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PHYSICS DEPARTMENT

PHY 2049, Fall 2012 Final Exam December 8, 2012

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 $m_e = 9.1 \times 10^{-31} kg$ $\epsilon_o = 8.85 \times 10^{-12} C^2/N \cdot m^2$

$k = 1/(4\pi\epsilon_o) = 9 \times 10^9\, N \cdot m^2/C^2$ nano $= 10^{-9}$ micro $= 10^{-6}$ pico $= 10^{-12}$ $\mu_0 = 4\pi \times 10^{-7} H/m$

Sphere: $A = 4\pi R^2$ $V = \frac{4\pi}{3} R^3$

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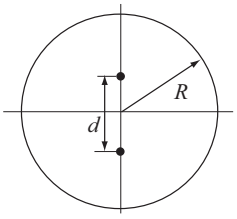
1. Two coherent radio-frequency point sources separated by $d = 2$ m radiate in phase at a wavelength $\lambda = 0.5$ m. A radio wave detector moves in a circular path of some radius R around the mid-point between the two sources (see figure) and measures the radio-wave intensity of the signal. Find how many maxima it detects. *Hint: consider the phase difference for wave emitted by the two sources at the bottommost point of the circle and then at the topmost point. Contemplate what happens to the phase difference as one moves along the circle between the bottommost to topmost points.*



(1) 6 (2) 12 (3) 4 (4) 8 (5) 16

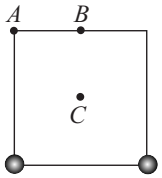
2. Costume jewelry beads are made of glass with index of refraction 1.55. To make them more reflective, they are coated with a layer of material with index of refraction 1.90. What is the minimum coating thickness needed to ensure that light of wavelength 540 nm and perpendicular incidence will be reflected with maximum constructive interference?

(1) 100 nm (2) 150 nm (3) 250 nm (4) 500 nm (5) 70 nm

3. A 1.60-m radius cylindrical region contains a uniform electric field that is parallel to the axis and is increasing at the rate 5.0×10^{12} V/m·s. The magnetic field at a point 0.25 m from the axis has a magnitude of:

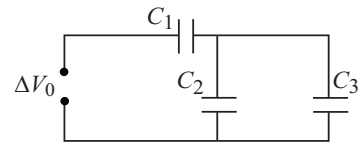
(1) 5.4×10^{-5}T (2) 7.0×10^{-5}T (3) 2.8×10^{-5}T (4) 0 (5) 7.0×10^{-6}T

4. Two tiny objects with equal charges of 10.0 nC are placed at the two lower corners of a square with sides of 3.0 m, as shown. What is the magnitude of the electric field at point A (in N/C)?



(1) 14 (2) 15 (3) 10 (4) 20 (5) 5

5. If $C_1 = 25\mu$F, $C_2 = 20\mu$F, $C_3 = 10\mu$F, and $\Delta V_0 = 21$ V, determine the energy stored by C_2.



(1) 0.40 mJ (2) 0.32 mJ (3) 1.21 mJ (4) 0.72 mJ (5) 0.91 mJ

6. Estimate the linear separation of two objects that the human eye can resolve at a distance of 1 meter. Take the diameter of the pupil to be 5 mm, and the wavelength of the light to be 420 nm.

(1) 0.5 mm (2) 0.2 mm (3) 0.4 mm (4) 0.3 mm (5) 0.1 mm

7. If the magnetic field in a plane electromagnetic wave is along the y axis and its component is given by $B_m \sin(kx - \omega t)$ in SI units, then the electric field is along the z axis, and its component is given by:

(1) $-(cB_m)\sin(kx - \omega t)$
(2) $(cB_m)\cos(kx - \omega t)$
(3) $-(cB_m)\cos(kx - \omega t)$
(4) $(cB_m))\sin(kx - \omega t)$
(5) $B_m \sin(kx - \omega t)$

8. A concave mirror has a radius of curvature of $R = 8$ m. An object is placed 5 m in front of the mirror. Is the image real or virtual, upright or inverted, larger or smaller than the object?

(1) virtual, inverted, smaller
(2) real, inverted, larger
(3) virtual, upright, larger
(4) virtual, upright, smaller
(5) real, inverted, smaller

9. An LC circuit has a capacitance of 30μF and an inductance of 15 mH. At time $t = 0$ the charge on the capacitor is 20μC and the current is 40 mA. The maximum current is:

(1) 50 mA (2) 40 mA (3) 65 mA (4) 36 mA (5) 82 mA

10. A circular loop of wire with radius 10.0cm and resistance 0.50Ω is in the plane of the page. It is sitting in a magnetic field directed into the page. The magnetic field strength varies in time at a rate of 10.0 T/s. Which of the following answers is a possibility for the current?

