PHYSICS

BOOKS - U-LIKE PHYSICS (HINGLISH)

ATOMS

N C E R T Textbook Exercises

1. Choose the correct alternative from the clues given at the end of the each statement :

The size of the atom in Thomson's model is ....

the atomic size in Rutherford's model.

(much greater than/no different from/much less than).

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2. Choose the correct alternative from the clues given at the end of the each statement :

In the ground state of .... electrons are in stable equilibrium, while in .... electrons always experience a net force.

(Thomson's model/Rutherford's model)

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3. Choose the correct alternative from the clues given at the end of the each statement :

A classical atom based on .... is doomed to collapse.

(Thomson's model/Rutherford's model)

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4. Choose the correct alternative from the clues given at the end of the each statement :

An atom has a nearly continuous mass distribution in a .... but has a highly non-uniform mass distribution in ....

(Thomson's model/Rutherford's model)

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5. Choose the correct alternative from the clues given at the end of the each statement :

The positively charged part of the atom possesses most of the mass in ....

(Rutherford's model/both the models)

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6. Suppose you are given a chance to repeat the alpha-particle scattering experiment using a thin sheet of solid hydrogen in place of the gold foil. (Hydrogen is a solid at temperatures below 14 K.) What results do you expect?

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7. What is the shortest wavelength present in the Paschen series of spectral lines ?

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8. A difference of 2.3 eV separates two energy levels in an atom. What is the frequency of radiation emitted when the atom make a transition from the upper level to the lower level ?

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9. The ground state energy of hydrogen atom is-13.6 eV. What are the kinetic and potential energies of the electron in this state?

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10. A hydrogen atom initially in the ground level absorbs a photon, which excites it to the n=4 level. Determine the wavelength and frequency of photon.

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11. (a) Using the Bohr's model calculate the speed of the electron in a hydrogen atom in the n = 1, 2, and 3 levels.

(b) Calculate the orbital period in each of these levels.

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12. The radius of the innermost electron orbit of a hydrogen atom is 5.3×10^{-11}m . What are the radii of the n = 2 and n = 3 orbits?

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13. A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. What series of wavelengths will be emitted ?

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14. In accordance with the Bohr's model, find the quantum number that characterise the earth's revolution around the Sun in an orbit of radius 1.5×10^{11} m with orbital speed $3 \times 10^{4} m / s$.

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Additional Exercises

1. Answer the following question , which help you understand the difference between Thomson's model and Rutherford's model better.

Is the average angle of deflection of a particles by a thin gold foil predicted by Thomson's model much less, about the same, or much greater than that predicted by Rutherford's model ?

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2. Answer the following question , which help you understand the difference between Thomson's model and Rutherford's model better.

Is the probaility of backward scattering (i.e., scattering of α - particle at angles greater than 90°) perdicted by Thomsom's model much less , about the same , or much greater than the predicted by Thomson'n model much less , about the same , or much greater than that predicted by Rutheford's model ?

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3. Answer the following question , which help you understand the difference between Thomson's model and Rutherford's model better.

Keeping other factors fixed, it is found experimentally that for small thickness t, the number of α - particles scatterd at moderate angles is proportional to t. What due does this linear dependence on t provide ?

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4. Answer the following question , which help you understand the difference between Thomson's model and Rutherford's model better.

In Which model is it completely wrong to ignore multiple scattering for the calculation of average angle of scatterig of α - particles by a thin foil?

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5. Obtain an epression for the frequency of radiation emitted when a hydrogen atom de-excites from levle (n-1). For large n, show that this frequency equals to classical frequency of revolution of the electron in the orbit .

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6. The total energy of an electron in the first excited state of the hydrogen atom is about - 3.4 eV.

(a) What is the kinetic energy of the electron in this state ?

(b) What is the potential energy of the electron in this state ?

Which of the answers above would change if the choice of the zero of potential energy is changed ?

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7. If Bohar 's quantisation postulate (angular momentum = $nh/2\pi$) is a basic law of nature , it should be equal be equally valid for the case of planetary motion also . Why then do we never speak of quatisation of orbit of planets around the Sun ?

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8. Obtain the first Bohr's radius and the ground state energy of muonic hydrogen atom [i.e., an atom in which a negatively charged (μ^{-}) of mass about 207 m_e orbits around a proton].

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Case Based Source Based Intergrated Questions

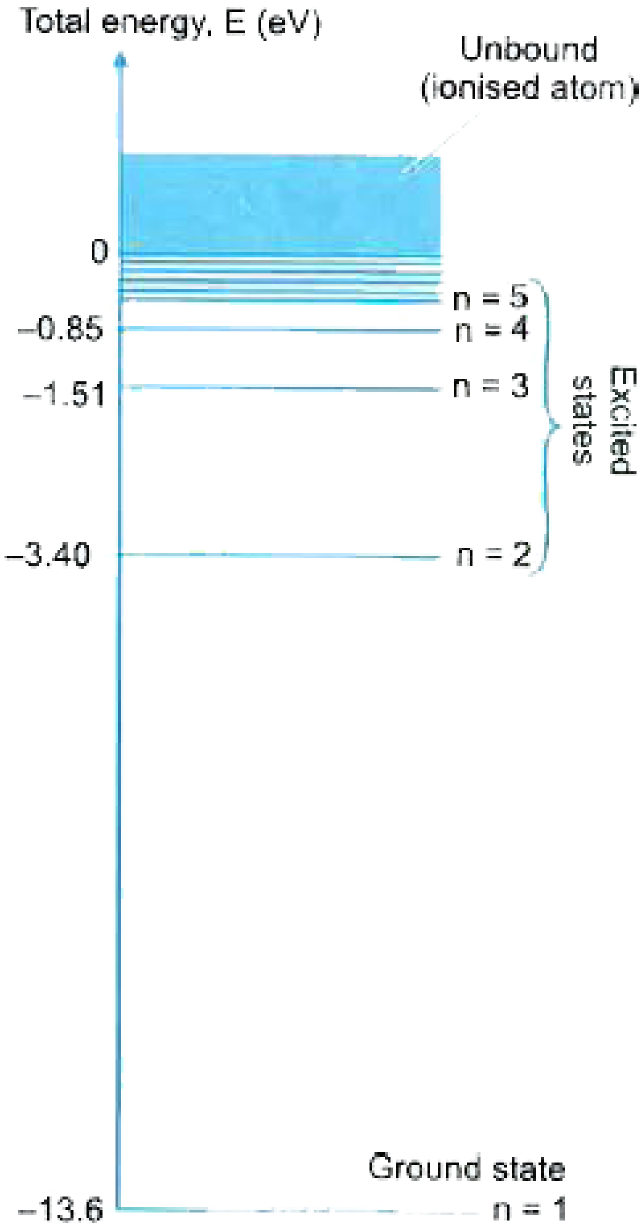
1. Read the pasage given below as well as the adjoining energy level diagram and then answer the questions given after the passage .

As per Bohr's theory og hydrogen atom the energy of an atom in a state corresponding to principal quantum number n is given as :

$$E_n = -\frac{13.6}{n^2} eV$$

The energy of an atom is the least when its electron is revolving in an orbit closets to the nucleus i.e., the one for which n =1. This state is called the ground state. When a hydrogen atom receives energy by processes such as electron collision , the atom may acquire sufficient energy to raise the electron to higher energy states and the atom is then said to be in an excited state . From these excited states the electron can then fall back to a state of lower energy , emitting a photon in the process.

The energy level diagram for the stationary states of a hydrogen atom , compouted from Bohr's relation for energy , is given in Fig.12.02. The principal quantum number n labels the stationary states in the ascending order of energy . Obviously , the highest energy corresponds to $n = \infty$ and has an energy of 0 eV. This is the energy of the atom when the electron is completely removed $(r = \infty)$ from the nucleus and is at rest.



