Dalton Group 1

1. What did Democritus say about the atom?
   - Democritus asked whether it is possible to divide a sample of matter forever into smaller and smaller pieces. After much thought, he concluded that it was not. At some point, a smallest piece would be reached.
   - He hypothesized that atoms were small, hard particles that were all made out of the same material. He also believed them to be infinite in number and that they were always moving and could be joined together.

2. List / explain the parts of Dalton's Atomic Theory.
   - All matter is made of atoms. Atoms are indivisible and indestructible.
   - All atoms of a given element are identical in mass and properties
   - Compounds are formed by a combination of two or more different kinds of atoms.
   - A chemical reaction is a *rearrangement* of atoms.
   - Atoms cannot be created or destroyed. When a compound decomposes, the atoms are recovered unchanged.

3. What was significant about Dalton's Atomic Theory as opposed to what Democritus merely suggested?
   - Many things are in fact combinations of atoms or compounds in particular ratios.
   - He defined hydrogen, oxygen, nitrogen, carbon, sulfur, and phosphorus as elements composed of atoms definitively by atomic weight.

4. What parts are technically incorrect?
   - Atoms can be destroyed (split or joined) via nuclear reactions but not by chemical reactions.
   - Also, there are different kinds of atoms (differing by their masses) within an element that are known as "isotopes" yet isotopes of an element have the same chemical properties.

5. Which portion of Dalton's Atomic Theory is still considered correct today?
   - During chemical reactions it is true that atoms cannot be divided, created, or destroyed only combined, separated, or rearranged.

6. How did Dalton's model further understanding at the time of the structure of the atom?
   - Dalton published his findings in print; the first published table of relative atomic weights. Six elements appear in this table, namely hydrogen, oxygen, nitrogen, carbon, sulfur, and phosphorus, with the atom of hydrogen conventionally assumed to weigh 1.

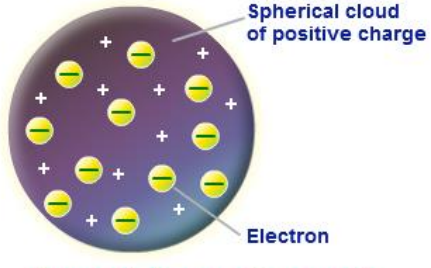
JJ Thomson Group 2

1. What are cathode rays?
   - Cathode rays are a stream of electrons following through vacuum tube.
   - Electrons

2. Describe JJ Thomson's Cathode Ray Experiment.
   - By balancing the effect of a magnetic field on a cathode-ray beam with an electric field, Thomson was able to show that cathode rays are actually composed of particles. This experiment also provided an estimate of the ratio of the charge to the mass of these particles. If you have the ratio and you know the charge, you can find the mass, or if you know the mass can find the charge (*just how negative (-) or positive + a particle can be.)*

3. What were the consequences of Thomson's experiment? What was his hypothesis?
   - There must be a positively charged particle that balances the negative charge of electrons being emitted from the cathode experiment.
   - He hypothesized there must be a positive charge to balance out the negative electrons somewhere.
4. What particle did Thomson discover?
   - a tiny particle carrying a negative electrical charge, the electron

5. Describe Thomson's "Plum Pudding" model of the atom. **Include a drawing. Label e- and positive parts**



Thomson's Plum pudding model

6. How did Thomson's model further understanding at the time of the structure of the atom?
   - It provided insight into the inner workings of the atom. It improved on Dalton's work. We now knew that atoms were indeed divisible and that particles (photons) of light energy could be emitted from them and that electrons can move freely through them.
   - If electrons are negative and atoms are neutral then there must be a positive particle still undiscovered out there.

Rutherford Group 3

1. What is an alpha particle?
   - A helium atom with no electrons

2. Describe Ernest Rutherford's Gold Foil Experiment.
   - bombarding thin gold foil with alpha particles

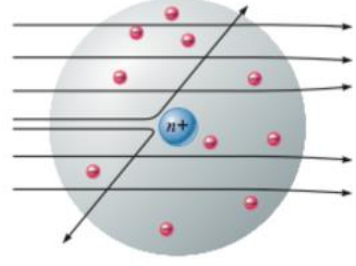
3. Why did the alpha particles go straight through?
   - Rutherford deduced that the atom must have nearly all its mass in a tiny central nucleus about 10,000 times smaller than the atom itself.

4. Why were some alpha particle deflected off at sharp angles or bounce straight back?
   - This was because sometimes the alpha particle actually struck the nucleus.

5. What part of the atom did Rutherford discover?
   - Nucleus

6. Describe Rutherford's model of the atom. **Include a drawing. Label e- and nucleus**

- Note alpha particles flying through



Rutherford Model 1908

7. How did Rutherford's model further understanding at the time of the structure of the atom?
   - His model of the atom revealed the nucleus as the positive source of charge in the atom. His experiments revealed that the atom is mostly empty space.
   - His work gave scientists a new question to try answer regarding the nature of the atom.

   - Why do negative electrons stay in their relative positions and not crash in on the positive nucleus?

8. Give one interesting biographical fact about him.
   - One of 12 children, he liked the hard work and open air of farming, but was a good student and won a university scholarship. After college, he won another scholarship to study at Cambridge University in England -- a turning point in his life. There he met J.J. Thomson (who would soon discover the electron), and Thomson encouraged him to study recently-discovered x-rays.

