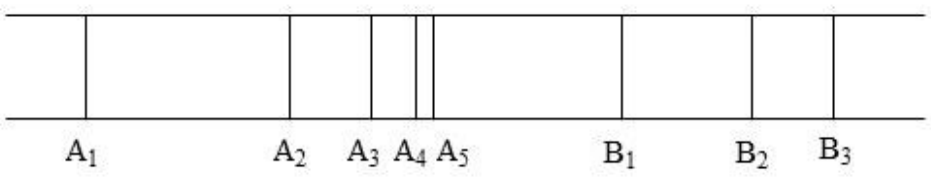
Tutorial 9:Hydrogen Spectrum

01. Given below is an experimental observation. Some of the explanations given by the students are given in front of them. One or more of these explanations could be true. Use the following instructions in order to assess those explanations.
    - If the explanation is true, put a "✓" on the appropriate blank.
    - If the explanation is false, put a "×" on the appropriate blank.
    - If the explanation could not be assessed, leave it as a blank.

Experimental observation	Explanation of the student
The Hydrogen emission spectrum consists of several line series. The lines grow closer and closer together as the frequency increases.	……... There are specific energy levels for the electrons in the Hydrogen atom. ……. The energy related to each line of the spectrum is equal to the energy of some electronic level of the H atom. ……. The energy of the electron is decreased when the radius of the atomic shell is increased.

02. What is the emission spectrum of Hydrogen? Draw a diagram related to the electron migration considering 6 energy levels and draw the Hydrogen emission spectrum.

03. An emission spectrum of Hydrogen is given below.



Draw a diagram showing the electron migration related to the formation of these lines, considering 7 energy levels.

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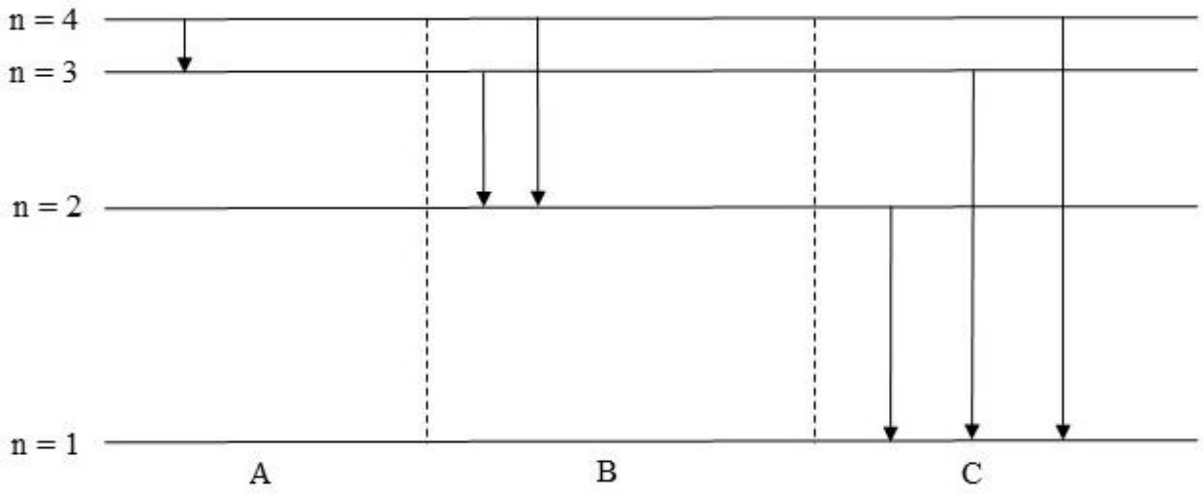
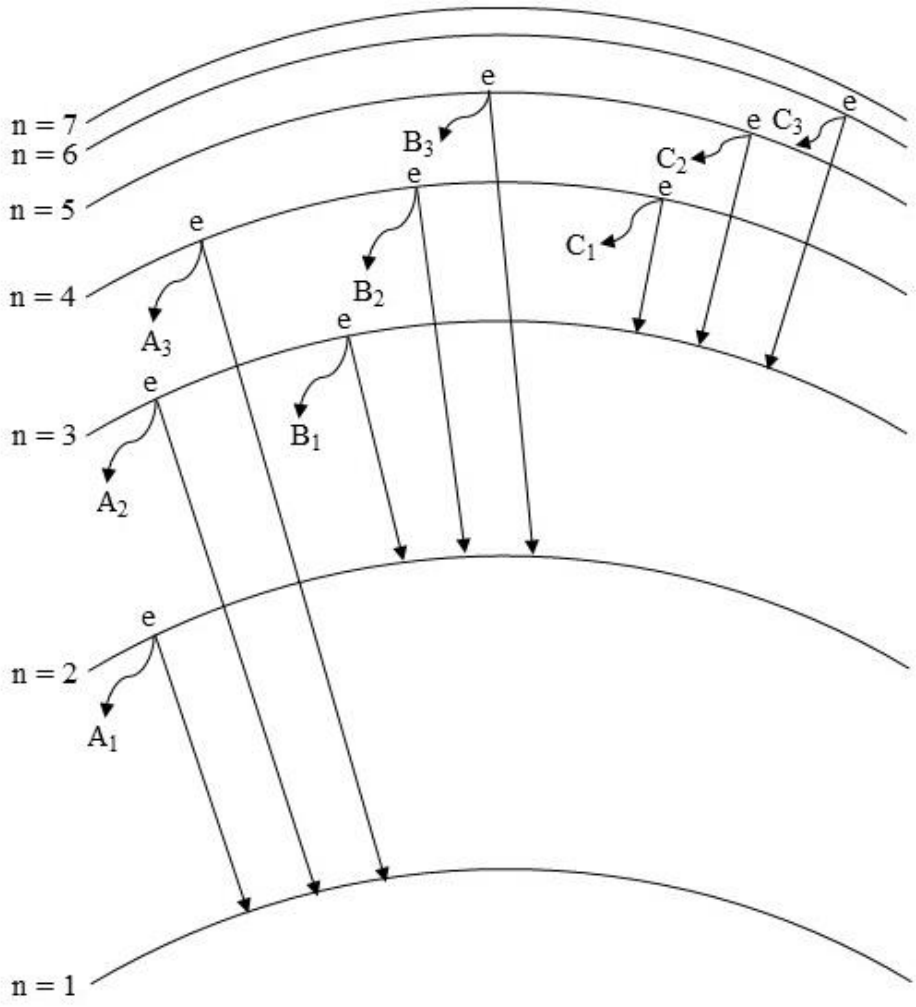
04. Following diagram shows the 4 initial energy levels of the Hydrogen atom.



