KEY 11.2 The Hydrogen Atom
Chemistry

Name _____ Date _____ Per. _____

Directions: Answer all open-ended questions in complete sentences, using evidence to support your answers. For math questions, show all of your work and include appropriate units and significant figures in your final answer to receive **FULL** credit.

1. Describe briefly why the study of electromagnetic radiation has been important to our understanding of the arrangement of electrons in atoms.

   Excited atoms emit light (which we can measure) because of changes in their microscopic structure. By studying emissions of atoms, we can trace back to what happened inside the atom.

2. What does it mean to say that the hydrogen atom has discrete energy levels? How is this fact reflected in the radiation that excited hydrogen atoms emit?

   When excited hydrogen atoms emit their excess energy, the photons of radiation released always have exactly the same wavelength and energy. Thus, the hydrogen atom possesses only certain allowed energy states.

3. What experimental evidence do scientists have that the energy levels of hydrogen are quantized?

   Hydrogen always transmits light at exactly the same wavelengths, which correspond to transitions of the electron between the fixed energy states of the atom.

4. What is meant by the ground state of an atom? What does it mean to say that an atom is in an excited state? What happens when an atom in an excited state returns to its ground state?

   The ground state is the lowest level of an atom (n=1). An excited state is any energy level above the ground state, atoms can go to these levels when they gain energy. When an atom returns to its ground state from an excited state, the excess is given off in the form of light.

5. According to Bohr, what types of motions do electrons have in an atom, and what happens when energy is applied to the atom?
   Electrons move in fixed circular orbits around the nucleus. An electron can move to a larger orbit if a photon of applied energy equals the difference in energy between two orbits.

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6. How does the Bohr theory account for the observed phenomenon of the emission of discrete wavelengths of light by excited atoms?
   The energy levels were definite and fixed, so the atom should always emit energy at the same wavelength.

7. Why was Bohr's theory for the hydrogen atom initially accepted, and why was it ultimately discarded?
   Bohr's theory explained the line spectrum of hydrogen exactly. It did not explain measurements made for atoms other than hydrogen.

8. What major assumption (that was analogous to what had already been demonstrated for electromagnetic radiation) did de Broglie and Schrödinger make about the motion of tiny particles?
   As light has both wave and particle characteristics, then perhaps the electron might exhibit both of these characteristics, maybe an electron has wavelike and particle-like properties.

9. We cannot exactly specify the location of an electron in an atom but can discuss only where an electron is most likely to be at any given time.How does the concept of an orbital show this?
   Trying to measure the exact location of an electron by shooting a beam of light at it would cause the electron to move. Measurement requires an energy change which causes the electron to move.

10. How do we know that the energy levels of the hydrogen atom are not continuous, as physicists originally assumed?
    Light is emitted from the hydrogen atom only at certain wavelengths. If the energy levels of hydrogen were continuous,, a hydrogen atom would emit energy at all possible wavelengths.