Physics 202 MWF 10:20 Spring 2005 (Ford)

Name (printed) with Answers

Name (signature as on ID) _____

Lab Section _____

Final Exam

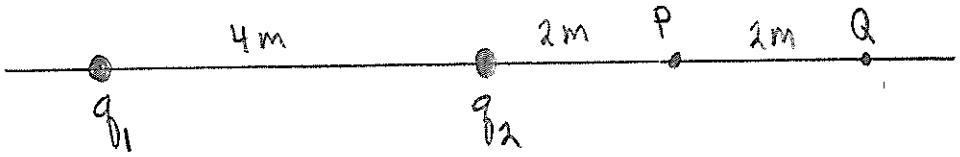
Show all your work. Partial credit will be given if earned. Write your answers in the blanks provided.

(10 pts) 1. A single slit has a width of 5.00×10^{-5} m. Electrons with kinetic energy E pass through the slit and produce an interference pattern on a distant screen. If the first minimum on one side of the central diffraction maximum is at an angle of 0.080 rad (measured from the line from the slit to the center of the central maximum), what is the energy E of the electrons?

Ans. 1.51×10^{-26} J

$= 9.42 \times 10^{-8}$ eV

(10 pts) 2. Two point charges $q_1 = 8.0 \times 10^{-6}$ C and $q_2 = -4.0 \times 10^{-6}$ C are separated by 4.0 m as shown in the figure. Note that q_1 is positive and q_2 is negative. Point P is 2.0 m to the right of q_2.



a) What are the magnitude and direction of the electric field at point P?

Ans. $E =$ 7000 N/C

direction left

b) A small particle with mass 0.020 kg and negative charge $q_3 = -4.0 \times 10^{-6}$ C is released from rest at point P. What is its speed when it reaches point Q, that is 2.0 m to the right of point P?

Ans. 1.55 m/s

(12 pts) 3.
a) A solid spherical conductor with radius $R = 0.050$ m and net charge $q = 6.0 \times 10^{-6}$ C is very far from any other object.

(i) What is the magnitude of the electric field at a point 0.100 m from the center of the sphere?

Ans. 5.4×10^6 N/C

(ii) What is the magnitude of the electric field at the center of the sphere?

Ans. 0

(iii) What is the electric potential at a point 0.100 m from the center of the sphere?

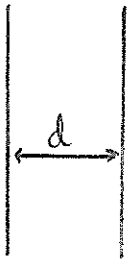
Ans. 5.4×10^5 V

(iv) What is the electric potential at the center of the sphere?

Ans. 1.08×10^6 V

b) Two very large parallel conducting plates carry charges of equal magnitude and opposite sign. Midway between the two plates the electric field is $E = 2.0 \times 10^4$ N/C. The potential difference between the two plates is 50 V. What is the distance d between the two plates?

Ans. 2.5×10^{-3} m



(10 pts) 4. An object 2.0 mm tall is 20.0 cm to the left of a lens. The image formed by the lens is 40.0 cm to the right of the lens.

a) Is the image real or virtual?

Ans. real

b) Is the image upright or inverted?

Ans. inverted

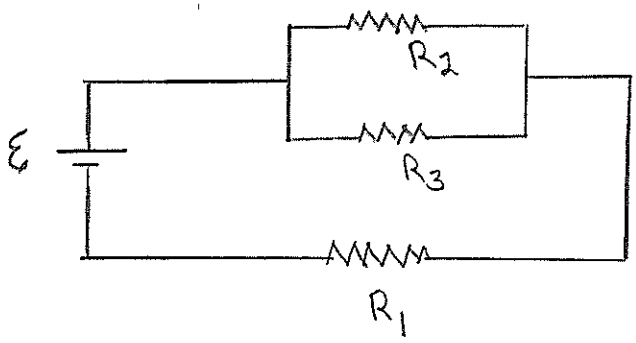
c) What is the focal length of the lens?

Ans. 13.3 cm

d) Is the lens converging or diverging?

