Problems Based On Atomic Structure : -

NEET

- ***Example*: 1** The ratio of areas within the electron orbits for the first excited state to the ground state for hydrogen atom is

  (a) 16 : 1 (b) 18 : 1 (c) 4 : 1 (d) 2 : 1

$n = 2$, $n = 1$

$r = \frac{r_0 n^2}{Z}$ → $n = 1$, $r = r_0$, $Z = 1, n = 1$; → $n = 2$, $r' = 4r_0$, $Z = 1, n = 2$

$\frac{Area_2}{Area_1} = \frac{\pi (4r_0)^2}{\pi r_0^2} = \frac{16}{1}$

***Example*: 2** The electric potential between a proton and an electron is given by $V = V_0 \ln \frac{r}{r_0}$, where r_0 is a constant. Assuming Bohr's model to be applicable, write variation of r_n with n, n being the principal quantum number

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[IIT-JEE (Screening) 2003]

(a) $r_n \propto n$ (b) $r_n \propto 1/n$ (c) $r_n \propto n^2$ (d) $r_n \propto 1/n^2$

$F = -\frac{dU}{dr}$, $F = \frac{d}{dr} V_0 \log \frac{r}{r_0}$

$F = V_0 \times \frac{r_0}{r} \times \frac{1}{r_0} = \frac{V_0}{r}$

$\frac{mv^2}{r} = \frac{V_0}{r}$, $v = \sqrt{\frac{V_0}{m}}$

$mvr = \frac{nh}{2\pi}$, $m\sqrt{\frac{V_0}{m}}\, r = \frac{nh}{2\pi}$, $r \propto n$

ground state.

***Example*: 3** The innermost orbit of the hydrogen atom has a diameter 1.06 $\mathring{A}$. The diameter of tenth orbit is

[UPSEAT 2002]

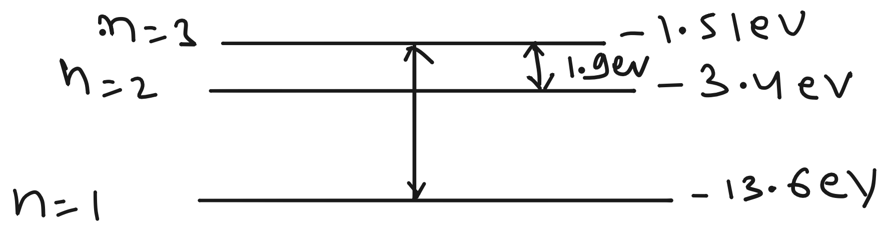
(a) 5.3 $\mathring{A}$ (b) 10.6 $\mathring{A}$ (c) 53 $\mathring{A}$ (d) 106 $\mathring{A}$

$r = \frac{r_0 n^2}{Z}$, $D = \frac{D_0 n^2}{Z}$, $D_0 = 1.06\mathring{A}$

$D = \frac{1.06 \times 10^2}{1} = 106\mathring{A}$

***Example*: 4** Energy of the electron in n^{th} orbit of hydrogen atom is given by $E_n = -\frac{13.6}{n^2} eV$. The amount of energy needed to transfer electron from first orbit to third orbit is

(a) 13.6 eV (b) 3.4 eV (c) 12.09 eV (d) 1.51 eV



$-1.51-(-13.6)$

$= 12.09$ eV

***Example*: 5** If the binding energy of the electron in a hydrogen atom is 13.6 eV, the energy required to remove the electron from the first excited state of Li^{++} is

(a) 122.4 eV (b) 30.6 eV (c) 13.6 eV (d) 3.4 eV

|TE| = B.E. = $13.6\frac{Z^2}{n^2}$ For ground state of H-atom $Z=1, n=1$

B.E. = 13.6 eV

$n=2, Z=3$

$T.E. = -13.6\frac{Z^2}{n^2}$

$T.E. = -\frac{13.6\times 3^2}{2^2} = -30.6$ eV

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***Example*: 6** The ratio of the wavelengths for $2\rightarrow 1$ transition in Li^{++}, He^{+} and H is **[UPSEAT 2003]**

(a) 1 : 2 : 3 (b) 1 : 4 : 9 (c) 4 : 9 : 36 (d) 3 : 2 : 1

$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right)$?

