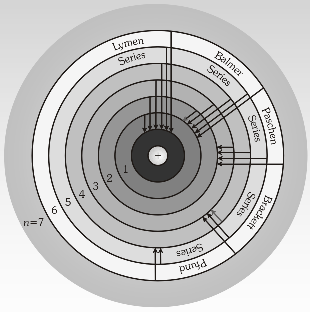



# Assignment

## *Atomic structure*

**1.** The Bohr's model of atoms **[CBSE PMT 1993, 2004; MP PMT 2004]**

(a) Assumes that the angular momentum of electrons is quantized

(b) Uses Einstein's photo-electric equation

(c) Predicts continuous emission spectra for atoms

(d) Predicts the same emission spectra for all types of atoms

**2.** In an orbital motion, the angular momentum vector is

(a) Along the radius vector (b) Parallel to the linear momentum

(c) In the orbital plane (d) Perpendicular to the orbital plane

**3.** The colour of the second line of Balmer series is **[J & K CET 2004]**

(a) Blue (b) Yellow (c) Red (d) Violet

**4.** If the ionization energy for the hydrogen atom is 13.6 *eV*, the energy required to excite it from the ground state to the next higher state is nearly

(a) 3.4 *eV* (b) 10.2 *eV* (c) 12.1 *eV* (d) 1.5 *eV*

**5.** If $r$ is the radius of the lowest orbit of Bohr's model of hydrogen atom, the radius of next higher energy orbit is**[MP PM**

(a) $4r$ (b) $9r$ (c) $16r$ (d) $2r$

**6.** The kinetic energy of an electron revolving around a nucleus will be

(a) Four times of P.E. (b) Double of P.E. (c) Equal to P.E. (d) Half of its P.E.

**7.** Which state of triply ionised Beryllium ($Be^{+++}$) has the same orbital radius as that of the ground state of hydrogen **[KCET 2004]**

(a) $n = 1$ (b) $n = 2$ (c) $n = 3$ (d) $n = 4$

**8.** An $\alpha$-particle of energy 5 *MeV* is scattered through 180° by a fixed uranium nucleus. The distance of the closest approach is of the order of **[IIT-JEE 1981; AIEEE 2004]**

(a) 1 Å (b) $10^{-10}$ *cm* (c) $10^{-12}$ *cm* (d) $10^{-15}$ *cm*

**9.** Dalton's atomic theory was in accordance with **[AFMC 2001, 2004]**

(a) Conservation of energy (b) Conservation of mass (c) Conservation of charge (d) None of these

**10.** The energy of $H_2$ atom in its ground state is – 13.6 *eV*. The energy corresponding to first excitation state is

**[CBSE 1993; CBSE 1996, 2001; AFMC 2002; MP PET 2003]**

(a) – 3.4 $eV$ (b) 3.4 $eV$ (c) – 1.5 $eV$ (d) 20.2 $eV$

**11.** The time of revolution of an electron around a nucleus of charge $Ze$ in $n^{th}$ Bohr orbit is directly proportional to **[MP PET**

(a) $n$ (b) $\frac{n^3}{Z^2}$ (c) $\frac{n^2}{Z}$ (d) $\frac{Z}{n}$

**12.** An electron in the $n$ = 1 orbit of hydrogen atom is bound by 13.6 $eV$ energy is required to ionize, it is

(a) 13.6 $eV$ (b) 6.53 $eV$ (c) 5.4 $eV$ (d) 1.51 $eV$

**13.** In the lowest energy level of hydrogen atom, the electron has the angular momentum

**[Similar to (DCE 2001); MP PET 1997; BCECE 2003]**

(a) $\pi/h$ (b) $h/\pi$ (c) $h/2\pi$ (d) $2\pi/h$

**14.** According to Bohr's theory the moment of momentum of an electron revolving in second orbit of hydrogen atom will be

**[MP PET 1999; KCET 2003]**

(a) $2\pi h$ (b) $\pi h$ (c) $\frac{h}{\pi}$ (d) $\frac{2h}{\pi}$

**15.** Which of the following transition will have highest emission wavelength

(a) $n$ = 2 to $n$ = 1 (b) $n$ =1 to $n$ = 2 (c) $n$ =2 to $n$ = 5 (d) $n$ =5 to $n$ = 2