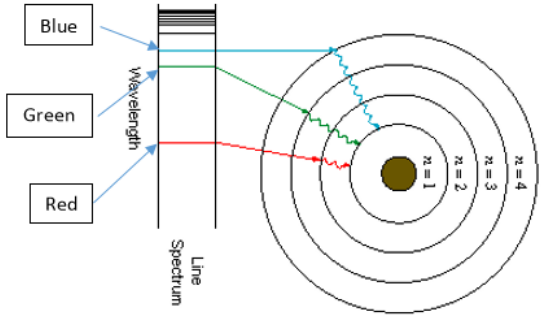
Bohr Group 4

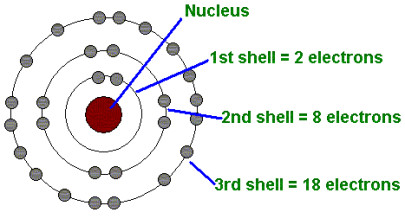
1. What is an orbit or shell? – Quanta
   - Places that exist in the atom where electrons can travel without losing energy. Let's call those places "permitted orbits," something like the orbits that planets travel in their journey around the Sun. If we can accept that idea, Bohr said, the problem with electrons in Rutherford's atom would be solved.

2. What is bizarre or unusual about electron shells in the Bohr model? Why did people find it *hard to swallow*?
   Imagine that you are taking a walking along a beach. As you walk along, you see a sand-castle that someone has built. As you get closer to the sand castle, you discover that you can only stand three meters, two meters, or one meter from the sand castle and no distance in between. You cannot stand at one and a half meters, nor can you stand at two and three quarters of a meter from the sand castle. No matter how hard you try, some mysterious force keeps you at one of those three distances. In everyday life such a situation is absurdly impossible. However, bizarre or unusual it might seem in the physics of the very small, it is a necessity.

3. What part of the atom did Bohr discover?
   - Proton, and he proposed electron levels

4. Describe Bohr's model of the atom. **Include a drawing. Label e- and protons**





5. Explain why Bohr's model of the atoms is sometimes called the planetary model.
   - He described it that way at one point. The electrons are found in distinct "orbits" analogous to the way planets revolve around the sun. We now know that this isn't really the case but, it makes a convenient way to described electrons moving around a nucleus even if it is conceptually wrong.

6. How did Bohr's model further understanding at the time of the structure of the atom?
   - It helped explain why electrons did not crashed down into the nucleus.

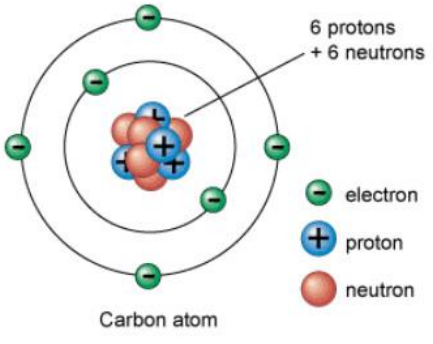
7. Give one interesting biographical fact about him.
   - In 1912 Bohr married Margrethe Nørlund. They had six sons, one of whom, Aage, followed his father into physics -- and into the ranks of Nobel Prize-winners. Bohr returned to Denmark as a professor at the University of Copenhagen, and in 1920 founded the Institute for Theoretical Physics

Chadwick Group 5

1. What problem did Chadwick try to solve?
   - In the Bohr model, there must be an equal number of protons and electrons. This balance is the only way to be sure that an atom is electrically neutral, which we know to be the case for all atoms. But, if one adds up the mass (total amount of matter) of all the protons and electrons in an atom, the total comes no where near the actual mass of an atom. Where then is the remaining mass?

2. What particle did he discover? Why had it evaded discovery for so long?
   - It turned out to be in a still yet to be discovered particle, the neutron. Because it was neutral, it evaded detection.

3. Describe Chadwick's model of the atom. **Include a drawing. Label (e-) protons & neutrons**



4. Describe the experiment that led to the discovery of the neutron.
   - Alpha particles are fired at beryllium. The beryllium decays and emits neutrons which strike paraffin wax. This paraffin wax then emits protons which strike a Geiger counter detector. Neutrons are neutral some evade detection but we can indirectly measure them because, they are knocking protons loose.

5. What was one leading explanation for the hidden mass of the atom? (search biography pg)
   - That there was entangled proton-electron pairs that were canceling the charge of one another out. They were escaping detection because they were neutral. We now know this is not case.

6. Why did physicists find the neutron to be the ideal "bullet"?
   What did it help to do which changed the world?
   - Physicists soon found that the neutron made an ideal "bullet" for bombarding other nuclei. Unlike charged particles, it was not repelled by similarly-charged particles (negative repel other negatives. It could smash right into the nucleus of an atom. Before long, neutron bombardment was applied to the uranium atom, splitting its nucleus and releasing the huge amounts of energy predicted by Einstein's equation $E = mc^2$.

7. Give one interesting biographical fact about him.
   - For four years, James Chadwick was a prisoner of war in Germany. When World War I ended, he returned to his native England to rejoin the mentor of his undergraduate days, Ernest Rutherford.

Name _____ per____ date_____ mailbox_____

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2. What did he discover about the nature of electrons? / What is the uncertainty principle?

3. How was Heisenberg radically different than the other physicist? Did he have a physical model?

4. What did the New York Times say about how he and peers like Planck were perceived by others at the time?

5. What were the consequences, however startling of what he was saying?

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7. Give one interesting biographical fact about him.

Heisenberg Group 6

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