Physics 202, Midterm Exam 1, Spring 2007

Instructions

1. **Do not wear hats or caps during the exam.**
2. **Please leave your back packs *etc.* near the wall of the hall. You should have ONLY your one 8-1/2 x 11 formula sheet and your calculator.** ***No cell phones!***
3. Use X5 answer sheet (scantron)
4. Use No. 2 pencil
5. Fill in your Last Name, First Name, Middle Initial
6. ***Fill in your 10 digit UW Student ID*** **(Very Important)**
7. Work out the problems, draw pictures, … on this exam book, you may use the back side as needed - **Please circle your final answers on this exam book and fill in the corresponding mark on the X5 answer sheet.**
8. You must write your name, UW Student ID and circle your lab instructor name on this exam book.
9. **You must turn in this exam book to your lab instructor**
10. Do not spend too much time on any particular problem - you need to answer all questions

Name:____

10 Digit UW Student ID:________________________________

Lab Instructor:

323-330	**307-322**	**302-305**	**324-326-327**
Adam Dally	**Tony Barnes**	**Yu Gao**	**Brendan Hodis**
311-321	**303-329**		**310-331**
Adam Falkowski	**Jon Eisch**		**Mike Phillips**
304-308	**309-325**		
Chris Rivard	**Miao Zhang**		

Constants:

$\varepsilon_0 = 8.85 \times 10^{-12}$ $C^2/N\text{-}m^2$

$c = 3.0 \times 10^8$ m/s

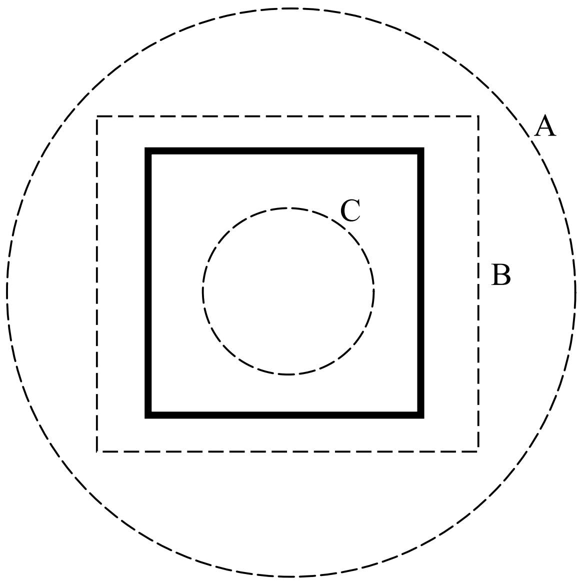
$e = 1.6 \times 10^{-19}$ C

$k = 1/4\pi\varepsilon_0 = 9 \times 10^9$ $N\text{-}m^2/C^2$

$g = 9.8$ m/s^2

The following ten questions refer to the diagram below:

A hollow metal cube of length a is centered on the origin and carries a total charge Q_0. The dashed lines indicate three Gaussian surfaces concentric with the cube (A is a sphere, B is a cube and C is a sphere). Assume the zero of potential is at infinity.

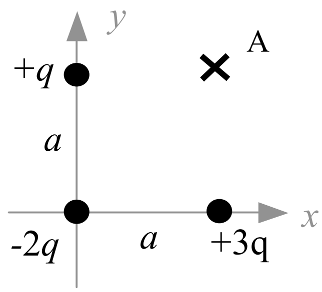


I. Mark the following statements true (a) or false (b)

1. (2pts) The total electric flux through surface A is zero.
2. (2pts) The total electric flux through surface B is zero.
3. (2pts) The total electric flux through surface C is zero.
4. (2pts) The electric potential inside the cube is zero.
5. (2pts) The electric potential outside the cube is zero.
6. (3pts) The electric energy density just inside the cube is zero.
7. (3pts) The electric energy density just outside the cube is zero.
8. (3pts) The gaussian surface A is an equipotential.
9. (3pts) The gaussian surface C is an equipotential.
10. (3pts) The surface of the cube is an equipotential.

The following two questions pertain to the situation described below.

Three charge +*q, -2q and +3q* are placed as shown in the diagram below. The negative point charge $-2q$ is placed at the origin. Point A is at (5,5).



$q = 5.0 \times 10^{-8}$ C
$a = 5.0$ cm

11. (5pts) The potential at point A is

a. $V_A = -13$ KV
b. $V_A = 9$ KV
c. $V_A = 23$ KV
d. $V_A = 18$ KV
e. $V_A = -9$ KV

12. (5pts) The vector electric field $\vec{E}$ at point A resulting *only* from the *negative* charge is:

a. **E** = (-1.3 x10$^5 \hat{i}$, -1.3 x10^5 $\hat{j}$) N/C
b. **E** = (-6.4 x10^4 $\hat{i}$, -6.4 x10^4 $\hat{j}$) N/C
c. **E** = (-2.6 x10^5 $\hat{i}$, -2.6 x10^5 $\hat{j}$) N/C
d. **E** = (+5.1 x10^5 $\hat{i}$, +5.4 x10^5 $\hat{j}$) N/C
e. **E** = (+5.1 x10^5 $\hat{i}$, +4.8 x10^5 $\hat{j}$) N/C

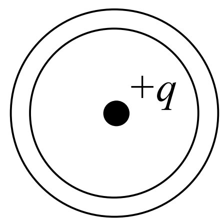
The following question is by itself.

