PHYSICS 241/261

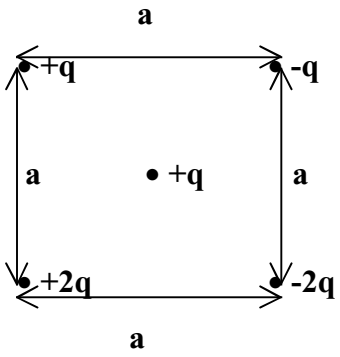
EXAM I **June 28, 2002**

This is a closed book exam. Print and encode your name, student ID number, and recitation number on the answer sheet. Answers to all questions are to be recorded on the answer sheet. There are 12 multiple-choice problems for a total of 100 points. Do not do the problems in the order in which they are given. Do the easy problems first. There is only one correct answer to each question. No penalty for a wrong answer. However, all credit for a question will be lost if more than one choice is marked for that question. You may use your crib sheet and your calculator. Fill out the op-scan card gradually, as soon as you finish the problem. Do not wait filling out the op-scan card during the last hectic five minutes!

USEFUL CONSTANTS:

$k=8.99\times10^{9}$ (Nm^2/C^2)
$\varepsilon_0=8.85\times10^{-12}$ (C^2/Nm^2)
$e=1.609\times10^{-19}$ C
$m_e=9.11\times10^{-31}$ Kg
$g=9.81$ m/s^2
$m_p=1.67\times10^{-27}$ Kg

1) In the picture below the charge **q** is 1μC and the distance **a** is 10 cm. Determine the magnitude of the total electrostatic force acting on the charge in the center. (5 pts)

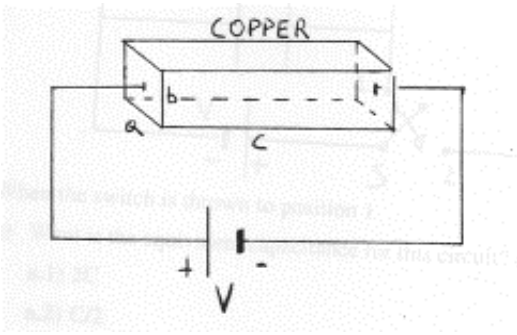


a) 5.0 N
b) 10.0 N
c) $2.12\ 10^{-12}$ N
d) 7.63 N
e) $1.06\ 10^{-12}$ N

2) A dipole moment **p**=2.0i-3.2j+4.2k Cm is placed in a region where an electric field **E**=-3.0i-4.3j-2.4k V/m is present. Calculate the torque acting on the dipole moment and the potential energy associated with the system. (5 pts)

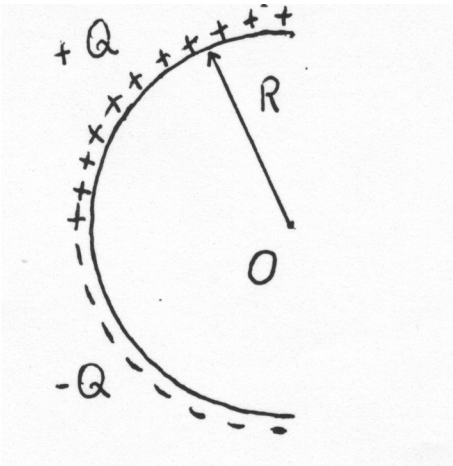
a) 23.21i+34.2j-4.55k CV; 4.35 J
b) 25.74i-7.8j-18.2k J; 2.32J
c) 25.74i-7.8j-18.2k CV; 2.32J
d) 25.74i-7.8j-18.2k CV; -2.32J
e) -25.74i+7.8j+18.2k CV; 2.32J

3) A potential V is applied to a wire (see picture below). Calculate the power dissipated by the wire when V=10 V, a=8 cm, b=3 cm, c=40 cm and the conductivity of copper is $\sigma=5.917\times10^{7}\ \Omega^{-1}m^{-1}$. (5 pts)



a) 4.51×10^{3} W
b) 3.20×10^{5} W
c) 4.20×10^{8} W
d) 5.33×10^{6} W
e) 3.55×10^{7} W

4) A thin glass rod is bent into a semicircle of radius R=10 cm. A positive charge +Q=1 C is uniformly distributed along the upper half and a negative charge —Q=1C is uniformly distributed along the lower half. What is the potential in the center **O**? (5 pts)

