

# PHYS102 - Introduction and Charge

Dr. Corcoran

Dr. Suess

January 8, 2007

Introduction .....	2
First Question .....	3
<b>History</b> .....	<b>4</b>
What is charge? .....	5
CHARGE CONVENTION .....	6
DEMO 1 .....	7
Properties of charge .....	8
Properties of charge II .....	9
Fundamental unit of charge .....	10
Objects and charge .....	11

## Introduction

- Welcome to PHYS102.
  - Lab preference sheets need to be submitted to Dr. Dodds's office (HZ Room 109). (There is a box on his file cabinet.)
- Important Changes from PHYS101:
  - The **pledged problems** are now worth **20%** of your final grade (**vs. 15%**)
  - The **final exam** is worth **20%** of your final grade (**vs. 25%**)

PHYS102

Introduction and Charge – slide 2

## First Question

Your first question:

- Why are you taking this course?
  - to form a deeper understanding of the world around me.(Only in the ideal case.)
  - to understand how my new cell-phone works.
  - I really like listening to lectures on physics, and I couldn't wait to get back to pledged problems.
  - I have to (it's required of my major).

PHYS102

Introduction and Charge – slide 3

## History

slide 4

### What is charge?

When you think of charge, what comes to mind?

- Positive and negative charges.(protons and electrons)
  - How is charge defined? Are you sure they exist? If so, how are you sure?

The answer to the numerous questions:

- Our understanding of charge comes through experiments and conventions.
- Charge is an **intrinsic** property of matter (just like mass).

PHYS102

Introduction and Charge – slide 5

## CHARGE CONVENTION

- We currently live by Benjamin Franklin's convention.



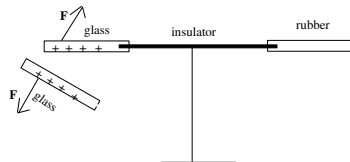
PHYS102

Introduction and Charge – slide 6

## DEMO 1

Rubbing glass (an insulator or dielectric) rod with silk, we note that the rod “acquired” a charge (positive) which means that the silk has a net negative charge.

- Based on the demonstration:



- There is *something* causing the objects to repel or attract.

Conclude:

- Charges of the same sign repel one another,
- and charges of the opposite sign attract one another.

PHYS102

Introduction and Charge – slide 7

## Properties of charge

- Charges of the same sign - **repel** each other.
- Charges of differing sign - **attract** each other.
- Charge is conserved.

Since this is physics, we need to quantify (or try to quantify) what we see.

We need to begin our analysis of the attraction or repulsion by quantifying charge.

We will usually represent **net** electric charge by the letter  $q$  or  $Q$ .

NOTE: Charge is treated as a scalar (only a number no direction).

PHYS102

Introduction and Charge – slide 8

## Properties of charge II

**S.I. unit of charge = 1 C “Coulomb”**

1 C of charge is extremely large and typical amounts of charge are pC, nC,  $\mu\text{C}$ :

$$(\text{pC}) \text{ pico C} = 1 \times 10^{-12} \text{ C}$$

$$(\text{nC}) \text{ nano C} = 1 \times 10^{-9} \text{ C}$$

$$(\mu\text{C}) \text{ micro C} = 1 \times 10^{-6} \text{ C}$$

When rubbing two objects like silk and glass together, we say charge transfers from one object to the other.

What do we mean by this?

Does charge “flow” like a liquid? or does it “flow” in tiny pieces?

- Experiments show that charge is made up of integer multiples of a fundamental unit of charge.

PHYS102

Introduction and Charge – slide 9

## Fundamental unit of charge

**Fundamental unit of charge =  $e = 1.602 \times 10^{-19} \text{ C}$ .**

NOTE: The charge of a single electron is  $-e$  and the charge of a single proton is  $e$ .

When any physical quantity exists in discrete amounts rather than in continuous amounts, it is said to be “quantized”.

If number of electrons transferred from the glass to the silk is  $n_e$ , then the silk acquires  $n_e$  “spare” electrons while an equal amount of non-neutralized (+) charges remain in the glass:

$$\therefore n_+(rod) = n_e(silk)$$

$$\Rightarrow \text{Total charge on silk is given by } q_{silk} = -n_e e$$

PHYS102

Introduction and Charge – slide 10

## Objects and charge

- Most objects around us have zero **net** charge. (Object contains equal number of positive and negative charges.)
- Materials can be classified into four main classes (depending on how electrons can move through the material)
  - Conductors - electrons can move *almost* freely through these materials (examples include metals).
  - Superconductors - electrons can move without any inhibitions through these materials (examples include metals or ceramics cooled to very low temperatures).
  - Insulators - electrons can not travel easily through these materials (examples include rubber, glass, and plastics).
  - Semiconductors - (an example is silicon)