$\frac{1}{\lambda_{Li}}:\frac{1}{\lambda_{He}}:\frac{1}{\lambda_H} = R3^2\left(\frac{1}{1}-\frac{1}{4}\right):R2^2\left(\frac{1}{1}-\frac{1}{4}\right):R\left(\frac{1}{1}-\frac{1}{4}\right)$

$= 9:4:1 = \frac{1}{\lambda_{Li}}:\frac{1}{\lambda_{He}}:\frac{1}{\lambda_H}$

$\frac{1}{\lambda_{Li}}:\frac{1}{\lambda_{He}}:\frac{1}{\lambda_H} = \frac{9}{36}:\frac{4}{36}:\frac{1}{36}$

$\lambda_{Li}:\lambda_{He}:\lambda_H = \frac{1}{4}:\frac{1}{9}:\frac{1}{36}$

***Example*: 7** Energy E of a hydrogen atom with principal quantum number n is given by $E=\frac{-13.6}{n^2}eV$. The energy of a photon ejected when the electron jumps $n = 3$ state to $n = 2$ state of hydrogen is approximately

[CBSE PMT/PDT Screening 2004]

(a) 1.9 eV (b) 1.5 eV (c) 0.85 eV (d) 3.4 eV

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

$E_1 = -\frac{13.6}{2^2}$ eV

$\Delta E = 1.5$ eV

$E_2 = -\frac{13.6}{}$ eV

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Example: 8 In the Bohr model of the hydrogen atom, let R, v and E represent the radius of the orbit, the speed of electron and the total energy of the electron respectively. Which of the following quantity is proportional to the quantum number n

(a) R/E (b) E/v (c) RE (d) vR

$$R = \frac{R_0 n^2}{Z}, \quad v = \frac{v_0 Z}{n}, \quad E = \frac{-13.6 Z^2}{n^2}$$

$$Rv = \frac{R_0 n^2}{Z} \times \frac{v_0 Z}{n}$$

Example: 9 The energy of hydrogen atom in nth orbit is E_n, then the energy in nth orbit of singly ionised helium atom will be

(a) $4E_n$ (b) $E_n/4$ (c) $2E_n$ (d) $E_n/2$

$$E = \frac{-13.6 Z^2}{n^2}$$ For H atom $Z = 1$

given $\rightarrow E_n = -\frac{13.6}{n^2}$ — (A)

For He

$$E_{He} = \frac{-13.6 \times 2^2}{n^2}$$

$$E_{He} = E_n 4$$

Example: 10 The wavelength of radiation emitted is λ_0 when an electron jumps from the third to the second orbit of hydrogen atom. For the electron jump from the fourth to the second orbit of the hydrogen atom, the wavelength of radiation emitted will be

(a) $\frac{16}{25}\lambda_0$ (b) $\frac{20}{27}\lambda_0$ (c) $\frac{27}{20}\lambda_0$ (d) $\frac{25}{16}\lambda_0$

$$\frac{1}{\lambda_0} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = R\left(\frac{9-4}{36}\right)$$

$$\frac{1}{\lambda_0} = \frac{5R}{36}, \quad \boxed{\lambda_0 = \frac{36}{5R} \text{ — (A)}}$$

$$\frac{1}{\lambda'} = R\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = R\left(\frac{1}{4} - \frac{1}{16}\right)$$

$$\frac{1}{\lambda'} = R\left(\frac{4-1}{16}\right) = \frac{3R}{16}$$

$$\boxed{\lambda' = \frac{16}{3R} \text{ — (B)}}$$

$$B/A \quad \frac{\lambda'}{\lambda_0} = \frac{\frac{16}{3R}}{\frac{36}{5R}} = \frac{16}{3} \times \frac{5}{36} = \frac{20}{27}, \quad \lambda' = \frac{\lambda_0 20}{27}$$

***Example*: 11** If scattering particles are 56 for 90^o angle then this will be at 60^o angle

(a) 224 ✓ (b) 256 (c) 98 (d) 108

$$N \propto \frac{1}{\sin^4(\theta/2)}, \quad \frac{N_2}{N_1} = \left(\frac{\sin 90/2}{\sin \frac{60}{2}}\right)^4 = \left(\frac{1/\sqrt{2}}{1/2}\right)^4$$

$$\frac{N_2}{56} = (\sqrt{2})^4 = 4, \quad N_2 = 56 \times 4$$

$$N_2 = 224$$

***Example*: 12** When an electron in hydrogen atom is excited, from its 4th to 5th stationary orbit, the change in angular momentum of electron is (Planck's constant: $h = 6.6 \times 10^{-34}\ J\text{–}s$)

(a) $4.16 \times 10^{-34}\ J\text{-}s$ (b) $3.32 \times 10^{-34}\ J\text{-}s$ (c) ✓ $1.05 \times 10^{-34}\ J\text{-}s$ (d) $2.08 \times 10^{-34}\ J\text{-}s$

$$L = \frac{nh}{2\pi}, \quad \frac{5h}{2\pi} - \frac{4h}{2\pi} = \frac{h}{2\pi}$$

$$= \frac{6.6 \times 10^{-34}}{2 \times 3.14} = 1.05 \times 10^{-34}$$

Example: 13 In hydrogen atom, if the difference in the energy of the electron in n = 2 and n = 3 orbits is E, the ionization energy of hydrogen atom is