Now answer the follwoing questions:

What does negative value of atomic energy signify?

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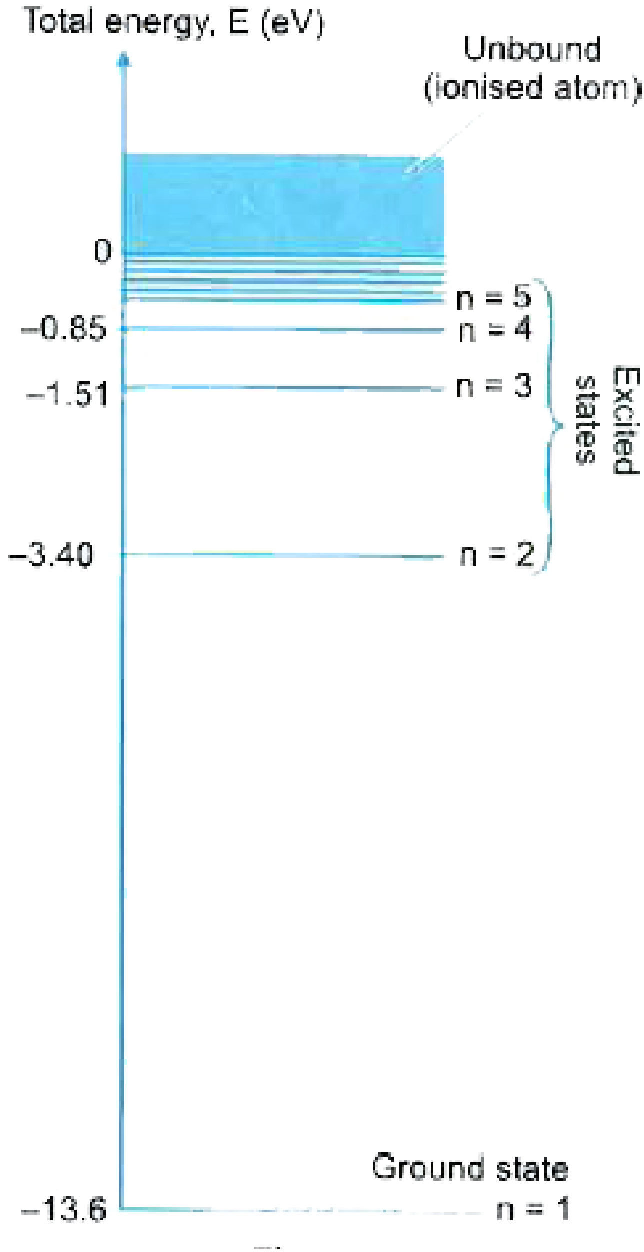

Now answer the follwoing questions:

How can a hydrogen atom receive energy to raise the electron to higher energy states ?

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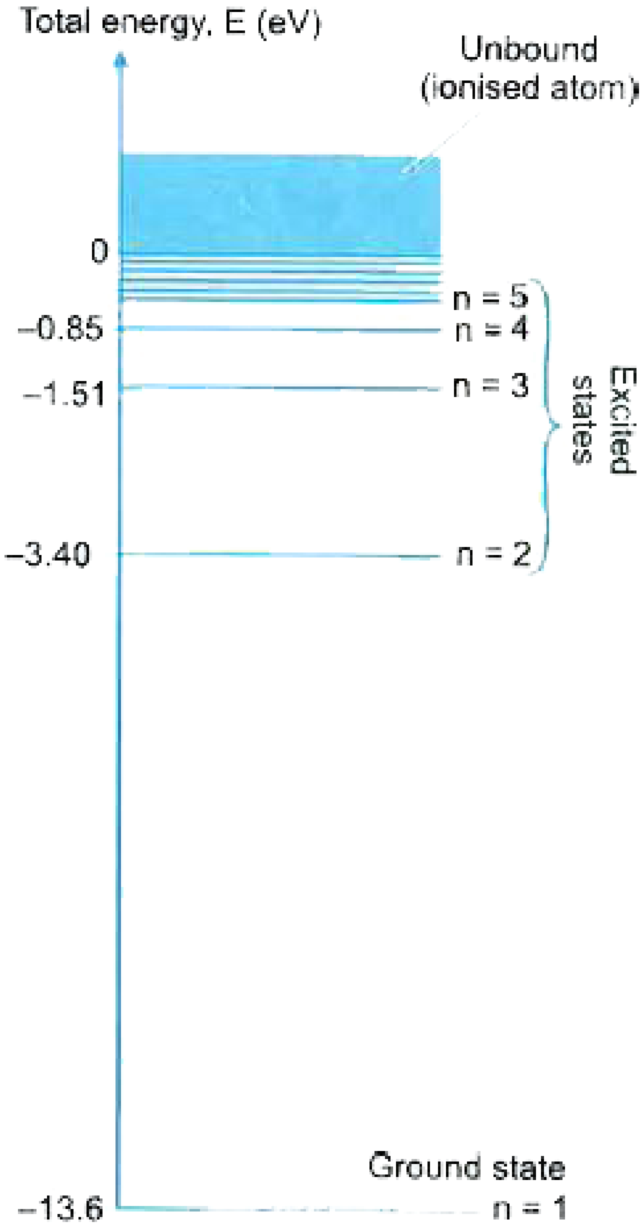

Now answer the follwoing questions:

What is the energy of hydrogen atom and give its value.

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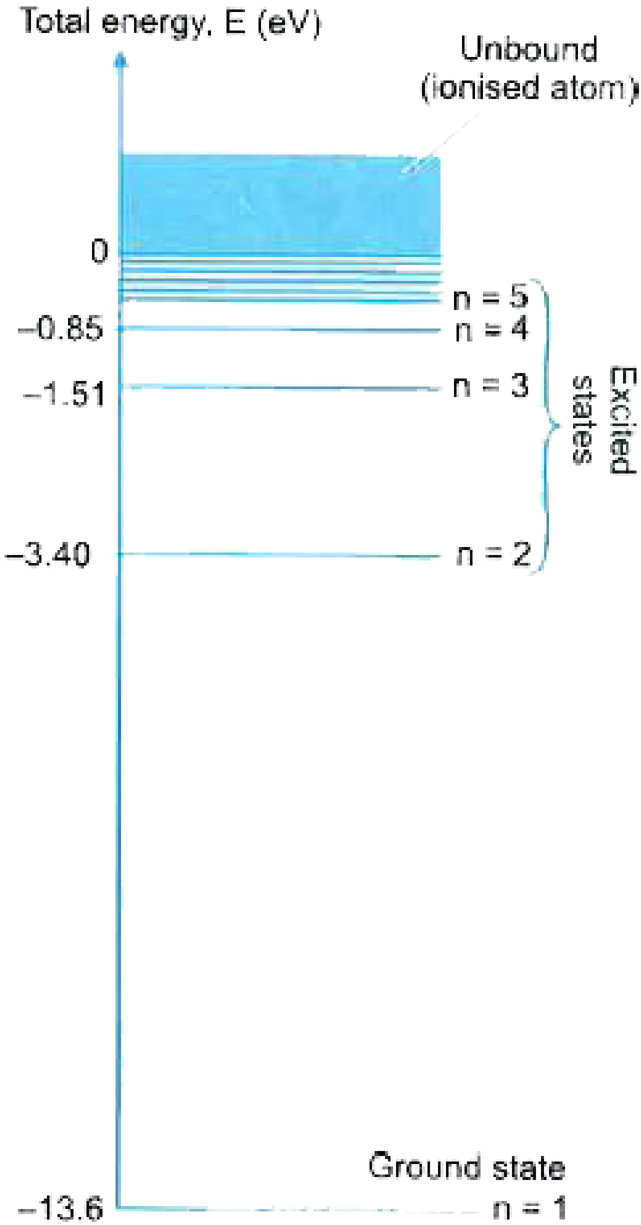

Now answer the follwoing questions:

Define ionisation energy of hydrogen atom and give its value.

