$E = \frac{kq}{r^2}$ N/coul $V = \frac{kq_1}{r}$ J/coul $W = f \cdot d$

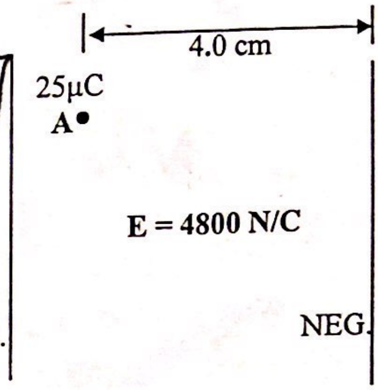
$F = \frac{kq_1q_2}{r^2}$ N $U_E = \frac{kq_1q_2}{r}$ J

78

PSTCC
PHYS 2110 P01 Fall 2017 Test 1

Name Zac freier

1) A 25μC-charge is placed in a 4800 N/C uniform electric field at Point **A**, a distance of 4.0cm from its negative plate as shown. Find (a) the magnitude of the force on it, (b) the work done by it in moving toward the negative plate, (c) its potential energy at **A**, (d) its K.E. just before hitting the negative plate, and (e) its speed prior to collision, if the charge is on a particle of mass 8.0μg. (25 pts)



a) $F = Eq_2 = 4800\ N/C \times 25\times10^{-6}\ Coul = \boxed{.12\ N}$

b) $W = F \cdot d \quad (.12\ N)(.04m) = .0048\ Nm = \boxed{4.8\times10^{-3}\ Nm}$

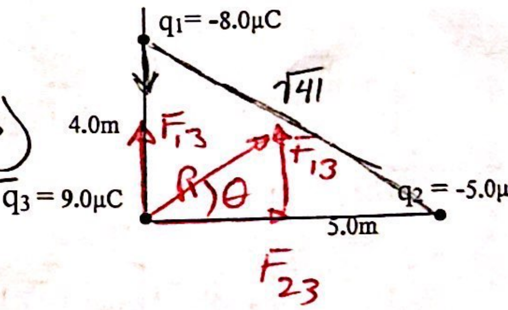
c) $v = \cancel{\frac{k(25\times10^{-6})}{.04m}} = \boxed{5.6\ MV}$

d) $= \boxed{\cancel{5.6\ MV}}$

e) ?

-8

2) In the figure shown, draw and calculate the **resultant force** on **q₃** = 9.0 μC placed at the origin.
k = 9.00x10⁹ Nm²/Coul². (25 pts)



$F_x = \frac{kq_1q_3}{r^2}x + \frac{kq_2q_3}{r^2}y$

$F = \cancel{\frac{(9\times10^9)(-8.0\times10^{-6})(9\times10^{-6})}{4^2}} \cancel{+} \frac{(9\times10^9)(-5\times10^{-6})(9\times10^{-6})}{5^2}$

vector addition.

F =

$F = \cancel{-.0567\ N}$ OR $\boxed{56\times10^{-3}\ N}$

56 mN

R = ?

θ = ?

-10

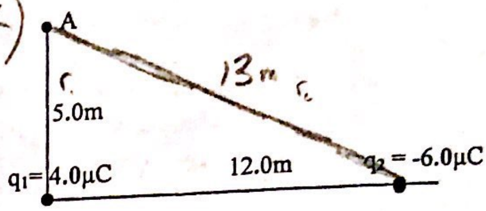
Scanned with CamScanner

3) In the figure shown, find (a) the total potential at Point A due point charges q_1 and q_2, and (b) the energy that a 3.0-nC charge will have if placed at A. (20 Pts)

$V = \frac{kq_1}{r_1} + \frac{kq_2}{r}$

$V = k\left(\frac{4\times10^{-6}C}{5m} + \frac{-6\times10^{-6}C}{13m}\right)$

$\boxed{V = 3.0\ kV}$



3.0×10^{3}

$U_e = 3\times10^{-12} C\,(V) = \boxed{9.1\times10^{-9}\ J}$

-6

-1

3 points each: Write your best answers in the column provided.

Ans.	No.	Question
C	1	As soon as electric charges are given to an isolated solid metallic sphere placed on an insulator mounting, (a) they tend to stay locally where they are placed at (b) they distribute throughout the solid metal sphere (c) they distribute evenly over the sphere outer surface.
d	2	A positively charged object is the one that (a) has protons distributed all over its surface (b) has more protons than electrons (c) has lost a number of electrons (d) b & c.
C	3	A metal sphere with an insulator mounting has -36.0µC of electric charge and another identical sphere has 16.0µC on it. The charge on each sphere after being brought into contact is (a) -22.0µC (b) -11.0 µC (c) -10.0µC.
a	4	The electric field of a single point charge q_1 at a distance r from it is (a) $E = kq_1/r^2$ (b) $E = kq_1/r$ (c) constant.
C	5	The way the light of a tiny light bulb weakens as we move away from it follows the (a) $1/r^4$ law (b) 1/r law (c) $1/r^2$ law.
b	6	The force of a +12µC charge placed at (0, -7) on a -15µC charge placed at (7, 0) has a direction of (a) 45° (b) -135° (c) 135°.
cb	7	Charge $-q_1$ is at (0,0) and $+q_2$ at (-4, 0). The force of $+q_2$ on $-q_1$ points (a) South (b) East (c) West.
C	8	The Metric unit for the electric potential, V, is (a) Joules/m (b) Joules/sec. (c) Joules/Coul.
b	9	The potential at 9.0m from a 15.0nC charge is (a) 45 Volts (b) 15 Volts (c) 75 Volts.
d	10	The electric field around an electric dipole is not uniform because (a) the field lines are not parallel (b) as a test charge changes distance from the dipole the density of field lines changes (c) neither a nor b (d) both a and b.

-3

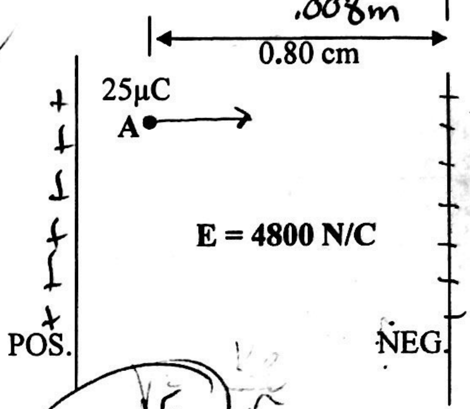
q_2 q_1

50

PSTCC

PHYS 2110 P01 Fall 2016 Test 1 Robert Goeke

1. A 25μC-charge is placed in a uniform electric field with strength of 4800 N/C at a Point **A**, a distance of 0.80cm from its negative plate. Find (a) the magnitude of the force on it, (b) the work done by it in moving toward the negative plate, (c) its initial potential energy at **A**, (d) its K.E. just before hitting the negative plate, and (e) its speed before hitting the negative plate, if the charge is on a particle of mass 4.0μg. (25 pts.)



$F = \frac{kq_1q_2}{r^2}$

$\frac{F}{q_2} = \frac{kq_1}{r^2}$

$E = \frac{kq_1}{r^2}$

$F = Eq$

$V = \frac{kq}{r}$

$F = Eq = (4800\,\frac{N}{C})(.000025C) = .12N$

$W = F\,\partial r = (.12N)(.008m)$

$9.6 \times 10^{-4}\,Nm$

$V = \cancel{\frac{kq}{r}} = \frac{(9\times10^9)(.000025)}{.008}$

28125000 volts

-15

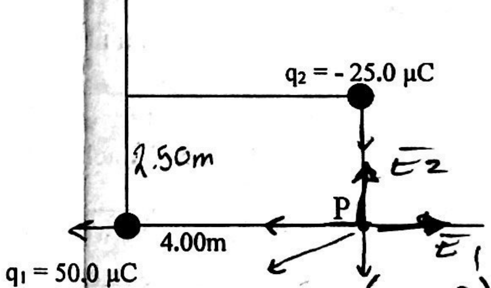
2. In the figure shown, with 2 vectors that start from P, (a) show the field vectors $\mathbf{E_1}$ and $\mathbf{E_2}$ that charges q_1 and q_2 develop at P. (b) Write $\mathbf{E_1}$ and $\mathbf{E_2}$ in their vector notation form (c) Find the resultant electric field vector (**E**) at P, and (d) the force on a -2.0nC charge if placed at P. $k = 9.00\times10^9$ Nm²/Coul² (20 pts.)

$E_1 = (28125\,\frac{N}{C}, \cancel{180°})$ 0°

$E_2 = (36{,}000\,\frac{N}{C}, +90°)$

$E = (45{,}683\,\frac{N}{C}, 218°)$

$F = \frac{kq_1q_2}{r^2} = 9\times10^9($



$E_1 = \frac{(9\times10^9)(.00005C)}{4^2}$

$E_1 = 28{,}125\,\frac{N}{C}$

$E_2 = \frac{(9\times10^9)(-.000025C)}{2.5^2}$

$E_2 = 36{,}000\,\frac{N}{C}$

-15

3. Use the figure shown for Problem 2 to find (a) the net electric potential V at P, and (b) the potential energy of a -2.0nC charge if placed at P. (15 pts.)

$V_T = \frac{kq}{r} = (9\times10^9)$?

$U_e = Vq$

-12

4. The attraction force between two identical tiny metal spheres that carry equal and opposite charges and are 1.00m apart is 36.00×10^{-3}N. (a) Find the amount of each charge. (b) If half of one charge is placed on the other, what will be the magnitude of the new force? (10 pts)

$$F = \frac{Kq^2}{r^2} \qquad F = \frac{K(\frac{1}{2}q)(\frac{3}{2}q)}{r^2}$$

$$\frac{Fr^2}{K} = q^2 \qquad F = \frac{(9\times10^9)(.000001)(.00000\cancel{3}^{1})}{1^2}$$

$$q_1 = q_2 = \sqrt{\frac{.036\times1^2}{9\times10^9}} = 2\,\mu C \qquad F = \cancel{27}^{9}\times10^{-3}\,N$$

-2

2 points each: Write your best answers in the column provided.