**16.** When the wave of hydrogen atom comes from infinity into the first orbit then the value of wave number is **[RPET 2003**

(a) $109700\ cm^{-1}$ (b) $1097\ cm^{-1}$ (c) $109\ cm^{-1}$ (d) None of these

**17.** In which of the following systems will the radius of the first orbit ($n$ = 1) be minimum**[Kerala PET 2002; CBSE PMT 2003**

(a) Single ionized helium (b) Deuterium atom (c) Hydrogen atom (d) Double ionized lithium

**18.** Which of the following atoms has the lowest ionization potential

(a) ${}^{16}_{8}O$ (b) ${}^{14}_{7}N$ (c) ${}^{133}_{55}Cs$ (d) ${}^{40}_{18}Ar$

**19.** In the Bohr's model of hydrogen atom, the ratio of the kinetic energy to the total energy of the electron in $n$th quantum state is

**[BHU 2002; RPMT 2002; 2003]**

(a) – 1 (b) + 1 (c) – 2 (d) 2

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

**[MNR 1988; SCRA 1994; CBSE 1996; AIIMS 1999; DCE 2002; RPMT 2002; RPMT 2003]**

(a) $n^{-1}$ (b) $n$ (c) $n^{-2}$ (d) $n^2$

**21.** With the increase in principal quantum number, the energy difference between the two successive energy levels

**[UPSEAT 2000; RPET 2003]**

(a) Increases (b) Decreases

(c) Remains constant (d) Sometimes increases and sometimes decreases

**22.** According to classical theory of Rutherford model the path of electron will be **[AFMC 2003]**

(a) Parabolic (b) Hyperbolic (c) Circular (d) Elliptical

**23.** Bohr's theory was modified by **[AFMC 2003]**

(a) Rutherford and Soddy (b) Planck (c) Hund (d) Somerfield

**24.** Minimum excitation potential of Bohr's first orbit in hydrogen atom is

(a) 13.6 $V$ (b) 3.4 $V$ (c) 10.2 $V$ (d) 3.6 $V$

**25.** To explain his theory, Bohr used

(a) Conservation of linear momentum (b) Conservation of angular momentum

(c) Conservation of quantum frequency (d) Conservation of energy

**26.** A hydrogen atom and a $Li^{++}$ ion are both in the second excited state. If $l_H$ and $l_{Li}$ are their respective electronic angular momenta, and $E_H$ and $E_{Li}$ their respective energies, then

(a) $l_H > l_{Li}$ and $|E_H| > |E_{Li}|$ (b) $l_H = l_{Li}$ and $|E_H| < |E_{Li}|$ (c) $l_H = l_{Li}$ and $|E_H| > |E_{Li}|$ (d) $l_H < l_{Li}$ and $|E_H| < |E_{Li}|$

**27.** The radius of the first orbit of the hydrogen atom is $a_0$. The radius of the second orbit will be

(a) $4a_0$ (b) $6a_0$ (c) $8a_0$ (d) $10a_0$

**28.** Energy of an electron in an excited hydrogen atom is – 3.4 *eV*. Its angular momentum will be $(h = 6.626 \times 10^{-34}\ J-s)$

**[UPSEAT 1999; Kerala PET 2002]**

(a) $1.11 \times 10^{34}\ J$ sec (b) $1.51 \times 10^{-31}\ J$ sec (c) $2.11 \times 10^{-34}\ J$ sec (d) $3.72 \times 10^{-34}\ J$ sec

**29.** Consider the spectral line resulting from the transition from $n$ = 2 to $n$ = 1 in atoms and ions given below. The shortest wavelength is produced by **[Kerala PET 2002]**

(a) Hydrogen atom (b) Deuterium atom (c) Singly ionized helium (d) Doubly ionized lithium

**30.** Find the correct statement about Bohr atom model **[TNPCEE 2002]**

(a) It could not explain about the spectral lines of hydrogen atoms

(b) Electrostatic force of attraction between the nucleus and the electron is $\frac{-z^2me^4}{8\varepsilon_0^2n^2h^2}$

