Note-Taking Guide: Light and the Big Bang

Learning Target: I can construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.

- Types of Electromagnetic Radiation
  - Electromagnetic _____ can be characterized by their wavelength or frequency and classified into different types of radiation.
  - The _____ wavelengths are called radio waves, followed by microwaves, infrared, visible light, ultraviolet, x rays, and gamma rays.
  - The wavelength of light is related to its frequency by the wave equation.

Type		**Wavelength**	
		> 0.3 m	
		0.3 m	1 mm
		1 mm	789 nm
		789 nm	625 nm
		625 nm	600 nm
		600 nm	577 nm
		577 nm	491 nm
		455 nm	390 nm
		390 nm	8.82 nm
		8.82 nm	6 pm
		< 6 pm	

- Frequency – Energy Relationship
  - The energy of the radiation is related to the frequency of the light wave:

  - The constant ***h*** is known as the Planck constant, and it is equal to:

- What is an electron volt? An **electron volt** is the energy required to accelerate an electron across an electric _____ of 1 volt.
- Think, Pair, Share: **What are some common sources of light? What do they have in common?**

- Thermal Radiation
  - Electromagnetic radiation that is generated by the _____ _____ in matter is known as **thermal radiation**.
  - The _____ of the particles in an object or system at a given time is defined as its **temperature**.
  - All matter with a temperature above _____ emits thermal radiation.
- Thermal Radiation Curve
  - Thermal radiation consists of a wide range of wavelengths—due to a wide spectrum of _____ even at a _____.
    - A few atoms move very fast—_____ wavelength radiation.
    - A few atoms move very slow—_____ wavelength radiation.
    - The majority of atoms move at a speed that depends on the temperature of the object.
  - For different temperatures, an object will emit thermal radiation that _____ at different _____.
    - _____ objects emit most of their radiation at _____ wavelengths.
    - _____ objects emit most of their radiation at _____ wavelengths.
- Wavelength of Maximum Intensity
  - The wavelength of maximum intensity is inversely proportional to the temperature of the object measured in Kelvins (K):

Example 1: A typical human being has an internal temperature of 98.6 degrees Fahrenheit (310 K). What wavelength of radiation does a typical human being give off most at this temperature? What type of electromagnetic radiation is this?

Example 2: The Sun appears to give off radiation with a wavelength of maximum intensity at 508 nm. What is the temperature of the Sun's surface?

- Observation of Light with Specific Wavelengths
    - If a low-density gas is given energy, it will also produce light—but in a different way.
    - Each _____ has specific wavelengths of light that it emits after being given energy.
- The Bohr Model of an Atom
    - The Bohr model of the atom explains this phenomenon.
    - The Bohr model predicts that the _____ in atoms are in orbits of differing energy (called "energy levels") around the nucleus.
    - The electron can be in _____ energy level or another but nothing in between.
    - The electron normally occupies the lowest energy level—or the _____ —but it can be "_____" to a higher energy level.
    - After being excited, the electron can return to its original ground state by _____ the energy it absorbed.
    - The energy is released as a _____ of electromagnetic radiation, and the amount of energy is equal to _____.

Example 3: An electron falls from the third energy level of 12.5 eV to the second energy level of 10.5 eV. What is the energy of the photon emitted? What is the wavelength of this photon? What type of electromagnetic radiation is this?

<u>Observations of the Universe</u>

- Cosmic Abundance of Elements
    - Astronomers look at the Sun's radiation and they find that it is made mostly of _____, some _____, and traces of other gases.
    - Based on the light from stars and galaxies, the universe appears to be made of approximately _____ Hydrogen, _____ Helium, and less than 0.1% other elements.
    - ***A theory of the origin of the universe must account for this abundance of hydrogen and helium.***
- Cosmic Microwave Background
    - In 1964, while attempting to detect faint radio waves bounced off balloon satellites, Arno Penzias and Robert Wilson kept getting interference (like static) in their receiver.
    - After attempting to get rid of all possible sources of interference—including removing bird droppings—they determined that the radio noise was coming from _____, and in all directions.
    - The radiation they were detecting looked like a thermal radiation curve with a peak wavelength of 1.07 mm. ***What does this imply about the temperature of the universe?***