Physics 202 MWF 10:20 Spring 2009 (Ford)

Name (printed)_____

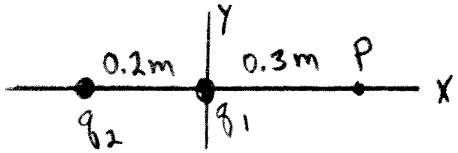
Name (signature as on ID)_____

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. Negative point charge $q_1 = -8.0 \times 10^{-6}$ C is at the origin and positive point charge $q_2 = +6.0 \times 10^{-6}$ C is on the $-x$-axis at $x = -0.20$ m.



a) What is the magnitude and direction ($+x$ or $-x$) of the net electric field produced by these two charges at the point P that is on the $+x$-axis at $x = +0.30$ m?

Ans. $E =$ _____

direction _____

b) What is the electric potential at point P produced by these two charges? (Take the potential to be zero at very larges distances from the charges.)

Ans. _____

(10 pts) 2.
a) In a region of space there is a uniform electric field with magnitude 800 N/C and that is in the $+x$-direction. If the electric potential at the origin is 300 V, what is the electric potential at a point that is on the $-x$-axis at $x = -0.50$ m?

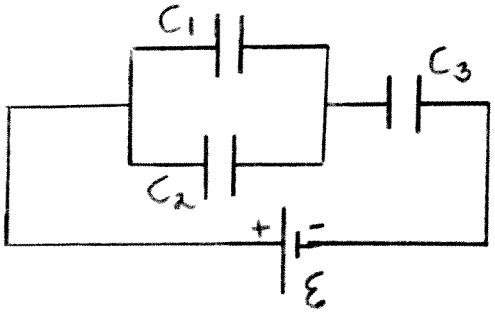
Ans. _____

b) A particle with charge $q = -8.0 \times 10^{-3}$ C is released from rest at point a. When the particle reaches point b, 5.0 m to the right of point a, its kinetic energy is 4.0 J. The only force acting on the particle is the electric force. If the electric potential at point a is 300 V, what is the electric potential at point b?

Ans. _____

(12 pts) 3.

a) Three capacitors are connected to a battery as shown in the sketch. $C_1 = 4.0 \times 10^{-6}$ F, $C_2 = 2.0 \times 10^{-6}$ F, and $C_3 = 3.0 \times 10^{-6}$ F. The charge Q_1 on C_1 is $Q_1 = 6.0 \times 10^{-4}$ C. What is the charge on each of the other two capacitors and what is the emf of the battery?

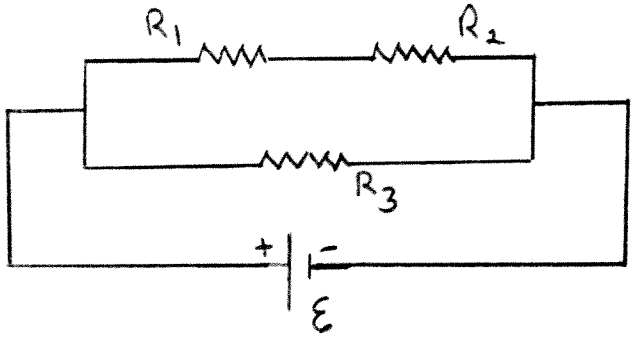


Ans. $Q_2 =$ _____

$Q_3 =$ _____

emf = _____

b) Three resistors are connected to a battery as shown in the sketch. $R_1 = 4.0\ \Omega$, $R_2 = 2.0\ \Omega$, and $R_3 = 3.0\ \Omega$. The voltage across R_1 is $V_1 = 36$ V. What is the voltage across each of the other two resistors and what is the emf of the battery?