(c) Bohr used the planck's constant to explain his two postulates

(d) The centripetal force on the electron is $\frac{ze^2}{4\pi\varepsilon_0 r_n^2}$

**31.** In a hydrogen atom what will be the radius of 5th orbit if the radius of the first orbit is 0.53$\mathring{A}$ **[TNPCEE 2002]**

(a) 2.65 $\mathring{A}$ (b) 5.3 $\mathring{A}$ (c) 0.106 $\mathring{A}$ (d) 13.25 $\mathring{A}$

**32.** The velocity of an electron in the inner-most orbit of an atom is **[AFMC 2002]**

(a) Zero (b) Highest (c) Lowest (d) Mean

**33.** An electron in revolving round a proton in an orbit of radius $5.3 \times 10^{-9}\ cm$. The speed of electron will be **[RPET 2002]**

(a) $2.2 \times 10^6\ m/s$ (b) $2.2 \times 10^8\ m/s$ (c) $2.2 \times 10^5\ m./s$ (d) $2.2 \times 10^4\ m/s$

**34.** If elements corresponding to $n$ > 5 do not exist, the number of possible elements will be **[RPMT 2002]**

(a) 60 (b) 5 (c) 75 (d) 110

**35.** The possible quantum number for 3$d$ electron are **[MP PMT 2002]**

(a) $n = 3, l = 1, m_l = +1, m_s = -\frac{1}{2}$ (b) $n = 3, l = 2, m_l = +2, m_s = -\frac{1}{2}$

(c) $n = 3, l = 1, m_l = -1, m_s = -\frac{1}{2}$ (d) $n = 3, l = 0, m_l = +1, m_s = -\frac{1}{2}$

**36.** The ratio of speed of an electron in ground state in Bohrs first orbit of hydrogen atom to velocity of light in air is

**[MP PMT 2000; MH CET 2002]**

(a) $\frac{e^2}{2\varepsilon_0 hc}$ (b) $\frac{2e^2\varepsilon_0}{hc}$ (c) $\frac{e^3}{2\varepsilon_0 hc}$ (d) $\frac{2\varepsilon_0 hc}{e^2}$

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

(a) – 13.6 *eV* (b) – 27.2 *eV* (c) – 6.8 *eV* (d) None of these

**38.** The wavelength of light emitted from second orbit to first orbits in a hydrogen atom is

(a) $1.215 \times 10^{-7} m$ (b) $1.215 \times 10^{-5} m$ (c) $1.215 \times 10^{-4} m$ (d) $1.215 \times 10^{-3} m$

**39.** Whenever a hydrogen atom emits a photon in the Balmer series **[KCET 2002]**

(a) It need not emit any more photon (b) It may emit another photon in the Paschen series

(c) It must emit another photon in the Lyman series (d) It may emit another photon in the Balmer series

**40.** The frequency of 1st line of Balmer series in $H_2$ atom is $\nu_0$. The frequency of line emitted by singly ionised *He* atom is **[CPMT 2002]**

(a) $2\nu_0$ (b) $4\nu_0$ (c) $\nu_0 / 2$ (d) $\nu_0 / 4$

**41.** When the electron in the hydrogen atom jumps from 2nd orbit to 1st orbit, the wavelength of radiation emitted is $\lambda$. When the electrons jump from 3rd orbit to 1st orbit, the wavelength of emitted radiation would be **[MP PMT 2002]**

(a) $\frac{27}{32}\lambda$ (b) $\frac{32}{27}\lambda$ (c) $\frac{2}{3}\lambda$ (d) $\frac{3}{2}\lambda$

**42.** The Lyman series of hydrogen spectrum lies in the region

**[CPMT 1990; MNR 1993; MP PET 1994; MP PMT 1995, 2000; UPSEAT 2002]**

(a) Infrared (b) Visible (c) Ultraviolet (d) Of X-rays

**43.** The hydrogen atom can give spectral lines in the series, Lyman, Balmer and Paschen. Which of the following statements is correct

**[CBSE 1990; CPMT 1997; AFMC 2002]**

(a) Lyman series is in the infrared region (b) Balmer series is in the visible region (partly)

