PHYSICS

NCERT - FULL MARKS PHYSICS(TAMIL)

ATOMIC AND NUCLEAR PHYSICS

Example

1. The radius of the 5^{th} orbit of hydrogen atom is 13.25Å. Calculate the wavelength of the electron in the 5^{th} orbit.

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2. Find the

angular momentum (ii) velocity of the electron in the 5^{th} orbit

of hydrogen atom

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3. Find the

velocity of the electron in the 5^{th} orbit of hydrogen atom

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4. Show that the ratio of velocity of an electron in the first Bohr

orbit to the speed of light c is a dimensionless number.

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5. Compute the velocity of electrons in ground state, first excited state and second excited state in Bohr atom model.

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6. The Bohr atom model is derived with the assumption that the nucleus of the atom is stationary and only electrons revolve around the nucleus. Suppose the nucleus is also in motion, then calculate the energy of this new system.

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7. Suppose the energy of a hydrogen–like atom is given as $E_n = -\frac{54.4}{n^2} eV$ where $n \in \mathbb{N}$. Calculate the following:

Sketch the energy levels for this atom and compute its atomic number.

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8. Suppose the energy of a hydrogen–like atom is given as $E_n = -\frac{54.4}{n^2} eV$ where $n \in \mathbb{N}$. Calculate the following:

If the atom is in ground state, compute its first excitation potential and also its ionization potential.

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9. Suppose the energy of a hydrogen–like atom is given as $E_n = -\frac{54.4}{n^2} eV$ where $n \in \mathbb{N}$. Calculate the following:

When a photon with energy 42 eV and another photon with energy 56 eV are made to collide with this atom, does this atom absorb these photons?

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10. Suppose the energy of a hydrogen–like atom is given as $E_n = -\frac{54.4}{n^2} eV$ where $n \in \mathbb{N}$. Calculate the following:

Determine the radius of its first Bohr orbit.

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11. Suppose the energy of a hydrogen–like atom is given as $E_n = -\frac{54.4}{n^2} eV$ where $n \in \mathbb{N}$. Calculate the following:

Calculate the kinetic and potential energies in the ground state.

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12. Calculate the average atomic mass of chlorine if no distinction is made between its different isotopes?

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13. Calculate the radius of ${}^{197}_{79}Au$ nucleus.

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14. Calculate the density of the nucleus with mass number A.

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15. Compute the binding energy of ${}^{4}_{2}He$ nucleus using the following data: Atomic mass of Helium atom, $M_A = 4.00260u$ and that of hydrogen atom, $m_H = 1.00785u$.

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16. Compute the binding energy per nucleon of ${}_{2}^{4}H$ nucleus.

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17. Calculate the disintegration energy when stationary ${}_{92}^{228}U$ nucleus decays to thorium ${}_{90}^{228}Th$ with the emission of α particle. The atomic masses are of ${}_{92}^{232}U = 232.037156u$, ${}_{90}^{228}Th = 228.028741u$ and ${}_{2}^{4}He = 4.002603u$

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18. Calculate kinetic energies of ${}_{90}^{228}Th$ and α-particle and their ratio.

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19. Calculate the number of nuclei of carbon-14 undecayed after 22,920 years if the initial number of carbon-14 atoms is 10,000. The half-life of carbon-14 is 5730 years.

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20. A radioactive sample has $2.6\mu g$ of pure $^{13}_{7}N$ which has a half-life of 10 minutes.

How many nuclei are present initially?

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21. A radioactive sample has $2.6\mu g$ of pure $^{13}_{7}N$ which has a half-life of 10 minutes.

What is the activity initially?

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22. A radioactive sample has $2.6\mu g$ of pure $^{13}_{7}N$ which has a half-life of 10 minutes.

What is the activity after 2 hours?

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23. A radioactive sample has $2.6\mu g$ of pure $^{13}_{7}N$ which has a half-life of 10 minutes.

Calculate mean life of this sample

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24. Keezhadi a small hamlet, has become one of the very important archeological places of Tamilandu. It is located in

Sivagangai district. A lot of artefacts (gold coins, pottery, beads, iron tools, jewellery and charcoal, etc.) have been unearthed in Keezhadi which have given substantial evidence that an ancient urban civilization had thrived on the banks of river Vaigai. To determine the age of those materials, the charcoal of 200 g sent for carbon dating is given in the following figure (b). The activity of ${}^{14}_{6}C$ is found to be 38 decays/s. Calculate the age of charcoal.

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25. Calculate the amount of energy released when 1 kg of ${}^{235}_{92}U$ undergoes fission reaction.

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Evaluation Multiple Choice Questions

1. Suppose an alpha particle accelerated by a potential of V volt is allowed to collide with a nucleus whose atomic number is Z, then the distance of closest approach of alpha particle to the nucleus is

A. $14.4\frac{Z}{V}\text{Å}$

B. $14.4\frac{V}{Z}\text{Å}$

C. $1.44\frac{Z}{V}\text{Å}$

D. $1.44\frac{V}{Z}\text{Å}$

Answer: C

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2. In a hydrogen atom, the electron revolving in the fourth orbit, has angular momentum equal to

A. h

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

C. $\frac{4h}{\pi}$

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

Answer: D

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3. Atomic number of H-like atom with ionization potential 122.4 V for n=1 is

A. 1

B. 2

C. 3

D. 4

Answer: C

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4. The ratio between the first three orbits of hydrogen atom is

A. $1:2:3$

B. $2:4:6$

C. $1:4:9$

D. $1:3:5$

Answer: C

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5. The charge of cathode rays is