Ans.	No.	Question
~~B~~ C	1	As soon as electric charges are given to a solid metal sphere that is placed on an insulator mount, (a) they stay locally where they are put (b) they distribute evenly throughout the sphere (c) they distribute evenly over the sphere's outer surface.
D	2	A positively charged object is the one that (a) has protons distributed over its surface (b) has more protons than electrons (c) has lost a number of electrons (d) b & c.
B	3	A metal sphere with an insulator mounting has -9.0μC of electric charge and another identical sphere has 29.0μC on it. The charge on each sphere after being brought into contact is (a) 38.0μC (b) 10.0 μC (c) 19.0μC.
B	4	The electric field around a single point charge is (a) uniform (b) non-uniform because the field lines are not parallel.
A	5	The light of a light bulb as we move away from it weakens as (a) $1/r^2$ (b) $1/r$ (c) $1/r^3$.
C	6	The force of a 12μC charge placed at (0,7) on a -25μC charge placed at (7,0) has a direction angle of (a) 45° (b) -45° (c) 135°.
B	7	Charge $-q_1$ is at (-4,0) and $+q_2$ at (4, 0). The force of $-q_1$ on $+q_2$ points (a) South (b) West (c) East.
C	8	The force of a point charge on other point charges around it that are at the same distance (a) has the same magnitude and direction (b) has the same magnitude only (c) has, in general, different magnitudes and different directions.
A C	9	A charge is considered **a point charge** if (a) its dimension with respect to the distances over which its effect is to be studied is relatively small (b) it has a zero diameter (c) both a & b.
C	10	The number of electrons in 1nC charge is (a) 6.25×10^6 (b) 6.25×10^3 (c) 6.25×10^9.

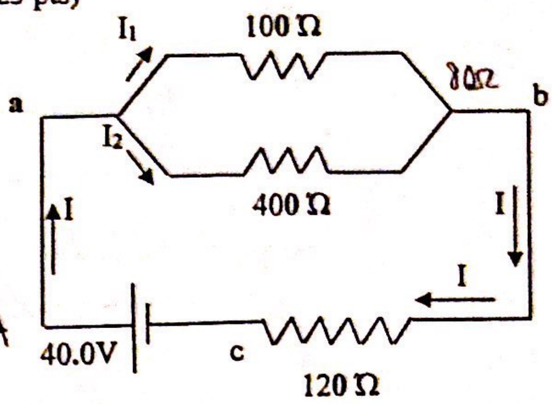
92

PSTCC

PHYS 2110 P01 Fall 2017, Test 2

Name: Zac Freier

1) In the figure shown, find R_{ab}, R_{ac}, I, V_{ab}, V_{bc}, and I_2. (25 pts)



$\boxed{R_{ab} = 80\Omega}$

$\boxed{R_{ac} = 200\Omega}$

$V = RI \quad I = V/R \quad 40.0V/200\Omega = .2A$

$\boxed{I = .2A}$

$I_2 = V/R \quad 16.0V/400\Omega$

$\boxed{I_2 = .04A}$

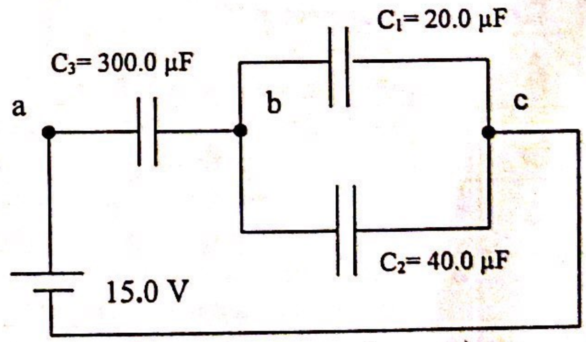
$V_{ab} = R \cdot I = (80\Omega)(.2A) = 16V$

$\boxed{V_{ab} = 16.0V}$

$V_{bc} = R/I \quad (120\Omega)(.2A) = 24V$

$\boxed{V_{bc} = 24.0V}$

2) In the figure shown, the circuit has been on for a long time. Find (a) C_{bc} and C_{ac}, (b) the charge that leaves the battery, (c) the charge on C_3, and (d) the charge on C_2. (25 pts)



$\boxed{C_{bc} = 60.0\mu F}$

$\boxed{C_{ac} = 50.0\mu F}$

$q = CV \quad (50\mu F)(15.0V)$

$\boxed{q = 750.0\mu Coul}$

$q_2 = C_2 V = (40\mu F)(15V)$

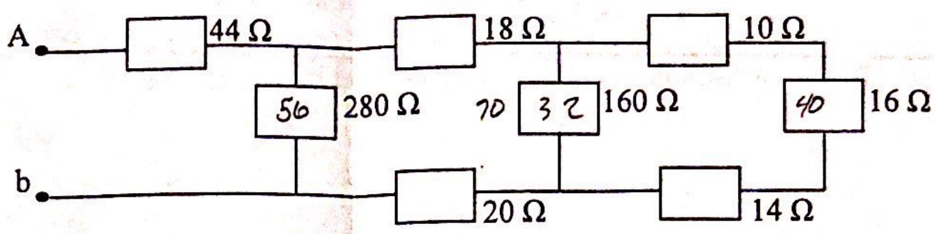
$\boxed{q_2 = 600\mu Coul}$

$q_3 = C_3 V \quad (300\mu F)(15.0V)$

$\boxed{q_3 = 4.5m\ Coul}$

-8

3) In the figure shown, each rectangle represents a resistor. Find R_{ab}. (20 pts.)



$\boxed{R_{ab} = 100\,\Omega}$

3 points each: Write your answers in the column provided.

Ans.	No.	Question
B	1	To fully charge a 144Ah car battery in 36h, the average current in the circuit must be (a) 5.0A (b) 4.0A (c) 3.0A.
B	2	When the voltage across an element with a fixed electric resistance increases, the current through that element (a) decreases (b) increases (c) remains unchanged.
A	3	When the resistance of an element connected to a constant-voltage-battery increases, the current through that element (a) decreases (b) increases (c) remains unchanged.
C	4	Different resistances in series have (a) the same voltage across them (b) the same power dissipation in them (c) the same current through them (d) both a and c.
A	5	Different resistances in parallel have (a) the same voltage across them (b) the same power dissipation in them (c) the same current through them (d) both b and c.
B	6	The voltage across a 50Ω resistor is 100V. The electric current it pulls from the socket and the power it dissipates as heat are (a) 2A and 100watts (b) 2.0A and 200watts (c) 5A and 500watts.
C	7	$P = VI$ may be written as (a) $P = V^2/R$ (b) $P = RI^2$ (c) Both a and b (d) neither a nor b.
-3 B	8	If a 5.00-hp motor is on for 2.00 minutes, the energy (in Joules) it consumes is (a) 7920J (b) 1980J (c) 448000J. **Note:** 1hp = 746 watts.
C	9	The equivalent capacity for an $18\mu F$ capacitor in series with a $90\mu F$ capacitor is (a) $108\mu F$ (b) $72\mu F$ (c) $15\mu F$.
B	10	The equivalent capacity for a $12\mu F$ capacitor in parallel with a $60\mu F$ capacitor is (a) $48\mu F$ (b) $72\mu F$ (c) $5.0\mu F$.

86

PSTCC

PHYS 2110 P01 Fall 2017, Test 3

Name: Zac Freier 86

1) A120-V electric iron has a 10.0-Ω heating element when measured at Room Temperature of 20°C. Calculate **(a)** the initial current it draws from the city electric outlet. When hot, its element reaches a temperature of 620°C. If the temperature coefficient of resistivity of its element is 2.5×10^{-3} per °C, use the approximate equation $R(T) = R(20)*[1 + \alpha (T-20)]$ to calculate **(b)** its resistance when hot. **(c)** What current does it draw when hot and **(d)** what is the power of the hot iron? (15 pts.)

(a) 12 A

(b) 25 Ω

(c) 4.8 A

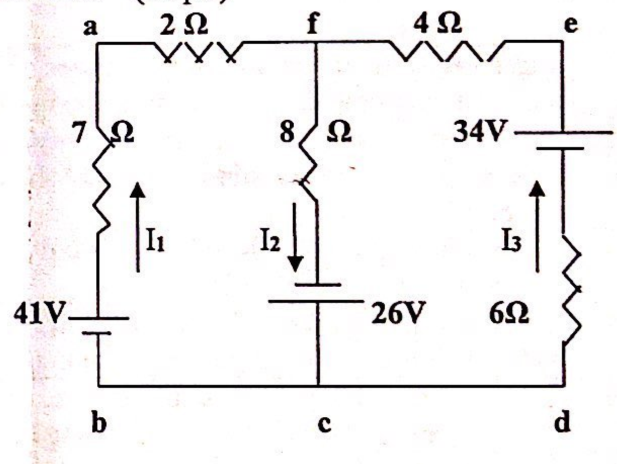
(d) 576 W

2) In the figure shown, use Kirchhoff's rules to find the **current** through each branch based on the assumed directions. Assume 3 significant figures on all numbers. (20 pts)

$I_1 = 3A$

$I_2 = 5A$

$I_3 = 2A$



* I was not here the day we derived this, I would've asked how if I knew we were going to be tested on it.