(c) Balmer series is solely in the ultraviolet region (d) Paschen series is in the visible region

**44.** Ionization potential of hydrogen atom is 13.6 *eV*. Hydrogen atoms in the ground state are excited by monochromatic radiation of photon energy 12.1 *eV*. The spectral lines emitted by hydrogen atoms according to Bohr's theory will be

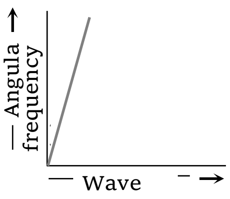
**[CPMT 1990; CBSE 1996; MP PMT 1999; AMU (Med.) 2002]**

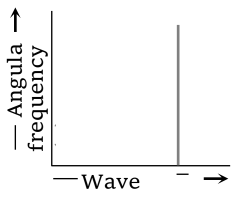
(a) One (b) Two (c) Three (d) Four

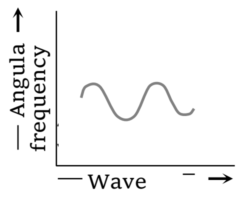
**45.** Minimum energy required to take out the only one electron from ground state of $He^+$ is **[Orissa JEE 2002]**

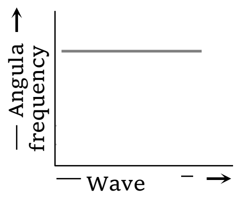
(a) 13.6 *eV* (b) 54.4 *eV* (c) 27.2 *eV* (d) 6.8 *eV*

**46.** The graph between wave number ($\nu$) and angular frequency ($\omega$) is **[AIIMS 2002]**

(a) 


(b) 


(c) 


(d) 


**47.** The energy of an electron in the $n^{th}$ orbit of hydrogen is given by **[RPET 1989; DCE 2002]**

(a) $E_n = -\frac{4\pi^2 mke^2}{n^2h^2}$ (b) $E_n = -\frac{n^2h^2}{4\pi^2 mke^2}$ (c) $E_n = -\frac{2\pi^2 mk^2e^4}{n^2h^2}$ (d) $E_n = -\frac{n^2h^2}{2\pi^2 mk^2e^2}$

**48.** If radiations of all wavelengths from ultraviolet to infrared are passed through hydrogen gas at room temperature, absorption lines will be observed in **[KCET 2001]**

(a) Lyman, Baklmer and Paschen series (b) Both Lyman and Balmer series

(c) Lyman series (d) Balmer series

**49.** In any excited state of hydrogen atom if $m$ = 5, then value of $n, i, m, s$ will be **[RPMT 2001]**

(a) 5, 5, 5, –1/2 (b) 7, 7, 5, +1/2 (c) 6, 6, 5, –1/2 (d) 8, 7, 5, +1/2

**50.** Which of the following is true for number of spectral lines in going form Lyman series to Pfund series **[RPET 2001]**

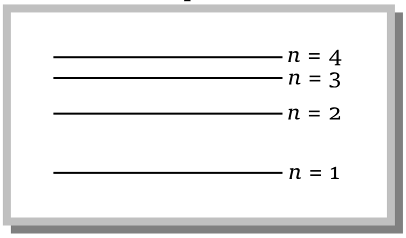
(a) Increases (b) Decreases (c) Unchanged (d) May decreases or increases

**51.** The first line in the Lyman series has wavelength $\lambda$. The wavelength of the first line in Balmer series is

**[CPMT 1998; MH CET (Med.) 2001]**

(a) $\frac{2}{9}\lambda$ (b) $\frac{9}{2}\lambda$ (c) $\frac{5}{27}\lambda$ (d) $\frac{27}{5}\lambda$

**52.** Four lowest energy levels of $H$-atom are shown in the figure. The number of possible emission lines would be **[MP PM**




(a) 3

(b) 4

(c) 5

(d) 6

**53.** The energy of hydrogen atom in its ground state is – 13.6 $eV$. The energy of the level corresponding to the quantum number $n$ is equal 5 is

(a) – 5.40 $eV$ (b) – 2.72 $eV$ (c) – 0.85 $eV$ (d) – 0.54 $eV$

**54.** The ionisation potential of hydrogen is 13.6$eV$. Then the energy released when an electron jumps from $n$ = 3 to $n$ = 2 orbit, is