A. positive

B. negative

C. neutral

D. not defined

Answer: B

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6. In J.J Th omson e/m experiment, a beam of electron is replaced by that of muons (particle with same charge as that of electron

but mass 208 times that of electrons). No deflection condition is achieved only if

A. B is increased by 208 times

B. B is decreased by 208 times

C. B is increased by 14.4 times

D. B is decreased by 14.4 times

Answer: C

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7. Th e ratio of the wavelengths for the transition from n =2 to n =1 in Li^{++}, He^{+} and H is

A. $1:2:3$

B. $1:4:9$

C. $3:2:1$

D. $4:9:36$

Answer: D

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8. The electric potential between a proton and an electron is given by $V = V_0 \ln\left(\frac{r}{r_0}\right)$, where r_0 is a constant. Assume that Bohr atom model is applicable to potential, then variation of radius of n^{th} orbit r_n with the principal quantum number n is

A. $r_n \propto \frac{1}{n}$

B. $r_n \propto n$

C. $r_n \propto \frac{1}{n^2}$

D. $r_n \propto n^2$

Answer: B

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9. If the nuclear radius of ^{27}Al is 3.6 fermi, the approximate nuclear radius of ^{64}Cu is

A. 2.4

B. 1.2

C. 4.8

D. 3.6

Answer: C

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10. The nucleus is approximately spherical in shape. Then the surface area of nucleus having mass number A varies as

A. $A^{2/3}$

B. $A^{4/3}$

C. $A^{1/3}$

D. $A^{5/3}$

Answer: A

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11. The mass of a ${}^{7}_{3}Li$ nucleus is 0.042u less than the sum of the masses of all its nucleons. The binding energy per nucleon of ${}^{7}_{3}Li$ nucleus is nearly

A. 46MeV

B. 5.6MeV

C. 3.9MeV

D. 23 MeV

Answer: B

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12. M_P denotes the mass of the proton and M_n denotes mass of a neutron. A given nucleus of binding energy B, contains Z protons and N neutrons. The mass M(N,Z) of the nucleus is given by(where c is the speed of light)

A. $M(N, Z) = NM_n + ZM_P - Bc^2$

B. $M(N, Z) = NM_n + ZM_P + Bc^2$

C. $M(N, Z) = NM_n + ZM_P - B/c^2$

D. $M(N, Z) = NM_n + ZM_P + B/c^2$

Answer: C

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13. A radioactive nucleus (initial mass number A and atomic number Z) emits 2α and 2 positrons. The ratio of number of neutrons to that of proton in the final nucleus will be

A. $\frac{A - Z - 4}{Z - 2}$

B. $\frac{A - Z - 2}{Z - 6}$

C. $\frac{A - Z - 4}{Z - 6}$

D. $\frac{A - Z - 12}{Z - 4}$

Answer: B

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14. The half-life period of a radioactive element A is same as the mean life time of another radioactive element B. Initially both have the same number of atoms. Then

A. A and B have the same decay rate initially

B. A and B decay at the same rate always

C. B will decay at faster rate than A

D. A will decay at faster rate than B

Answer: C

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15. A system consists of N_0 nucleus at t=0. The number of nuclei remaining after half of a half-life (that is, at time $t = \frac{1}{2}T_{\frac{1}{2}}$)

A. $\frac{N_0}{2}$

B. $\frac{N_0}{\sqrt{2}}$

C. $\frac{N_0}{4}$

D. $\frac{N_0}{8}$

Answer: B

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Evaluation Exercises

1. In the Bohr atom model, the frequency of transitions is given by the following expression $v = Rc\left(\frac{1}{n^2} - \frac{1}{m^2}\right)$, where $n < m$,

Consider the following transitions:

Show that the frequency of these transitions obey sum rule (which is known as Ritz combination principle)

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2. A hydrogen atom is excited by radiation of wavelength 97.5 nm. Find the principal quantum number of the excited state.

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3. Show that the total number of lines in emission spectrum is $\frac{n(n-1)}{2}$ and compute the total number of possible lines in emission spectrum

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4. Calculate the radius of the earth if the density of the earth is equal to the density of the nucleus.[mass of earth $5.97 \times 10^{24} kg$]

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5. Calculate the mass defect and the binding energy per nucleon of the ${}_{47}^{108}Ag$ nucleus. [atomic mass of $Ag = 107.905949$]

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6. Half lives of two radioactive elements A and B are 20 minutes and 40 minutes respectively. Initially, the samples have equal number of nuclei. Calculate the ratio of decayed numbers of A and B nuclei after 80 minutes.

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7. On your birthday, you measure the activity of the sample $_{210}Bi$ which has a half-life of 5.01 days. The initial activity that you measure is $1\mu Ci$.

What is the approximate activity of the sample on your next birthday? Calculate

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8. On your birthday, you measure the activity of the sample $_{210}Bi$ which has a half-life of 5.01 days. The initial activity that you measure is $1\mu Ci$.

the decay constant

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9. On your birthday, you measure the activity of the sample $_{210}Bi$ which has a half-life of 5.01 days. The initial activity that you measure is $1\mu Ci$.

the mean life

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10. On your birthday, you measure the activity of the sample ${}_{210}Bi$ which has a half-life of 5.01 days. The initial activity that you measure is $1\mu Ci$.

initial number of atoms

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11. Calculate the time required for 60% of a sample of radon undergo decay. Given $T_{1/2}$ of radon =3.8 days

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12. Assuming that energy released by the fission of a single ${}^{235}_{92}U$ nucleus is 200MeV, calculate the number of fissions per second required to produce 1 watt power.

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13. Charcol pieces of tree is found from an archeological site. The carbon-14 content of this charcol is only 17.5% that of equivalent sample of carbon from a living tree. What is the age of tree?

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