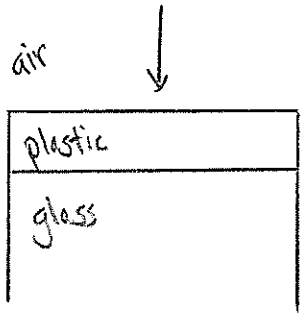
Ans. Converging

(10 pts) 5. Three resistors are connected to a battery of emf ε as shown in the sketch. $R_1 = 5.0\ \Omega$, $R_2 = 3.0\ \Omega$ and $R_3 = 6.0\ \Omega$. The voltage across R_2 is $V_2 = 6.0$ V. What is the emf ε of the battery?



Ans. 21 V

(6 pts) 6. Light of wavelength 600 nm in air falls perpendicularly on a thin film of plastic ($n = 1.20$) that is on the surface of a flat piece of glass ($n = 1.50$). What is the minimum nonzero thickness of the plastic film for which there is destructive interference for the light reflected at the top and bottom surfaces of the film?



Ans. 125 nm

(10 pts) 7. a) An ac series circuit consists of a resistor, an inductor and an ac generator that supplies an rms voltage of 160 V. The reactance of the inductor is 60 Ω and the rms current in the circuit is 1.50 A. What is the resistance R of the resistor?

Ans. 88.2 Ω

b) An ac series circuit consists of an ac generator, a resistor R, and inductor L and a capacitor C. The frequency of the ac generator equals the resonant frequency of the circuit. The voltage amplitude for the generator is 160 V. $R = 40\ \Omega$, $L = 0.2$ H, and $C = 5.0 \times 10^{-6}$ F. What is the voltage amplitude across

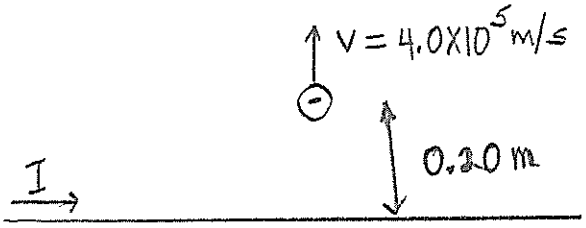
(i) the resistor

Ans. 160 V

(ii) the inductor

Ans. 800 V

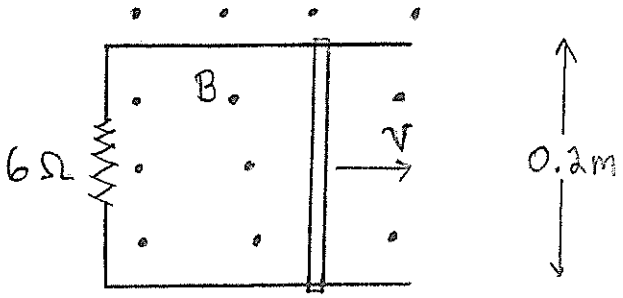
(10 pts) 8. A small charged particle with negative charge $q = -3.00 \times 10^{-6}$ C is moving away from a long straight wire that carries current $I = 5.0$ A in the direction shown. What are the magnitude and direction of the force on the particle due to the magnetic field of the wire? (Show the direction of the force on the diagram).



Ans. 6×10^{-6} N

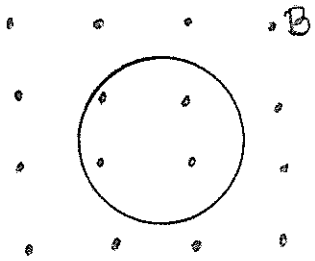
(10 pts) 9.

a) The circuit in the sketch has constant resistance 6.0 Ω. The bar slides to the right on frictionless rails that are separated by 0.20 m. There is a uniform magnetic field $B = 5.0$ T directed out of the page. Electrical energy is being dissipated in the 6.0 Ω resistor at a rate of 24 W. What is the speed v of the bar?



Ans. 12 m/s

b) A circular conducting loop is in a uniform magnetic field that is directed out of the page. The strength of the magnetic field is decreasing. Is the current induced in the loop clockwise or counterclockwise?



Ans. counterclockwise

(6 pts) 10. Find the binding energy (in MeV) for the isotope $^{9}_{4}$Be (atomic mass of the neutral atom is 9.012182 u).

Ans. 58.2 MeV

(6 pts) 11. A radioactive isotope has atomic number $Z = 11$ and $N = 13$. A 1.0 g sample of this isotope has activity 3.30×10^{17} Bq. What is the half-life of the radioactive decay?

Ans. 14.6 hr