3) Derive the equation for I(t) in an RC circuit during the charging phase. (10 pts)

$I_i = I_{max} e^{t/RC}$

-8

4) In an RC charging circuit $R = 2.00k\Omega$, $C = 50.0\mu F$, and $V_{bat} = 20.00$ volts. If at $t = 0$, the circuit is turned on, find (a) the initial current, (b) the final current, and (c) the capacitor voltage at the following times: 0.100s, 0.200s, 0.300s, 0.400s, and 0.500s. (25pts.)

(a) $.01\,A = 10mA = I_0$

(b) $\emptyset = I_f$

(c) $V_c(.1) = 12.64V$

$V_c(.2) = 17.29V$

$V_c(.3) = 19.00V$

$V_c(.4) = 19.63V$

$V_c(.5) = 19.87V$

3 points each: Write your answers in the column provided.

Ans.	No.	Question
-3 B	1	In an RC circuit with a battery in series, the equation $V_{bat} = V_C + V_R$ is true (a) $t = 0$ only (b) after a long time only (c) at any given instant.
-3 B	2	The reason for the increase in resistivity with an increase in temperature is (a) thermal expansion (b) an increase in the number of outer shell electrons (c) an increase in the kinetic energy of electrons.
C	3	The temperature coefficient of resistivity has the SI unit of (a) cm^{-1} (b) Ωm (c) $°C^{-1}$ (d) none of a, b, or c, it is dimensionless.
C	4	According to Kirchhoff's Voltage Rule, the sum of voltages across the elements (a) of any branch (b) of all branches that go to a junction (c) of any closed loop is zero.
C	5	According to Kirchhoff's Current Rule, the algebraic sum of currents (a) flowing into any branch (b) flowing out of any branch (c) going to and out of any junction is zero.
C	6	The equation $V_{bat} = V_C + V_R$ for an RC circuit may be written as (a) $V_{bat} = Q/C + I/R$ (b) $V_{bat} = QC + IR$ (c) $V_{bat} = Q/C + IR$.
B	7	The VIt product has the unit of (a) power (b) work (c) work per unit of time where V denotes voltage, I amperage, and t an elapsed time.
B	8	A 1600w kettle that is on for 6.0 minutes consumes (a) 160kwh (b) 0.16kwh (c) 96000J of electric energy.
C	9	In an RC series circuit, the final current through the resistor or the capacitor is (a) V_{bat}/R (b) I_{max} (c) 0.
B	10	In an RC circuit with a battery, the initial current through the capacitor is (a) V_{bat}/C (b) V_{bat}/R (c) 0.

Scanned with CamScanner

84

PSTCC

PHYS 2110 P01 Fall 2017, Test 4

.0075 T

Name: Zac Freier

1) Protons entering a 7.5mT magnetic field normal to its field lines take a circular path of radius 0.25m. For each, find (a) speed (b) kinetic energy, (c) force, and (d) acceleration. $M_p = 1.674 \times 10^{-27}$kg , $e^+ = 1.6 \times 10^{-19}$ C. (20 pts)

$B = 7.5\,mT$ $\quad r = .25\,m$

$R = \frac{MV}{qB}$ $\quad RqB = MV$ $\quad V = \frac{RqB}{M}$

(a) $V = \frac{(.25m)(1.6\times10^{-19}Coul)(.0075T)}{(1.674\times10^{-27}kg)} = \boxed{180\,km/s}$ ✓

(b) $K = \frac{1}{2}mv^2$

$= \frac{1}{2}(1.674\times10^{-27}kg)(180{,}000)^2 = \boxed{1.51\times10^{-22}\,J}$ ✗

(c) $F = qVB\sin\theta = qVB$

$(1.6\times10^{-19}Coul)(180{,}000\,m/s)(.0075T) = \boxed{2.16\times10^{-16}\,N}$ ✓

(d) $F = ma \quad = \quad a = \frac{F}{m}$

$$\frac{(2.16\times10^{-16}\,N)}{(1.674\times10^{-27}\,kg)}$$

$\boxed{a = 1.29\times10^{11}\,m/s^2}$ ✓

2) A 20.0-cm long solenoid produces a 5.00mT magnetic field at its center when a 350mA current flows through it. Find (a) its number of loops per meter and (b) its actual number of loops. $\mu_o = 4\pi \times 10^{-7}$ Tm/A (15 pts)

$l = 20.0\,cm \quad B = 5.00\,mT \quad I = 350\,mA$

$n = \frac{loops}{m} \quad B = \mu_o n I \quad n = \frac{B}{\mu_o I}$

$n = \frac{.005T}{(4\pi\times10^{-7})(.350A)} = 11368.21\,\frac{loops}{m}$

$= \boxed{11400\,\frac{loops}{m}}$ ✓

$(11368.21\,\frac{loops}{m})(.2m) = 2273.64\,loops$

$= \boxed{2270\,loops}$ ✓

1) A cyclotron is used to accelerate protons. If B = 158mT, find (a) the period of rotation of protons. (b) Also, find the period of rotation when the protons average speed reaches 0.96c. $M_p = 1.672 \times 10^{-27}$ kg. The charge of proton is $e^+ = 1.6 \times 10^{-19}$ C. (15 pts)

$V = .96c$

$\frac{v}{c} = .96$

$\frac{v^2}{c^2} = .9216$

$T = \frac{2\pi M}{qB}$ $\quad \frac{2\pi(1.672\times10^{-27}kg)}{(1.6\times10^{-19}Coul)(.158T)} = \boxed{4.16\times10^{-7}\,\frac{kg}{CT}}$ ✓

-1

$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{1}{\sqrt{1-(.9216)}}$

$= \boxed{3.57\,times}$ ✓

$T_2 = ?$

Scanned with CamScanner

.8000 76

(b) A coil of wire 2.0cm in radius and 20.0cm long contains 2000 loops. Find (a) the number of loops per meter of it and (b) its self-inductance, L. (c) When connected to a 12.0V battery, a sudden opposing voltage of 330V develops across it. If the current in the coil stabilizes at 0.80Amps, calculate the connection time, Δt. (20 pts)

$L = \mu_0 n^2 A l$ $\quad A = \pi(.02)^2 = .00126 m^2$ $\quad \mu_0 = 4\pi \times 10^{-7}$

$r = .02m \quad N = 2000$ loops $\quad l = .2m$

(a) $n = \frac{N}{l} = \frac{2000}{.2} = \boxed{10{,}000 \frac{loops}{m}}$

(b) $L = (4\pi \times 10^{-7})(10{,}000)^2(.00126 m^2)(.2m)$

$\boxed{L = .0317 \Omega \cdot S}$

(c) $V_L = L\frac{dI}{dt} = dt = L\frac{dI}{V_L}$

$\Delta t = (.0317)\frac{.80}{330V} = \boxed{76.85 \mu sec}$

3 points each: Choose the best answer..

Ans.	No.	Question
-3 A C	1	If the four bent fingers of the right hand point in the direction of positive current in the loops of a magnetized coil, then the thumb points to the (a) the North (b) South pole (c) normal direction to the magnet coil.
-3 B C	2	In a hydrogen molecule, H_2, the net magnetic effect caused by the rotation of its two electrons is zero because (a) at any instant, the two electrons spin in opposite directions creating opposite magnetic effects (b) the instant its two electrons pass by each other, they repel and change planes of rotation that are opposite to each other causing opposite magnetic effects (c) both a & b.
A	3	The magnetic field in between the poles of a horseshoe magnet is (a) uniform (b) non-uniform (c) uniform with unparallel field lines.
B	4	When a bar magnet is cut in halves, (a) one piece is an independent North pole and the other piece an independent South pole. (a) True (b) False
-3 D B	5	The magnetic field that a current-carrying circular wire generates is (a) perpendicular to the plane of the loop (b) has its maximum effect at the center of the loop and normal to it (c) has an upward direction if the current flows in the circular loop (looking from the top) in the counterclockwise direction (d) a, b, & c.
-3 B C	6	If a ring is held under vertical rain such that the angle of its surface is 30 degrees with the vertical direction, then the flux of rain through the ring is (a) 86.6% of the maximum flux (b) 50% of the maximum flux (c) 30% of the maximum flux. Note that the maximum flux occurs, of course, when the ring is held horizontally.
-3 D A	7	In a velocity selector the speed v of the particles that pass through, (a) depends on the amount of charge (b) does not depend on the amount of the charge (c) does not depend on the sign of the charge (d) b & c.
A	8	Equating the force of magnetic field, F_m and the centripetal force, F_c is like (a) $Mv^2/R = qvB$ (b) $Mv^2/R = qvB$ (c) $Mv/R = qvB$.
A	9	1eV is the energy of 1 electron in an electric field where the potential is 1Volt. This follows the formula (a) P.E. = qV where q is electric charge and V is voltage (b) P.E. = Mgh (c) both a and b.
A	10	For a bar-magnet, the magnetic field lines (a) emerge from its North pole and enter its South pole (b) emerge from its South pole and enter its North pole (c) emerge from its poles and enter its middle, the neutral zone.

78

PSCC

PHYS 2110 P01 Fall 2017, Test ~~A~~ 5

Name: Zac Freier

1) A light 50.0-watt bulb is connected to a 125V AC source. Find (a) the RMS values of power, voltage and current, (b) their corresponding maximum values, and (c) the bulb's electric resistance R when in use. (20 pt.)