**[KCET (Engg.) 2001]**

(a) 2.89 $eV$ (b) 1.89 $eV$ (c) 3.89 $eV$ (d) 4.89 $eV$

**55.** The transition from the state $n$ = 4 to $n$ = 3 in a hydrogen-like atom results in ultraviolet radiation. Infrared radiation will be obtained in the transition

(a) $2 \to 1$ (b) $3 \to 2$ (c) $4 \to 2$ (d) $5 \to 4$

**56.** Orbital acceleration of electron is

(a) $\frac{n^2h^2}{4\pi^2m^2r^3}$ (b) $\frac{n^2h^2}{2n^2r^3}$ (c) $\frac{4n^2h^2}{\pi^2m^2r^3}$ (d) $\frac{4n^2h^2}{4\pi^2m^2r^3}$

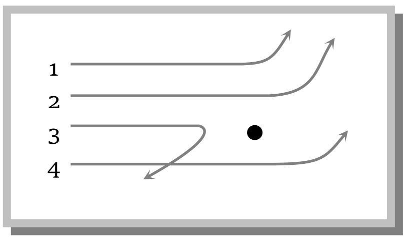
**57.** Which of the following transitions in a hydrogen atom emits photon of the highest frequency **[MP PET 1996; CBSE 2000; D**

(a) $n$ = 1 to $n$ = 2 (b) $n$ = 2 to $n$ = 1 (c) $n$ = 2 to $n$ = 6 (d) $n$ = 6 to $n$ = 2

**58.** Radius of the first orbit of the electron in a hydrogen atom is 0.53 $\mathring{A}$. So, the radius of the third orbit will be **[Kerala (**

(a) 2.12 $\mathring{A}$ (b) 4.77 $\mathring{A}$ (c) 1.06 $\mathring{A}$ (d) 1.59 $\mathring{A}$

**59.** The diagram shows the path of four $\alpha$-particles of the same energy being scattered by the nucleus of an atom simultaneously. Which of these are/is not physically possible




(a) 3 and 4

(b) 2 and 3

(c) 1 and 4

(d) 4 only

**60.** An electron jumps from 5$^{th}$ orbit to 4$^{th}$ orbit of hydrogen atom. Taking the Rydberg constant as $10^7$ *per metre*. What will be the frequency of radiation emitted

(a) $6.75 \times 10^{12}$ $Hz$ (b) $6.75 \times 10^{14}$ $Hz$ (c) $6.75 \times 10^{13}$ $Hz$ (d) None of these

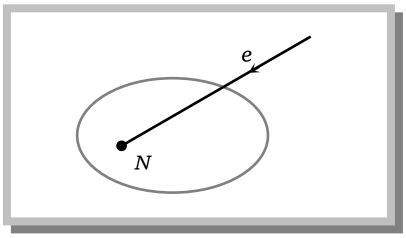
**61.** The electron in a hydrogen atom makes a transition $n_1 \to n_2$ where $n_1$ and $n_2$ are the principal quantum numbers of the two states. Assume the Bohr model to be valid. The time period of the electron in the initial state is eight times that in the final state. The possible values of $n_1$ and $n_2$ are **[IIT 1998; KCET 2001]**

(a) $n_1 = 4, n_2 = 2$ (b) $n_1 = 8, n_2 = 2$ (c) $n_1 = 8,. n_2 = 1$ (d) $n_1 = 6, n_2 = 3$

**62.** For principal quantum number $n = 3$, the possible values of orbital quantum number '$l$' are **[MP PET/PMT 2001]**

(a) 1, 2, 3 (b) 0, 1, 2, 3 (c) 0, 1, 2 (d) – 1, 0, + 1

**63.** An electron moves towards a nucleus at the focus of a an elliptical orbit with velocity *V*. Its angular momentum with respect to nucleus is **[RPMT 2001]**




(a) Always zero

(b) Always remains constant

(c) Changes with time

(d) Can not determined

**64.** The total energy of the electron in the hydrogen atom in the ground state is –13.6 *eV*. The kinetic energy of this electron is

