Physics 202 MWF 10:20 Spring 2007 (Ford)

Name (printed) With Answers

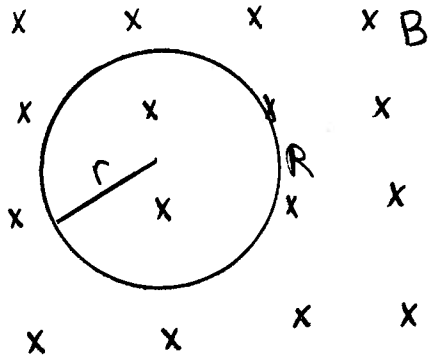
Name (signature as on ID)_____

Lab Section_____

Final Exam

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

(8 pts) 1. A circular loop of wire with radius $r = 0.20$ m and resistance $R = 0.40\ \Omega$ is in a uniform magnetic field directed into the page as shown in the sketch. At $t = 0$ the magnetic field is $B = 6.00$ T and it then decreases at a constant rate of $\Delta B/\Delta t = -0.40$ T/s. What are the magnitude and direction of the induced current in the loop at $t = 2.0$ s? (The direction is either clockwise or counterclockwise).



Ans. $I =$ 0.126A

direction clockwise

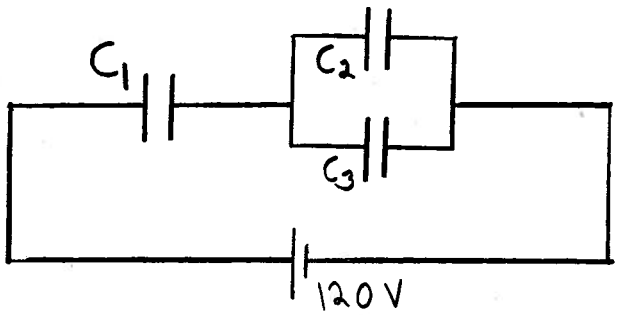
(9 pts) 2. Two point charges are placed on the x axis and held in place. $q_1 = -6.0 \times 10^{-9}$ C is at $x = +0.30$ m and q_2 is at $x = -0.20$ m. The net electric field at the origin produced by these two charges has magnitude 900 N/C and is in the $-x$-direction. What are the magnitude and sign of q_2?

Ans. -6.67×10^{-9} C

(9 pts) 3. Two point charges are placed on the x axis and held in place. $q_1 = -6.0\times10^{-9}$ C is at $x = +0.30$ m and $q_2 = +4.0\times10^{-9}$ C is at $x = -0.20$ m. Point charge $q_3 = -5.0\times10^{-4}$ C moves from point A at the origin to point B that is on the x-axis at $x = +0.20$ m. How much work is done on q_3 by the net electric field of q_1 and q_2 when q_3 moves from A to B?

Ans. -0.225 J

(9 pts) 4. Consider the circuit shown in the sketch.



$C_1 = 8.0 \times 10^{-9}$ F

$C_2 = 4.0 \times 10^{-9}$ F

$C_3 = 6.0 \times 10^{-9}$ F

a) When the capacitors have their final charges, what is the charge on C_2?

Ans. 2.13×10^{-7} C

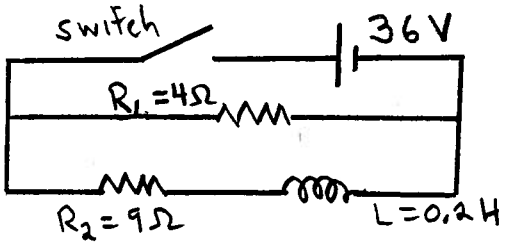
b) When the capacitors have their final charges, what is the voltage across C_1?

Ans. 66.6 V

c) Without making any other change in the circuit, a dielectric with $K = 3.0$ is inserted between the plates of capacitor C_2, completely filling the region between the plates. After the charges have reached their final values, what is the voltage across C_1?

Ans. 83.1 V

(8 pts) 5. Consider the circuit shown in the sketch. The switch is closed at $t = 0$.



a) Just after the switch is closed, what is the current through R_1?

Ans. 9 A

b) Just after the switch is closed, what is the current through R_2?

Ans. 0

c) After the switch has been closed a long time, what is the current through R_1?

Ans. 9A

d) After the switch has been closed a long time, what is the current through R_2?