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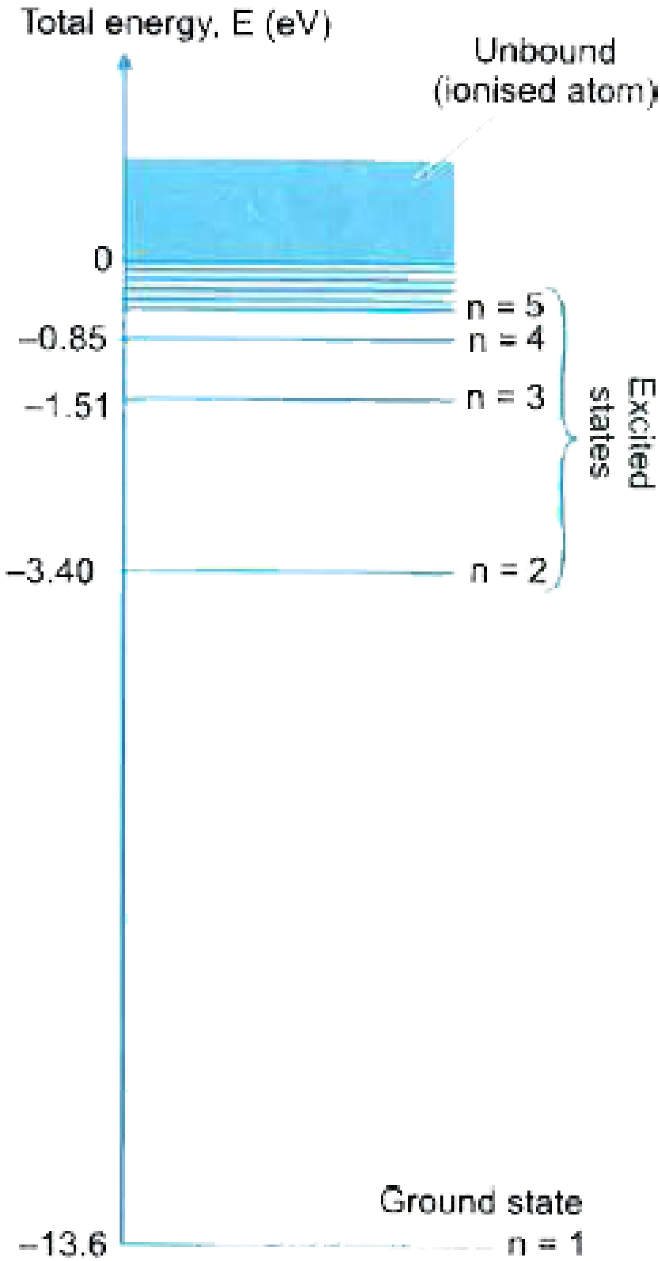

Now answer the follwoing questions:

When does a hydrogen atom emit a photon ?

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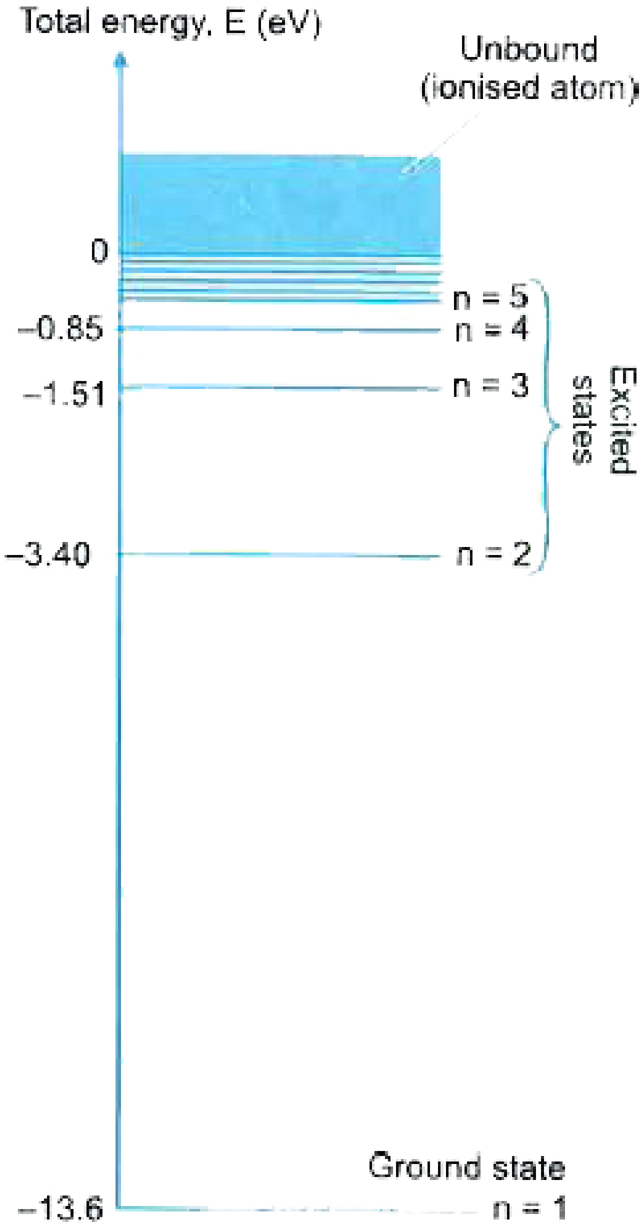

Now answer the follwoing questions:

Which atomic transition correspond to spectral lines of hydrogen in visible light ?

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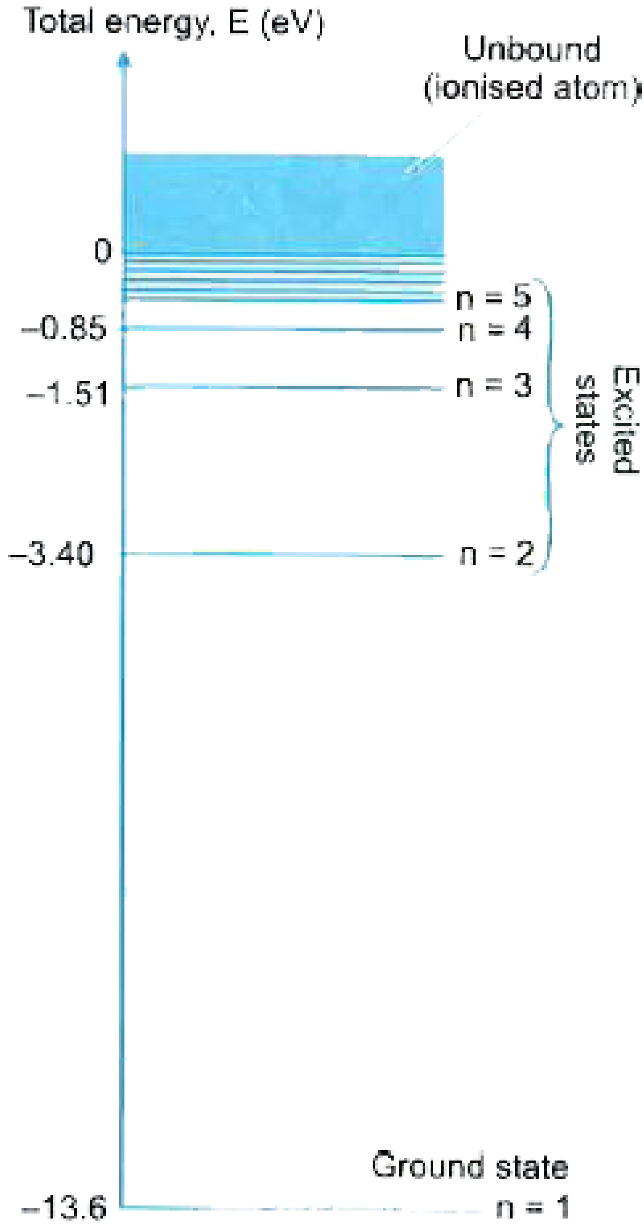

Now answer the follwoing questions:

Name the spectral series of hydrogen atom observed in visible light region.