$P_{rms} = 50.0\ W$ $\quad V_{rms} = 125V$

Rest? (-5)

$P_{max} = 2(50)$ $\quad V_{max} = \frac{125}{.707}$

$P_{max} = 100\ W$ $\quad V_{max} = 176.8V$

2) A 40.0μF capacitor is connected to an AC source with a voltage equation of V = 17.0sin(250**t**) where V is in volts and **t** in seconds. Draw an appropriate circuit diagram for this problem and calculate the RMS current through the capacitor. (20 pts)

$C = 40.0\mu F$ $\quad V = 17.0\sin(250t)$

$V_{max} = 17.0V$ $\quad V_{rms} = .707\ V_{max}$ $\quad V_{rms} = 12.0V$

$W = 250\ \frac{rad}{s}$

$X_L = \frac{1}{CW}$ $\quad \frac{1}{(40\times10^{-6})(250)} = 100\ \Omega$

$I_{rms} = \frac{V_{rms}}{X_L} = \frac{12V}{100\Omega} = \boxed{.12\ A}$

3) For a 90.0% efficient transformer, the following set of data is known: $N_p = 3600$ loops, $N_s = 180$ loops, $V_p = 240.0V$ AC, and $(I_s)_{real} = 54.0A$. (a) Calculate the values of V_s, $(I_s)_{ideal}$, and I_p. (20 pts)

$\frac{V_s}{V_p} = \frac{N_s}{N_p}$ $\quad V_s = \frac{N_s V_p}{N_p} = \frac{(180)(240.0)}{3600}$ $\quad \boxed{V_s = 12\ V}$

$\frac{I_s}{I_p} = \frac{N_p}{N_s}$ $\quad I_p = \frac{I_s N_s}{N_p}$

$\frac{(54)(180)}{3600} = \boxed{2.7A = I_p}$

3.0A

60.0A

$\% = \frac{P_{out}}{P_{in}} = \frac{V_s I_s}{V_p I_p}$ $\quad (.90)(240)(2.7)$

$(I_s)_{real}$

$P_{out} = 583.2 = V_s I_s$

$\boxed{I_s = 48.6\ A}$

(-6)

Scanned with CamScanner

4) Prove that $X_C = 1/(C\omega)$ when a capacitor of capacity C is connected to an AC source with a voltage equation of $V = [V_{max}]\sin(\omega t)$. Show that the current through the capacitor leads voltage by $\pi/2$ by comparing the current equation you find to this voltage equation. (10 pts.)

$V = L\frac{dI}{dt}$ $\quad$ $V = V_{max}\sin(\omega t)$

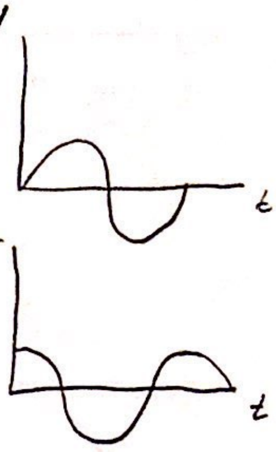
$L\frac{dI}{dt} = V_{max}\sin(\omega t)$ $\quad$ α

$\int dI = \frac{V_{max}}{L}\int \sin(\omega t)\,dt$

-5

$I = I_{rms} -\cos(\omega t)$

$I = I_{max}\sin(\frac{\pi}{2} - \omega t)$



3 points each: Write your **best** answers in the column provided.

Ans.	No.	Question
C	1	A transformer is connected to a 24V battery. If $N_s = 3000$ turns and $N_p = 150$ turns, the voltage at the secondary is (a) 480V (b) 1.2V (c) 0.
A	2	The 120V that we may measure at a wall electric outlet is (a) V_{rms} (b) V_{max} (c) $0.707V_{rms}$.
C	3	For AC sources, P_{rms} is (a) $1.414P_{max}$ (b) $0.707P_{max}$ (c) $0.5P_{max}$.
-3 AC	4	For AC sources, V_{max} is (a) $1.414V_{rms}$. (b) $0.5V_{rms}$ (c) $0.707V_{rms}$.
A	5	Power in AC sources fluctuates between (a) zero and a positive maximum (b) two negative amounts (c) a negative minimum and a positive maximum.
C	6	If a constant current of 3.00A flows through an inductor for which L = 16mH for a duration of 2.00ms, the opposing voltage that develops across the inductor is (a) 40.0V (b) 24.0V (c) 0
-3 bC	7	The reason $V_s/V_p = N_s/N_p$ works for both real and ideal transformers is that (a) $I_s/I_p = I_p/I_s$ for both real and ideal transformers as well (b) the primary and secondary coils share exactly the same magnetic flux (c) both a & b.
C	8	The SI unit for self-inductance L is (a) Ω (b) Ω -Volt (c) Ω -Sec.
C	9	In a circuit with a constant current, a small inductor that has a negligible ohmic resistance acts as (a) a reversed battery (b) a forward battery that adds to the voltage (c) if it does not exist.
B	10	Inductors store (a) electric energy (b) magnetic energy (c) mechanical energy.

74

PSCC

PHYS 2110 P01 Fall 2017 Test 6

Name: Zac Freier

1) Show that the net electric flux because of charge Q entrapped in any closed surface equals ~~Q/(2ε₀)~~ $\frac{Q}{\varepsilon_0}$.
Hint: For simplicity, let the closed surface be a sphere with charge Q concentrated at its center. (20 pts)

$\phi = E \cdot dA = E \cdot \int dA = \frac{kq}{r^2}(4\pi r^2)$ $\quad A = (4\pi r^2) \quad E = \frac{kq}{r^2}$

$k = \frac{1}{4\pi \varepsilon_0}$

$= \frac{kq\, 4\pi r^2}{r^2} = kq\,4\pi$

$\phi_E = \frac{q\, 4\pi}{4\pi \varepsilon_0} = \boxed{\frac{q}{\varepsilon_0}}$

2) An inductor connected to a 1.60×10^{-14} F initially charged capacitor forms an LC circuit with a natural frequency of 2.00GHz. Find (a) the self-inductance, **L** of the inductor. (b) In order to make such an inductor, how many loops of a thin copper wire it is needed if the limitations on radius and length are 5.0mm and 7.0mm, respectively. $\mu_o = 4\pi \times 10^{-7}$ Tm/A.

$c = 1.60\times10^{-14}$ $\quad \cancel{\omega} f = 2.00\text{ GHz}$ $\quad \omega = 2\pi f$

$\frac{1}{\omega} = \sqrt{LC}$ $\quad \omega = \frac{1}{\sqrt{LC}}$

$(\frac{1}{\omega})^2 = LC$

$\left(\frac{1}{2\times10^9}\right)^2 / 1.6\times10^{-14} = L$ $\quad (\frac{1}{\omega})^2/c = L$ $\quad LC = \frac{1}{\omega}^2$

$L = \cancel{1.56\times10^{5}}\ 3.96\times10^{-7}$ H $\quad \frac{1}{\omega^2 c} = L$ $\quad L = (\frac{1}{\omega})^2/c$

$L = \mu_0 n^2 l A$ $\quad A = 2\pi r^2$

$\cancel{N}\, n = \sqrt{\frac{L}{\mu_0 l A}}$ $\quad \frac{1.56\times10^{-5}}{(4\pi\times10^{-7})(.007)(1.57\times10^{-4})} = \boxed{3360 \text{ loops}}$ ∝ meter $\quad A = 2\pi(.005)^2$ $\quad A = 1.57\times10^{-4}\text{ m}^2$

∝ 112 ≈ 6x01 loops

$N = nl = ?$

-5

3) Derive the formula for the electric field at a distance Y straight above the center of a charged disc of radius a that carries a uniform surface charge density σ. (15 pts)

$dE = \frac{|k\,dq|}{r^2}\cos\theta$ $\qquad \cos\theta = \frac{y}{r}$ $\qquad r = \sqrt{x^2+y^2}$

$dq = 2\pi\sigma x\,dx$ $\qquad u = (x^2+y^2) \quad du = 2x\,dx$

$dE = \frac{2\pi k\sigma\, x\,dx}{r^2}\left(\frac{y}{r}\right) = \frac{2\pi k y\sigma\, x\,dx}{(\sqrt{x^2+y^2})^{3/2}}$ $\qquad \frac{1}{2}u^{-\frac{1}{2}}$

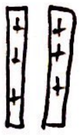
$\frac{2\pi k y\sigma}{r^3}\int_0^a \frac{2x\,dx}{(\sqrt{x^2+y^2})^{3/2}} = \frac{1}{2}u^{-\frac{1}{2}}$ $\qquad \frac{1}{2}(x^2+y^2)^{-\frac{1}{2}}$ $\qquad -\left[\frac{1}{(a^2+y^2)^{1/2}} - \frac{1}{y}\right]2\pi k\sigma$

Figure?

$E = 2\pi k\sigma\left(1 - \frac{y}{(a^2+y^2)^{1/2}}\right)$

-3

4) Two nonmetal infinite surfaces (parallel to each other) are uniformly charged with a positive surface charge density σ. Draw a figure for these **vertical** surfaces and find the electric field **E** for (a) the space in between and (b) for the space outsides of the two surfaces. You may first draw them separately and then show them superposed. (15 pts)



?

-15

3 points each: (Write your **best** answers in the column provided).

