History of Atomic Structure

1) **Democritus** - Greek philosopher

a) matter is composed of tiny particles called atoms which could not be subdivided or made any smaller
b) atoms were different only in size and shape
c) atoms were in constant motion
d) atoms were able to join with other atoms to form different types of matter

2) John Dalton click on name for more complete background

a) matter is composed of tiny particles called atoms
b) atoms of a particular element are alike in size, shape, and weight but differ from atoms of other elements
c) during chemical changes, atoms of different elements unite forming molecules (compounds)
d) during these chemical changes, atoms themselves do not change, that is, are not broken down
e) when atoms combine, they do so in definite whole number ratios by weight (called the Law of Definite Proportions)

3) **J. J. Thomson** - gas tube experiments of the late 1800's

a) when a high electrical voltage was placed across electrodes in a glass vessel from which most of the air had been removed an electrical discharge occurred
b) these 'cathode rays' traveled in straight lines because they cast a well defined shadow on any fluorescent surface of objects placed in their path
c) since these `rays' could be deflected by magnetic and electrical fields they consisted of electrical charges in motion
d) from the direction of deflection the charge on these particles had to be negative
e) in 1897 J. J. Thomson first measured the ratio of charge to mass, e/m, of these small mass, negatively charged, high velocity particles called electrons

4) **Wilhelm Roentgen**

a) found that shooting a beam of high speed electrons at a glass plate, by using a cathode ray tube, it gave off a type of radiation he called X rays
b) medical uses for this technique were soon developed

5) **Henri Becquerel** - 1896

a) performed the following experiment in attempting to find out if fluorescence contained X rays
1) exposed photographic film wrapped in black paper to fluorescent chemicals in bright sunlight
2) he knew X rays would expose the film as well as sunlight
3) he tried to determine in sunlight might cause fluorescence which would be seen in exposed film
4) found that a fluorescent chemical, potassium uranyl sulfate, fogged the film, suggesting X rays might be present

b) due to cloudy weather he left this set-up in a drawer for several days
c) he developed the film, hoping that residual fluorescence might produce a slight fogging
d) he found a strongly fogged film (sunlight had not been needed to cause exposure of the film)

e) this new type radiation was not X rays because it needed no cathode ray tube and could not be turned off and was not fluorescence because it did not need sunlight or particle or any type radiant energy to cause it to work
f) the study of this new radiation (called radioactivity by Marie Curie) helped to change the nineteenth-century concept of atomic structure

6) **Marie and Pierre Curie** - 1898

a) both studied radioactive elements in detail
b) discovered that thorium was radioactive and discovered (and named) polonium and radium

7) Radioactivity (click to see full information)

8) **Rutherford-Geiger-Marsden** gold foil experiments - 1911

a) these men knew that alpha particles were, charged helium ions that traveled in straight lines at very high speeds
b) the plum pudding model of the atom (J. J. Thomson - 1897) said atom was sphere of positive matter in which electrons were randomly embedded (like raisins)
c) according to the plum pudding model the expected results of shooting a beam of alpha particles at thin gold foil should be that the alpha particles would pass straight through since there would be no concentration of charge and mass large enough to deflect the relatively massive alpha particle
d) actual results: most of the particles passed through unharmed (missed Au atoms) a few were deflected off to the side a very few were reflected backward (head on collision with nucleus
e) initial conclusions reached:

1) scattering must be due to encounters with charged atomic particles that are much smaller than the atom and at least as heavy as an alpha particle

2) must be some positive electric charges inside the atom to compensate for negative charges of the electrons

3) must be something in the atom much heavier than an electron to account for the mass of the atom

4) atoms must be mostly empty space

5) suppose an atom has a small central core (nucleus) which contains most of the mass of the atom and carries a positive electric charge that attracts the negative electrons (helping to keep them in orbit around this nucleus)

f) final conclusions:

1) positively charged protons concentrated in region inside atom called nucleus

2) atoms total diameter much larger than that of the nucleus

3) negatively charged particles, called electrons, were circling in orbit around the nucleus (a balance of forces holds them in orbit; the positive nucleus pulls electrons inward toward nucleus and a counterbalancing force called centripetal (which is the force that tends to make rotating bodies

move away from the center of rotation) tending to throw them outward (like a ball on a string being swung around your head)).

4) the positive electrical charge of the proton is equal in strength to the negative electrical charge of the electron

5) the weight of the proton is 1836 times as great as the weight of an electron

6) a particle in the nucleus having no electrical charge was predicted

9) **James Chadwick** - 1932

a) found the weight of atom did not check out when working with isotopes and thus found the predicted particles in nucleus with nor charge called the **neutron**
b) neutron weighs about the same as a proton
c) neutron has no electrical charge

DEFINITIONS:

a) **radiation** - energy transferred by electromagnetic waves

b) **fluorescence** - visible light given off by a substance when struck by radiation or electrons

c) **Law of Definite Proportions** - atoms combine in whole number ratios based on weights

d) **Law of Electrical Charges** - like charges repel, unlike charges attract

e) **radioactivity** - spontaneous release of radiation and particles by unstable nucleus