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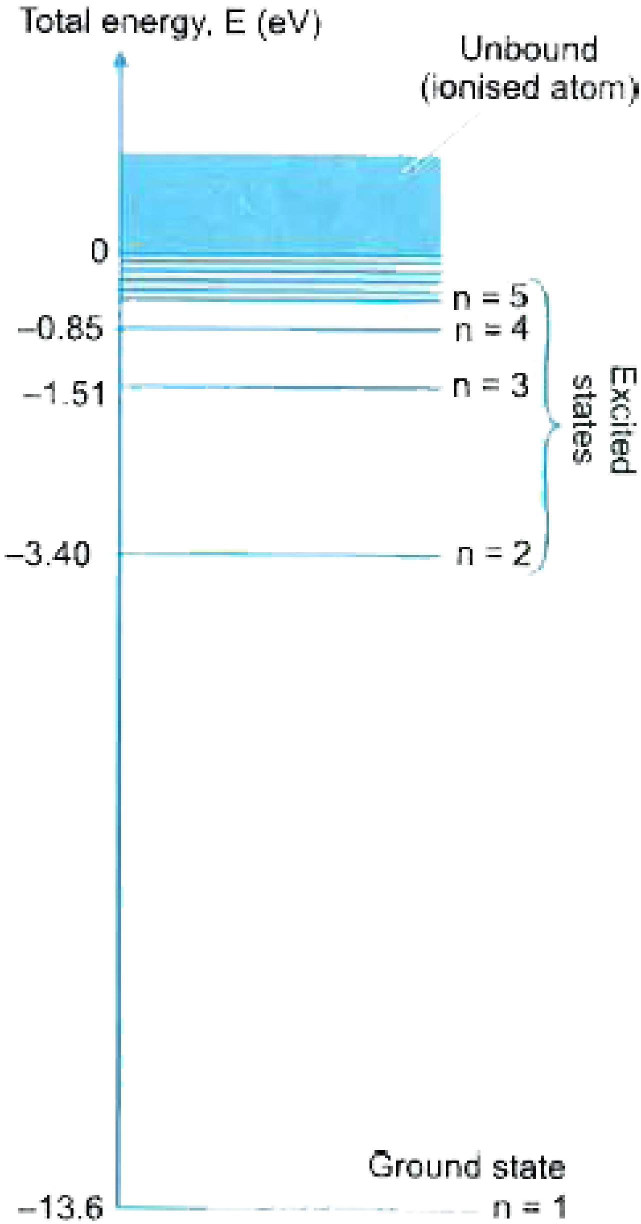

Now answer the follwoing questions:

Calculate the wavelenght of first spectral lines of series mentioned in part (g) of question.

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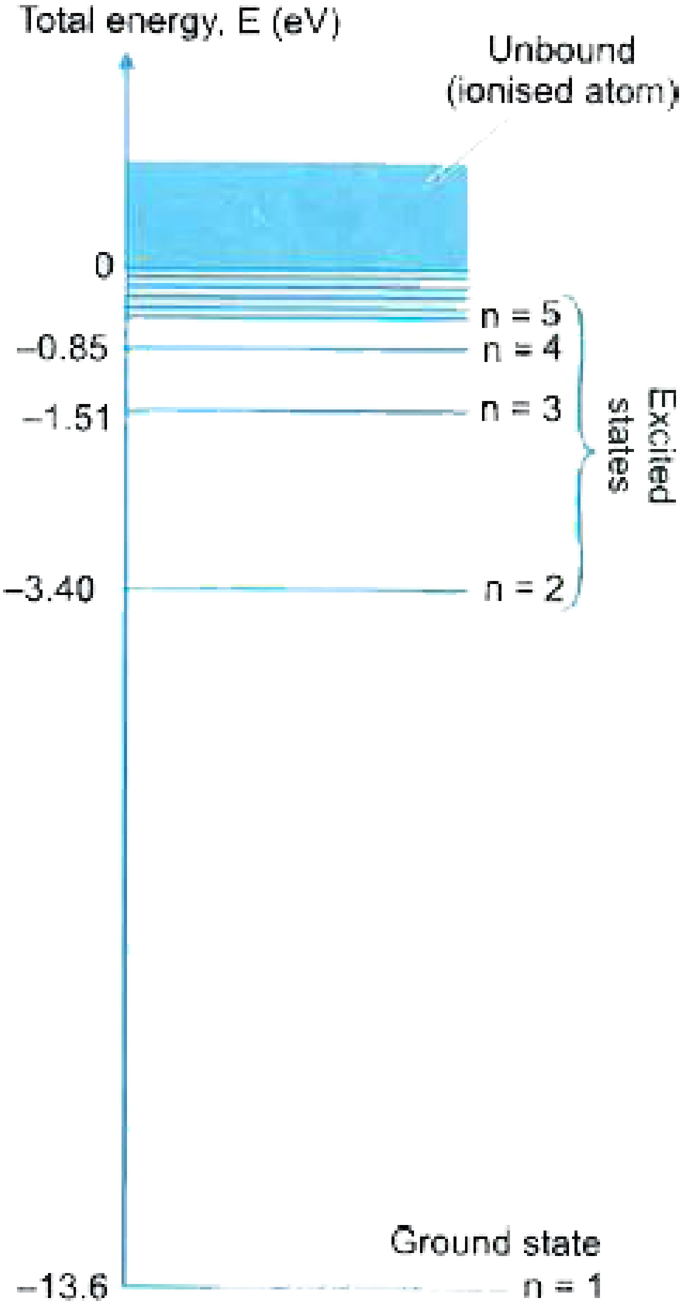

Now answer the follwoing questions:

Find a relation between wavelengths of first line and series limit of hydrogen spectrum in vissible light.

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10. Read the pasage given below as well as the adjoining energy level diagram and then answer the questions given after the passage . As per Bohr's theory og hydrogen atom the energy of an atom in a state corresponding to principal quantum number n is given as :

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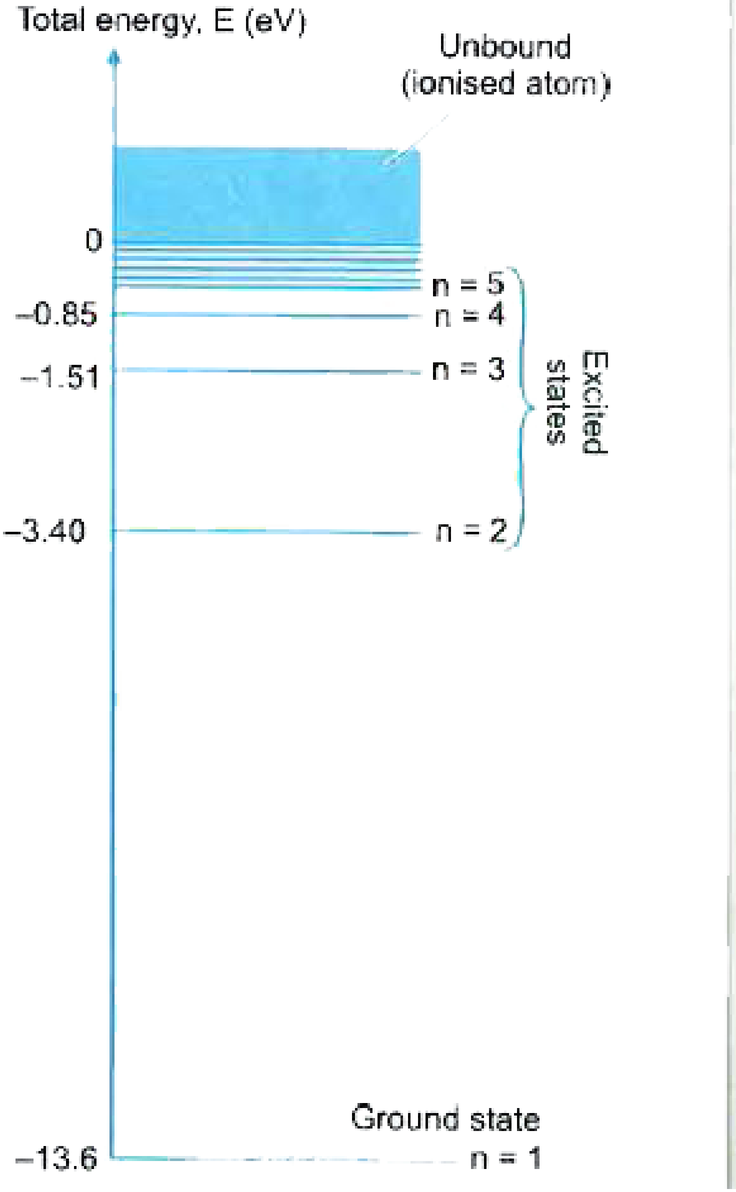

