NAME:_____

DATE:_____

PHY 1308:
General Physics II
Electricity and Magnetism

Exam 1

RULES AND NOTES

- Write your name and the date on the cover sheet, and hand in this exam at the end. Please attach any extra work on additional paper.

- Show all work. Writing down an answer, even the correct answer, without showing work will result in significant loss of points.

Potentially Useful Integrals

$$\int_{surface} dA = A$$

$$\int x^n = \frac{1}{n+1} x^{n+1}$$

Potentially Useful Trigonometry

$$r\theta = s$$

arc-length of a part of circle circumference subtending angle θ at radius r.

$$\cos^2\theta + \sin^2\theta = 1$$

$$a^2 + b^2 = c^2$$

Pythagorean theorem for a right-triangle whose hypotenuse is length *c*

Potentially Useful Derivatives

$$\frac{d}{dx} x^n = n\, x^{n-1}$$

MULTIPLE CHOICE (20 Points)

Select only ONE answer for each of the following multiple choice questions. Each question is worth 5 points.

QUESTION 1: A positive point charge has an electric field whose field lines point . . .

(a) Toward the charge
(b) Away from the charge
(c) In a circle around the charge
(d) None of the above

YOUR ANSWER:_____

QUESTION 2: Which of the following is true about a conductor?

(a) Conductors prevent electric charge from moving freely
(b) Conductors can never carry a net electric charge
(c) Conductors contain no electric fields
(d) Conductors have an intrinsic dipole moment

YOUR ANSWER:_____

QUESTION 3: A Gaussian Surface is . . .

(a) Closed and characterized by normal vectors pointing outward
(b) Closed and characterized by normal vectors pointing inward
(c) A real surface that is part of a real charge distribution
(d) Open in at least one location on the surface

YOUR ANSWER:_____

QUESTION 4: Electric potential is defined as . . .

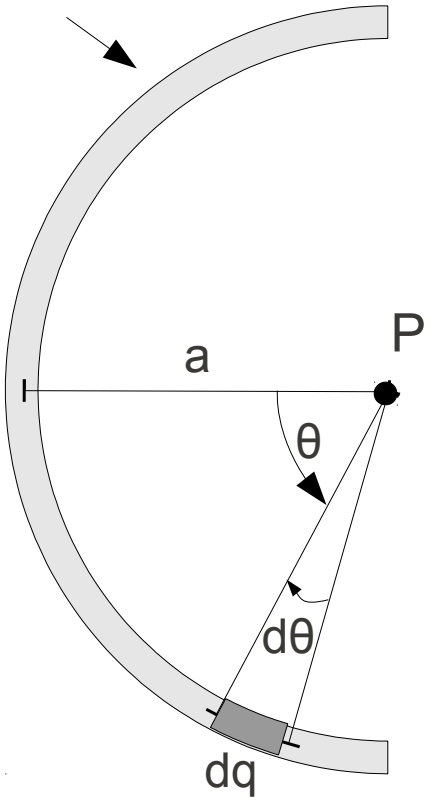
(a) The force required to move a charge along some path
(b) The change in potential energy per unit charge along a path
(c) The difference in electric fields between two places
(d) The force per unit charge exerted by an electric charge

YOUR ANSWER:_____

PROBLEM 1 (30 Points)

Consider the thin, semi-circular uniform distribution of charge, *Q* (shown below), whose radius is *a*. The center of the semi-circle is marked as the point *P*. ***Write the expression for the electric field at point P.*** The expression can contain an unsolved integral, but must ONLY otherwise contain constants, definite limits of integration, and geometric variables that result from your choice of coordinates.

Thin semi-circle of uniformly distributed charge, Q



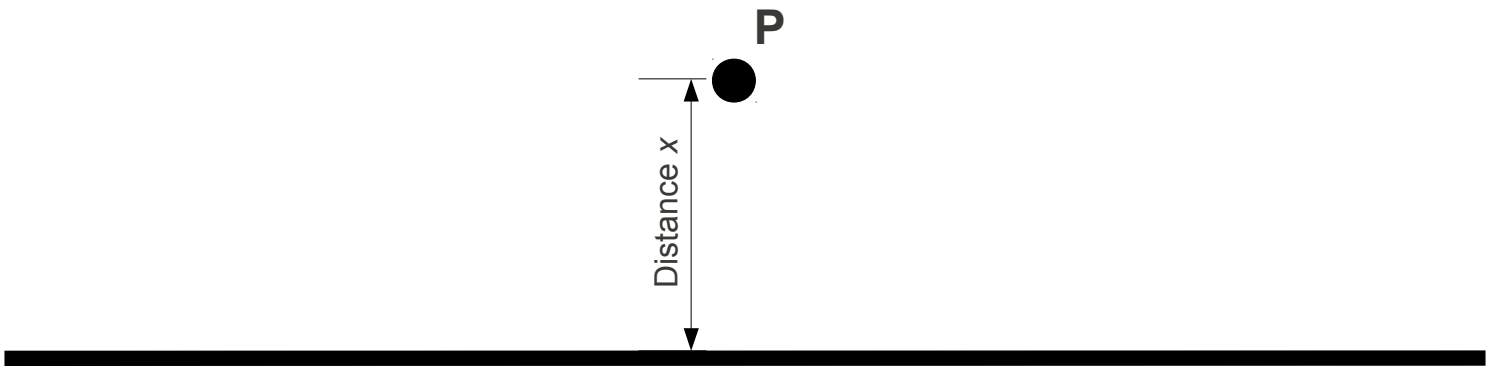
PROBLEM 2 (30 Points)

Consider the thin, infinitely long line of electric charge illustrated below. The charge carried by the line, Q (where Q<0), is uniformly distributed along its length. If you were to use Gauss's Law to determine the electric field at point P a distance *x* away from the line . . .

(a) Using symmetry arguments, draw a vector indicating the direction of the electric field at point P. Provide a 1-2 sentence argument as to why you chose this vector.

(b) Draw the Gaussian Surface that will let you most easily solve the flux integral in Gauss's Law. Draw one normal on each distinct part of the Gaussian Surface.

(c) Write an expression, in terms of the linear charge density and any relevant dimensions of your Gaussian Surface, for the charge enclosed by the Gaussian Surface.



Infinite line of uniformly distributed electric charge

PROBLEM 3 (20 Points)

Air is normally a very poor conductor, but when subjected to an electric potential difference whose magnitude is at least 3.0×10^6 V becomes highly conductive. Such conditions exist routinely during a thunderstorm, and lightning is the result. Let us model a storm as a flat, uniform layer of negative charge (in the sky, at the base of the clouds) 2.0km above the surface of the earth. This layer of charge causes a uniform electric field between the clouds and the ground, and that field results in a potential difference of -100.0×10^6 V.

(a) What is the strength of the electric field?

(b) What is the work required to move an electron from the base of the cloud to a point directly below it on the ground?