Name each region and state the series of the emitting radiation. Indicate the region of the electromagnetic spectrum which corresponds to the energy and frequency of this radiation.

05. A diagram of the electron transition between energy levels of the Hydrogen atom is given below.



a) i) What is the series of the spectrum that A_1-A_3 radiation belongs to?

ii) Which region does this radiation belong to?

iii) State the radiation energy of the electromagnetic spectrum that corresponds to the energy that is stored in this radiation.

iv) Draw the spectral position of this radiation.

b) i) In which region does B_1-B_3 radiation belong to?

ii) State the radiation energy of the electromagnetic spectrum that corresponds to the energy that is stored in this radiation.

iii) Draw the spectral position of this radiation.

iv) How does the H_α radiation occurs here?

v) What is the color of H_α?

vi) What is the color of H_β?

vii) How does the H_β radiation occurs?

viii) What is the color of H_γ?

ix) How does the H_γ radiation occurs?

c) i) What is the series of the spectrum that C_1-C_3 radiation belongs to?

ii) Which region does this radiation belong to?

iii) State the radiation energy of the electromagnetic spectrum that corresponds to the energy that is stored in this radiation.

iv) Give another name for this radiation.

v) Draw the spectral position of this radiation.

d) Indicate the location of each of these radiations (A_1-C_3) in the spectrum and label them properly.

06. The first electronic energy levels of the H atom are shown in the figure 1 below. Figure 2 shows six lines in the emission spectrum of H atom.

