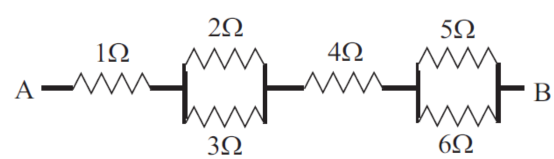
(1) 280 T/s, increasing
(2) 280 T/s, decreasing
(3) 830 T/s, increasing
(4) 830 T/s, decreasing
(5) 140 T/s, decreasing

8. The current i in a long wire is going up as shown in the figure, but decreasing in magnitude. What is the direction of the induced current in the left loop and the right loop. (List the direction of the induced current in the left loop first.)



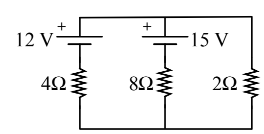
(1) counterclockwise, clockwise
(2) clockwise, counterclockwise
(3) clockwise, clockwise
(4) counterclockwise, counterclockwise
(5) There is no induced current.

9. If the voltage between A and B in the figure is 12 V, how much current, in A, flows through the 2Ω resistor?



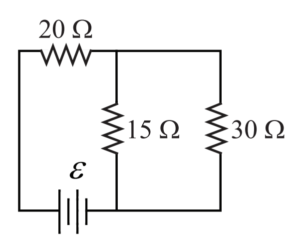
(1) 0.81 (2) 0.61 (3) 0.71 (4) 0.91 (5) 1.01

10. In the circuit shown, what is the current through the 15 V battery?



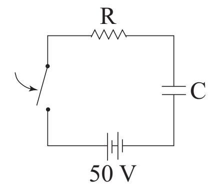
(1) 1.18 A upwards (2) 3.41 A downwards (3) 1.12 A upwards (4) 2.79 A upwards (5) 1.83 A downwards

11. If $\mathcal{E} = 24$ V, at what rate is thermal energy generated in the 20-Ω resistor?



(1) 13 W
(2) 3.2 W
(3) 23 W
(4) 28 W
(5) 39 W

12. A series RC circuit has a time constant of 1.0 s. The battery has a voltage of 50 V and the maximum current just after closing the switch is 500 mA. The capacitor is initially uncharged. What is the charge on the capacitor 2.0 s after the switch is closed?



(1) 0.43 C (2) 0.66 C (3) 0.86 C (4) 0.99 C (5) 0.22 C

13. Unpolarized light of intensity I_0 is sent through 4 polarizers, each of the last three rotated 30° from the previous polarizer so that the last polarizer is perpendicular to the first. What is the intensity transmitted by this system?

(1) 0.21 I_0 (2) 0.50 I_0 (3) 0.42 I_0 (4) 0.75 I_0 (5) 0

14. If the two 2nd order maxima ($m = 2$) are separated by 2.0 cm on the screen in a double-slit experiment, what is the separation of the $m = 3$ minima? Assume the angle is very small.

(1) 3.5 cm (2) 2.0 cm (3) 2.5 cm (4) 3.0 cm (5) 1.5 cm

15. A grating with 8,000 slits space over 2.54 cm is illuminated by light of a wavelength of 546 nm. What is the angle corresponding to the third order maximum?

(1) 31.1° (2) 15.1° (3) 26.3° (4) 10.5° (5) 21.3°