PHYSICS

BOOKS - NN GHOSH PHYSICS (HINGLISH)

ATOMIC STRUCTURE

Example

1. Find the atomic structure of $._{20}^{40}Ca.$

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2. Show that the kinetic energy of an electron in the first Bohr orbit (ground state) is numerically half of its potential energy.

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3. Electrons of energy 12.1 eV are fired at hydrogen atoms in a discharge tube. If the ionization potential of hydrogen is 13.6 eV, then

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4. The binding energy of an electron in the ground state of He is equal to 24.6 eV: Find the energy required to remove both electrons.

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5. Find the binding energy of an electron in the ground state of hydrogen-like ions in whose spectrum the third line of the Balmer series is $120nm$.

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6. Calculate the separation between particles, the binding energy and the wave-length of the first line of the Kyman series of a mesonic hydrogen (i.e an atom consisting of a proton +a revolving meson in place of an electron). Mass of a meson $= 207$ times mass of electron and charge of meson = charge of electron.

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Exercise

1. Find the structure of the following atoms:

(i) $._{8}^{16}O$ (ii) $._{17}^{35}Cl$ (iii) $._{13}^{27}Al.$

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2. Calculate the frequency of revolution of an electron in the first orbit of an aluminum atom. Given that mass of electron $= 9x10^{-31}kg, e = 1.6 \times 10^{-19}C,$ radius of the orbit $= 0.2 \times 10^{-11}m.$

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3. Show that the energy of hydrogen atom in the ground state is

$$E = -\frac{1}{8\pi\varepsilon_0}\frac{e^2}{r}$$

[Hint: Energy in the gound state = kinetic energy of electron in the first orbit + electrostatic potential energy of the electron.]

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4. Calculate the energy of hydrogen atom in the ground state given that the after Bohr orbit og hydrogen is $5 \times 10^{-11} m$ and electronic charge is $1.6 \times 10^{-19} C$.

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5. Calculate the speed of the electron in the first Bohr orbit given that $h = 6.6 \times 10^{-34} Js, m = 9.11 \times 10^{-31} kg$ and $e = 1.603 \times 10^{-19} C$.

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6. Find the atomic structure of ${}_{12}^{24}Mg$. What is its valency?

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7. Calculate the radius of the first and second orbit of sodium atom $(Z = 11)$.

$\left(h = 6.6 \times 10^{-34} Js, e = 1.6 \times 10^{-19} C \text{ and } m = 9.1 \times 10^{-31} kg.\right)$

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8. A n α-particle of velocity $1.6 \times 10^{7} ms^{-1}$ approaches a gold nucleii $(Z = 79)$. Calculate the distance of closest approach. Mas of an α-particle $= 6.6 \times 10^{-27} kg$.

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9. A single electron orbits around a stationary nucleus of charge $+Ze$, where Z is a constant and e is the electronic charge. It requires

$47.2eV$ to excited the electron from the second Bohr orbit to the third Bohr orbit. Find (i) the value of Z, (ii) the energy required to excite the electron from the third to the fourth Bohr orbit and (iii) the wavelength of the electromagnetic radiation radiation to remove the electron from the first Bohr orbit to infinity.

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10. Calculate for a hydrogen atom the ionization potential, the first excitation potential and the wavelength of the resonance line $(n' = 2 \rightarrow n = 1)$.

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11. An electron in an excited hydrogen atom acquired an energy of 12.1 eV. To what energy level did it jump? How many spectral lines may be emitted in the course of the transition to

lower energy level? Calculate the corresponding wavelengths.

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12. Calculate the radius of the first Bohr orbit of a He^{+} ion and the binding energy of its electron in the ground state.

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13. A hydrogen atom in a state of binding energy 0.85 eV makes a transition to a state of excitation energy of 10.2 eV . Find the energy and wavelength of photon emitted.

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14. Calculate the wavelengths of the member of Lyman, Balmer and Paschen series.

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15. A double ionised lithium atom is hydrogen like with atomic number 3

(i)Find the wavelength of the radiation to excite the electron in Li^{++} from the first to the third bohr orbit (lonisation energy of the hydrogen atom equals $13.6eV$

(ii) How many spectral lines are observed in the emission spectrum of the above excited system ?

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16. Calculate the Rydberg constant R if He^+ ions are known to have the wavelength difference between the first (of the longest wavelength) lines of the Balmer and Lyman series equal to $\Delta\lambda = 133.7nm$.

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17. The minimum kinetic energy of a ground state hydrogen atom required to have head-on collision with another ground state

hydrogen atom but at rest to produce a photon is given by

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18. A stationary hydrogen atom emits a photon corresponding to the first line of the Lyman series. What is the velocity of recoil of the atom? $\left(m_H = 1.672 \times 10^{-27} kg\right)$

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19. What hydrohen-like ion has the wave-length difference between the first lines of the Balmer and Lyman series equal to 593Å.

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20. Calculate the separation of the particles and the binding energy of a positronium (an atom consisting of an electron and a position revolving around their centre of mass).

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21. A gas of identical hydrogen-like atoms has some atoms in the lowest in lower (ground) energy level A and some atoms in a partical upper (excited) energy level B and there are no atoms in any other energy level.The atoms of the gas make transition to higher energy level by absorbing monochromatic light of photon energy $2.7eV$.

Subsequenty , the atom emit radiation of only six different photon energies. Some of the emitted photons have energy $2.7eV$ some

have energy more , and some have less than $2.7eV$.

a Find the principal quantum number of the intially excited level B

b Find the ionization energy for the gas atoms.

c Find the maximum and the minimum energies of the emitted photons.

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22. A hydrogen like atom (atomic number z) is in a higher excited state of quantum number n. This excited atom can make a transition to the first excited state by successively emitting two photons of energies $10.2eV$ and $17.0eV$ respectively. Alternatively the atom from the same excited state can make a transition to the second excited state by successively emitting 2 photons of energy $4.25eV$ and $5.95eV$ respectively. Determine the value of $(n+z)$

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23. Find the binding energy of an electron in the ground state of a hydrogen like atom in whose spectrum the third Balmer line is equal to 108.5 mm.

24. An electron , in a hydrogen-like atom, is in excited state. It has a total energy of -3.4 eV. Calculate

(a) the kinetic energy and

(b) the de Broglie wavelength of the electron.

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