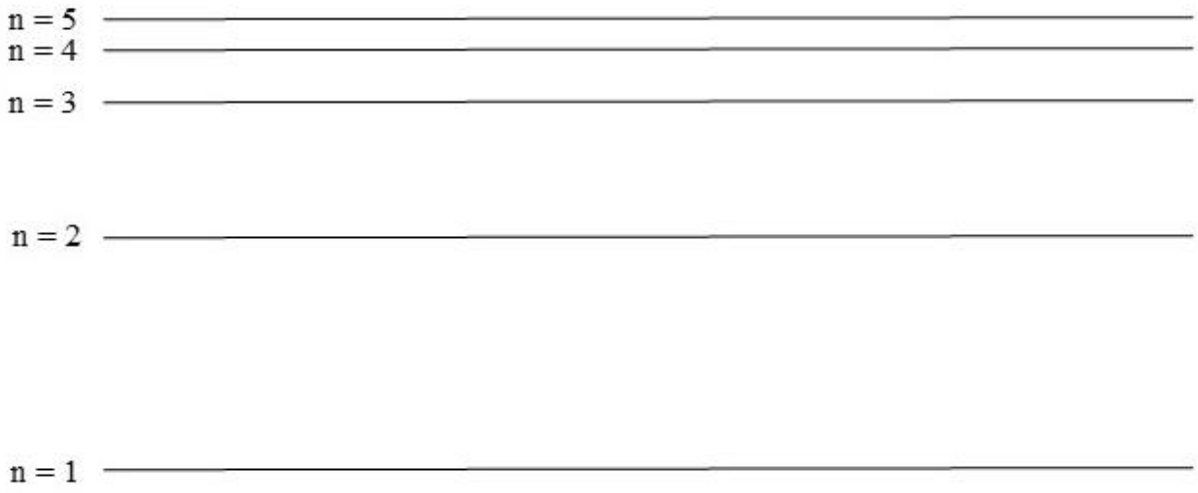


Figure 1

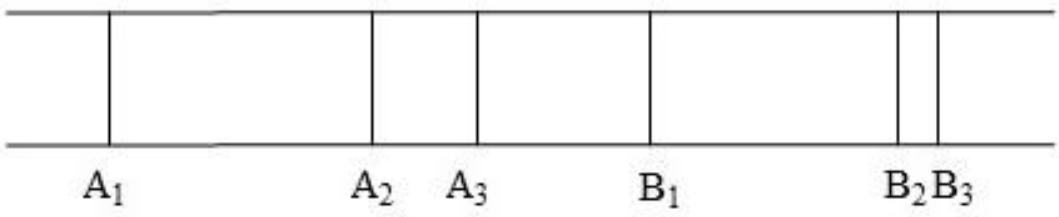


Figure 2

A_1, A_2, and A_3 are the first 3 lines belonging to the same series of the emission spectrum. B_1, B_2, and B_3 are the first 3 lines of the next series of this spectrum.

i) Draw six arrows between the energy levels in Figure 1 to show the electronic transitions corresponding to the six lines in the spectrum in Figure 2.

ii) Name the arrows as A_1, A_2, A_3, B_1, B_2, B_3 appropriately.

iii) Cross out the inappropriate words in brackets in the following sentence. The spectral frequency from A_1 to B_3 (increases / decreases).

07. Complete the following passage about H atomic spectrum with suitable words given within brackets.

(absorbs, Paschen, discrete, light, Balmer, excited, Brackett, emitted, Pfund, dissociate, Lyman)

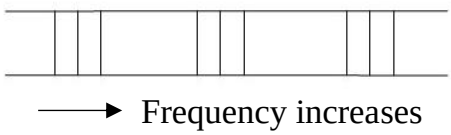
The Hydrogen atoms of the molecule …… as soon as an electric discharge is passed through a gaseous hydrogen molecule. It results in the emission of electromagnetic radiation initiated by the energetically …….. Hydrogen atoms. The Hydrogen emission spectrum comprises radiation of …….. frequencies.

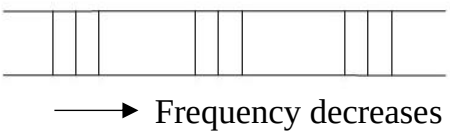
When a hydrogen atom …….. a photon, it causes the electron to experience a transition to a higher energy level, for example, n = 1, n = 2. When a photon is ……. through a hydrogen atom, the electron undergoes a transition from a higher energy level to a lower, for example, n = 3, n = 2. During this transition from a higher level to a lower level, there is the transmission of …….. occurs. The quantized energy levels of the atoms, cause the spectrum to comprise wavelengths that reflect the differences in these energy levels.

