PES 1120 - Physics 2
Practice Exam 1 Questions

Name:__________________________________ Score: / ….

Instructions
Time allowed for this is exam is 1 hour 15 minutes
5 multiple choice (5 points)
3 to 5 written problems (30 to 40 points)

For written problems:
Write all answers in the spaces provided. **An extra sheet is included at the back if you need more space for your calculations. Answers to questions involving calculations should be evaluated to appropriate significant figures and given in decimal form**. Despite an incorrect final result, credit may be obtained for method and working, provided these are clearly and legibly set out.

Only required equipment may be placed on the desk.
No talking permitted.
No questions. If you are unsure of what is being asked, take your best guess and state your reasoning.
Cell phones must be turned off.

Equipment
This Question/Answer booklet
Pens, pencil, eraser, ruler, water bottle
Graphing or scientific calculator (cell phones may not be used as a calculator)

Information you may need for this exam

$e = 1.602 \times 10^{-19}\ C$ $\quad k = 8.99 \times 10^{9}\ Nm^2/C^2 = \frac{1}{4\pi\varepsilon_0}$ $\quad \varepsilon_0 = 8.854 \times 10^{-12}\ C^2/(Nm^2)$

Coulomb's Law: $F_{12} = F_{21} = \frac{k|q_1||q_2|}{r^2}$ $\quad \vec{F} = k\frac{q_1 q_2}{r^2}\hat{r}$ $\quad \hat{r}$ .... unit vector

Electric field: $\vec{E} = \frac{\vec{F}}{q}$

Charge density: $\rho(\vec{r}) = \frac{dq}{dV}$, $\sigma(\vec{r}) = \frac{dq}{dA}$, $\lambda(\vec{r}) = \frac{dq}{dl}$

Gauss' Law: $\Phi = \oint \vec{E}(\vec{r}) \cdot d\vec{A} = \frac{q_{enc}}{\varepsilon_0}$

Work and electric potential energy: $W_{i \to f} = -\Delta U_{elec} = \int_i^f q\vec{E} \cdot d\vec{l}$

Electric potential: $\Delta V = \frac{\Delta U}{q} = -\frac{W}{q} = -\int_{r_i}^{r_f} \vec{E} \cdot d\vec{l}$

Surface area of some shapes:
- Area of the side of a cylinder of radius R and height h: $A = 2\pi Rh$
- Area of a sphere with radius R: $A = 4\pi R^2$

Study guide: Go over HW and in-class problems &know the following:
- Know how objects become electrically charged
- Understand the difference between conductors and insulators
- Use Coulomb's law to calculate the electric force between charges (two or more point charges)
- Understand the meaning of quantized and conserved charge. Be able to calculate the number of electrons of a given charge.
- Know how to draw electric field lines and how to use them to interpret electric fields: point charge, dipole, three point charges, charged plate, etc
- Be able to calculate the electric field due to a collection of charges using vectors: electric dipoles, line of charge, ring of charge, charged disk, infinite sheet of charge, etc
- Calculate the force on (acceleration of) a particle in an electric field
- Understand the concept of flux (ϕ).
- Be able to calculate the net flux through a closed surface like in the HW problem
- Use Gauss's law and choose appropriate Gaussian surfaces to calculate the electric field due to symmetrical charge distributions such as: point charge, spherical shell of charge, infinite line charge, infinite flat plane of charge, solid sphere of charge, etc
- Be able to apply Gauss's law to conductors
- Calculate electric potential energy (U) and electric potential (V)
- Know how to determine the sign of the electric potential
- Be able to calculate the electric potential from an electric field due to: a point charge, collection of charge, parallel plate capacitor, dipole, spherical shell, etc.
- Know how to draw equipotential surfaces and how to use them to interpret electric fields
- Be able to calculate the work required to move a charge in an electric field
- Understand electrostatic interactions of point charges in terms of electric force, electric field, electric potential, and electric potential energy
- Be able to apply conservation of energy using electric potential.

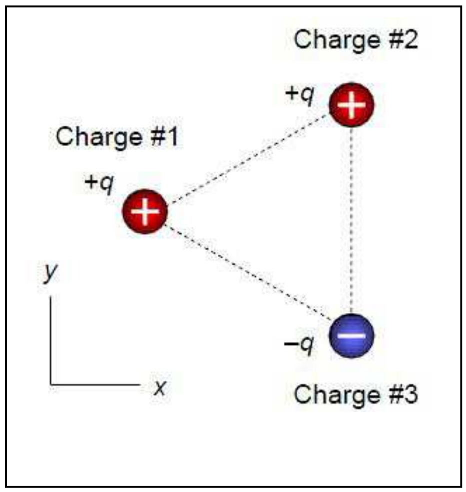
Part 1) Multiple Choice Problems: Circle the correct answer