**[EAMCET (Med.) 1998; JIPMER 2000]**

(a) – 13.6 *eV* (b) 0 (c) 6.8 *eV* (d) 13.6 *eV*

**65.** What change in energy per mole of atoms will be associated with an atomic transition giving rise to radiation at 1 *Hz*

**[BHU Med. 2000]**

(a) $0.399 \times 10^{-10}\ J\ mol^{-1}$ (b) $9.390 \times 10^{-10}\ J\ mol^{-1}$ (c) $3.990 \times 10^{-10}\ J\ mol^{-1}$ (d) None of these

**66.** According to Bohr's theory the radius of electron orbit is proportional to **[J & K CET 2000]**

(a) $Z^2 n^2$ (b) $\frac{Z^2}{n^2}$ (c) $\frac{Z^2}{n}$ (d) $\frac{n^2}{Z}$

**67.** According to Bohr's postulate which of the following take discrete values **[J & K CET 2000]**

(a) Kinetic energy (b) Potential energy (c) Angular momentum (d) Linear momentum

**68.** Who indirectly determined of the mass of the electron by measuring the charge of the electrons **[CBSE PMT 2000]**

(a) Rutherford (b) Einstein (c) Thomson (d) Millikan

**69.** Who discovered spin quantum number **[RPMT 2000]**

(a) Unlenbeck and Goudsmit (b) Neil's Bohr

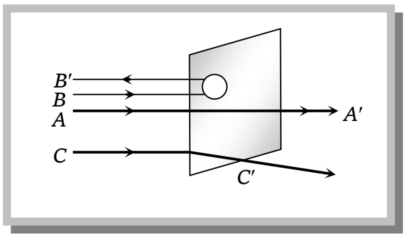
(c) Zeeman (d) Sommerfield

**70.** In Rutherford scattering experiment, what will be the correct angle for $\alpha$ scattering for an impact parameter *b* = 0

**[CBSE 1994; JIPMER 2000]**

(a) $90^o$ (b) $270^o$ (c) $0^o$ (d) $180^o$

**71.** A beam of fast moving alpha particles were directed towards a thin film of gold. The parts *A′*, *B′* and *C′* of the transmitted and reflected beams corresponding to the incident parts *A*, *B* and *C* of the beam, are shown in the adjoining diagram. The number of alpha particles in **[CPMT 1986, 88; RPET 2000]**




(a) *B′* will be minimum and in *C′* maximum

(b) *A′* will be maximum and in *B′* minimum

(c) *A′* will be minimum and in *B′* maximum

(d) *C′* will be minimum and in *B′* maximum

**72.** The radius of hydrogen atom in its ground state is $5.3 \times 10^{-11}\, m$. After collision with an electron it is found to have a radius of $21.2 \times 10^{-11}\, m$. What is the principal quantum number $n$ of the final state of the atom**[CBSE 1994; CPMT**

(a) $n = 4$ (b) $n = 2$ (c) $n = 16$ (d) $n = 3$

**73.** The de-Broglie wavelength of thermal neutrons is of the order of the

(a) Distance between atoms in crystals (b) Size of the nucleus

(c) Bohr's radius (d) Size of a grain

**74.** As per Bohr model the minimum energy required to remove an electron from the ground state of doubly ionised $Li^{(z=3)}$ atom is

**[IIT-JEE 1997; MH CET 2000]**

(a) 1.51 $eV$ (b) 13.6 $eV$ (c) 4.08 $eV$ (d) 122.4 $eV$

**75.** The concept of stationary orbits was proposed by **[Pb. PMT 2000]**

(a) Neil Bohr (b) J.J. Thomson (c) Rutherford (d) I. Newton

**76.** The electron in a hydrogen atom makes a transition from an excited state to ground state. Which of the following statements is true

**[IIT-JEE (Screening) 2000]**

(a) Its kinetic energy increases and its potential and total energies decrease

(b) Its kinetic energy decreases, potential energy increases and its total energy remains same