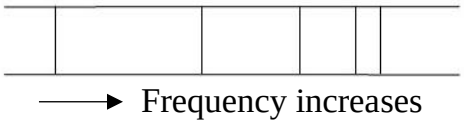
These transitions result in different series. Some of them are;

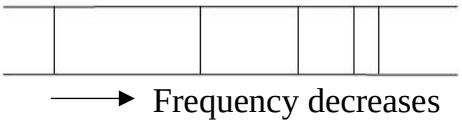
- The transition from the first shell to any other shell – …….. series
- The transition from the second shell to any other shell – …… series
- The Transition from the third shell to any other shell – ……. series
- The transition from the fourth shell to any other shell – ……. series
- The transition from the fifth shell to any other shell – …….. series

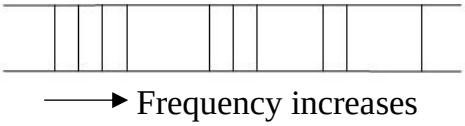
08. Which of these diagrams most closely matches the emission lines of the Hydrogen spectrum?

1) 

2) 

3) 

4) 

5) 

09. Which of the following statements about the atomic spectrum of Hydrogen is not true?

a) The transition from n = 4 to n = 2 corresponds to the H_β line.

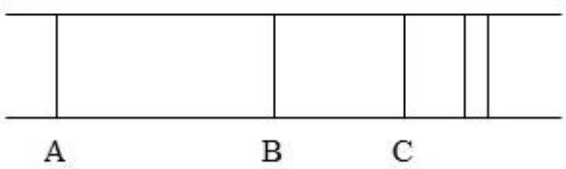
b) The energy difference between the n = α and n = 2 levels is the ionization energy of Hydrogen.

c) Each line in the spectrum corresponds to an energy level of the H atom.

d) The energy difference between n = 2 to n = 1 levels is smaller than the energy difference between n = 3 to n = 2 levels.

1) a, b 2) b, c 3) c, d 4) a, c 5) b, c, d

10. The emission lines of the Balmer series of the Hydrogen spectrum are given below.



The colors of lines A, B, and C are respectively,

1) Red, Green, Blue 2) Blue, Green, Red 3) Green, Red, Blue

4) Blue, Red, Green 5) Red, Blue, Green

11. Which transition in a H atom emit photons of highest frequency?

1) n = 2 to n = 1 2) n = 1 to n = ∞ 3) n = ∞ to n = 1

4) n = 3 to n = 1 5) None of the above

12. Which of the following spectral series of H atom is lying in visible electromagnetic wave?

1) Paschen series 2) Pfund series 3) Lyman series

4) Balmer series 5) Brackett series

13. Which one among the following transitions is associated with the largest change in energy in H atom?

1) n = 5 to n = 3 2) n = 2 to n = 1 3) n = 3 to n = 2

4) n = 4 to n = 2 5) n = 5 to n = 4

14. For H spectrum of Lyman series falls under ……. region.

1) Visible 2) UV 3) Infrared

4) X-ray 5) None of the above

15. Atomic H displays

1) Emission spectrum 2) Absorption spectrum 3) Dispersion spectrum

4) Continuous spectrum 5) None of the above

16. The transition from the 3^{rd} shell to any other shell is known as,

1) Balmer series 2) Paschen series 3) Pfund series

4) Lyman series 5) Brackett series

17. The H emission spectrum comprises radiation of discrete

1) Frequency 2) Wavelength 3) Energy

4) Intensity 5) Refraction

18. What causes spectral lines?

1) The transition of electrons between two energy levels
2) The transition of electrons between two wavelength ranges
3) Magnetic and electronic field exiting in an atom
4) The transition of electrons from an electric to a magnetic field
5) None of the above

In questions 19 to 21, two statements are given in respect of each question.
From the table given below, select the response out of the responses (1), (2), (3), (4), and (5) that best fit the two statements and mark appropriately on the given space.

Response	**First statement**	**Second statement**
(1)	True	True, and correctly explains the first statement
(2)	True	True, but does not explain the first statement correctly
(3)	True	False
(4)	False	True
(5)	False	False

	First statement	**Second statement**	
19	The frequency interval between two successive lines in each series of the atomic spectrum of Hydrogen decreases rapidly as the frequency of the spectral lines increases.	As the distance from the nucleus increases, the energy values of the successive energy levels from the H atom become increasingly similar.	…….
20	The electron density distribution in the 1s orbital of the H atom is spherical.	According to Bohr's theory, the electron in H moves in a circular path.	…….
21	The emission spectrum of H and the emission spectrum of Li are almost identical.	H and Li atoms have only one electron each in their outermost energy levels.	…….