13. (5pts) A uncharged metal sphere will be attracted to a metal wall that has a net charge of +6.0 μC.

a. True
b. False

The following three questions pertain to the situation described below.

Consider an uncharged metal spherical shell (inner radius $a=0.9\ m$ and outer radius $b=1.0\ m$). Concentric with it is a small sphere of radius $1\ cm$ charged to $q=-2\ \mu C$. Assume the potential is zero at infinity.



14. (5pts) The electric field at $r = (a+b)/2$ is

a. $\vec{E} = \frac{\lambda}{2\pi\varepsilon_0}\frac{2}{(a+b)^2}\hat{r}$

b. $\vec{E} = 0$

c. $\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{a^2}\hat{r}$

d. $\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{b^2}\hat{r}$

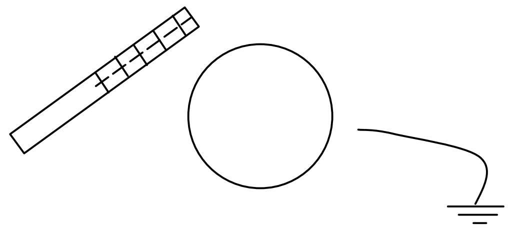
15. (5pts) The potential at $r = a$ is

a. V= - 9 KV
b. V= -18 KV
c. V= 9 KV
d. V= 18 KV
e. V= 900 V

16. (5pts) If the sphere is moved 25 cm off the center of the shell, the potential at $r=b$

a. becomes a little smaller in some places
b. becomes a little larger in some places
c. becomes smaller
d. remains the same
e. cannot be calculated

The next three questions refer to the situation shown below:



17. (5pts) A positively charged rod is brought close to an isolated uncharged conducting sphere (i.e. the net charge on the sphere is zero). The net force between the rod and the sphere is

a. zero
b. attractive
c. repulsive

18. (5pts) The conducting sphere is now connected to ground for a time and then disconnected. The net charge of the sphere is then

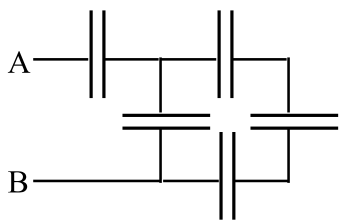
a. zero
b. positive
c. negative

19. (5pts) The positively charged rod is removed and now a negatively charged rod is brought near the charged sphere. The sphere is again connected to the ground for a time and then disconnected. The net charge on the sphere is

a. zero
b. positive
c. negative

The following question is by itself.

20. (5pts) Five capacitors (all have 20 μF capacitance) are connected as shown. The equivalent capacitance between points A and B is:



C = 20 μF

a) 35.0 μF
b) 7.0 μF
c) 5.7 μF
d) 11.4 μF
e) 4.7 μF

The next four questions refer to the situation described below:

A parallel plate capacitor is made of two circular aluminum plates of area = *160 cm²*. They are placed 1 mm apart and are attached to a 10 V battery.

21. (5pts) The plates are then separated to 1 cm separation. The change in potential resulting from separating the plates is;

a) 0. KV
b) 29. KV
c) 26. KV
d) 2.6 KV
e) 2.9 KV

22. (5pts) Now a 1 cm thick dielectric slab (dielectric constant κ = 5.0) is introduced between the plates, completely filling the space. The charge on one plate is now

a) 7.08×10^{-10} C
b) 1.42×10^{-9} C
c) 1.42×10^{-12} C
d) 7.2×10^{9} C
e) 35.0 μC

23. (5pts) The stored energy in the capacitor after the dielectric was introduced was

a) 7.0 nJ
b) 35.0 nJ
c) 70.8 nJ
d) 3.5 nJ
e) 0.35 nJ

24. (5pts) The battery (source of potential difference) is now removed. After this, the dielectric was removed. The energy stored

a) increased.
b) decreased.
c) remained the same.

The following question is by itself.

25. (5pts) Two small pith balls are attached to each end of a spring (equilibrium length = 10 cm). One ball is attached to a plastic block and the other hangs vertically below it. Each ball (mass 20 g) is charged to +0.5 μC. The spring extends 5 mm at rest. The spring constant of the (Hooke's law) spring is:

a. 20 N/m
b. 35. N/m
c. 120 N/m
d. 41 N/m
e. 80 N/m