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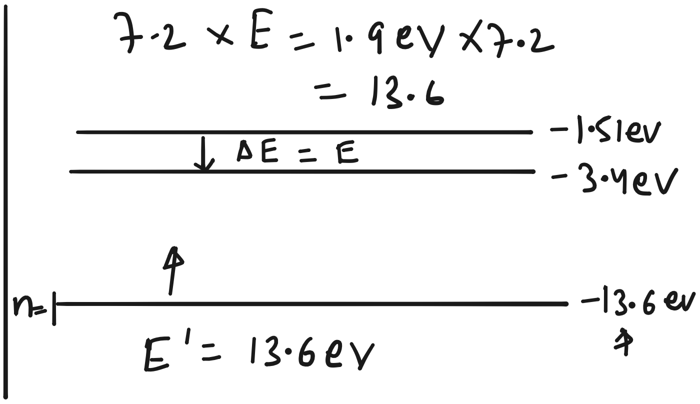
(a) 13.2 E (b) 7.2 E (c) 5.6 E (d) 3.2 E

$\Delta E = E_2 - E_3 = -\frac{13.6}{3^2} - \left(-\frac{13.6}{2^2}\right) = E$

$\Delta E = 13.6\left[\frac{1}{4} - \frac{1}{9}\right] = E = 13.6\left[\frac{9-4}{36}\right] = \frac{13.6 \times 5}{36} = E$

$E' = -\frac{13.6 z^2}{n^2} = 13.6$ eV. $E' = \frac{36}{5}E = 7.2\,E$



Example: 14 In Bohr model of hydrogen atom, the ratio of periods of revolution of an electron in n = 2 and n = 1 orbits is

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[EAMCET (Engg.) 2000]

(a) 2 : 1 (b) 4 : 1 (c) 8 : 1 (d) 16 : 1

$T \propto n^3$

$\frac{T_1}{T_2} = \left(\frac{n_1}{n_2}\right)^3 = \left(\frac{2}{1}\right)^3 = 8$

$Z = 3$

Example: 15 A double charged lithium atom is equivalent to hydrogen whose atomic number is 3. The wavelength of required radiation for emitting electron from first to third Bohr orbit in Li^{++} will be (Ionisation energy of hydrogen atom is 13.6 eV)

(a) 182.51 $\mathring{A}$ (b) 177.17 $\mathring{A}$ (c) 142.25 $\mathring{A}$ (d) 113.74 $\mathring{A}$

$\frac{1}{R} = 912\,\mathring{A}$

$\frac{1}{\lambda} = Z^2 R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = 3^2 R\left(\frac{1}{1} - \frac{1}{9}\right)$

$\frac{1}{\lambda} = 9 \times R\left(\frac{8}{9}\right)$, $\lambda = \frac{1}{8R} = \frac{912}{8} \cong 113.74\,\mathring{A}$

Example: 16 The absorption transition between two energy states of hydrogen atom are 3. The emission transitions between these states will be

$(n-1) = 3$, $n = 4$ absorption transmission

No. of absorption lines

(a) 3 (b) 4 (c) 5 (d) 6 ✓

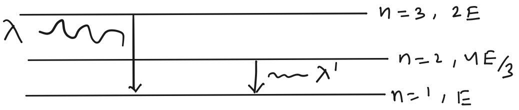
$$= \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$$

$$= \frac{(4-1)(4-1+1)}{2} = \frac{3 \times 4}{2} = 6$$

***Example*: 17** The energy levels of a certain atom for 1st, 2nd and 3rd levels are E, $4E/3$ and $2E$ respectively. A photon of wavelength λ is emitted for a transition $3 \rightarrow 1$. What will be the wavelength of emissions for transition $2 \rightarrow 1$

[CPMT 1996]

