Field Theory

The idea of the field was first proposed by Michael Faraday. He worked extensively in the study of electricity and needed a way to explain why object feel a force when nothing touching it.

There are 2 ways an object can exert a force on another object:
1. Direct contact
2. "Action at a distance" or ***Fields***

Forces exerted by fields are considered to be action-at-a-distance because the two objects involved never touch

A "source" object is able to influence the space around it, setting up a field that will in turn be able to exert forces on other certain objects

Fields are unique to their source. They only affect objects through the specific mechanism. Certain object characteristics are invisible in certain fields.

3 types of field this class will consider:

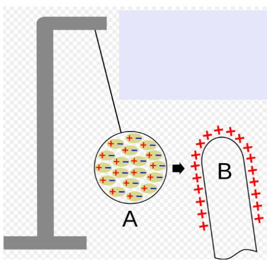
	Gravitational Fields	Electric Fields	Magnetic Fields
affect...	masses	charge	magnetic poles
surround...	objects of mass	objects with electric charge	objects with magnetic poles
exert...	attractive force only	attractive & repulsive forces	attractive & repulsive forces
Field strength is directly proportional to...	size of source mass	amount of electric charge	size of magnetic poles
strength is inversely proportional to ...	distance of separation squared	→	

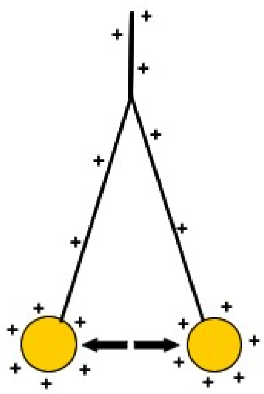
$\propto \frac{1}{r^2}$

Read page 641-642

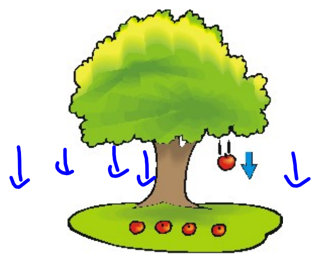
Table 14.1 Differences among Electrostatic, Gravitational, and Magnetic Forces

Electrostatic force	Gravitational force	Magnetic force
▪ can be attractive or repulsive ▪ demonstrates an inverse square relationship in terms of distance ▪ depends directly on the unit property (charge) ▪ law easily verified using point charges (or equivalent charged spheres)	▪ can only be attractive ▪ demonstrates an inverse square relationship in terms of distance ▪ depends directly on the unit property (mass) ▪ law easily verified using point masses (or solid spheres) ▪ magnitude of the force is much weaker than electrostatic or magnetic force	▪ can be attractive or repulsive ▪ demonstrates an inverse square relationship in terms of distance (between isolated poles) ▪ depends directly on the unit property (pole strength) ▪ law cannot be verified using magnetic monopoles as they have never been detected (must be simulated using long, thin magnets or thin, magnetized wire)

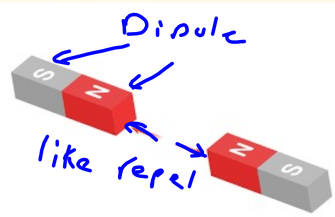


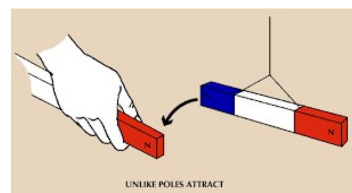


$$F_e = \frac{kq_1q_2}{r^2}$$

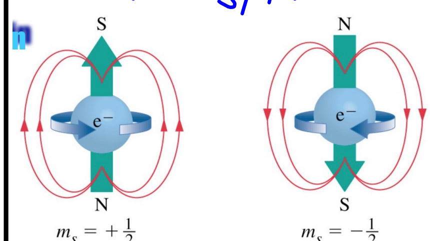


$$F_g = \frac{Gm_1m_2}{r^2}$$



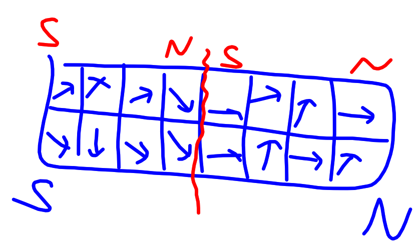


electron spin



$$F_B \propto \frac{p_1p_2}{r^2}$$

Magnetic monopoles



Comparisons of these fields and the forces they exert on objects is discussed in the textbook on pp. 641 – 642.

In each table below, make parallel comparisons between the two fields listed to illustrate how they are **different**

	Magnetic Fields	Electric Fields
1	surround magnetic poles only	surround electric charge only
2	exist external and interal because dipole can't be separated	exists external to th object with charge
3	forms closed loop around/ inside th source object	do not form closed loops as They are external only

Higgs Boson

	Electric Fields	Gravitational Fields
1	Can exert both attractive and repulsive forces	exert attractive forces only
2	relatively strong forces	relatively weak forces
3	fields exist external to source	fields exist external and internal to source

	Magnetic Fields	Gravitational Fields
1		
2		
3		