Now answer the follwoing questions:

Write the formula for spectral lines the of hydrogen atom in visible light in terms of Rydberg's constant.

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Multiple Choice Questions

1. The Rutherford α - particle experiment shows that most of the α - particle pass through almost unscattered while some are scattered though large angles. What information does it gives about the structure of the atom ?

A. Atom is hollow.

B. The whole mass of theh atom is concentrated in a small centre called nucleus.

C. Nucleus is positively charged

D. All the above.

Answer: D

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2. In the Bohr's hydrogen atom model, the radius of the stationary orbit is directly proportional to (n = principal quantum number)

A. n^{-1}

B. n

C. n^{-2}

D. n^2

Answer: D

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3. Which one of the series of hydrogen spectrum is in the visible region ?

A. Lyman series

B. Balmer series

C. Paschen series

D. Bracket series

Answer: B

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4. If the wavelength of the first line of the Balmer series of hydrogen is 6561 A, the wavelength of the second line of the series should be.

A. 13122Å

B. 3280Å

C. 4860Å

D. 2178Å

Answer: C

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5. In hydrogen atom, when electron jumps from second to first orbit, then energy emitted is

A. $-13.6eV$

B. $-27.2eV$

C. $-6.8eV$

D. None of these

Answer: D

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6. The ground state energy of hydrogen atom is - 13.6 eV. What is the potential energy of the electron in this state?

A. 0 eV

B. $-27.2eV$

C. 1 eV

D. 2 eV

Answer: B

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7. The radius of an electron orbit in a hydrogen atom is of the order of.

A. $10^{-8}m$

B. $10^{-8}m$

C. $10^{-11}m$

D. 2eV

Answer: B

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8. In a Rutherford scattering experiment when a projectile of charge Z_1 and mass M_1 approaches a target nucleus of charge Z_1 and mass M_2 , the distance of closest approach is r_0 . The energy of the projectile is .

A. directly proportional to $Mx_1 \times M_2$

B. directly proportional to $Z_1 Z_2$

C. inversely proportional to Z_1

D. directly proportiona to mass M_1

Answer: B

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9. The ground state energy of hydrogen atom is - 13.6 eV. When its electron is in the first excited state, its excitation energy is.

A. 6.8 eV

B. 10.2eV

C. 0

D. 3.4 eV

Answer: B

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10. Which of the following transitions in hydrogen atoms emit photons of highest frequency?

A. n = 1 to n = 2

B. n = 2 to n = 6

C. 11 = 6 to n = 2

D. n=2 to n=1

Answer: D

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11. In hydrogen atom which quantity is integral multiple of

A. angular momentum.

B. angular velocity

C. angular acceleration.

D. momentum

Answer: A

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12. The energy of electron in first excited state of H-atom is - 3.4 eV. Its kinetic energy is.

A. -3.4 eV

B. $+3.4 eV$

C. $-6.8 eV$

D. $+6.8 eV$

Answer: B

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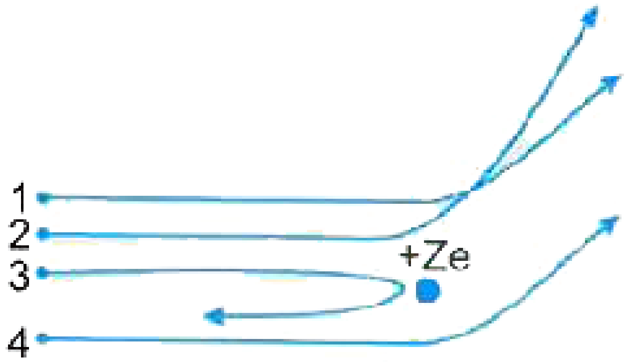
13. The diagram 12.03 shows the path of four a-particles of the same energy being scattered by the nucleus of a gold atom, of atomic number z, simultaneously. Which of these is/are not physically possible ?



A. 3 and 4

B. 2 and 3

C. 1 and 4

D. Only 4

Answer: D

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14. Bohr's atom model presumes that.

A. the nucleus is of infinite mass and is at rest.

B. mass of electron remains constant.

C. electron in a quantised orbit will not radiate energy.

D. all the above conditions.

Answer: D

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15. In the nth stable orbit of a hydrogen atom, the energy of an electron $E = -\frac{13.6}{n^2}$ eV. The energy required to take the electron from first orbit to second orbit will be

A. 10.2 eV

B. 12.1 eV

C. 13.6 eV

D. 3.4 eV

Answer: A

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16. The Lyman series of hydrogen spectrum lies in which of the following regions ?

A. Ultraviolet

B. Visible

C. Infrared

D. X-rays region

Answer: A

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17. Size of an atom is of the order of

A. 10^{-8} m

B. 10^{-10} m

C. $10^{-12}m$

D. $10^{-14}m$

Answer: B

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18. Hydrogen atoms in the ground state (E = -13.6 eV) are excited by monochromatic radiation of photon energy 12.1 eV. The maximum number of spectral lines emitted by hydrogen atoms as per Bohr's theory will be

A. 1

B. 2

C. 3

D. 4

Answer: C

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19. The ratio of the energies of the hydrogen atom in its first excited state to second excited state is

A. $\frac{1}{4}$

B. $\frac{4}{9}$

C. $\frac{9}{4}$

D. $\frac{4}{1}$

Answer: B

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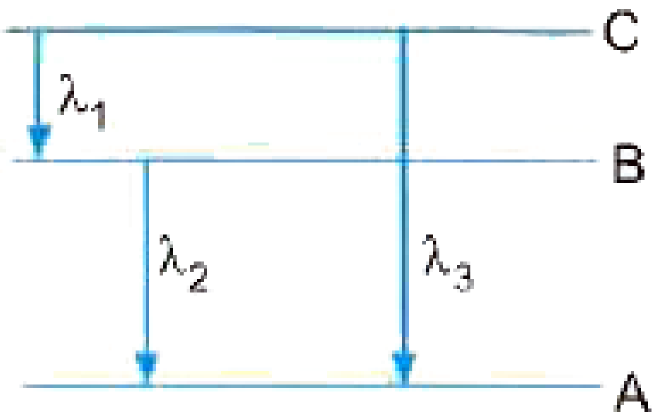
20. Energy levels A, B and C of a certain atom correspond to increasing values of energy i.e., $E_A < E_B < E_C$ .If λ_1, λ_2 and λ_3 are the wavelengths of radiations corresponding to the transitions Cto B, B to A and C to A respectively as shown in Fig. 12.04, then which of the following statement is correct?



