PHYSICS DEPARTMENT

PHY 2053 Practice Exam November, 2000

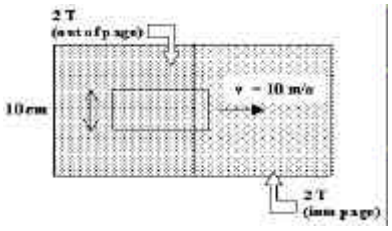
B. Whiting Sec.#_____

Name (print, last first): _____ Signature: _____

Constants

$k_e = 8.99 \times 10^9$ N·m^2·C^{-2}	$\epsilon_0 = 8.85 \times 10^{-12}$ C^2·N^{-1}·m^{-2}	$m_e = 9.1 \times 10^{-31}$ kg
$g = 9.80$ m·s^{-2}	$e = 1.6 \times 10^{-19}$C	$\mu_0 = 4\pi \times 10^{-7}$ Tm/A
$c = 3 \times 10^8$m/s	1μC $= 10^{-6}$ C	$m_p = 1.67 \times 10^{-27}$kg

1. Compute the magnitude of the induced current (in A) for the moving loop shown. Assume the total resistance in the wire is 3- .

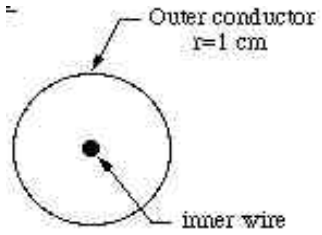


(1) 1.33 (2) 0.67 (3) 0.33 (4) 2.80 (5) 0.13

2. An FM radio station broadcasts using an antenna that radiates 1 megawatt of average power equally in all directions. What is the magnitude of the peak electric field (in V/m) at a distance of 30 km?

(1) 0.26 (2) 0.18 (3) 0.36 (4) 1.45 (5) 0.07

3. A coaxial cable has an inner conducting wire surrounded by a hollow cylindrical outer conductor (see Figure). The inner wire and the outer cylindrical conductor are concentric. Suppose the inner and outer conductors both carry currents of 1A, with the two currents being oppositely directed (i.e., in and out of the page). What is the magnitude of the magnetic field in tesla (a) at a radius of 0.5 cm, between the inner and outer conductors; and (b) at a radius of 2 cm, outside both conductors?



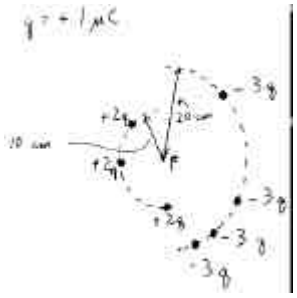
End view - coaxial cable

(1) (a) 4×10^{-5}; (b) 0
(2) (a) 4×10^{-7}; (b) 0
(3) (a) 4×10^{-7}; (b) 1×10^{-7}
(4) (a) 4×10^{-5}; (b) 8×10^{-5}
(5) (a) 8×10^{-5}; (b) 2×10^{-5}

4. The sun produces radiation over a broad range of wavelengths. Consider the travel time for this radiation from the sun to the earth. How does this travel time compare for infrared (IR) radiation with wavelength 10^{-4} m versus ultraviolet (UV) light with wavelength 10^{-8} m?

   (1) They have the same travel time.
   (2) IR has 10^4 times longer travel time than UV.
   (3) IR has 10^2 times longer travel time than UV.
   (4) UV has 10^4 times longer travel time than IR.
   (5) UV has 10^2 times longer travel time than IR.

5. What is the magnitude of the electric potential (in V) at the point F in Figure?



   (1) 0 (2) 1.1×10^6 (3) -1.1×10^6 (4) 1.1×10^7 (5) -3.4×10^7

6. A convex mirror has a radius of curvature of 3 m. If a 2 cm tall object is placed 1 m in front of the mirror, how tall (in cm) will the image be and what orientation will it have?

   (1) 1.2 cm, erect (2) 0.6 cm, erect (3) 0.6 cm, inverted (4) 2 cm, erect (5) 3.2 cm, inverted

7. You are told that a particular converging lens has focal length 25 cm, and that it produces a virtual image which is 0.5 m away from the lens. What is the magnification (if it can be determined)?

   (1) +3 (2) +1 (3) −1 (4) +4 (5) A converging lens produces a real image, so provided information is wrong.

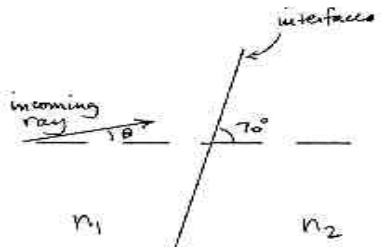
8. Which of the following statements is false?

   (1) The magnetic flux through a coil is proportional to $cos\theta$, where θ is the angle between the magnetic field direction and the plane of the coil.
   (2) The peak intensity of a beam of light is greater than its average intensity for a transverse electromagnetic wave.
   (3) The capacitance increases when a dielectric is inserted between the plates of a capacitor.
   (4) Total internal reflection can only occur when light encounters an interface with a material having a lower index of refraction.
   (5) Gauss's law can be used to solve for the electric field outside of a long, straight, charged wire.

9. An electromagnetic wave passes through a certain dielectric. Inside the material, the wave has frequency $2\times10^{10}(\text{sec})^{-1}$ and wavelength 4 mm. What is the index of refraction for the dielectric? Select the closest answer.