(a) $\lambda/3$ (b) $4\lambda/3$ (c) $3\lambda/4$ (d) 3λ ✓



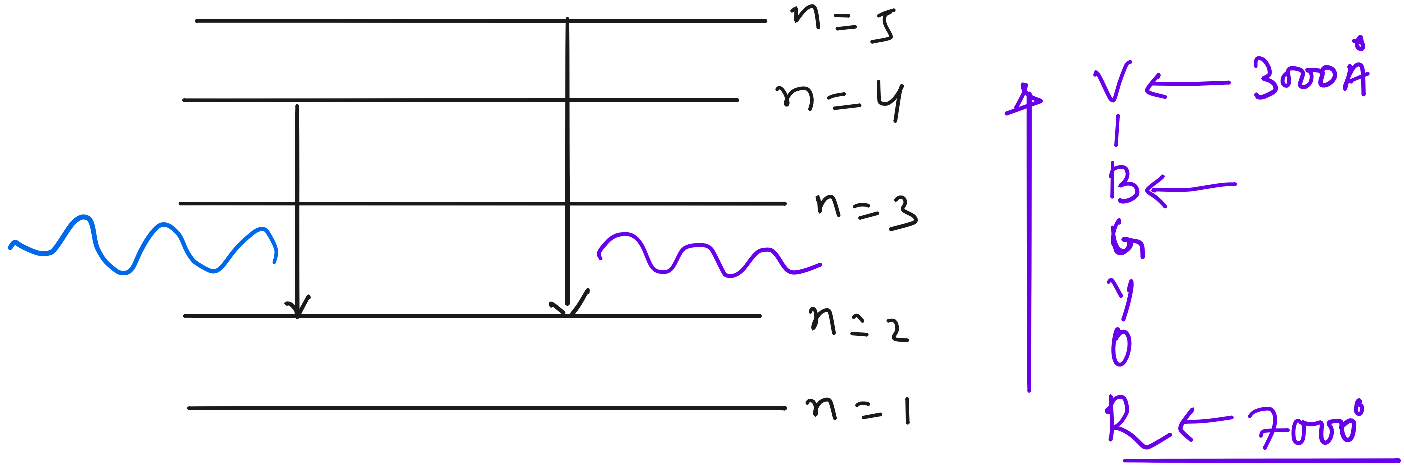
$\Delta E = \frac{hc}{\lambda}$, $2E - E = \frac{hc}{\lambda}$, $\lambda = \frac{hc}{E}$ — (A)

$$\frac{4E}{3} - E = \frac{hc}{\lambda'}$$

$$\frac{hc}{3\lambda} = \frac{E}{3} = \frac{hc}{\lambda'}, \quad \lambda' = 3\lambda$$

***Example*: 18** Hydrogen atom emits blue light when it changes from n = 4 energy level to n = 2 level. Which colour of light would the atom emit when it changes from n = 5 level to n = 2 level **[KCET 1993]**

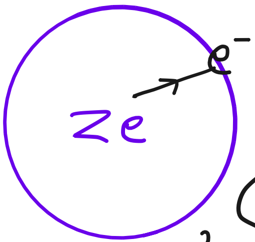
(a) Red (b) Yellow (c) Green (d) Violet ✓



Example: 19 A single electron orbits a stationary nucleus of charge $+Ze$, where Z is a constant. It requires $47.2\ eV$ to excited electron from second Bohr orbit to third Bohr orbit. Find the value of Z **[IIT-JEE 1981]**

(a) 2 (b) 5 ✓ (c) 3 (d) 4

$$Z^2 = \frac{47.2 \times 36}{13.6 \times 5}$$



$$E = -\frac{13.6\, Z^2}{n^2}$$

$$Z = \sqrt{25} = 5$$

$$Z^2 \left\{ -\frac{13.6}{3^2} - \left(-\frac{13.6}{2^2} \right) \right\} = 47.2\ eV$$

Example: 20 The first member of the Paschen series in hydrogen spectrum is of wavelength 18,800 Å. The short wavelength limit of Paschen series is **[EAMCET (Med.) 2000]**

(a) 1215 Å (b) 6560 Å (c) 8225 Å ✓ (d) 12850 Å

electrons jusmet From any where $n>3$ to $n=3$

$$\frac{1}{\lambda_{min}} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\frac{1}{\lambda_{min}} = R\left(\frac{1}{3^2} - \frac{1}{\infty}\right), \quad \lambda_{min} = \frac{9}{R}$$

$$\lambda_{min} = 9 \times 912\ Å = 8225\ Å$$

Example: 21 Ratio of the wavelengths of first line of Lyman series and first line of Balmer series is **[EAMCET (Engg.) 1995; MP PMT 1997]**

(a) 1 : 3 (b) 27 : 5 (c) 5 : 27 ✓ (d) 4 : 9

First line of lyman series $n_2 = 2,\ n_1 = 1$

$$\frac{1}{\lambda} = R\left(\frac{1}{1} - \frac{1}{4}\right) = R\left(\frac{3}{4}\right), \quad \lambda = \frac{4}{3R} \text{ — (A)}$$

First line of Balmer series $n_2 = 3$ to $n_1 = 2$

$\frac{1}{\lambda'} = R\left(\frac{1}{2^2}-\frac{1}{3^2}\right) = R\left(\frac{1}{4}-\frac{1}{9}\right)$, $\lambda' = \frac{36}{5R}$ (B)