A. $\lambda_3 = \lambda_1 + \lambda_2$

B. $\frac{1}{\lambda_3} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$

C. $\lambda_1 + \lambda_2 + \lambda_3 = 0$

D. $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

Answer: B

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21. Consider an electron in the nth orbit of a hydrogen atom in the Bohr's model. In terms of de-Broglie wavelength of that electron the circumference of the orbit is given as .

A. $0.259n\lambda$

B. $\sqrt{n}l$

C. 13.6λ

D. $n\lambda$

Answer: D

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22. Ratio of the wavelengths of line of Lyman series and first line of Balmer series is.

A. $1:3$

B. $27:5$

C. $5:27$

D. $4:9$

Answer: C

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23. In Rutherford's scattering experiment if impact parameter is zero then the angle of scattering will be.

A. 0°

B. $\frac{\pi}{2}$

C. π

D. $\frac{3\pi}{2}$

Answer: C

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24. As per Bohr atom model if the radius of the first orbit in an hydrogen atom is to, then the radius of the third orbit is.

A. $\frac{r_0}{9}$

B. $\frac{r_0}{3}$

C. $3r_0$

D. $9r_0$

Answer: D

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25. The concept of stationary (non-radiating) orbits was proposed by

A. J.J. Thomson

B. Rutherford

C. Neils Bohr

D. Somerfeld

Answer: C

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26. The first line of the Paschen series in hydrogen spectrum has a wavelength of 18800Å. The short wavelength limit of Paschen series is

A. 1215Å

B. 6560Å

C. 8225Å

D. 12850Å

Answer: C

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27. Whenever a hydrogen atom emits a photon in the Balmer series, it

A. need not emit any more photon.

B. may emit another photon in the Paschen series.

C. must emit another photon in the Lyman series.

D. may emit another photon in Balmer series.

Answer: C

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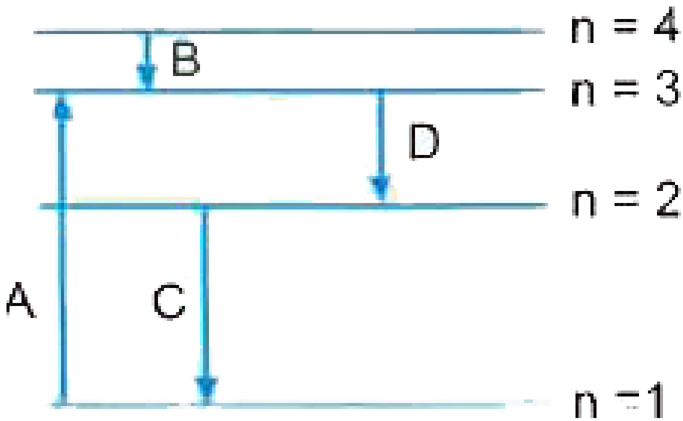
28. The diagram shows the energy level for an electron in a hydrogen atom. Which transition, shown here, represents the emissions of a photon of maximum energy?



A. A

B. B

C. C

D. D

Answer: C

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29. The energy of the highest energy photon of Balmer series of hydrogen atom is close to.

A. 13.6 eV

B. 3.4 eV

C. 10.4 eV

D. 1.5eV

Answer: B

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30. Energy of an electron in an excited state of hydrogen atom is - 3.4 eV. Its angular momentum will be

A. 1.11×10^{-34} Js

B. $1.51 \times 10^{-34} Js$

C. $2.11 \times 10^{-34} Js$

D. $3.72 \times 10^{-34} Js$

Answer: C

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Fill In The Blanks

1. The radius of the first Bohr orbit in the hydrogen atom is ro. The radius of the third Bohr in the hydrogen atom will be______ .

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2. As per Bohr's theory when electrons jump from higher energy orbits to second orbit (n=2 state), the emitted spectral lines belong to _______ series.

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3. The minimum energy required to excite a hydrogen atom from its ground state is ______.

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4. The energy of an electron in the first orbit of hydrogen atom is -13.6 eV. The energy of electron in the 4th orbit is______ eV.

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5. The total energy of an electron in the atom is always______.

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6. Difference of energy levels goes on______ as we move towards higher energy levels.

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7. As per Bohr's theory of hydrogen atom the value of Rydberg constant R is ______.

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8. As per de-Broglie explanation of Bohr's quantum condition, for an electron revolving in nth circular orbit the total circumference of the orbit $2\pi r$, is equal to_____.

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9. The angle of scattering for zero value of impact parameter 'b' is_______.

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10. When an electron jumps from 2nd stationary orbit to 1st stationary orbit of hydrogen atom, the emitted energy is_____ ev.

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11. Empirical formula for wave number of spectral lines of Balmer series for hydrogen atom is $\overline{V}$ = ________.

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12. Alpha-particle scattering experiment was performed by______ .

View Text Solution

13. In a hydrogen atom as the electron moves to higher level its potential energy_________ and ________ kinetic energy.

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True Or False

1. According to Bohr's quantum condition an electron in hydrogen and hydrogen like atoms can revolve in those stable orbits in which its momentum is an integer multiple of Planck's constant.

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2. In alpha-particle scattering experiment it was found that about one alpha particle in 8000 deflects by more than 90°.

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3. Paschen series of hydrogen spectrum lies in UV region and the Lyman series lies in IR region.

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4. If in an hydrogen atom electron is excited to n=4 state then we can have six different spectral lines in all.

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5. According to Bohr's atomic model the radii of stationary orbits are directly proportional to cube of the quantum number n.

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Assertion Reason Type Questions

1. Assertion (A) : The positively charged nucleus of an atom has a radius of almost

10^{-15} m.

Reason (R) : In a-particle scattering experiment the distance of closest approach for α - particles is of the order of 10^{-15} m.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: A

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2. Assertion (A) : Hydrogen atom consists of only one electron but its emission spectrum has many lines.

Reason (R) : Only Lyman series is found in the absorption spectrum of hydrogen atom where as in the emission spectrum all the spectral series all present.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: B

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3. Assertion (A) : Lines of Lyman series of hydrogen spectrum lie in ultraviolet region but lines of Balmer series lie in visible light region.

Reason (R) : Subsequent to the emission of a line of Balmer series we must obtain the first line of Lyman series of hydrogen atom.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: B

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4. Assertion (A) : In a hydrogen atom the radius of nth orbit is directly proportional to the quantum number n.

Reason (R) : The speed of electron in nth orbitis inversely proportional to the quantum number.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: D

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5. Assertion (A) : Rutherford visualised the nuclear model of an atom.

Reason (R) : Rutherford's atom model fails to explain the stability of the atom.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer: B

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Very Short Answer Questions

1. What is the main conclusion of a-particle scattering experiment?

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2. Define the distance of closest approach.

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3. What do you mean by the term impact parameter?

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4. What is the main feature of Rutherford's atom model?

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5. Why is the classical (Rutherford) model for an atom, of electron orbiting around the nucleus, not able to explain the atomic structure ?

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6. Give the empirical formula for observed wavelengths of Balmer series lines

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7. What is the value of Rydberg constant for hydrogen ?

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8. When is H_α line of the Balmer series in the emission spectrum of hydrogen atom obtained ?

View Text Solution

9. State Bohr's quantisation condition for defining stationary orbits.

View Text Solution

10. The radius of innermost electron orbit of a hydrogen atom is 5.3×10^{-11} m. What is the radius of orbit in the second excited state ?

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11. Write the expression for Bohr's radius in hydrogen atom.

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12. How does speed of electron vary with change in quantum number in hydrogen atom?

View Text Solution

13. What is the ratio of radii of the orbits corresponding to first excited state and ground state in a hydrogen atom?

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14. Energy of an electron in the nth orbit of hydrogen atom is given by E,- ev. How much energy is required to take an electron from the ground state to the first excited state?