Ans.	No.	Question
C	1	The electric field at a distance R from an infinite surface with a uniform charge density σ (a) varies with $1/R$ (b) varies with $1/R^2$ (c) does not depend on R.
C	2	**dq** for a disc that has uniform charge density σ on it at a typical radius x is (a) $2\pi\sigma x dq$ (b) $\pi\sigma x^2 dx$ (c) $2\pi\sigma x dx$.
A	3	The formula $\mathbf{E} = 2\pi k\sigma\left[1 - y/(a^2+y^2)^{1/2}\right]$ gives us the electric field at distance **y** from a (a) disc of charge of radius **a** (b) a line of charge of length **a** (c) a solid sphere of charge of radius **a**.
B	4	The electric field **E** of an infinite line of charge decreases with (a) square of the distance from the line (b) the distance from the line (c) the square root of the distance from the line.
B	5	$2\pi k\sigma$ is equivalent to (a) $\sigma/2$ (b) $\sigma/(2\varepsilon_o)$ (c) σ/ε_o
B	6	The current through an inductor when connected to an AC source, (a) leads voltage by 90° (b) lags voltage by 90° (c) leads voltage by 180°.
C	7	If α is the central angle and λ is the linear charge density, then dq for an arc of length $d\ell$ is (a) $Rd\ell$ (b) $Rd\lambda$ (c) $\lambda R d\alpha$. $d\ell = R d\alpha$ $dq = \lambda d\ell$ $dq = \lambda R d\alpha$
B	8	As the distance from a uniformly charged disc of radius **a** increases, the electric field approaches (a) infinity (b) zero (c) $2k\lambda/R$.
3 B A	9	When a charged capacitor is connected to a negligible resistance inductor, the electric charges of the capacitor will (a) quickly dissipate in the inductor (b) flow back and forth between the capacitor and the inductor (c) stay on the capacitor because the inductor repels them.
B	10	The electric flux φ_E of an electric field E through a surface of area A is maximum if the field lines are (a) parallel to the surface (b) normal to the surface (c) at 45° angle with the surface.

Zac Freier

$P = VI$ ①

$V = RI$

$R = V/I$

$R_T = 10\left[1 + 2.5\times10^{-3}\,/°C\,(620-20)\right]$

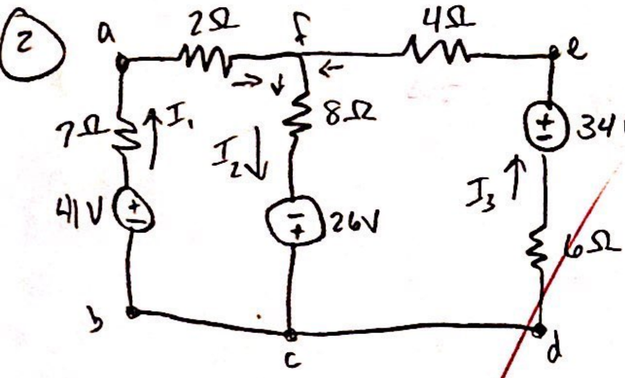
$R_T = 25\,\Omega$

$I = V/R$ @ $\frac{120}{10} = \boxed{12A}$

$I_{hot} = V/R \qquad \frac{120V}{25\,\Omega} = \boxed{4.8A}$

$P = VI = (120V)(4.8A) = 576\,W$

②



$I_1 = 3A$

$I_2 = 5A$

$I_3 = 2A$

Loop abcfa

$7I_1 - 41 - 26 + 8I_2 + 2I_1 = 0$

$9I_1 + 8I_2 = 67$

Loop edcfe

$-34 + 6I_3 - 26 + 8I_2 + 4I_3 = 0$

$8I_2 + 10I_3 = 60$

Junction F

$I_1 - I_2 + I_3 = 0$

④ $RC = (2000\,\Omega)(50.0\,\mu F) = .1\,sec$

$I_0 = V/R = \frac{20.00V}{2000\,\Omega} = .01A = 10mA$

$V_c(.1) = 20.00V(1 - e^{-.1/.1}) = 12.64V$

$V_c(.2) = 20.00V(1 - e^{-2}) = 17.29V$

$V(.3) = 20.00V(1 - e^{-3}) = 19.00V$

$V(.4) = 20.00V(1 - e^{-4}) = 19.63V$

$V(.5) = 20.00V(1 - e^{-5}) = 19.87V$

b) $I_\infty = 0$

-3

Objective:

The objective of this experiment ~~two~~ was to verify Ohm's Law

Equipment:

A few ceramic resistors(100Ω - 200Ω) a rheostat (variable resistor), a DC power source, 2 multi-meters, a calculator, and a few connecting wires with alligator clips.

Theory:

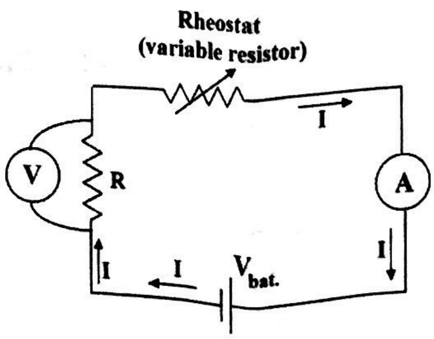
The voltage across a resistor divided by the current through the same resistor is known as the "electric resistance, R," this is known as Ohm's Law.

$$R = V / I$$

V is the unit for volts and *I* is unit for amps. This make the unit or R be "volts per amp." Also known as Ohm's. Ohm's has the symbol "Ω" and is said "omega."

Procedure:

The circuit ~~[illegible]~~ was set up as shown in the figure below so that the power of 5 volts flows out of the battery, through the resistor and the voltmeter, through the Rheostat, passing through the ammeter and back into the battery. The Rheostat is a resistor that is variable so the slider on it can be moved into multiple different locations along the Rheostat and it changes the resistance that the current experiences.



The experiment was to move the Rheostat slider in five different positions and get five different current and voltage readings on the ammeter and voltmeter to then do the calculations to tell what size resistor ~~we~~ used in the circuit.

Data:

Given:

V = 5 volts
R = 100Ω
R = (0-90) Ω

Measured:

The measured values of *I* and V are in the table that was filled out on the separate sheet of paper.

Calculations:

For each setting the Rheostat slider was placed we calculated R with the formula R = V / I.

$$
\begin{aligned}
R = V / I &= 2.19V/.0219A = 100.0\Omega \\
&= 2.41V/.0240A = 100.4\Omega \\
&= 2.69V/.0269A = 100.0\Omega \\
&= 2.99V/.0298A = 100.3\Omega \\
&= 4.10V/.0410A = 100.0\Omega
\end{aligned}
$$

Comparison of the Results:

Calculated % error on R. this value should be very low if the experiment was done right.

$$\% \text{ error} = \frac{|\text{Accepted} - \text{Measured}|}{\text{Accepted}} \times 100$$

$$\frac{|100 - 100.14|}{100} \times 100 = .14\% \text{ error}$$

% error on R = .14% error

Conclusion:

In conclusion the objective of this experiment was to verify Ohm's Law. The whole lab did not take very long and it was really neat to find out how a Rheostat Resistor works and to learn that that is used in a lot of applications in everyday life. It was good practice to show us how one of these worked so that if when use a variable resistor in our lives somewhere down the road we will understand how it works.

What else about getting 100.0 Ω each time under the calculations you've shown?

Zoc Freier

R: 100Ω

Rheostat Position	Current I (A)	Voltage V (volts)	R = V/I (Ω)
1	.0219	2.19	100.0
2	.0240	2.41	100.4
3	.0269	2.69	100.0
4	.0298	2.99	100.3
5	.0410	4.10	100.0
		Mean R:	100.14

1) In the figure shown, find the voltage across, current through, and power dissipation for the 100-Ω resistor. (20 pts)

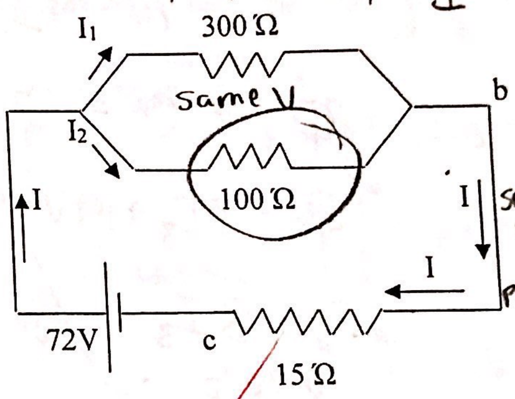
$P = VI \quad R = \frac{V}{I}$

$V = RI \qquad I = \frac{V}{R} \qquad I = \frac{60}{300} = .2$

$V = (75\Omega)(.8A) \qquad I = \frac{60}{100} = .6$

$60V$

$P = VI = (60V)(.6A) = 36W$



series share current
parallel share voltage

$R = \frac{1}{\frac{1}{300} + \frac{1}{100}} = 75\Omega$

For 100Ω: $V = 60V$ / $I = .6A$ / $P = 36W$

2) A120-V electric iron has a 10.0-Ω heating element when cold (at 20°C). Calculate **(a)** the initial current it draws from the city electric outlet. Find its resistance when hot and at 520 °C knowing that its temperature coefficient of resistivity is 4.00×10^{-3}/°C. **(b)** What current does it draw when hot? **(c)** Find its power when hot. (20 pts)