Example: 22 The third line of Balmer series of an ion equivalent to hydrogen atom has wavelength of 108.5 *nm*. The ground state energy of an electron of this ion will be

(a) 3.4 *eV* (b) 13.6 *eV* (c) 54.4 *eV* ✓ (d) 122.4 *eV*

$\frac{1}{\lambda} = RZ^2\left(\frac{1}{2^2}-\frac{1}{5^2}\right) = \frac{1}{108.5\times10^{-9}}$

$R = \frac{1}{912\,Å} = \frac{1}{912\times10^{-10}}$

$\frac{1}{912\times10^{-10}}\times Z^2\left(\frac{1}{4}-\frac{1}{25}\right) = \frac{1}{108.5\times10^{-9}}$

$Z = 2$

$E = -\frac{13.6Z^2}{n^2}$

For ground state $n=1$

$E = -13.6\times4$

$E = -54.4\,eV$

Example: 23 Hydrogen (H), deuterium (D), singly ionized helium (He^+) and doubly ionized lithium (Li^{++}) all have one electron around the nucleus. Consider $n=2$ to $n=1$ transition. The wavelengths of emitted radiations are $\lambda_1, \lambda_2, \lambda_3$ and λ_4 respectively. Then approximately

(a) $\lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$ ✓ (b) $4\lambda_1 = 2\lambda_2 = 2\lambda_3 = \lambda_4$ (c) $\lambda_1 = 2\lambda_2 = 2\sqrt{2}\lambda_3 = 3\sqrt{2}\lambda_4$ (d) $\lambda_1 = \lambda_2 = 2\lambda_3 = 3\lambda_4$

$\frac{1}{\lambda} = RZ^2\left(\frac{1}{1^2}-\frac{1}{2^2}\right)$

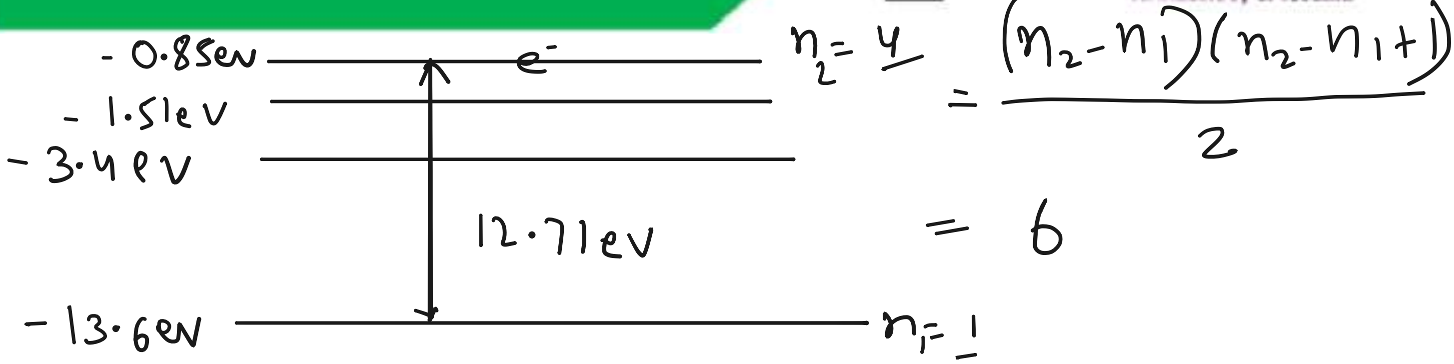
For Deuterium & Hydrogen Z is same.

$\frac{1}{\lambda_{He}} = R\times4\left(\frac{1}{1^2}-\frac{1}{2^2}\right)$, $\frac{1}{\lambda_{Li}} = 9R\left(\frac{1}{1^2}-\frac{1}{2^2}\right)$

Example: 24 Hydrogen atom in its ground state is excited by radiation of wavelength 975 *Å*. How many lines will be there in the emission spectrum

(a) 2 (b) 4 (c) 6 (d) 8

$E = \frac{12400}{975\,Å}\,eV = 12.71\,eV$



Example: 25 A photon of energy 12.4 eV is completely absorbed by a hydrogen atom initially in the ground state so that it is excited. The quantum number of the excited state is

(a) $n = 1$ (b) $n = 3$ (c) $n = 4$ (d) $n = \infty$

Example: 26 The wave number of the energy emitted when electron comes from fourth orbit to second orbit in hydrogen is 20,397 cm^{-1}. The wave number of the energy for the same transition in He^{+} is **[Haryana PMT 2000]**

