Models of the Hydrogen Atom

Spoken Tutorial Project
http://spoken-tutorial.org
National Mission on Education through ICT
http://sakshat.ac.in

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Learning Objectives

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- **Demonstrate Models of the Hydrogen Atom, PhET Simulation**

System Requirement

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- **Ubuntu Linux OS v 14.04**

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- **Ubuntu Linux OS v 14.04**
- **Java v 1.7.0**

Pre-requisites

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- **Learner should be familiar with topics in high school science**

Learning Goals

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- **Visualize different models of the hydrogen atom**

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- **Visualize different models of the hydrogen atom**
- **Explain the experimental predictions of each model**

Learning Goals

- **Visualize different models of the hydrogen atom**
- **Explain the experimental predictions of each model**
- **Discuss limitations of each model**

Learning Goals

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- **Explain the energy level diagram**

Learning Goals

- **Explain the energy level diagram**
- **Determine the orbital shape and orientation from n, l and m values**

PhET Simulation-Link

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https://phet.colorado.edu

Billiard Ball Model

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- **Billiard Ball model is also called as Dalton's atomic model**

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- **It was proposed by John Dalton**

Billiard Ball Model

- **Billiard Ball model** is also called as Dalton's atomic model
- It was proposed by John Dalton
- Individual atom is visualized as solid, hard spheres, like billiard balls

Limitations of Billiard Ball Model

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- **Experiments showed that atoms are mostly made up of empty space**

Limitations of Billiard Ball Model

- **Experiments showed that atoms are mostly made up of empty space**
- **Presence of different kinds of sub-atomic particles was also established**

Limitations of Billiard Ball Model

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- **Sub-atomic particles carry positive and negative charges**

Limitations of Billiard Ball Model

- **Sub-atomic particles carry positive and negative charges**
- **Based on these observations, Plum Pudding Model was suggested**

Limitations of Plum Pudding Model

Limitations of Plum Pudding Model

- **Gold foil scattering experiments by Rutherford showed that,**

Limitations of Plum Pudding Model

- **Gold foil scattering experiments by Rutherford showed that,**
- **Positive charge is not spread evenly over the entire atom**

Solar System Model

Solar System Model

- **Rutherford nuclear model of an atom is like a small scale solar system**

Solar System Model

- **Rutherford nuclear model of an atom is like a small scale solar system**
- **Nucleus plays the role of sun and the electrons that of revolving planets**

Solar System Model

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- **The very small positive charge portion of the atom was called nucleus**

Solar System Model

- **The very small positive charge portion of the atom was called nucleus**
- **Electrons move around the nucleus**

Solar System Model

- **The very small positive charge portion of the atom was called nucleus**
- **Electrons move around the nucleus**
- **They move with very high speed in circular paths called orbits**

Limitations of Solar System Model

Limitations of Solar System Model

Rutherford model cannot explain,

Limitations of Solar System Model

Rutherford model cannot explain,

- **The stability of an atom**

Limitations of Solar System Model

Rutherford model cannot explain,

- **The stability of an atom**
- **The distribution of electrons and their energies**

Assignment

Assignment

- **Select Bohr Atomic Model**

Assignment

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- **Change the light beam to Monochromatic**

Assignment

- **Select Bohr Atomic Model**
- **Change the light beam to Monochromatic**
- **Observe the electronic transitions at 103 nm, 112 nm and 122 nm**

Assignment

Assignment

- **Observe the energy level diagram and the spectrometer results**

Assignment

- **Observe the energy level diagram and the spectrometer results**
- **Note the observation and give an explanation**

Limitations of Bohr's Model

Limitations of Bohr's Model

Unable to explain:

- **The spectrum of atoms other than hydrogen**

Limitations of Bohr's Model

Unable to explain:

- **The spectrum of atoms other than hydrogen**
- **Finer details of the hydrogen atom spectrum**

Limitations of Bohr's Model

Unable to explain:

- **The spectrum of atoms other than hydrogen**
- **Finer details of the hydrogen atom spectrum**
- **Ability of atoms to form molecules by chemical bonds**

Limitations of Bohr's Model

Limitations of Bohr's Model

- **Splitting of spectral lines:**
  Magnetic field (Zeeman effect)
  Electric field (Stark effect)

de Broglie Atomic Model

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- **French Physicist - de Broglie (1924): Dual behavior of electrons**

de Broglie Atomic Model

- **French Physicist - de Broglie (1924): Dual behavior of electrons**
- **Like radiation, matter should also exhibit both particle and wavelike properties**

de Broglie Atomic Model

de Broglie Atomic Model

- **Electrons should also have momentum as well as wavelength**

Schrodinger Model

Schrodinger Model

- **Erwin Schrodinger proposed the quantum mechanical model of the atom**

Schrodinger Model

- **Erwin Schrodinger proposed the quantum mechanical model of the atom**
- **Schrodinger used mathematical equations to describe the probability of finding an electron**

Quantum Numbers

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- **The 3 coordinates that come from Schrodinger's wave equations are quantum numbers:**

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Quantum Numbers

- **The 3 coordinates that come from Schrodinger's wave equations are quantum numbers:**
  - **Principal (n)**
  - **Angular (l)**
  - **Magnetic (m)**

Quantum Numbers

Quantum Numbers

- **Quantum numbers describe size, shape and orientation of the orbitals**

Assignment

Assignment

- **For the Schrodinger's atomic model, select Monochromatic light beam**

Assignment

- **For the Schrodinger's atomic model, select Monochromatic light beam**
- **Note n,l,m values for the electron at four absorption wavelengths**

Assignment

- For the Schrodinger's atomic model, select Monochromatic light beam
- Note n,l,m values for the electron at four absorption wavelengths
- Note the orbital shape & possible orientation for each wavelength

Summary

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- **How to use Models of the Hydrogen Atom, PhET simulation**

Summary

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- **Visualized different models of the hydrogen atom**
- **Explained the experimental predictions of each model**
- **Discussed limitations of each model**

Summary

Summary

- **Determined the orbital shape and orientation from n, l and m values**
- **Explained the energy level diagram**

About the Spoken Tutorial Project

- **Watch the video available at http://spoken-tutorial.org /What_is_a_Spoken_Tutorial**
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- **Do you have questions in THIS Spoken Tutorial?**
- **Please visit**

  http://forums.spoken-tutorial.org
- **Choose the minute and second where you have the question**
- **Explain your question briefly**
- **Someone from our team will answer them**

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- More information on this Mission is available at http://spoken-tutorial.org/NMEICT-Intro