1) Where an electric field line crosses an equipotential surface, the angle between the field line and the equipotential is
(a) zero.
(b) between zero and 90°.
(c) 90°.
(d) not enough information given to decide

2) Consider a point *P* in space where the electric potential is zero. Which statement is correct?
(a) A point charge placed at *P* would feel no electric force.
(b) The electric field at points around *P* is directed toward *P*.
(c) The electric field at points around *P* is directed away from *P*.
(d) none of the above
(e) not enough information given to decide

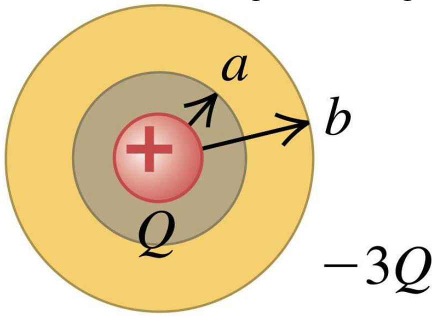
3) The electric potential due to a point charge approaches zero as you move farther away from the charge.

If the three point charges shown here lie at the vertices of an equilateral triangle, the electric potential at the center of the triangle is
(a) positive.
(b) negative.
(c) zero.
(d) not enough information given to decide



4) For which of the following charge distributions would Gauss's law not be useful for calculating the electric field?
(a) a uniformly charged sphere of radius *R*
(b) a spherical shell of radius *R* with charge uniformly distributed over its surface
(c) a right circular cylinder of radius *R* and height h with charge uniformly distributed over its surface
(d) an infinitely long circular cylinder of radius *R* with charge uniformly distributed over its surface
(e) Gauss's law would be useful for finding the electric field in all of these cases.

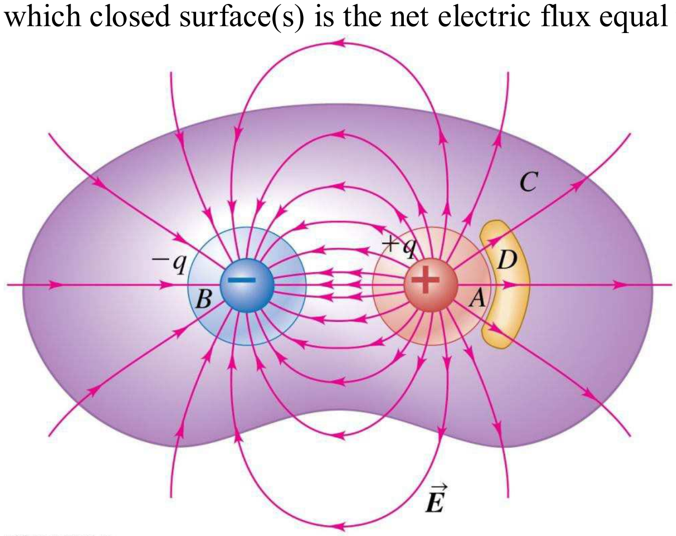
5) A conducting spherical shell with inner radius *a* and outer radius *b* has a positive point charge *Q* located at its center. The total charge on the shell is –3*Q*, and it is insulated from its surroundings. In the region $a < r < b$,



(a) the electric field points radially outward.
(b) the electric field points radially inward.
(c) the electric field is zero.
(d) not enough information given to decide

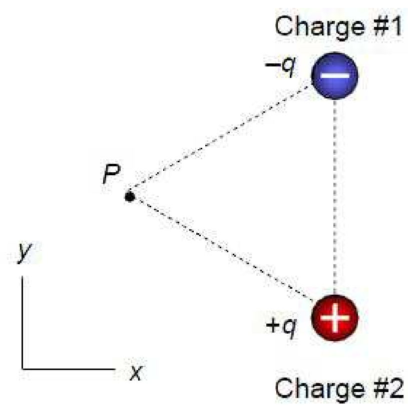
6) There is a negative surface charge density in a certain region on the surface of a solid conductor. Just beneath the surface of this region, the electric field
(a) points outward, toward the surface of the conductor.
(b) points inward, away from the surface of the conductor.
(c) points parallel to the surface.
(d) is zero.
(e) not enough information given to decide

7) Two point charges, +*q* (in red) and –*q* (in blue), are arranged as shown. Through which closed surface(s) is the net electric flux equal to zero?