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15. How are kinetic energy K and potential energy U of an electron in nthe state of hydrogen atom related to ?

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16. Find the ratio of energies of photons produced due to transition of an electron of hydrogen atom from its .

(i) second permitted energy level to the first level, and

(ii) the highest permitted energy level to the first permitted level.

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17. Define ionisation energy. What is its value for a hydrogen atom ?

View Text Solution

18. What is the maximum number of spectral lines emitted by a hydrogen atom when it is in the third excited state ?

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19. State Bohr's quantum condition for stationary orbits in terms of de-Broglie wavelength.

View Text Solution

20. When an electron falls from a higher energy to a lower energy level, the difference in the energies appears in the form of electromagnetic radiation. Why cannot it be emitted as other forms of energy?

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Short Answer Questions

1. State the results obtained from a particle scattering experiment. Also draw a graph showing number of a particles scattered at different angles.

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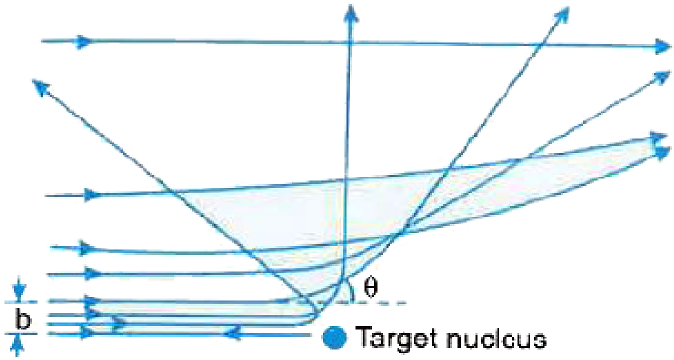
2. The trajectories, traced by different α-particles in Geiger-Marsden experiment were observed as shown in the Fig. 12.07.

(a)What names are given to the symbols 'b' and 'q' shown here?

(b) What can we say about the values of 'V' for

(i) $\theta \cong 0^\circ$ (ii) $\theta = \pi$ radian ?



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3. An α -particle moving with initial kinetic energy 'K' towards a nucleus of atomic number Z approaches a distance 'r_0' at which it reverses its direction. Obtain the expression for the distance of closest approach 'r_0' in terms of kinetic energy of a particle.

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4. Define the distance of closest approach. An a-particle of kinetic energy 'K' is bombarded on a thin gold foil. The distance of the closest approach is 'Y. What will be the distance of closest approach for an a-particle of double the kinetic energy?

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5. In the study of Geiger-Marsden experiment on scattering of alpha particles by a thin foil of gold, draw the trajectory of alpha-particles in the coulomb field of target nucleus, Explain briefly how one gets the information on the size of the nucleus from this study.

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6. State the basic assumptions of the Rutherford model of the atom.

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7. Write two important limitations of Rutherford's nuclear model of the atom.

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8. Using Rutherford model of the atom, derive the expression for the total energy of the electron in hydrogen atom. What is the significance of total negative energy possessed by the electron?

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9. State and explain Bohr's postulates for hydrogen atom.

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10. Using Bohr's postulates of the atomic model, derive the expression for radius of th electron orbit. Thus, obtain the expression of Bohr's radius.

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11. Show that the radius of the orbit in hydrogen atom varies as n^2, where it is the principal quantum number of the atom.

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12. Using relevant Bohr's postulates establish an expression for the speed of the electron in nth orbit of hydrogen atom.

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13. Calculate the value of Bohr's radius. Given that mass of electron $= 9.11 \times 10^{-31}$ kg, Planck's constant $h = 6.63 \times 10^{-34}$ J s and electronic charge is 1.60×10^{-19} C.

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14. Calculate the orbital period of the electron in the first excited state of hydrogen atom.

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15. Sketch the energy level diagram for hydrogen atom and mark the transitions for different spectral series of hydrogen.

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16. The energy of the electron in hydrogen atom is known to be expressible in the form $E_n = -\frac{13.6}{n^2} eV$ (n = 1,2,3,.....). Use this expression to show that the .

(i) electron in the hydrogen atom cannot have an energy of -2 eV.

(ii) spacing between the lines (consecutive energy levels) within the given set of the observed hydrogen spectrum decreases as increases.

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17. In the ground state of hydrogen atom , its Bohr radius is given as 5.3×10^{-11} m. The atom is excited such athat th radius becomes 21.2×10^{-11} m. Find (i) the value of principal quantum number , and (ii) the total energy of the atom in this excited state.

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18. Calculate the wavelenght of H_{α} line in Balmer series of hydrogen . Given Rydberg constant $R = 1.097 \times 10^{-7} m^{-1}$

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19. Define ionisation energy.

How would the ionisation energy when electron in hydrogen atom is replaced by particle of mass 200 times that of the electron but having the same charge ?

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20. A hydrogen atom in the ground state is excited by an electron beam of 12.5 eV energy . Find out the maximum number of lines emitted by the atom from its excited state.

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21. Calculate the shortest wavelength of the spectral lines emitted in Balmer series.

[Given Rydberg constant $R = 10^7 m^{-1}$].

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22. State Bohr's quantisaiton condition of angular momentum . Calculate the shortest wavelenght of the Bracket series and state to which part of the electromagnetic spectrum does it belong .

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23. In Bohr's theory of hydrogen atom , calculate the energy of the photon emitted during a transition of the electron from the first excited state to its ground state . Write in which region of the electromagnetic spectrum this transition lies . Given Rydbergy constant $R = 1.03 \times 10^7 m^{-1}$.

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24. The short wavelength limit for the Lyman series of the hydrogen spectrum is 913.4Å. Calculate the short wavelength limit for Balmer series of the hydrogen spectrum.

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25. Calculate the de-Broglie wavelength of the electron orbiting in the n= 2 state of hydrogen atom.

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26. Find out the wavelength of the electron orbiting in the ground state of hydrogen atom

.

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27. (a) In hydrogen atom an electron undergoes transitions from 2nd excited state to the 1st excited state and then to the ground state. Identify the spectral series to which transition belong .

(b) Find out the ratio of the wavelenght of the emitted radiations in the two cases.

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28. Calculate the ratio of the frequencies of the radiation emitted due to transition of the electron in a hydrogen atom from its (i) second permitted energy level to the first level, and (ii) highest permitted energy level to the second permitted level.

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29. A photon emitted during the de-excitation of electron from a state to the first excited state in a hydrogen atom, irradiates a metallic cathode of work function 2eV, in a photo cell, with a stopping potential of 0.55 V. Obtain the value of the quantum number of the state.

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30. Using de-Broglie's hypothesis, explain Bohr's second postulate of quantisation of energy levels in a hydrogen atom.

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Long Answer Questions I

1. Draw a schematic arrangement of the Geiger-Marsden experiment. How did the scattering of a-particles by a thin foil of gold provide an important way to determine an upper limit on the size of the nucleus ? Explain briefly.

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2. Draw a schematic arrangement of Geiger-Marsden experiment showing the scattering of C-particles by a thin foil of gold. Why is it that most of the O-particles go right through the foil and only a small fraction gets scattered at large angles ?

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3. In a Geiger Marsden experiment, calculate the distance of closest approach to the nucleus of Z 80, when and particle of 8 MeV energy impinges on it before it comes momentarily to rest and reverses its direction. How will the distance of closest approach be affected when the kinetic energy of the O-particle is doubled ?

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4. Using Bohr's postulates , obtain the expreesion for the total energy in the stationary states of hydrogen atom . Hence , draw the energy level diagram showing how the line spectra corresponding to Balmer series occur due to transition between energy levels.

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5. (a)Using Bohr's postulates, derive the expression for the total energy of the electron revolving in nth orbit of hydrogen atom.