(c) Its kinetic and total energies decrease and its potential energy increases

(d) Its kinetic, potential and total energies decrease

**77.** Imagine an atom made up of a proton and a hypothetical particle of double the mass of the electron but having same charge as the electron. Apply Bohr atom model and consider all possible transitions of this hypothetical particle to the first excited level. The longest wavelength photon that will be emitted has wavelength $\lambda$ (given in the terms of Rydberg constant $R$ for hydrogen atom) equal to

**[IIT-JEE (Screening) 2000]**

(a) $9/5\, R$ (b) $36/5\, R$ (c) $18/5\, R$ (d) $4/R$

**78.** According to the Rutherford's atomic model, the electrons inside the atom are **[KCET (Med.) 2000]**

(a) Stationary (b) Not stationary (c) Centralized (d) None of these

**79.** The radius of hydrogen atom in ground state is of the order **[EAMCET 1994; MH CET 2000]**

(a) $10^{-8}\, cm$ (b) $10^{-6}\, cm$ (c) $10^{-4}\, cm$ (d) $10^{-7}\, cm$

**80.** The radius of the Bohr orbit in the ground state of hydrogen atom is 0.5 $\mathring{A}$. The radius of the orbit of the electron in the third excited state of $He^{+}$ will be **[MP PMT 2000]**

(a) 8 $\mathring{A}$ (b) 4 $\mathring{A}$ (c) 0.5 $\mathring{A}$ (d) 0.25 $\mathring{A}$

**81.** What will be the angular momentum of a electron, if energy of this electron in $H$-atom is 1.5 $eV$ (in $J$-$sec$)

**[RPMT 2000]**

(a) $1.05 \times 10^{-34}$ (b) $2.1 \times 10^{-34}$ (c) $3.15 \times 10^{-34}$ (d) $-2.1 \times 10^{-34}$

**82.** The ratio of the longest to shortest wavelengths in Brackett series of hydrogen spectra is **[EAMCET (Engg.) 2000]**

(a) $\frac{25}{9}$ (b) $\frac{17}{6}$ (c) $\frac{9}{5}$ (d) $\frac{4}{3}$

**83.** The ratio of minimum to maximum wavelength in Balmer series is **[MP PET 2000]**

(a) 5 : 9 (b) 5 : 36 (c) 1 : 4 (d) 3 : 4

**84.** When an electron jumps from the fourth orbit to the second orbit, one gets the **[CBSE 2000]**

(a) Second line of Lyman series (b) Second line of Paschen series

(c) Second line of Balmer series (d) First line of Pfund series

**85.** Calculate the series limit of the Lyman series of hydrogen atom **[BHU Med. 2000]**

(a) $9.1176 \times 10^{-6} cm$ (b) 10968 *cm* (c) $1.2157 \times 10^{-5} cm$ (d) 82259 *cm*

**86.** Which of the following phenomena suggests the presence of electron energy levels in atoms **[JIPMER 1999]**

(a) Radio active decay (b) Isotopes (c) Spectral lines (d) $\alpha$ -particles scattering

**87.** The ionisation potential of *H*-atom is 13.6 V when it is excited from ground state by monochromatic radiations of 970.6 Å, the number of emission lines will be (according to Bohr's theory) **[RPET 1999]**

(a) 10 (b) 8 (c) 6 (d) 4

**88.** Which of the following spectral series in hydrogen atom give spectral line of 4860 Å **[Roorkee 1999]**

(a) Lyman (b) Balmer (c) Paschen (d) Bracket

**89.** The energy required to excite an electron from the ground state of hydrogen atom to the first excited state, is **[Pb PMT**

(a) $1.602 \times 10^{-14} J$ (b) $1.619 \times 10^{-16} J$ (c) $1.632 \times 10^{-18} J$ (d) $1.656 \times 10^{-20} J$

**90.** The ratio of longest wavelength and the shortest wavelength observed in the five spectral series of emission spectrum of hydrogen is

**[MP PET 1999]**

(a) $\frac{4}{3}$ (b) $\frac{525}{376}$ (c) 25 (d) $\frac{900}{11}$

**91.** If in Rutherford's experiment, the number of particles scattered at 90° angle are 28 per *min*, then number of scattered particles at an angle 60° and 120° will be **[UPSEAT 1999]**