(a) 5,099 cm^{-1} (b) 20,497 cm^{-1} (c) 40,994 cm^{-1} (d) 81,998 cm^{-1}

Example: 27 In an atom, the two electrons move round the nucleus in circular orbits of radii R and $4R$. the ratio of the time taken by them to complete one revolution is

(a) 1/4 (b) 4/1 (c) 8/1 (d) 1/8

Example: 28 Ionisation energy for hydrogen atom in the ground state is E. What is the ionisation energy of Li^{++} atom in the 2nd excited state

(a) E (b) $3E$ (c) $6E$ (d) $9E$

Example: 29 An electron jumps from $n = 4$ to $n = 1$ state in H-atom. The recoil momentum of H-atom (in eV/C) is

(a) 12.75 (b) 6.75 (c) 14.45 (d) 0.85

Example: 30 If elements with principal quantum number $n > 4$ were not allowed in nature, the number of possible elements would be

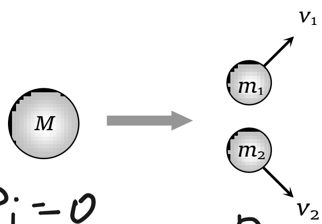
[IIT-JEE 1983; CBSE PMT 1991, 93; MP PET 1999; RPET 1993, 2001; RPMT 1999, 2003; J & K CET 2004]

(a) 60 (b) 32 (c) 4 (d) 64

Problems based on Nuclear Physics :-

***Example*: 1** A heavy nucleus at rest breaks into two fragments which fly off with velocities in the ratio 8 : 1. The ratio of radii of the fragments is

(a) 1 : 2 ✓ (b) 1 : 4 (c) 4 : 1 (d) 2 : 1



$P_i = 0$ $\quad$ $P_f = 0$

$0 = m_1v_1 + m_2v_2$

$m_1v_1 = -m_2v_2$

$\frac{8}{1} = \frac{v_1}{v_2} = \frac{m_2}{m_1}$

$\frac{8}{1} = \frac{\frac{4}{3}\pi r_2^3 \times \rho}{\frac{4}{3}\pi r_1^3 \times \rho}$, $\quad \frac{r_2}{r_1} = \frac{2}{1}$, $\quad \frac{r_1}{r_2} = \frac{1}{2}$

***Example*: 2** The ratio of radii of nuclei ${}^{27}_{13}Al$ and ${}^{125}_{52}Te$ is approximately

(a) 6 : 10 ✓ (b) 13 : 52 (c) 40 : 177 (d) 14 : 7

$R = R_0 A^{1/3}$

$\frac{R_{Al}}{R_{Te}} = \left(\frac{27}{125}\right)^{1/3} = \frac{3}{5} \times \frac{2}{2} = \frac{6}{10}$

Example: 3 If Avogadro's number is 6×10^{23} then the number of protons, neutrons and electrons in 14 *g* of $_6C^{14}$ are respectively

(a) 36×10^{23}, 48×10^{23}, 36×10^{23} (b) 36×10^{23}, 36×10^{23}, 36×10^{21}

(c) 48×10^{23}, 36×10^{23}, 48×10^{21} (d) 48×10^{23}, 48×10^{23}, 36×10^{21}

In one atom of $_6C^{14}$ we have 6 protons and 8 neutrons and 6 electrons

total no. of atoms in 14gm $= 6 \times 10^{23}$

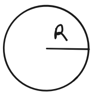
total no. of protons $= 6 \times 10^{23} \times 6 = 36 \times 10^{23}$

total no. of neutrons $= 8 \times 6 \times 10^{23} = 48 \times 10^{23}$

Example: 4 Two Cu^{64} nuclei touch each other. The electrostatics repulsive energy of the system will be

(a) 0.788 *MeV* (b) 7.88 *MeV* (c) 126.15 *MeV* (d) 788 *MeV*

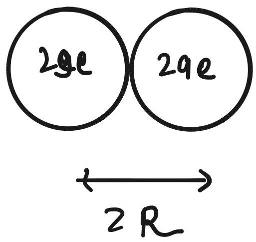
$q_1 \overset{r}{—} q_2$ $U = \frac{kq_1q_2}{r}$



$R = R_0 A^{1/3} = (1.2\, fm) \times (64)^{1/3}$

$R = 1.2 \times 4\ fm = 4.8\ fm.$

$Z = 29$



$$U = \frac{9 \times 10^9 \times (29e)^2}{(4.8 \times 10^{-15})^2}$$

$U = 126.15\ MeV$

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Example: 5 When $_{92}U^{235}$ undergoes fission. 0.1% of its original mass is changed into energy. How much energy is released if 1 *kg* of $_{92}U^{235}$ undergoes fission **[MP PET 1994; MP PMT/PET 1998; BHU 2001**