(1) 20 A, cw (2) 0.63 A, cw (3) 0.2 A, ccw (4) 20 A, ccw (5) 0.63 A, ccw

11. A 24Ω resistor and a 15μF capacitor are connected in series to a 12 V battery. At $t = 0.5$ ms after the connection is made, what is the current in the circuit?

(1) 0.12 A (2) 0.5 A (3) 0.35 A (4) 0.18 A (5) 0.27 A

12. Two converging lenses each with focal length 6 cm are placed on the x-axis at $x = 0$ cm and $x = 12$ cm. An object is placed at $x = -30$ cm. What is the x position of the final image for light going through the two lenses?

(1) -4 cm (2) -6 cm (3) 6 cm (4) 8 cm (5) 4 cm

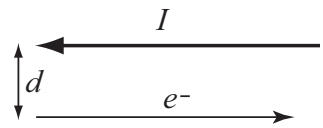
13. A particle with a charge of 11.0×10^{-8}C is fixed at the origin. A particle with a charge of -4.6×10^{-8}C is moved from $x = 3.5$ cm on the x axis to $y = 4.3$ cm on the y axis. The change in potential energy of the two-particle system is:

(1) -12.4×10^{-3}J (2) 12.4×10^{-3}J (3) 24.0×10^{-5}J (4) 0 (5) -24.0×10^{-5}J

14. When the distance between a point source of light and a light meter is reduced from 6.0 m to 2.0 m, the intensity of illumination at the meter will be the original value multiplied by:

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

15. An electron moves at a speed of $v = 3 \times 10^7$ m/s parallel to and a distance $d = 20$ cm from a conducting wire carrying a current of $I = 40$ A. If the directions of the electron and current are as shown in the figure, what is the magnitude and direction of the force experienced by the electron?



(1) 1.9×10^{-18} N, into the page
(2) 1.9×10^{-16} N, toward the wire
(3) 1.9×10^{-19} N, away from the wire
(4) 1.9×10^{-13} N, out of the page
(5) 1.9×10^{-12} N, against the motion of electron

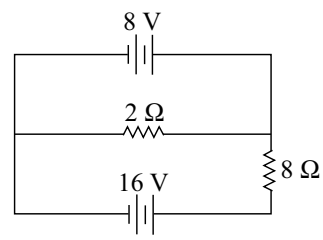
16. A beam of light polarized along the y axis and moving along the +z axis passes through two polarized sheets with axes of polarization oriented 30° and 70° relative to the y axis. The final intensity of the beam is measured to be 61 W/m^2. What is the initial beam intensity?

(1) 140 W/m^2 (2) 200 W/m^2 (3) 700 W/m^2 (4) 90 W/m^2 (5) 280 W/m^2

17. Three large parallel charged insulating sheets have charge per unit area of $\sigma_1 = -3\mu$C/m^2, $\sigma_2 = 4\mu$C/m^2, σ_3. What is the charge density of sheet 3, in order for the electric field to be zero in the region between sheets 1 and 2?

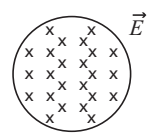
(1) -1μC/m^2 (2) 1μC/m^2 (3) 7μC/m^2 (4) 4μC/m^2 (5) -7μC/m^2

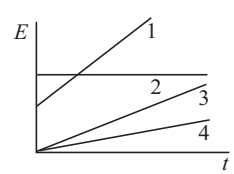
18. What is the current flowing through the 2-Ω resistor?



(1) 2 A
(2) 6 A
(3) 3 A
(4) 4 A
(5) 5 A

19. An electric field exists in the cylindrical region shown and is parallel to the cylinder axis. The magnitude of the field might vary with time according to any of the four graphs shown. Rank the four variations according to the magnitudes of the magnetic field induced at the edge of the region, least to greatest.





(1) 2, 4, 3, 1 (2) 2, 1, 3, 4 (3) 4, 3, 2, 1 (4) 3 and 4 tie, then 1,2 (5) 4, 3, 1, 2

20. An electron and a proton both enter a region of uniform magnetic field. If the ratio of the radius of the proton orbit to the radius of the electron orbit $(r_p/r_e) = 50$, what is the ratio of their kinetic energy (K_p/K_e)?

(1) 0.82 (2) 4.41 (3) 1.36 (4) 3.16 (5) 2.45