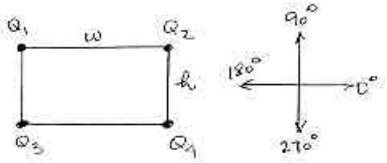
   (1) 3.8 (2) 2.5 (3) 0.004 (4) 1.9 (5) 5

10. An incoming ray of light is incident from the left at an angle $\theta = +15$ degrees relative to the horizontal, as shown. What is the direction (in degrees) of the exiting ray with respect to the horizontal? Take the indices to be $n_1 = 1.6$ and $n_2 = 2.4$. Select the closest answer.



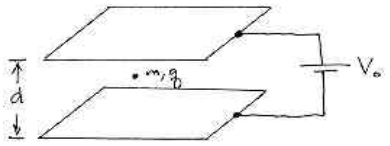
(1) 3 (2) 42 (3) 10 (4) 23 (5) −2

11. Four charges are located on the corners of a rectangle, as shown. Charge $Q_1 = +20\mu$C, $Q_2 = -15\mu$C, $Q_3 = -25\mu$C, $Q_4 = +10\mu$C, $h = 10$ cm, and $w = 15$ cm. What is the direction (in degrees) of the electric field acting on charge Q_3? Select the closest answer.



(1) 270 (2) 285 (3) 90 (4) 105 (5) 255

12. A charged particle with charge $q = -e$ ($+e$ is the charge on a proton) and mass $m = 2 \times 10^6 m_p$ (m_p is the mass of a proton) lies between the two horizontal plates of a capacitor, as shown. Gravity acts downward upon the particle. The separation between the capacitor plates is $d = 0.5$ m. If the particle remains stationary, what is the voltage V_o (in V)? Select the closest answer.



(1) 0.1 (2) 1 (3) 10 (4) 100 (5) 1000

13. A 100 turn coil with area 15 cm^2 and a total resistance of 0.5 - is placed in a steadily increasing magnetic field. The magnetic field is perpendicular to the plane of the coil. If the current induced in the coil is 0.7 A, what is the magnitude of the magnetic field (in T) after 30 s? Assume the magnetic field is 0 at $t = 0$ s.

(1) 70 (2) 45 (3) 22 (4) 12 (5) 109

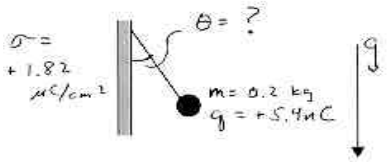
14. An unpolarized beam of light is incident upon a series of three linear polarizers with polarization axes $\theta_1 = 55°$, $\theta_2 = 20°$, and $\theta_3 = 145°$. The average intensity after the second polarizer is 0.3 W/m^2. The first polarizer is then rotated to an angle $\theta_1 = 25°$. What is the average intensity (in W/ m^2) after the third polarizer?

(1) 0.15 (2) 1.2 (3) 0.65 (4) 0.32 (5) 0.11

15. You are listening to a radio station which has an emission wavelength of 3.34 m. What station are you listening to?

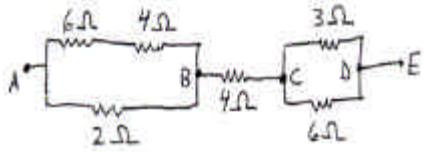
(1) 89.9 FM (2) 103.7 FM (3) 105.3 FM (4) 890 AM (5) 1290 AM

16. 0.2 kg, +5.4 nC point charged is attached to a conducting sheet by an insulating thread. (See Figure) The sheet has a surface charge density of $+1.82\mu\text{C/cm}^2$. Find the angle (in degrees) that the thread makes with the conducting sheet.



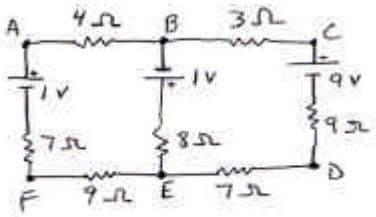
(1) 70.6 (2) 19.4 (3) 34.9 (4) 82.0 (5) 4.5

17. Compute the equivalent resistance (in -) between points A and C for the resistor network shown.



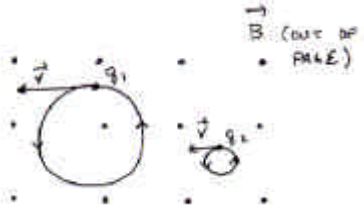
(1) 5.7 (2) 12.0 (3) 10.0 (4) 16.0 (5) 2.3

18. For the circuit shown, how much current (in A) is going through the 4 - resistor?



(1) 0.038 (2) 0.123 (3) 0.382 (4) 0.342 (5) 0.089

19. Consider a region of spatially uniform magnetic field shown. The magnetic field is directed out of the page. Two particles with identical masses are moving in circular orbits in the direction shown with instantaneous velocities v_1 and v_2. Which statement must be true?



(1) $q_1,\ q_2 < 0,\ |v_1/q_1| > |v_2/q_2|$
(2) $q_1,\ q_2 > 0,\ |v_1/q_1| > |v_2/q_2|$
(3) $q_1,\ q_2 < 0,\ |q_1| > |q_2|$
(4) $q_1,\ q_2 > 0,\ |q_1| < |q_2|$
(5) $q_1 > 0,\ q_2 < 0,\ |v_1/q_1| > |v_2/q_2|$

20. Three polarizers are oriented such that the relative angle between the each of the transmission axes of the polarizers is the same. If 10% of the initially unpolarized light is transmitted through the final polarizer, what is the angle (in degrees)?

(1) 48° (2) 26° (3) 67° (4) 19° (5) 33°