(a) $9 \times 10^{10}\ J$ (b) $9 \times 10^{11}\ J$ (c) $9 \times 10^{12}\ J$ (d) $9 \times 10^{13}\ J$

$E = 0.1\%$ of $1kg = \frac{0.1}{100} \times 1 \times (3 \times 10^8)^2$

↓

Δm

$E = 9 \times 10^{13}\ J$

0.1% of 1kg

$E = mc^2$

Example: 6 1 *g* of hydrogen is converted into 0.993 *g* of helium in a thermonuclear reaction. The energy released is

[EAMCET (Med.) 1995; CPMT 1999]

(a) $63 \times 10^{7}\,J$ (b) $63 \times 10^{10}\,J$ (c) $63 \times 10^{14}\,J$ (d) $63 \times 10^{20}\,J$

$\Delta m = 1 - 0.993 = 0.007\ gm = 0.007 \times 10^{-3}\ kg$

$E = \Delta m c^2 = 0.007 \times 10^{-3} \times (3 \times 10^{8})^2$

$E = 63 \times 10^{10}\ J$

Example: 7 The binding energy per nucleon of deuteron $({}_1^2H)$ and helium nucleus $({}_2^4He)$ is 1.1 *MeV* and 7 *MeV* respectively. If two deuteron nuclei react to form a single helium nucleus, then the energy released is

[MP PMT 1992; Roorkee 1994; IIT-JEE 1996; AIIMS 1997; Haryana PMT 2000; Pb PMT 2001; CPMT 2001; AIEEE 2004]

(a) 13.9 *MeV* (b) 26.9 *MeV* (c) 23.6 *MeV* (d) 19.2 *MeV*

${}_1H^2 + {}_1H^2 \longrightarrow {}_2He^4 + Q\ value$

7×4

$28\ MeV$

$B.E. = 1.1 \times 2 + 1.1 \times 2$

$(B.E.)_{parents} = 4.4\ MeV$

$Q\ value = 28 - 4.4 = 23.6\ MeV$

Example: 8 The masses of neutron and proton are 1.0087 *amu* and 1.0073 *amu* respectively. If the neutrons and protons combine to form a helium nucleus (alpha particles) of mass 4.0015 *amu*. The binding energy of the helium nucleus will be [1 *amu*= 931 *MeV*]

(a) 28.4 *MeV* (b) 20.8 *MeV* (c) 27.3 *MeV* (d) 14.2 *MeV*

$\Delta m = (2 \times m_p + 2 m_N - 4.0015)$

$\Delta m = (2 \times 1.0073 + 2 \times 1.0087 - 4.0015)$

B.E. = $\Delta m c^2 = (2\times1.0073 + 2\times1.0087 - 4.0015)\times931$ MeV

Example: 9 A atomic power reactor furnace can deliver 300 *MW*. The energy released due to fission of each of uranium atom U^{238} is 170 *MeV*. The number of uranium atoms fissioned per hour will be **[UPSEAT 2000]**

(a) 5×10^{15} (b) 10×10^{20} (c) 40×10^{21} (d) 30×10^{25}

MeV ↓

$\frac{170\times n}{1} = \frac{E}{1\,sec.} = 300\times10^{6}$ watt.

$170\times10^{6}\times1.6\times10^{-19}\times n = 300\times10^{6}$

V.IMP.

Example: 10 The binding energy per nucleon of O^{16} is 7.97 *MeV* and that of O^{17} is 7.75 *MeV*. The energy (in *MeV*) required to remove a neutron from O^{17} is

(a) 3.52 (b) 3.64 (c) 4.23 (d) 7.86

$O^{17} \longrightarrow O^{16} + {}_0n^1 + Q$ value

B.E. $= 7.75\times17$ $\quad 16\times7.97$

$Q = 16\times7.97 - 17\times7.75 = -4.23$ MeV.

Example: 11 A gamma ray photon creates an electron-positron pair. If the rest mass energy of an electron is 0.5 *MeV* and the total kinetic energy of the electron-positron pair is 0.78 *MeV*, then the energy of the gamma ray photon must be

(a) 0.78 *MeV* (b) 1.78 *MeV* (c) 1.28 *MeV* (d) 0.28 *MeV*

***Example*: 12** What is the mass of one Curie of U^{234} **[MNR 1985]**

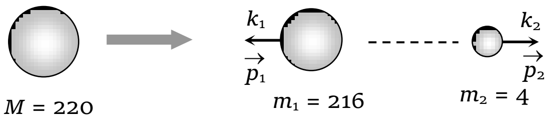
(a) 3.7×10^{10} *gm* (b) 2.348×10^{23} *gm* (c) 1.48×10^{-11} *gm* (d) 6.25×10^{-34} *gm*

