Physics 302
Winter Quarter 1995
March 15, 1995
George Williams

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FINAL EXAM

Name (print) WILLIAMS Name (signed) _____

Discussion Instructor (circle): Brown Chakhbazian Condella Portnoi Zhukov

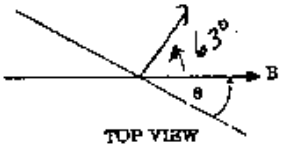
Discussion Section # _____

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

(a) If the earth's magnetic field in Salt Lake City is 0.750 gauss downwards at an angle of 75.0° from horizontal, calculate the magnetic flux, in T-m^2, through a rectangular section of the physics parking lot that is 6.00 × 9.00 meters.

$\Phi_B = \int_B \vec{B}\cdot d\vec{A} = |B||A|\cos 15^\circ = (.75\times10^{-4}\,T)(54.0\,m^2)(\cos 15^\circ) = \boxed{3.91\times10^{-3}\,T\cdot m^2}$

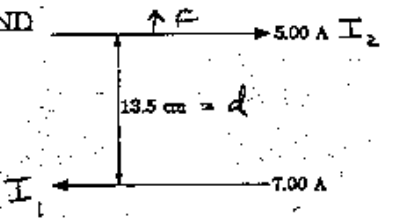
(b) Calculate the torque on a coil of wire of 17 turns, radius 2.50 cm, carrying a current of 1.25 A. The plane of the coil is at an angle θ = 27.0° with respect to the magnetic field, as shown. B = 375 gauss.



$\tau = NI(\text{Area})(\sin 63^\circ)B = (17)(1.25\,A)(\pi)(2.5\times10^{-2}\,m)^2(\sin 63^\circ)(.0375\,T) =$

$\boxed{1.39\times10^{-3}\,N\cdot m}$

(c) Two long, parallel wires carry the currents shown. Calculate the force, magnitude AND direction on 3.25 m of the *upper* wire.



$|F| = \frac{\mu_0 I_1 \cdot I_2 \ell}{2\pi d} = \frac{4\pi\times10^{-7}(7.00\,A)(5.00\,A)(3.25\,m)}{2\pi\times(.135\,m)}$

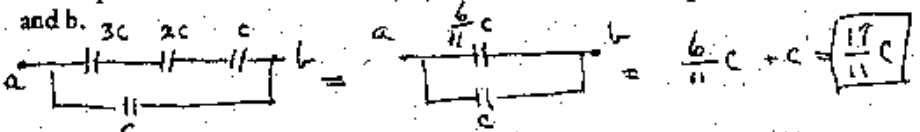
$\boxed{|F| = 1.69\times10^{-4}\,N}$ Direction: UP on I_2.

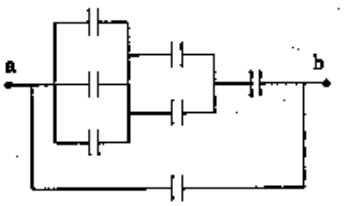
(d) For the expression $1/(x^2-a^2)^{7/2}$ use the binomial expansion and calculate completely the third term (the term in a^4). (Assume $x << a$.)

PROBLEM OMITTED BECAUSE of Ambiguity in statement and corrections announced.

Everyone got (+5).

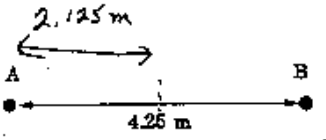
(e) If all capacitors have the same value, C, calculate the effective capacitance between a and b.





$\frac{1}{C_{eff}} = \frac{1}{3C} + \frac{1}{2C} + \frac{1}{C} = \frac{2}{6C} + \frac{3}{6C} + \frac{6}{6C} = \frac{11}{6C}$; $C_{eff} = \frac{6C}{11}$

(f) Calculate the electric potential, magnitude and sign at the point midway between charges A and B. A = 3.00 × 10^{-9} C; B = -4.25 × 10^{-9} C.



Potential has a sign, but NO direction!

$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R} \Rightarrow V = \frac{1}{4\pi\varepsilon_0}\left[\frac{+3.00\times10^{-9}}{2.125} + \frac{-4.25\times10^{-9}}{2.125}\right] = 9\times10^9\left[\frac{-1.25\times10^{-9}}{2.125\,m}\right]$

$\boxed{= -5.29\ \text{Volts}}$

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Problem 1:NOTES

(a) and (b): Many people grabbed the angle from the problem and stuffed it directly into the formula, without checking to see if that one, or 90 minus it was the proper angle to use.

(c): Many people reported the direction of the magnetic field, not the direction of the force. Many calculated the force per unit length, and did not multiply by 3.25 meters.

(d): This problem was not graded: There was ambiguity in the statement; and more in the corrections announced. Everyone got +5 points, no matter what they did. The binomial expansion can be done, keeping the square root of minus 1 multiplying the whole business, but that was a confusion I did not mean to have.

(e): I was appalled at the number of people who did not do the algebra properly to get the effective capacitance of 6C/11 for the series combination of the top group.

(f): Many people calculated the electric field. Many also thought that potential has a direction. Electric fields have direction, but potential is a scalar; it has a sign, but NO direction.