The Questions

1. How do electrons change from one energy level to another?
Bohr model of the atom

- **Ground State:** An atom is in its ground state when all of its electrons have filled all of the lowest possible energy levels.
Bohr model of the atom

- **Excited State:** An atom is in its excited state when one or more of its electrons have jumped up to a higher energy level.
Bohr model of the atom

- Electrons *can* change between energy levels.
- To do this energy must be added to the atom or given off by the atom.
- Where does the energy come from to move an electron from a low energy level to a high energy level?
  - The energy comes from photons. These photons are what we know as light.
- When an electron goes from a high energy level to a low energy level the atom gives off light.
Bohr model of the atom

- He proposed that these energy levels correspond to orbitals around the nucleus.
- These orbitals are the only locations where electrons can be found.
- Since these orbitals surround the nucleus far away from the nucleus the atom is mostly empty space.
- Bohr also said that electrons fill these orbitals in a very specific way.
Diagram of Spectral Lines and Energy

- Violet
- Blue - violet
- Blue - green
- Hydrogen spectrum
- Red
- Light

Energy levels

Light energy

high to low
1. How do electrons change from one energy level to another?

- By absorbing energy to climb to a higher energy level.
- By emitting energy when they fall to a lower energy level.
The Questions

- What are the forces that hold an atom together?
4 Forces of Nature

- **Strong Nuclear Force:** Strongest force in nature.
  - Force that attracts neutrons and protons to each other.
  - Works only over very short distances.

- **Electromagnetic Force:** Second strongest force in nature.
  - Force that attracts positive to negative charges.
4 Forces of Nature

- **Weak Nuclear Force:** Nuclear force (meaning it applies to particles found in the nucleus, protons and neutrons).
  - Much weaker than the Strong Nuclear and ElectroMagnetic force.
  - Plays a role in radioactivity.

- **Gravity:** Very weak force and plays a role outside of the atom.
  - Subatomic particles do not have enough mass to have significant gravity.
Forces that hold atoms together

Electrons are bound to the nucleus by the attractive force between electrons (-e) and protons (+e). The Electromagnetic force.
Forces that hold atoms together

- What holds the nucleus together?
- There is another force that is even stronger than the electric or electromagnetic force.
- We call it the strong nuclear force.
Forces that hold atoms together

- The model:
  - The + charged protons repel each other because they are the same charge. The Strong Nuclear force between the protons and neutrons holds the nucleus together.
  - The electromagnetic force attracts the protons to the electrons and is what keeps the electrons from flying away from the atom.
The Answers

- What are the forces that hold an atom together?
- Strong nuclear and Electromagnetic forces.
The Questions

- How do we know what we know?
- In other words “Where did the atomic model we are studying come from?”
John Dalton:  
- Did his research/experiments in the early 1800s.
- Current theory at the time said substances combined in definite proportion.
- His research was on gasses and he concluded that: Elements consist of tiny particles called atoms and that all atoms have the same mass.
- Dalton’s Theory: All atoms were tiny, indivisible, indestructable particles and each had a certain size, mass and chemical behavior.

Wrong... What is wrong with this?
4 Scientists (2)

- **JJ Thomson:**
  - Did his research/experiments in the late 1890s.
  - Observed that when electricity was passed through a gas particles were given off.
  - These were too small to be atoms and had a negative charge (remember atoms are neutral).
  - He call them electrons.
  - They were the first sub-atomic (smaller than the whole atom) particles discovered.
  - Thomson’s Theory: Negative electrons were sprinkled around the atom like “chocolate chips in a cookie”. He said raisons in a loaf of bread. This was the first model for the sub-atomic atom.

  - And he was wrong...
4 Scientists (3)

- **Ernst Rutherford:**
  - Did his research/experiments in the early 1900s.
  - Gold foil experiment:
    - Launched helium atoms at a thin sheet of gold foil.
    - Theorized helium atoms would be deflected.
    - Most of the helium atoms went right through the foil.
    - Some of the helium atoms bounced right back.
  - Rutherford’s Theory: Gold atoms (and all atoms) were mostly empty space and that most of the mass of the atom was concentrated in a very small region called...
    - The nucleus. Still part of the current model.
4 Scientists (4)

- **Neils Bohr:**
  - Did his research/experiments in the early 1900s.
  - Proposed the Bohr model of the Atom in 1913:
    - Observed that very specific colors of light are emitted from atoms when excited.
    - Proposed that electrons exist in very specific energy levels around the nucleus and could not exist in between these levels.
  - Foundation of Modern Quantum Physics.
The Answers

- How do we know what we know?
  - In other words “Where did the atomic model we are studying come from?”

- From the discoveries of Dalton, Thomson, Rutherford and Bohr.

- There are others but these are 4 keys that we need to know.