Ans. 4A

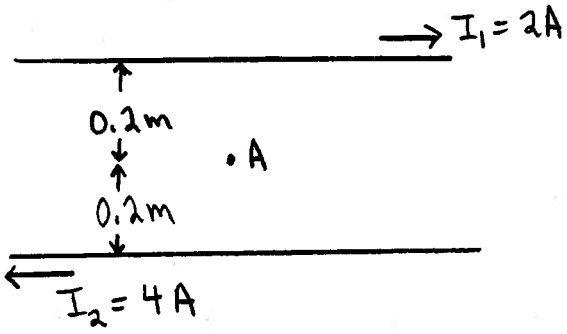
e) After the switch has been closed a long time it is opened again. Just after the switch has been reopened, what is the current through R_1?

Ans. 4A

f) Just after the switch has been reopened, what is the current through R_2?

Ans. 4A

(8 pts) 6. Two long straight parallel wires carry currents as shown in the sketch. Point A is midway between the two wires, 0.20 m from each wire. What are the magnitude and direction of the net magnetic field at point A due to the two wires?



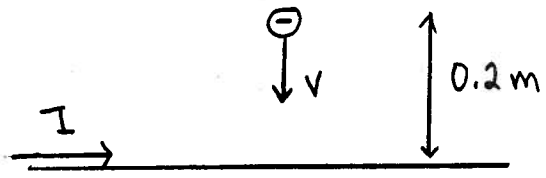
Ans. $B =$ 6×10^{-6} T

direction ⊗

(8 pts) 7. An electron is moving in the vicinity of a long straight wire. The current in the wire is $I = 5.0$ A, in the direction shown in the sketch. Consider the instant when the electron is 0.20 m from the wire and moving toward it with a speed of 3.0×10^4 m/s. What are the magnitude and direction of the force that the current in the wire exerts on the electron?

Ans. $F =$ 2.4×10^{-20} N

direction to the right →



(9 pts) 8. An ac series circuit contains a source with voltage amplitude $V = 240$ V and angular frequency $\omega = 100$ rad/s. The circuit contains a resistor with $R = 400\ \Omega$ and a capacitor with $C = 5.0 \times 10^{-5}$ F.

a) What is the maximum voltage across the capacitor?

Ans. 107 V

b) What is the phase angle between the source voltage and the current in the circuit? Does the source voltage lag or lead the current?

Ans. angle -26.6°

lag or lead? lags

c) What is the average power delivered by the source?

Ans. 57.6 W

(9 pts) 9. An object 6.0 mm tall is placed 0.45 m to the left of a spherical mirror. The image formed by the mirror is inverted and is 2.0 mm tall.

a) What is the focal length of the mirror? Be sure to indicate whether the focal length is positive or negative?

Ans. +11.2 cm

b) Is the image formed by the mirror real or virtual?

Ans. real

(8 pts) 10. A thin film with thickness t is placed on the surface of a flat piece of glass. The film has $n = 1.20$ and the glass has $n = 1.50$. For air with wavelength in air of 500 nm incident perpendicular to the surface of the film, what is the minimum nonzero thickness of the film for which there will be constructive interference between the light reflected from the top and bottom surfaces of the film?

Ans. 208 nm

(7 pts) 11. A portion of Table 30.2 Atomic Masses of Light Elements from the textbook is reproduced below. Use the information in the table to calculate the total binding energy of the nucleus ^4_2He.

Ans. 28.3 MeV

TABLE 30.2 Atomic masses of light elements

Element	Atomic number, Z	Neutron number, N	Atomic mass, u	Mass number, A
Hydrogen, H	1	0	1.007825	1
Deuterium, H	1	1	2.014101	2
Helium, He	2	1	3.016029	3
Helium, He	2	2	4.002603	4
Lithium, Li	3	3	6.015123	6
Lithium, Li	3	4	7.016005	7

(8 pts) 12. The nucleus $^{47}_{20}\text{Ca}$ is a β^- emitter with a half-life of 4.5 days.

a) How many neutrons are in the daughter nucleus that is produced by this decay?

Ans. 26

b) If a sample contains 8.0 g of this isotope, how many β^- particles will be emitted per second by the sample?

Ans. $1.83 \times 10^{17}\ s^{-1}$