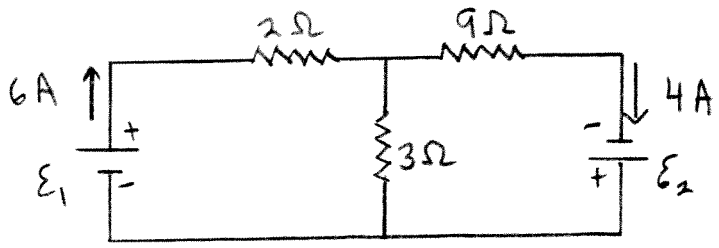


Ans. $V_2 =$ _____

$V_3 =$ _____

emf = _____

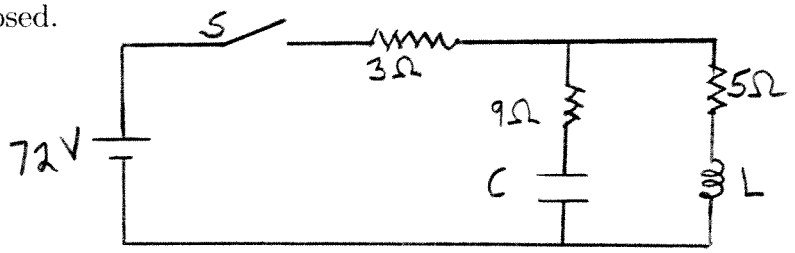
(8 pts) 4. Consider the circuit shown in the sketch. Note that two currents are shown. Calculate the two battery emfs, $\mathcal{E}_1$ and $\mathcal{E}_2$.



Ans. $\mathcal{E}_1$ _____

$\mathcal{E}_2$ _____

(6 pts) 5. Consider the circuit shown in the sketch. $C = 5.0 \times 10^{-6}$ F and $L = 0.30$ H. Initially the switch S is open, there are no currents, and there is no charge on the capacitor. Then the switch is closed.



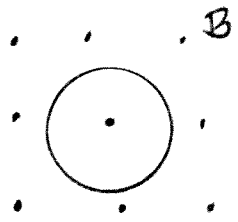
a) Just after the switch is closed, what is the voltage across the 3 Ω resistor?

Ans. _____

b) After the switch has been closed a long time, what is the voltage across the 3 Ω resistor?

Ans. _____

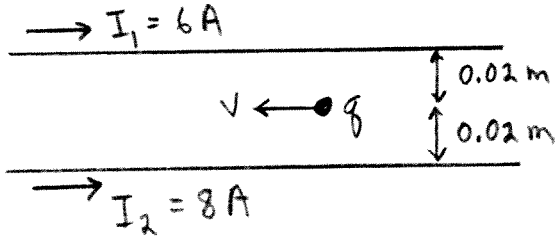
(8 pts) 6. A circular loop of wire has radius $r = 0.20$ m and resistance 40 Ω. The loop is in a uniform magnetic field that is directed out of the plane on the paper, as shown in the sketch. The magnetic field is decreasing at a constant rate of $\Delta B/\Delta t = -0.050$ T/s. What are the magnitude and direction (clockwise or counterclockwise) of the current that is induced in the loop?



Ans. $I =$ _____

direction _____

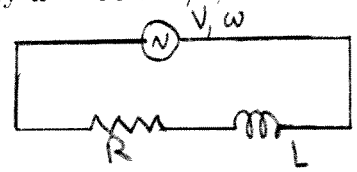
(9 pts) 7. Two long, straight parallel wires carry currents as shown in the sketch. The distance between the wires is 0.040 m. A small object with negative charge $q = -5.0 \times 10^{-4}$ C is moving parallel to the wires, in the opposite direction to the currents, with speed $v = 7.0 \times 10^4$ m/s. What are the magnitude and direction of the net force that the magnetic field of the two wires exerts on q?



Ans. $F =$ _____

direction _____

(9 pts) 8. A series *ac* circuit has a source with voltage amplitude $V = 120$ V and angular frequency $\omega = 50$ rad/s, a resistor with $R = 15\ \Omega$ and an inductor with $L = 0.40$ H.



a) What is the current amplitude?

Ans. _____

b) What is the phase angle? Does the source voltage lag or lead the current?

Ans. phase angle _____

lag or lead _____

c) What is the rate at which the source is delivering electrical energy to the circuit?

Ans. _____

(6 pts) 9. An object that is 2 mm tall is placed 40 cm to the left of a thin lens that has $f = +30$ cm.

a) Is the image real or virtual?

Ans. _____

b) Is the image upright or inverted?

Ans. _____

c) What is the height of the image?

Ans. _____

(8 pts) 10. An oil film that is 400 nm thick is on top of water. The oil has $n = 1.2$ and the water has $n = 1.33$. White light in air is incident normal to the surface of the oil. What wavelengths in air within the limits of the visible spectrum ($\lambda = 400$ nm to 700 nm) have destructive interference between the light that is reflected from the upper and lower surfaces of the oil film?

Ans. _____

(6 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 ${}^{9}_{4}\mathrm{Be}$.

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
Beryllium, Be	4	5	9.012182	9

Ans. _____

(8 pts) 12. The gold nucleus ${}^{198}_{79}\mathrm{Au}$ undergoes α-decay with a half-life of 2.70 days.

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

Ans. _____

b) What is the activity in Bq (decays/sec) of a sample that contains 5.0 grams of ${}^{198}_{79}\mathrm{Au}$ nuclei?

Ans. _____