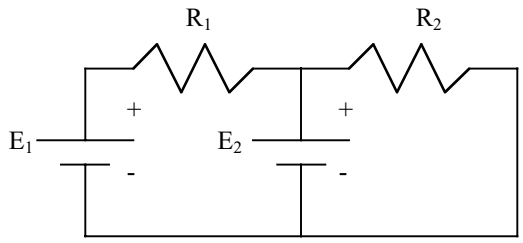


a) 0 V
b) 2.2 V
c) 3 V
d) 3.6 V
e) none of the above

5) A charge q_1=+2.0 μC is placed at x=0 m on the x-axis. Another charge q_2=+8.0 μC is placed at x=3.0 m. Where must be placed a third charge q on the x-axis so that the net electric field acting on it is zero? (7.5 pts)

a) x=-3.0 m
b) x=1.0 m
c) x=2.0 m
d) x=4.0 m
e) None of the above

6) A resistive circuit with batteries is shown in the figure. Here R_1=10 Ω, R_2=20 Ω, E_1=10 V, E_2=20 V. Calculate the current flowing trough R_1. (7.5 pts)



a) 12.0 A
b) 2.35 A
c) 1.99 A
d) 1.50 A
e) 1.00 A

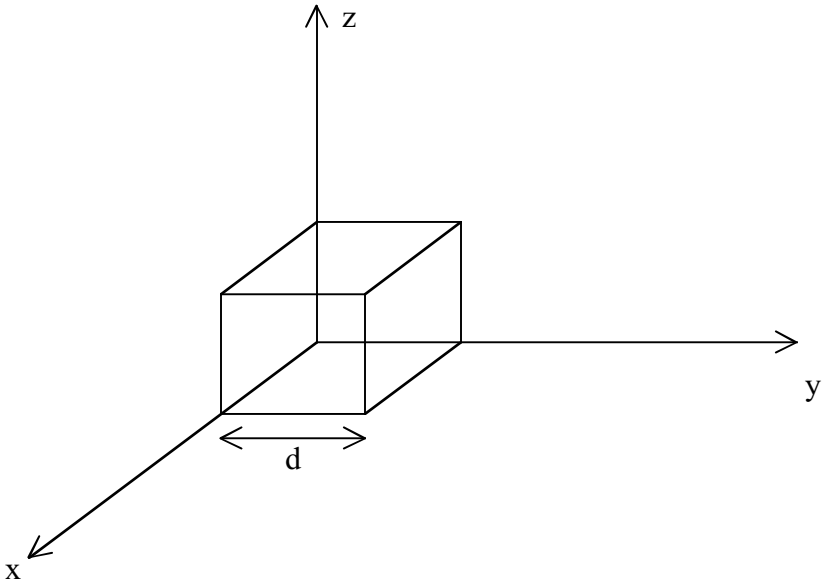
7) A potential V(x,y,z) has the following expression:

$$V(x,y,z)=x^3y - 3yz + 2z^3$$

Calculate the field E at the point P(1,2,1). (7.5 pts)

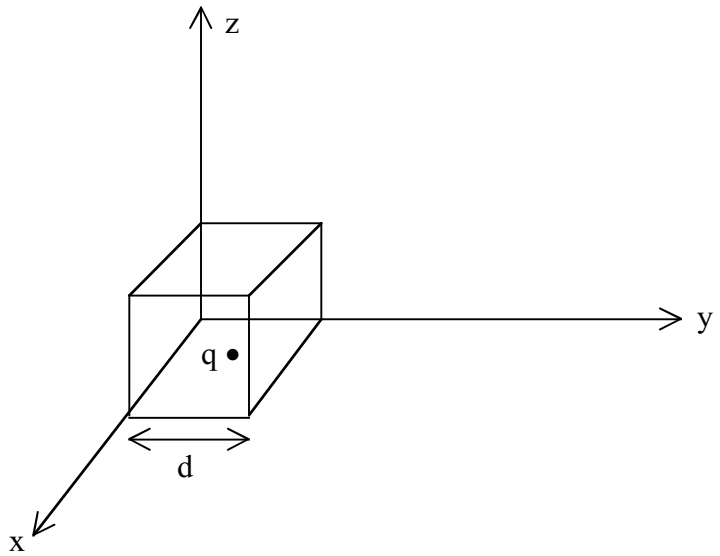
a) _ =2.3i + 3.2j —4.0k V/m
b) _ =2.5i - 3.1j —4.0k V/m
c) _ =-6.0i + 2.0j V/m
d) _ =6.0i - 2.0j V/m
e) _ =2.3i + 2.0j +3.0k V/m