(b) Find the wavelength of the H_{α} line. Given the value of Rydberg constant is $1.1 \times 10^7 m^{-1}$.

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6. Explain the origin of spectral lines of hydrogen using Bohr's theory.

View Text Solution

7. The ground state energy of hydrogen atom is -13.6 eV.

(i) What is the kinetic energy of an electron in the second excited state ?

(ii) If the electron jumps to the ground state from the second excited state, calculate the wavelength of the spectral line emitted.

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8. (i) State Bohr's quantisation condition for defining stationary orbits. How does de-Broglie hypothesis explain the stationary orbits ?

(ii) Find the relation between the three wavelengths, λ_1, λ_2 and λ_3 from the energy level diagram shown here.

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9. The ground state energy of hydrogen atom is - 13.6 eV. If an electron makes a transition from an energy level - 0.85 eV to -3.4 eV, calculate the wavelength of the spectral line emitted. To which series of hydrogen spectrum does this wavelength belong?

View Text Solution

10. (a) State Bohr's postulate to define stable orbits in hydrogen atom. How does de-Broglie's hypothesis explain the stability of these orbits ?

(b) A hydrogen atom initially in the ground state absorbs a photon which excites it to the p=4 level. Estimale the frequency of the pholon.

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11. The value of ground state energy of hydrogen atom is - 13.6 eV.

(a) Find the energy required to move an electron from the ground state to the first excited state of the atom.

(b) Determine (i) the kinetic energy, and (ii) the orbital radius in the first excited state of the atom.

(Given the value of Bohr radius $= 0.53 \text{Å}$)

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12. The energy of the electron in the ground state of hydrogen is - 13.6 eV. Calculate the energy of the photon that would be emitted if the electron were to make a transition corresponding to the emission of the first line of the (i) Lyman series, (ii) Balmer series of the hydrogen spectrum.

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13. The electron in a given Bohr orbit $E_n = -1.54 eV$. Calculate (i) its kinetic energy (ii) potential energy and (iii) wavelenght of light emitted , when the electron makes a transition to the ground state . Ground state energy is $-13.6eV$

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14. The energy levels of a hypothetical atom are shown in Fig.12.13. Which of the shown transitions will result in the emission of a photon of wavelength 275 nm ?

Which of these transitions correspond to emission of radiation of (i) maximum and (ii) minimum wavelength ?

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15. The energy level diagram of an element is given below. Identify, by doing necessary calculations,-085 eV which transition corresponds to the emission of a spectral line of wavelength 102.7 mm.

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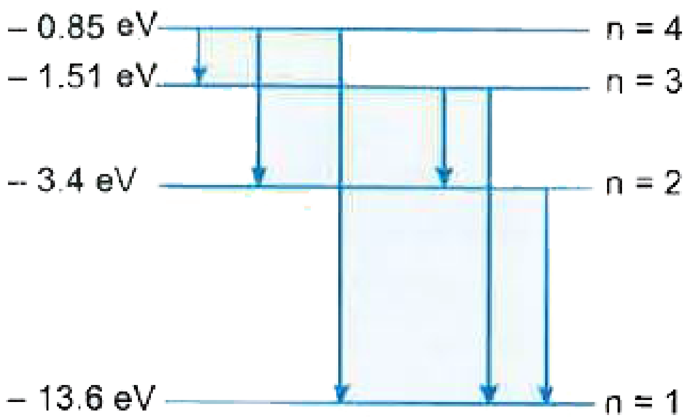
16. The fig.12.15 showes energy level diagram of hydrogen atom .

(a) Find the transition which results in the emission of a photon of wavelenght 496 nm .

(b) Which transition corresponds to the emission of radiation of maximum wavelenght ? Justify your answer .



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17. State the limitation of Bohr's theory.

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18. (a) Using Bohr's second postulate of quantisation of orbital angular momentum, show that the circumference of the electron in the nth orbital state in hydrogen atom is a times the de Broglie wavelength associated with it.

(b) The electron in hydrogen atom is initially in the third excited state. What is the maximum number of spectral lines which can be emitted when it finally move to the ground state ?

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Long Answer Questions Ii

1. Using Bohr's postualtes , derive the expression for the frequency of radiation emitted when electron in hydrogen atom undergoes transition from higher energy state (quantum number n_i) to the lower state (n_f) .

When electron in hydrogen atom jumps from energy state $n_i = 4$ to $n_f = 3, 2, 1$ identify the spectral series to which the emission lines belong .

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2. Write two important limitations of Rutherford model which could not explain the observed feature of atomic spectra . How were these explain in Bohr's model of hydrogen atom ?

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3. Use the Rydberg formula to calculate the wavelenght of the H_{α} line. Given that Rydberg's constant $R = 1.1 \times 10^{7} Jm^{-1}$

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4. Using Bohr's postulates obtain the expression for the radius of the nthe orbit in hydrogen atom.

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Self Assessment Test Section A Multiple Choice Questions

1. The minimum energy required to excite a hydrogen atom from its ground state is .

A. 13.6 eV

B. 10.2 eV

C. 3.4 eV

D. 1.51eV

Answer: B

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2. Which of the following spectral series in hydrogen atom gives spectral line of wavelenght 486 nm ?

A. Lyman

B. Balmer

C. Paschen

D. Brackett

Answer: B

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3. The electron in a hydrogen atom makes a transition from an excited state to the ground state . Which of the following stateements is ture ?

A. Its kinetic energy increase and its potential and total energies decreases.
B. Its kinetic energy decreases, potential energy and total energy remains the same .
C. Its kinetic and total energies decrease but its potential energy increases.

D. Its kinetic potenital as well as total energies decrease.

Answer: A

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4. The ground state energy of hydrogen atom is $-13.6eV$. What is the potential energy of the electron in this state ?

A. 0eV

B. 13.6 eV

C. 27.2 eV

D. $-27.2eV$

Answer: D

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5. Speed of a revolving electron around the nucleus varies with principal quantum number n as :

A. $v \propto m$

B. $v \propto n^2$

C. $v \propto \frac{1}{n}$

D. $v \propto \frac{1}{n^2}$

Answer: C

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Self Assessment Test Section A Fill In The Blanks

1. The relationship between kinetic energy (K) of alpha - particle bombarded on the gold film ant the distance of closed approch (r_0) is _________.

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2. Centripetal force needed for an electron to revolve in its stable orbit around the nucleus is provided by_______.

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Self Assessment Test Section C

1. A monochromatic radiation of wavelength 975Å excites the hydrogen atom from its ground state to a higher state . How many different spectral lines are possivle in the resulting spectrum ? Which transition corresponds to the longest wavelenght amongst them ?

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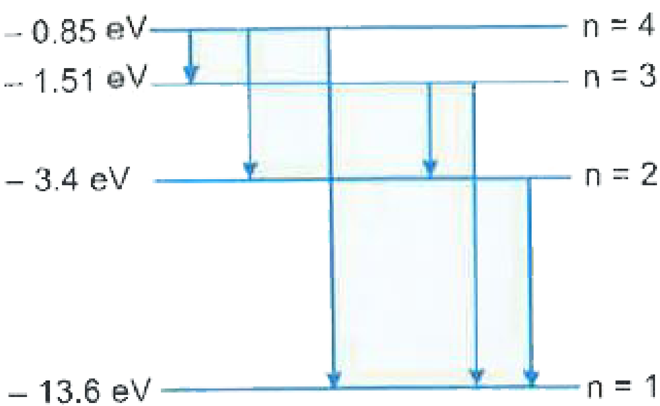
2. The Fig 12.17 shows energy level diagram of hydrogen atom.

(a) Find the transition which results in the emission of a photon of wavelenght 496 nm .

(b) Which transition corresponds to the emission of radiation of maximum wavelenght ? Justify your answer .



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