PHYSICS

BOOKS - NEW JYOTHI PHYSICS (TAMIL ENGLISH)

ATOMS

Solved Problems

1. It is found experimentally that 13.6 eV energy is requied to separate a hydrogen atom into a proton and an electron . Compute the orbital radius and the velocity of the electron in a hydrogen atom .

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2. According to the classical electromagnetic theory , calculate the initial frequency of the light emitted by the electron revoling around a proton in hydrogen atom .

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3. A 10 kg satellite circles earth once every 2 hrs in an orbit having a radius of 8000 Km . Assuming that bohr 's angular momentum postulate applies to satellites

just as it does to an electron in the hydrogen atom , find the quantum number of the orbit of the satellite

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4. Using the Rydberg formula , calculate the wavelength of the first four spectral lines in the Lyman series of the hydrogen spectrum .

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5. The wavelength H_a line is 6563 Å . Calculate the wavelength of First member of Lyman series

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6. Given $R_H = 1.097 \times 10^7 m^{-1}$ find the longest and shortest wavelength limit of Pashen series for longest wavelength $n_i = 3$and $n_f = 4$ for shortest wavelength $n_i = 3$ and $n_f = \infty$ (infinity)

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7. Calculate the energy required to excite hydrogen atom from ground state to the second excited state

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8. Compute the first three energy levels of doubly ionized lithium . What is the ionisation potential

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Solutions To Exercises From Ncert Text

1. The size of the atom in Thomson's model is ..... the atomic size in Ruther ford's model. (much greater than/not different from/much less than.)

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2. 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. A classical atom based on ..... is doomed to collapse. (Thomson's model/ Rutherford's model.)

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4. 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. 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 makes a transition from the upper level to the

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9. Answer the following questions, which help you to understand the difference between Thomson's model and Rutherford's model better.

a. 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?

b. Is the probability of backward scattering (i.e., scattering of a-particles at angles greater than 90°) predicted by Thomson's model much less, about the same, or much greater than that predicted by Rutherford's model?

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

d. In which model is it completely wrong to ignore multiple scattering for the calculation of average angle of scattering of α particles by a thin foil?

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10. The gravitational attraction between electron and proton in a hydrogen atom is weaker than the coulomb attraction by a factor of about 10^{40}. An alternative way of looking at this fact is to estimate the radius of the

first Bohr orbit of a hydrogen atom if the electron and proton were bound by gravitational attraction. You will find the answer interesting,

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

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12. The wavelength of the second line of the balmer series in the hydrogen spectrum is 486 1 Å . Calculate the wavelength of the first line

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Evaluation Questions And Answers

1. Pick the odd one out from the following

a. Lyman series b. Paschen series c . Brackett series d. Pf und series e. Hum[hrey series

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2. fill in the black

A	B	C
i. Balmer series	$\frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{n^2}\right]$	.....
ii.	+ve	$1836\, m_e$
iii. Series limit	.....	$\frac{1}{\lambda} = \frac{R}{4}$
iv. Scattering angle (θ)	Impact parameter (b)	$\cot\left(\frac{\theta}{2}\right)$ = ...

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3. a. What is impact parameter ?

b. How is it related to scattering angle ?

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4. what is the bohr quantisation condition for the angular momentum of an electron in the second orbit ?

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5. a. For the calculation of average angle of scattering of a particles by a thin foil, why multiple scattering cannot be ignored in Thomson's model?

b. Name the model in which it can be ignored.

c. The majority of a particles pass through gases with no deflections. To what conclusion about the atomic structure does this observation lead?

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6. For scattering by an 'inverse square field' (such as that produced by a charged nucleus in Rutherford's model) the relation between impact parameter b and the scattering angle θ is given by

$$b\frac{Ze^2\cot\left(\frac{\theta}{2}\right)}{4\pi\varepsilon_0\left(\frac{mv^2}{2}\right)}$$

a. What is the scattering angle for b =0?

b. For a given impact parameter h, does the angle of deflection increase or decrease with increasing energy?

c .What is the impact parameter at which the scattering angle is 90° for Z = 79 and initial energy of 10 MeV?

d. Why is it that the mass of the nucleus does not enter the formula above but the charge does?

e. For a given energy of the projectile, does the

scattering angle increase or decrease with decrease in impact parameter?

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7. What is the distance of closest approach when a 5 MeV proton approaches a gold nucleus ?

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Continuous Evaluation

1. Discuss the various models of atom .

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2. Explain hydrogen spectrum .

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Previous Year Question

1. When a vapour is excited at low pressure by passing an electric current through it ,a spectrum is obtained .

a . Draw a spectral series of emissions lines in hydrogen

b. Name the different series of hydrogen atom .

c . In which region Lyman series is located .

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Competitive Exam Corner

1. The set which represents the isotope , isobar, isotone respectively is

A. a)

$\left({}_1H^2, {}_1H^3\right), \left({}_{79}Au^{197}, {}_{80}Hg^{198}\right)$ and $\left({}_2He^3, {}_1H^2\right)$

B. b)

$\left({}_2He^3, {}_1H^1\right), \left({}_{79}AU^{197}, {}_{80}Hg^{198}\right)$ and $\left({}_1H^1, {}_1H^3\right)$

C. c)

$\left({}_2He^3, {}_1H^3\right), \left({}_1H^2, {}_1H^3\right),$ and $\left({}_{79}Au^{197}, {}_{80}Hg^{198}\right)$

D. d) $\left({}_1H^2, {}_1H^3\right), \left({}_2He^3, {}_1H^3\right),$ and $\left({}_{79}Au^{197}, {}_{80}Hg^{198}\right)$

Answer: D

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2. The distance of closet approch of an α - particle fired towards a nucleus with momentum p , is r. If the momentum of the α - particle is 2p , the corresponding distance of closest apporach is

A. A) $\frac{r}{2}$

B. B) $2r$

C. C) $4r$

D. D) $\frac{r}{4}$

Answer: D

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3. The ratio between the radii of nuclei with mass numbers 27 and 125 is

A. A) $5:3$

B. B) $3:5$

C. C) $27:125$

D. D) $125:27$

Answer: B

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4. The ratio of volumes of nuclei (assumed to be in spherical shape) with respective mass numbers 8 and 64 is

A. a) 0.5

B. b) 2

C. c) 0.125

D. d) 0.25

Answer: C

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5. The significant result deduced from the Rutherford's scattering experiment is that

A. a) whole of the positive charge is concentrated at the centre of atom

B. b) there are neutrons inside the nucleus

C. c) α - particle are helium nuclei

D. d) electrons are embedded in the atom

Answer: A

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