***Example*: 13** In the nuclear fusion reaction ${}_1^2H + {}_1^3H \rightarrow {}_2^4He + n,$ given that the repulsive potential energy between the two nuclei is $-7.7 \times 10^{-14} J$, the temperature at which the gases must be heated to initiate the reaction is nearly [Boltzmann's constant $k = 1.38 \times 10^{-23} J/K$]

(a) $10^9 K$ (b) $10^7 K$ (c) $10^5 K$ (d) $10^3 K$

***Example*: 14** A nucleus with mass number 220 initially at rest emits an α-particle. If the Q value of the reaction is 5.5 MeV. Calculate the kinetic energy of the α-particle

(a) 4.4 MeV (b) 5.4 MeV (c) 5.6 MeV (d) 6.5 MeV



***Example*: 15** Let m_p be the mass of a proton, m_n the mass of a neutron, M_1 the mass of a $^{20}_{10}Ne$ nucleus and M_2 the mass of a $^{40}_{20}Ca$ nucleus. Then

(a) $M_2 = 2M_1$ (b) $M_2 > 2M_1$ (c) $M_2 < 2M_1$ (d) $M_1 < 10(m_n + m_p)$

***Example*: 16** When $_{90}Th^{228}$ transforms to $_{83}Bi^{212}$, then the number of the emitted α–and β–particles is, respectively

[MP PET 2002]

(a) $8\alpha, 7\beta$ (b) $4\alpha, 7\beta$ (c) $4\alpha, 4\beta$ (d) $4\alpha, 1\beta$

***Example*: 17** A radioactive substance decays to $1/16^{th}$ of its initial activity in 40 days. The half-life of the radioactive substance expressed in days is

(a) 2.5 (b) 5 (c) 10 (d) 20

***Example*: 18** A sample of radioactive element has a mass of 10 *gm* at an instant t = 0. The approximate mass of this element in the sample after two mean lives is

(a) 2.50 *gm* (b) 3.70 *gm* (c) 6.30 *gm* (d) 1.35 *gm*

***Example*: 19** The half-life of ^{215}At is 100 μs. The time taken for the radioactivity of a sample of ^{215}At to decay to $1/16^{th}$ of its initial value is

(a) 400 μs (b) 6.3 μs (c) 40 μs (d) 300 μs

***Example*: 20** The mean lives of a radioactive substance for α and β emissions are 1620 years and 405 years respectively. After how much time will the activity be reduced to one fourth

(a) 405 year (b) 1620 year (c) 449 year (d) None of these

***Example*: 21** At any instant the ratio of the amount of radioactive substances is 2 : 1. If their half lives be respectively 12 and 16 hours, then after two days, what will be the ratio of the substances **[RPMT 1996]**

(a) 1 : 1 (b) 2 : 1 (c) 1 : 2 (d) 1 : 4

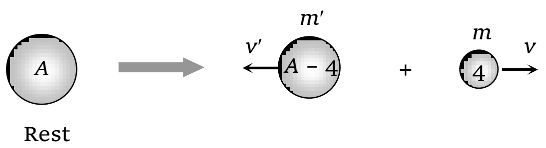
***Example*: 22** From a newly formed radioactive substance (Half-life 2 *hours*), the intensity of radiation is 64 times the permissible safe level. The minimum time after which work can be done safely from this source is

[IIT 1983; SCRA 1996]

(a) 6 *hours* (b) 12 *hours* (c) 24 *hours* (d) 128 *hours*

***Example*: 23** nucleus of mass number A, originally at rest, emits an α-particle with speed v. The daughter nucleus recoils with a speed

(a) $2v/(A+4)$ (b) $4v/(A+4)$ (c) $4v/(A-4)$ (d) $2v/(A-4)$



***Example*: 24** The counting rate observed from a radioactive source at t = 0 second was 1600 counts per second and at t = 8 seconds it was 100 counts per second. The counting rate observed as counts per second at t = 6 seconds will be

(a) 400 (b) 300 (c) 200 (d) 150

***Example*: 25** The kinetic energy of a neutron beam is 0.0837 eV. The half-life of neutrons is 693s and the mass of neutrons is 1.675×10^{-27} kg. The fraction of decay in travelling a distance of 40m will be

(a) 10^{-3} (b) 10^{-4} (c) 10^{-5} (d) 10^{-6}

***Example*: 26** The fraction of atoms of radioactive element that decays in 6 days is 7/8. The fraction that decays in 10 days will be

(a) 77/80 (b) 71/80 (c) 31/32 (d) 15/16