a) $I = \frac{V}{R} = \frac{120V}{10\Omega} = 12A$

$R_T = R_{20}[1 + \alpha(T - 20)]$

$R_T = 10\Omega[1 + 4E\text{-}3\frac{1}{°C}(520 - 20)°C]$

b) $R_T = 30\Omega$

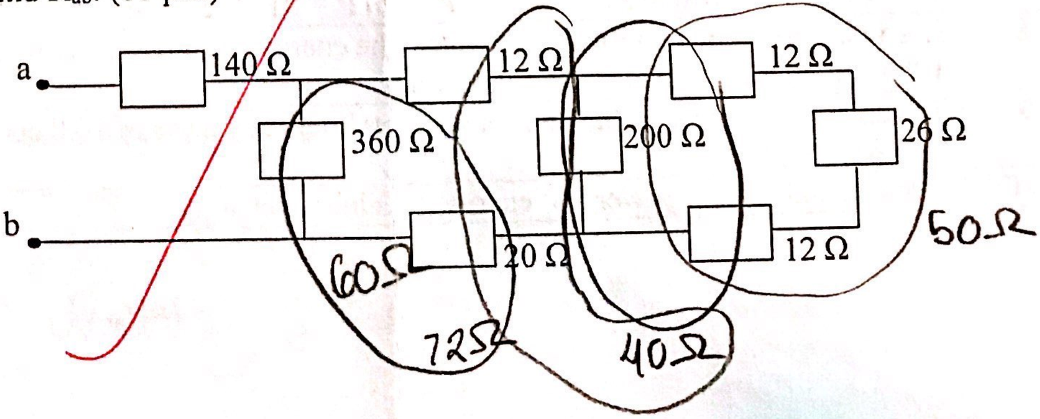
c) $P = VI$

$P = V\left(\frac{V}{R}\right)$

$P = \frac{V^2}{R} = \frac{120V^2}{30} = 480W$

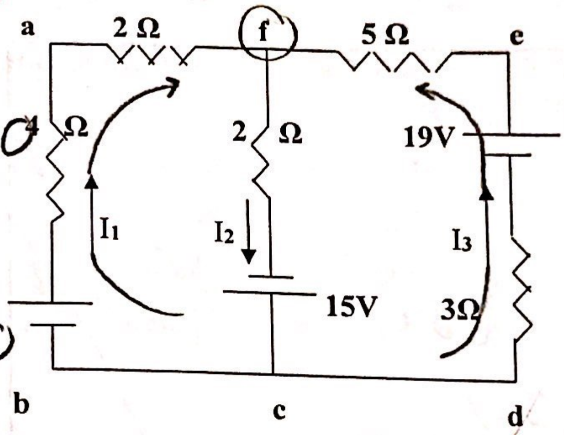
3) In the figure shown, each rectangle represents a resistor. Find the equivalent resistance of the whole circuit: in other words, find R_{ab}. (10 pts.)

$R_{ab} = 200\Omega$



Scanned with CamScanner

4) In the figure shown, use Kirchhoff's rules to find the **current** through each branch. Assume 3 significant figures on all numbers. (20 pts)



KLR F

$-2I_2 + 15V + 7V - 4I_1 - 2I_1 = 0$

$-6I_1 - 2I_2 - 0 = -22V$

$-2I_2 + 15V - 3I_3 + 19V - 5I_3 = 0$

$0 - 2I_2 - 8I_3 = -34V$

KJR/F

$I_1 - I_2 + I_3 = 0$

$$\begin{bmatrix} -6 & -2 & 0 & -22 \\ 0 & -2 & -8 & -34 \\ 1 & -1 & 1 & 0 \end{bmatrix} \text{ RREF}$$

$I_1 = 2A$

$I_2 = 5A$

$I_3 = 3A$

3 points each: Write your answers in the column provided.

Ans.	No.	Question
B	1	To fully charge a 108Ah car battery in 36h, the average current in the circuit must be (a) 5.0A (b) 3.0A (c) 4.0A.
A	2	When the voltage across an element with a fixed electric resistance increases, the current through that element (a) increases (b) decreases (c) remains unchanged. $I = \frac{V}{R}$
B	3	When the resistance of an element connected to a constant-voltage-battery increases, the current through that element (a) increases (b) decreases (c) remains unchanged. $I = \frac{V}{R}$
C	4	Different resistances in series have (a) the same voltage across them (b) the same power dissipation in them (c) the same current through them (d) both a and c.
A	5	Different resistances in parallel have (a) the same voltage across them (b) the same power dissipation in them (c) the same current through them (d) both b and c.
B	6	The voltage across a 50Ω resistor is 100V. The electric current it pulls from the socket and the power it dissipates as heat are (a) 2A and 100watts (b) 2.0A and 200watts (c) 5A and 500watts.
C	7	P = VI may be written as (a) $P = V^2/R$ (b) $P = RI^2$ (c) Both a and b (d) neither a nor b.
C	8	If a 5.00-hp motor is on for 2.00 minutes, the energy (in Joules) it consumes is (a) 7920J (b) 1980J (c) 448000J. **Note:** 1hp = 746 watts.
C	9	The cost of running a 1.50kw heater for 20.0 hours at a price of 10.0 cents per kwh is (a) \$6.00 (b) \$4.50 (c) \$3.00
B	10	kwh is a unit for (a) power (b) energy (c) electric charge.

$V_c + V_R = \cancel{0}\ V_{bat}$ -2

$\left(\frac{Q}{C} + RI = \cancel{0}\right) \frac{\partial}{\partial t}$ V_{bat}

$\frac{1}{C}\frac{\partial Q}{\partial t} + R\frac{\partial I}{\partial t} = 0$

$\frac{1}{C} I + R\frac{\partial I}{\partial t} = 0$

$\frac{I}{RC} + \frac{\partial I}{\partial t} = 0$

$\frac{1}{I}\left(\frac{\partial I}{\partial t} = \frac{-I}{RC}\right) \cdot \partial t$

$\frac{\partial I}{I} = \frac{-\partial t}{RC}$

$\int \frac{1}{I} \partial I = \frac{1}{RC}\int -1\, \partial t$

$\ln(I) = \frac{-t}{RC} + K$

at $t = 0$ $I_0 = I$

$\ln(I_0) = 0 + K$

$K = \ln(I_0)$

$\ln(I) = \frac{-t}{RC} + \ln I_0$

$\ln(I) - \ln(I_0) = \frac{-t}{RC}$

$\ln\left(\frac{I}{I_0}\right) = \frac{-t}{RC}$

$\frac{I}{I_0} = e^{-\frac{t}{RC}}$

$\frac{I}{I_0} = e^{-\frac{t}{RC}}$

$I = I_0\left(e^{-\frac{t}{RC}}\right)$

$I = \left(\frac{V}{R}\right) e^{-\frac{t}{RC}}$

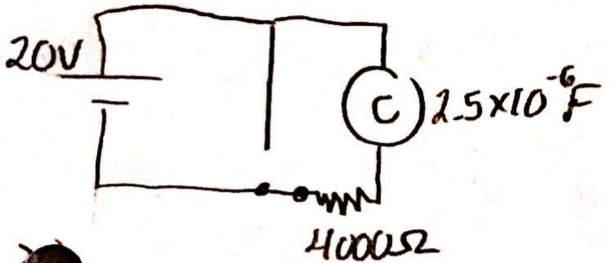
$q = CV \quad V = \frac{q}{C}$

$I = \frac{\frac{Q}{C}}{R}\left(e^{-\frac{t}{RC}}\right)$

$I = \frac{Q}{CR}\left(e^{-\frac{t}{RC}}\right)$

1) Derive the equation for I(t) in an RC circuit during the charging phase knowing that at t = 0 the capacito
is empty. Show all details. Use the back of this sheet.(~~5 pts~~) ~~10~~ 20

2) In an RC charging circuit R = 4.00kΩ, C = 2.5μF, and V_{bat} = 20.0 volts. (a) Draw an appropriate circuit diagram for this problem. If at t = 0, the circuit is turned on, find (b) the initial current, (c) the final current and (d) the capacitor voltages at the following times: 0.01s, 0.02s, 0.03s, 0.04s, and 0.05s. (20pts.)



$V = RI$ b) $I = \frac{V}{R} = \frac{20V}{4000\Omega} = 5mA$

c) As $t \to \infty$ $I \to 0$ $V_c \to$

$V_c(t) = V_B\left(1 - e^{\frac{-T}{RC}}\right)$

$V_c(.01) = 20V\left(1 - e^{\frac{-.01}{4000\cdot 2.5\times10^{-6}}}\right)$

$V_c(.01) = 12.6V$ $V_c(.02) = 17.3V$ $V_c(.03) = 19.0V$

$V_c(.04) = 19.6$ $V_c(.05) = 19.9V$

3) 0.11Mev protons are caught in a magnetic field perpendicular to its field lines and attain a radius of rotation of 0.92m. Find (a) their average speed, and (b) the strength **B** of the magnetic field. (~~15~~ pts) 20

$R = .92m$

$.11MeV$

$= 110000eV$

$1eV = 1.6E{-19}J$

$\frac{Mv^2}{R} = QvB$

$\frac{Mv}{R} = QB$

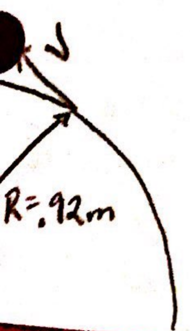
α

$F_c = \frac{Mv^2}{R}$

$F_m = QvB$

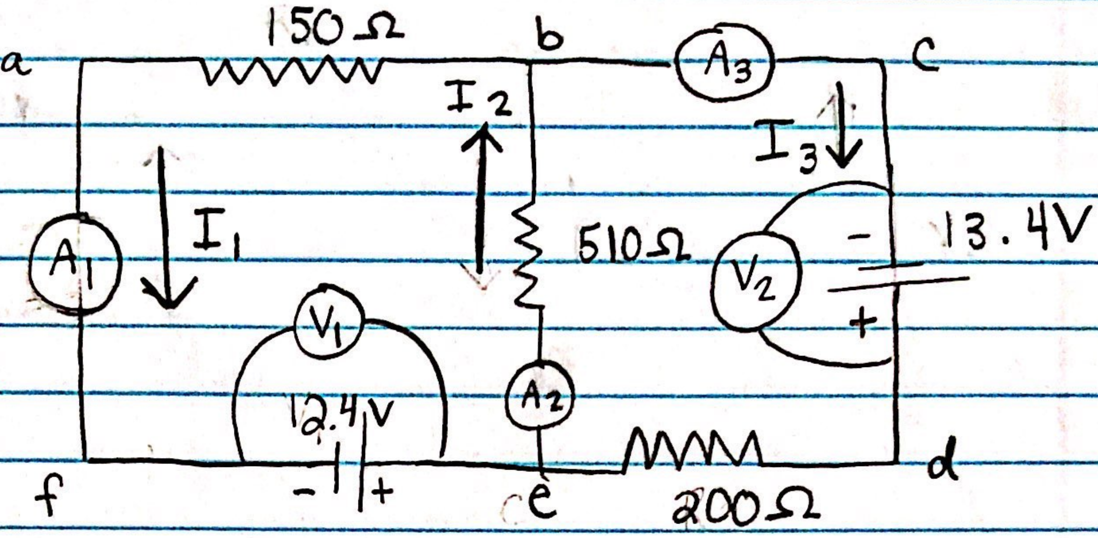
~~-8~~

-6



$K.E. = 0.11\times10^{6}\times1.6\times10^{-19}J = \frac{1}{2}MV^2$

$B = \frac{N}{Coul\cdot\frac{m}{s}}$



ABEF

$-510 I_2 + 12.4V - 150 I_1 = 0$

$-510 I_2 - 150 I_1 = -12.4V$

BCDE

$+510 I_2 + 200 I_3 - 13.4V = 0$

$+510 I_2 + 200 I_3 = +13.4V$

$-I_1 + I_2 - I_3 = 0$

$$\text{RREF} \quad \begin{array}{cccc} I_1 & I_2 & I_3 & \\ \left[\begin{array}{cccc} -150 & -510 & 0 & -12.4 \\ 0 & 510 & 200 & +13.4 \\ -1 & +1 & -1 & 0 \end{array}\right] \end{array}$$

experimental:

$I_1 = .0094A = 9.4mA$

$I_2 = .0215A = 21.5mA$

$I_3 = .0121A = 12.1mA$

Scanned with CamScanner

5) Use Faraday's law and the magnetic flux formula to derive the equation for the voltage variation V(t) of an electric generator in which a coil of N loops with a fixed loop area A spins at a constant angular speed ω inside a uniform magnetic field of strength B. (15 pt.)

$\Phi_m = NBA \cos\theta$

$\int \Phi_m = NBA \int \cos\theta$

$\propto$

$V_t = \frac{-\partial \Phi}{\partial t}$

$V = V_{max} \sin(\omega t)$

-10

3 points each: Write your answers in the column provided.

Ans.	No.	Question
A	1	The magnetic field around a very long and straight current-carrying wire varies as (a) 1/r (b) $1/r^2$ (c) $1/r^{1/2}$ from the wire where **r** is the distance from the wire.
-3 A B	2	The 120V that we may measure at a wall electric outlet is (a) V_{rms} (b) V_{max} (c) $2V_{rms}$.
C	3	For an AC source, P_{rms} is (a) $1.414P_{max}$ (b) $0.707P_{max}$ (c) $0.5P_{max}$.
-3 AC	4	For an AC source, V_{max} is (a) $1.414V_{rms}$. (b) $0.5V_{rms}$ (c) $0.707V_{rms}$.
-3 AC	5	Power in an AC source fluctuates between (a) zero and a positive maximum amount (b) two negative amounts (c) a negative minimum and a positive maximum amount.
C	6	If a **constant** current of 3.00A flows through an inductor for which L = 16mH for a duration of 2.00ms, the opposing voltage that develops across the inductor is (a) 40.0V (b) 24.0V (c) 0 $\left(\frac{\Delta I}{\Delta t}\right)L$
-3 B	7	The period of a cyclotron is (a) a constant for all particles (b) varies directly with both the mass and charge of the accelerating particle (c) increases at speeds close to that of light. $2\pi R$
C	8	The SI unit of self-inductance is (a) Ω (b) Ω -Volt (c) Ω -Sec. Henry
C	9	In a circuit with a constant current, a small inductor that has a negligible ohmic resistance acts as (a) a reversed battery (b) a forward battery that adds to the voltage (c) if it does not exist.
B	10	Inductors store (a) electric energy (b) magnetic energy (c) mechanical energy.

1) The current in a 2.50-cm inductor changes from zero to 1.70 amps in 0.00336 second. Knowing that the inductor has 1250 turns with an average radius of 4.00cm, find (a) its self-inductance (L) and (b) the opposing voltage generated in the inductor because of this current change. (15 pts)

$$L = \mu_0 n^2 A l = (4\pi\times10^{-7}\,Tm/A)\left(\frac{1250}{.025m}\right)^2(.005)(.025m) = .39\,\Omega\cdot s$$

$$V_L = L\left(\frac{\Delta I}{\Delta t}\right) = .39\left(\frac{1.7}{.00336}\right) = 198\,V$$

-1

$$A = \pi r^2 = \pi(.04)^2 = 5.0\times10^{-3}\,m^2$$

2) The data on a light bulb reads 50.0 Watts and 125 Volts. Find (a) the mean values of power, voltage and current, (b) their corresponding max. values, and (c) the bulb's electric resistance R when in use. (15 pt.)

$P_{rms/max} = 50.0W$ $\quad I_{max} = .4A$ $\quad V_{rms} = \frac{V_{max}}{\sqrt{2}} = \frac{125}{\sqrt{2}} = 88V$

$V_{max} = 125V$ $\quad -5$ $\quad I_{rms} = \frac{I_{max}}{\sqrt{2}} = \frac{.4}{\sqrt{2}} = .28A$

$P = VI$

$I = \frac{P}{V} = \frac{2}{5}A$ $\quad P_{rms} = \frac{P_{max}}{2} = 25W$

R=?

3) A 23.0-cm long solenoid has a B value of 5.98mT at its center when a 238mA current flows through it. What are the loops per meter, n, and the # of loops, N, of this solenoid? $\mu_0 = 4\pi \times 10^{-7}$ Tm/A (10 pts).

$l = .23m$ $\quad B = \mu_0 n I l$ $\quad -2$ $\quad$ 19994 loops

$B = .00598T$

$$n = \frac{B}{\mu_0 l I} = \frac{.00598T}{(4\pi\times10^{-7})(.23)(.238)} = \cancel{86{,}933\ \text{loops/meter}} \times .23m$$

$I = .238A$ $\quad$ 8 $\quad$ 4600

4) In a cyclotron with B = 0.0450T electrons are being accelerated to high speeds. Find (a) the period of rotation of the electrons (or the cyclotron) at [redacted] the beginning when their speed is not high enough for relativistic calculation to be significant, and (b) when their speed is 0.99999c.
$M_e = 9.108\times10^{-31}$ kg and $|e^-| = 1.6\times10^{-19}$ C. (15 pts) $\quad c = 3\times10^8\,m/s$

$M = M_0\gamma$ $\qquad T = \frac{2\pi M}{QB}$

$$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} = 316$$

$$= \frac{(2)(\pi)(9.108\times1}{(1.6\times10^{-19})(.045}$$

-5

$\boxed{a)\ T = 7.9\times10^{-10}s}$

$\boxed{b)\ T = \cancel{7.9}\times10^{-10}s}$

charging

t (s)	0	10	20	30	40	50	60	70	80	90	100	120	130
V_c (V)	0	3.91	6.01	7.21	8.00	8.49	8.83	9.07	9.24	9.36	9.46	9.54	9.60
I_c (A)	$\frac{V_B}{R}$	3.14	2.13	1.53	1.16	.91	.76	.64	.55	.49	.45	.41	.38

discharging

t (s)	0	10	20	30	40	50	60	70	80	90	100	120	130	
V_c (V)	10	6.41	4.18	2.77	1.83	1.29	.91	.65	.48	.35	.26	.20	.16	.13
I_c (A)	$\frac{10}{20,000}$	3.16	2.08	1.33	.86	.62	.44	.32	.23	.17	.13	.10	.7	.6

Scanned with CamScanner

$$M = \frac{(.00495)^2 (1.6 \times 10^{-19}) (.00753T)^2}{2(135)}$$

$$M = 8.23 \times 10^{-31} \text{ kg}$$

1 $V = 5.19$ $I = 1.28$	2 5.20 1.28	3 5.19 1.28	4 5.19 1.28
5 5.20 1.28	6 5.19 1.28	7 5.21 1.28	8 5.19 1.28
9 5.21 1.29	10 5.21 1.29	11 5.21 1.29	12 5.21 1.29
13 5.22 1.29	14 5.21 1.29	15 5.21 1.29	16 5.22 1.29
17 5.21 1.29	18 5.21 1.29	19 5.21 1.29	20 5.17 1.29

mean V = 5.203 V
mean I = 1.286 A

T_f - 29.00°C

$U_e = VI * t$

$(5.900)(1.286)(600) = \boxed{4552.44\,J}$

$$\frac{4552.44J}{1182.17\,Cal} = 3.851$$

$$\%\ error = \frac{|4.186 - 3.851|}{4.186} \times 100 = 8.00\ \%$$

Scanned with CamScanner

$Q = [M_w C_w + M_{Al} C_{Al} + M_{Br} C_{Br}](T_f - T_i)$

$Q = [(163.21g)(1 \frac{cal}{g°C}) + (46.45g)(.215 \frac{cal}{g°C}) + (50g)(.0921 \frac{cal}{g°C})](29.00°C - 20°C)$

$\boxed{Q = 1600.21 \text{ \# of calories}}$

$U_e = VIt$

$U_e = (5.900V)(1.286A)(600s)$

$\boxed{U_e = 4522.44 \text{ \# of Joules}}$

$W = \frac{\text{\# of Joules}}{\text{\# of Calories}}$

$W = \frac{4522.44 J}{1600.21 Cal}$

$\boxed{W = 2.84 \frac{J}{Cal}}$

Scanned with CamScanner

Magnetic Induction Chart			Without Iron Core (Weak Magnet)		With Iron Core in the 2nd coil (strong magnet)	
			Galvanometer Reading	Deviation (+) or (-)	Galvanometer Reading	Deviation (+) or (-)
Low Current $\frac{1}{2}$ Amp	Slow	In	0.1	−	0.5	−
	Slow	Out	0.1	+	0.5	+
	Fast	In	0.2	−	1.5	−
	Fast	Out	0.2	+	1.5	+
High Current 1 Amp	Slow	In	0.2	−	1.0	−
	Slow	Out	0.2	+	1.0	+
	Fast	In	0.3	−	2.0	−
	Fast	Out	0.3	+	2.0	+

