##### DO NOT BEGIN THIS EXAM UNTIL TOLD TO START

# Name: \_\_\_\_\_\_\_SOLUTION\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

#### ECE 2317

#### Applied Electricity and Magnetism

**Exam 1**

#### March 20, 2014

1. This exam is closed-book and closed-notes notes. A formula sheet is provided. A calculator is allowed (as long as it cannot be used to communicate), but no other device (laptop, phone, tablet, etc.) is allowed.
2. Show all of your work. No credit will be given if the work required to obtain the solutions is not shown.
3. Perform all your work on the exam in the space allowed.
4. Write neatly. You will not be given credit for work that is not **easily** legible.
5. Leave answers in terms of the parameters given in the problem.
6. Show units in all of your final answers.
7. Circle your final answers.
8. Double-check your answers. For simpler problems, partial credit may not be given.
9. If you have any questions, ask the instructor. You will not be given credit for work that is based on a wrong assumption.
10. Make sure you sign the academic honesty statement on the next page.

Academic Honesty Statement

I agree to abide by the UH Academic Honesty Policy during this exam. I understand that the punishment for violating this policy will be most severe, including the possibility of getting an F in the class and/or getting expelled from the University.

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Signature

FORMULA SHEET







































**TABLE OF INTEGRALS**

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TABLE OF COORDINATE SYSTEM FORMULAS

 

 

 

 

 

 



























Problem 1 (20 pts.)

**Please provide a short answer to the following questions:**

a) You have a good chance of being safe if you stay inside your car if it gets struck by lightning. What is the name of the electrostatic principle that explains this?

Faraday Cage Effect

b) Who was responsible for the convention that protons have positive charge and electrons have negative charge?

Benjamin Franklin

c) Who is responsible for the convention that current flows in the direction that positive charges move?

Benjamin Franklin

d) Give two reasons why a grounded system is preferable to an ungrounded one.

(1) For safety. (2) To reduce noise.

e) In what year did the speed of light become a defined quantity?

1983

Problem 2 (25 pts.)

A circular annulus of uniform surface charge density *ρs*0 is shown below. The electric field along the *z* axis is given by

.

Assume that a particle of positive charge *q* and mass *m* is released from a position on the *z* axis at a height *h* above the *xy* plane. The particle starts to move upward along the *z* axis from this point. Derive a formula for the velocity of the particle *v*(*z*) when the particle is at a height *z* above the *xy* plane, where *z* > *h*.



**Room for Work**



where

.

Performing the integration, we have

.

Hence,

.

We then have

.

Problem 3 (25 pts.)

A sheet of uniform surface charge density lies in the *xy* plane, in the region *x* > 0. The sheet is in the form of a strip, having a width *w* in the *y* direction, and extends to infinity in the positive *x* direction. Find the electric field vector components *Ex*, *Ey*, and *Ez* at a point on the negative *x* axis, at a distance *h* away from the origin, as shown below.

You do not need to evaluate any integrals (your answers can be left in terms of integrals). If a particular field component is zero, you can simply say this.

*x*

*y*

*ρs*0

*r*

*h*

*w*

*y= w*/2

*y=* -*w*/2

**Room for Work**

We start with

.

In our case we have

.

We then use

.

Hence



and

.

We thus have

,

so that

.

From symmetry we have

.

Hence



and

.

Problem 4 (30 pts.)

A spherical shell of uniform volume charge density *ρv*0 has an inner radius of *a* and an outer radius of *b*, as shown below. Surrounding the shell is a perfectly conducting neutral spherical shell having an inner radius *c* and an outer radius *d*.

a) Find the electric field vector in all five regions: *r* < *a*, *a* < *r* < *b*, *b* < *r* < *c*, *c* < *r* < *d*, *r* > *d*.

b) Assume that the conducting shell is now grounded. Find the electric field in all five regions. If the field in a certain region is the same as it was in part (a), you can simply say this (no need to write down the expression again).

*q*

PEC

*b*

*a*

*ρv*0

*c*

*d*

**Room for Work**

**Part (a)**

In all regions outside of the PEC, we have

.

Inside the PEC (*c* < *r* < *d*) the electric field is zero.

Hence, we have

*r* < *a*: 

*a <r* < *b*: 

*b <r* < *c*: 

*c <r* < *d*: 

*r* > *d*: 

**Part (b)**

The answers are the same in all regions except for the region *r* > *d*. In this region the electric field is zero.