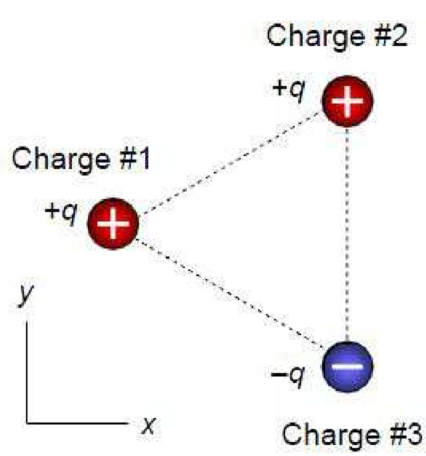
(a) surface A
(b) surface B
(c) surface C
(d) surface D
(e) both surface C and surface D

8) Two point charges and a point *P* lie at the vertices of an equilateral triangle as shown. One point charge is positive and the other negative. Both changes have the same magnitude (q). There is nothing at point *P*. The net electric field that charges #1 and #2 produce at point *P* is in



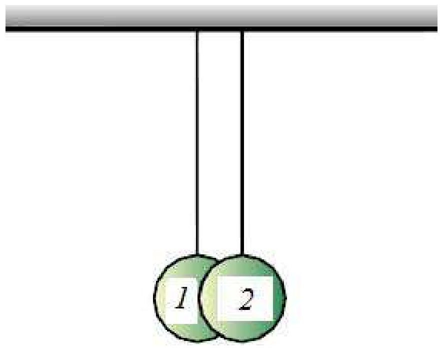
(a) the +x-direction.
(b) the –x-direction.
(c) the +y-direction.
(d) the –y-direction.
(e) none of the above

9) Three point charges lie at the vertices of an equilateral triangle as shown. All three charges have the same magnitude, but charges #1 and #2 are positive ($+q$) and charge #3 is negative ($-q$). The net electric force that charges #2 and #3 exert on charge #1 is in



(a) the +x-direction.
(b) the –x-direction.
(c) the +y-direction.
(d) the –y-direction.
(e) none of the above

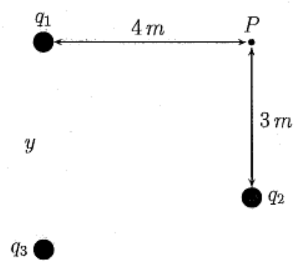
10) Two lightweight “pith" balls are hanging from the ceiling as shown. What can you say about the type of charge on each of the pith balls?



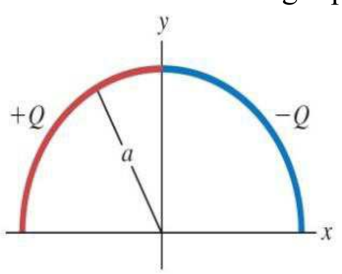
(a) #1 is positive and #2 is negative
(b) #1 is positive and #2 is positive
(c) #1 is negative and #2 is negative
(d) #1 is negative and #2 is positive
(e) Both (a) and (d) are possible
(f) Both (b) and (c) are possible

Part 2) Written Problems: You need to show all your workings to receive full credit

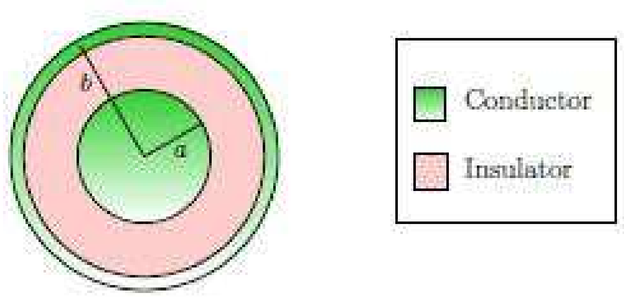
1) Two point charges, q_1 = 1.55 μC and q_2 = 4.75 μC are placed as shown below. A third charge q_3 is a distance y directly below q_1. If the electric field at the point labeled P is zero, find the distance y and the amount of charge q_3.



2) A semicircle of radius a is in the first and second quadrants, with the center of curvature at the origin. Positive charge $+Q$ is distributed uniformly around the left half of the semicircle, and negative charge $-Q$ is distributed uniformly around the right half of the semicircle in the following figure. What is the magnitude and direction of the net electric field at the origin produced by this distribution of charge?



3) A long metal cylinder has radius a. Outside of the metal from radius a to a larger radius b is an insulator. At b there is metallic ring. (A cross section of the situation is shown below.) The inner conductor has been given a positive charge per unit length λ, while the outer ring has been given an equal negative charge, −λ.



(a) Using Gauss's law, find the electric field for the regions
(i) $r < a$; (ii) $a < r < b$; (iii) $r > b$; (iv) plot E(r)

(b) Take V = 0 at r = a ($V(a)=V_a=0$). Calculate the potential $V(r)=V_r$ for
(i) $r < a$; (ii) $a < r < b$;

More practice problems out of the book on potential energy and potential:
chapter 24, problem 17
chapter 24, problem 28
chapter 24, problem 43
chapter 24, problem 42
chapter 24, problem 45
chapter 24, problem 47

Chapter 24 topics you will not be tested on in Exam 1:
- Calculating the electric field from the electric potential
- Electric potential of a charged isolated conductor