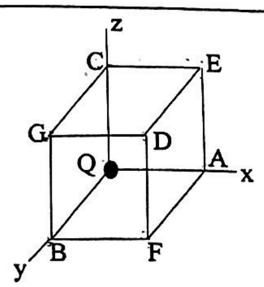
1) In the figure shown, determine (a) what fraction of the total electric flux is received by the cube if charge Q is placed at the origin, and (b) the net flux through each face of the cube in terms of Q and ε_o. (15 pts)

Each face gets $\frac{1}{3}$ of $\frac{1}{8}\Phi_{total}$

Ans: (a): .... $\frac{1}{8}$

(b): $\varphi_{Q\,BGC} = 0$ $\quad \varphi_{AFDE} = \frac{1}{24}\frac{Q}{\varepsilon_o}$ $\quad \varphi_{Q\,CEA} = 0$

$\varphi_{BGDF} = \frac{1}{24}\frac{Q}{\varepsilon_o}$ $\quad \varphi_{GCED} = \frac{1}{24}\frac{Q}{\varepsilon_o}$ $\quad \varphi_{Q\,AFB} = 0$

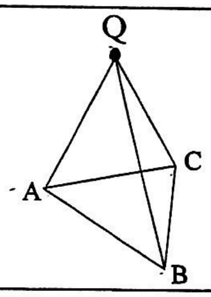


2)

In the figure shown, if 1/20 of the total flux that Q generates in space is received by the tetrahedron, determine the net flux through each face of it in terms of Q and ε_o. (8 pts)

Ans:

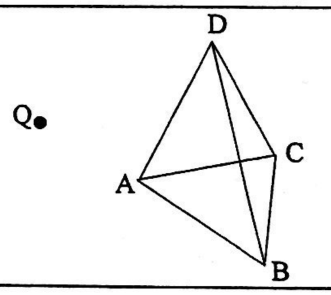
$\varphi_{Q\,AB} = 0$ $\quad \varphi_{QBC} = 0$ $\quad \varphi_{QAC} = \emptyset$ $\quad \Phi_{ABC} = \frac{1}{20}\frac{Q}{\varepsilon_o}$



3)

In the figure shown, calculate the net flux through the tetrahedron in terms of Q and ε_o. (7 pts) No charge trapped within tetrahedron

Ans: 0 If tetrahedron is closed surface



4) Charge Q is placed at the center of a sphere of radius R. Show that the net flux through the surface of the sphere is $4\pi kQ$ wher k is Coulomb's constant. (15 pts)

$$\oint E \cdot dA = \frac{Q}{\varepsilon_o}$$

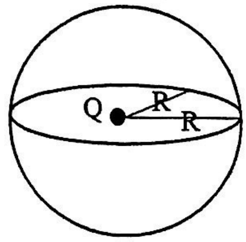
$$\Phi = \oint E \cdot dA = \frac{Q}{\varepsilon_o}$$

more!

$$\Phi = \frac{Q}{\frac{1}{4\pi K}}$$

-8

$$\Phi = 4\pi K Q$$



$$\varepsilon_o = \frac{1}{4\pi K}$$

$$K = \frac{1}{\varepsilon_o}$$

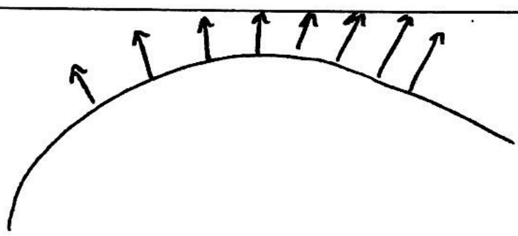
Scanned with CamScanner

5) Using an appropriate Gaussian surface show that the magnitude of the electric field at a distance R from an infinite line of charge with a linear charge density of λ C/m is equal to $2k\lambda/R$. **Use the back of the sheest.** (10 pts)

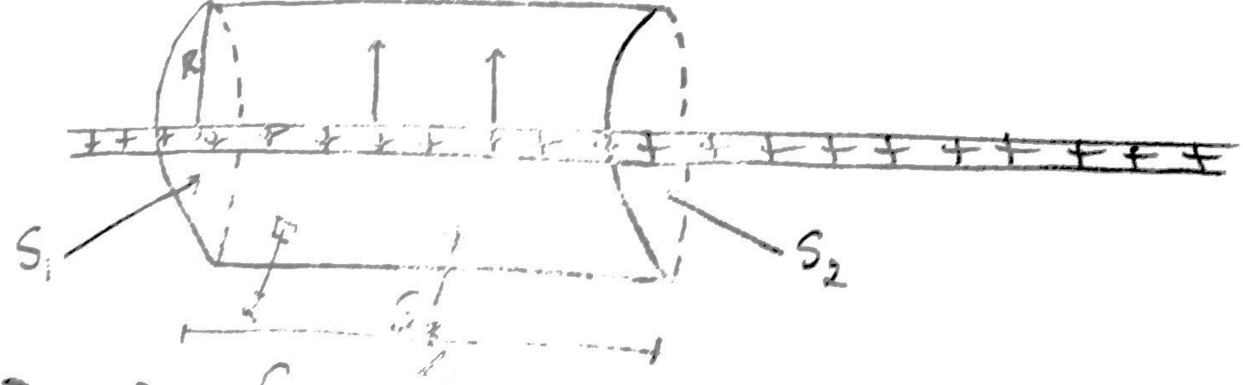
6) Derive the formula for the electric field **E** along a slender rod (of length **L** with a [redacted] linear density λ) at point P that is at distance **b** from one of its ends and along the rod. **Use the back of the sheets.** (15 pts)

3 points each: (Write your answers in the column provided).

Ans.	No.	Question
B	1	According to Gauss's law, the net flux through ~~any~~ a closed surface is equal to Q/ε_0. (a) True (b) False
A	2	According to Gauss's law, the net flux through a closed surface is equal to Q/ε_0 regardless of where the charge is located inside the closed surface. (a) True (b) False
C	3	In spherical coordinates, in order to calculate the surface area of a sphere of radius r, the differential element chosen on the surface has a horizontal length of (a) $rd\theta$ (b) $r\cos\theta d\theta$ (c) $r\cos\varphi d\theta$ where θ is the horizontal angle and φ the vertical angle. arclength
C	4	In spherical coordinates, in order to calculate the surface area of a sphere of radius r, the area of the differential element chosen on the surface is (a) $r^2 d\theta d\varphi$ (b) $r^2\cos\theta d\theta d\varphi$ (c) $r^2\cos\varphi d\theta d\varphi$ where θ is the horizontal angle and φ the vertical angle.
C	5	In spherical coordinates, in order to calculate the volume of a sphere, the volume of a differential cube-like element is (a) $r^2\sin\varphi d\theta d\varphi$ (b) $r^2\cos\varphi d\theta d\varphi$ (c) $r^2\cos\varphi d\theta d\varphi dr$ (d) r^3 where θ is the horizontal angle and φ the vertical angle.
B	6	The electric field around an infinite non-conducting surface with a uniform charge density of σ is (a) σ/ε_0 (b) $\sigma/2\varepsilon_0$ (c) $\sigma/4\varepsilon_0$.
A	7	The electric field around an infinite conducting surface with a uniform charge density of σ is (a) σ/ε_0 (b) $\sigma/2\varepsilon_0$ (c) $\sigma/4\varepsilon_0$.
C	8	For a cavity in a conductor that has a point charge –Q inside, the total charge on its outer surface is (a) 0 (b) +Q (c) –Q.
3 CA	9	For a cavity in a conductor that has a point charge –Q inside, the electric field inside the material of the conductor is (a) 0 (b) $-kQ/r$ (c) $-kQ/r^2$.
C	10	The electric field around a curved surface that caries a uniform surface charge density σ is (a) uniform (b) constant (c) non-uniform.



5



$$\int \vec{E}\cdot \partial\vec{A} = \frac{C}{\varepsilon_0}$$

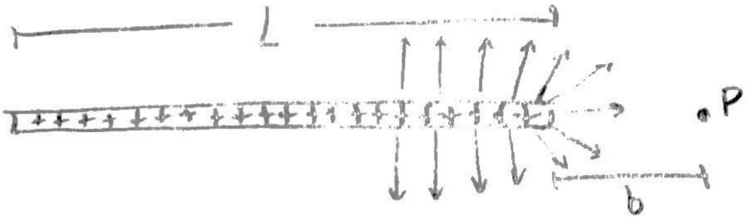
$C = \lambda L$ charge entra

$$\cancel{\int_{S_1} E\cdot\partial A}^{\,0} + \int_{S_2} E\cdot\partial A + \cancel{\int_{S_3} E\cdot\partial A}^{\,0} = \frac{\lambda L}{\varepsilon_0}$$

$$E(2\pi R\cancel{L}) = \frac{\lambda\cancel{L}}{\varepsilon_0}$$

$$E\,2\cancel{\pi}R = 4\cancel{\pi}k\lambda$$

$$E = \frac{2k\lambda}{R}$$



$$E = \frac{KQ}{a(a+L)}$$

$$\int E \cdot \partial A = \frac{Q}{\varepsilon_0}$$

$$E \int_L^{L+b} \partial A = \frac{Q}{\varepsilon_0}$$

$$E \int_L^{L+b} \partial A = 4\pi K Q$$

−10