8) A current density **J**=3.0xi-4.5yj+5.0zk A/m^2 flows trough a cube of side d=2.0 cm as shown in the picture. Calculate the current flowing through the top face. (7.5 pts)



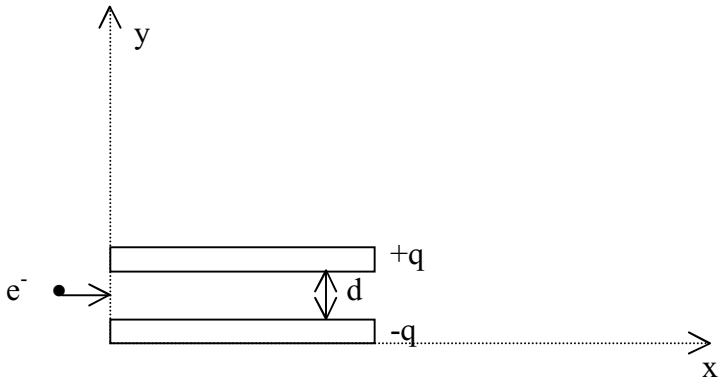
a) 4.0×10^{-2} mA
b) -4.0×10^{-2} mA
c) 4.0×10^{-1}mA
d) -4.0×10^{-1} mA
e) 3.5×10^{-3} mA

9) A charge q=5.0 μC is placed at the point P(0.5 m, 0.5 m, 0.0 m). A closed gaussian surface of the shape of a cube has the left face lying in the x-z plane, the bottom face in x-y plane and the back face in the y-z plane. The side of the cube is d=1.0 m. Calculate the flux of the electric field through the cube. (12.5 pts)



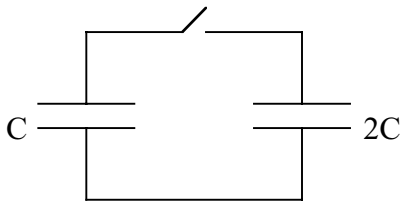
a) 2.33×10^5 Vm
b) 2.82×10^5 Vm
c) 2.82×10^5 V/m
d) 3.28×10^4 Vm
e) 4.66×10^5 Vm

10) An electron enters a region where a uniform electric field is present as showed in the picture below. The electric field is produced by a parallel plate capacitor. What value has to have the charge q on the plates of the capacitor to let the electron go trough the capacitor at constant speed? The area of the plates is A =0.5 m^2, the distance between the plates is d=1 cm. (12.5 pts)



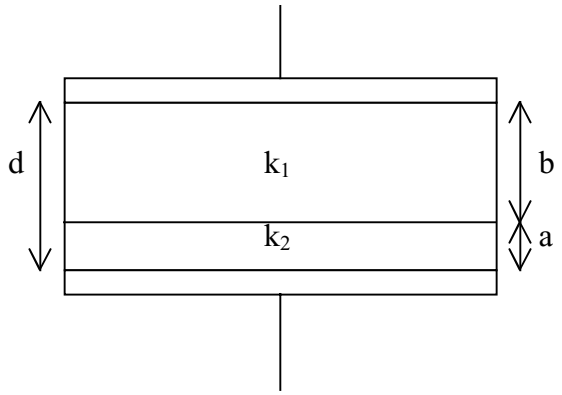
a) -2.46×10^{-22} C
b) 3.18×10^{-19} C
c) 4.15×10^{-18} C
d) 5.22×10^{-21} C
e) 2.46×10^{-22} C

11) A capacitor C is charged to a certain potential V and the energy stored on it is U=14 mJ. This capacitor is connected, by closing a switch, to a second capacitor having capacitance 2C. What is the final energy stored on both capacitors? (Hint: Remember that the switch has always a small resistance). (12.5 pts)



a) 9.33 mJ
b) 42.0 mJ
c) 4.67 mJ
d) 5.33 mJ
e) 3.44 mJ

12) What is the capacitance of the system? A=2 m^2, d=5.0 cm, k_1=4, k_2=6, a=2 cm, b= 3cm. (12.5 pts)



a) 3.01 nF
b) 2.12 nF
c) 4.57 nF
d) 1.63 nF
e) 3.54 nF

Exam 1 Answers

problem # solution

1 d
2 c
3 e
4 a
5 b
6 e
7 c
8 a
9 b
10 e
11 c
12 d