(a) 112/*min*., 12.5/*min* (b) 100/*min*., 200/*min* (c) 50/*min*., 12.5/*min* (d) 117/*min*., 25/*min*

**92.** When the hydrogen atom is changed from its ground state to excited state **[AMU 1999]**

(a) P.E. increases but K.E. decreases (b) K.E. increases but P.E. decreases

(c) P.E. increases (d) K.E. increases

**93.** The velocity of an electron in the second orbit of sodium atom (atomic number = 11) is *v*. the velocity of an electron in its fifth orbit will be **[MP PET 1999]**

(a) $v$ (b) $\frac{22}{5}v$ (c) $\frac{5}{2}v$ (d) $\frac{2}{5}v$

**94.** The ratio between potential energy and kinetic energy of the electron in $(n-1)^{th}$ orbit of hydrogen atom is

**[MP PET 1994; KCET 1999]**

(a) – 2 (b) 2 (c) 1 (d) – 1

**95.** Which of the following transitions in hydrogen atom emits a photon of lowest frequency ($n$ = quantum number)**[BHU 1**

(a) $n = 2$ to $n = 1$ (b) $n = 4$ to $n = 3$ (c) $n = 3$ to $n = 1$ (d) $n = 4$ to $n = 2$

**96.** In hydrogen spectrum the shortest wavelength in Balmer series is $\lambda$. The shortest wavelength in Bracket series will be

**[EAMCET (Engg.) 1999]**

(a) $2\lambda$ (b) $4\lambda$ (c) $9\lambda$ (d) $16\lambda$

**97.** Which of the following statements is true regarding Bohr's model of hydrogen atom.

(I) Orbiting speed of electrons decreases as it falls to discrete orbits away from the nucleus.

(II) Radii of allowed orbits of electrons are proportional to the principal quantum number.

(III) Frequency with which electrons orbit around the nucleus in discrete orbits is inversely proportional to the principal quantum number.

(IV) Binding force with which the electron is bound to the nucleus increases as it shifts to outer orbits.

Select the correct answer using the codes given below **[SCRA 1998]**

(a) I and III (b) II and IV (c) I, II and III (d) II, III and IV

**98.** The Rydberg constant $R$ for hydrogen is **[MP PMT 1998]**

(a) $R = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{2\pi^2 me^2}{ch^2}$ (b) $R = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{2\pi^2 me^4}{ch^2}$ (c) $R = \left(\frac{1}{4\pi\varepsilon_0}\right)^2\frac{2\pi^2 me^4}{c^2h^2}$ (d) $R = \left(\frac{1}{4\pi\varepsilon_0}\right)^2\frac{2\pi^2 me^4}{ch^3}$

**99.** In the Bohr model of a hydrogen atom, the centripetal force is furnished by the coulomb attraction between the proton and the electron. If $a_0$ is the radius of the ground state orbit, $m$ is the mass and $e$ is charge on the electron and $\varepsilon_0$ is the vacuum permittivity, the speed of the electron is **[CBSE PMT 1998]**

(a) 0 (b) $\frac{e}{\sqrt{\varepsilon_0 a_0 m}}$ (c) $\frac{e}{\sqrt{4\pi\varepsilon_0 a_0 m}}$ (d) $\sqrt{\frac{4\pi\varepsilon_0 a_0 m}{e}}$

**100.** The 21 *cm* radio wave emitted by hydrogen in interstellar space is due to the interaction called the hyperline interaction in atomic hydrogen. The energy of the emitted wave is nearly **[CBSE 1998]**

(a) $10^{-17}$ *Joule* (b) 1 *Joule* (c) $7\times10^{-8}$ *Joule* (d) $10^{-24}$ *Joule*

**101.** Which one of the series of hydrogen spectrum is in the visible region **[RPMT 1999; MP PET 1990; MP PMT 1994; AFMC 1998**

(a) Lyman series (b) Balmer series (c) Paschen series (d) Bracket series

**102.** Frequency of the series limit of Balmer series of hydrogen atom in terms of Rydberg constant $R$ and velocity of light $C$ is **[KCET 1998]**

(a) $RC$ (b) $\frac{RC}{4}$ (c) $4RC$ (d) $\frac{4}{RC}$

**103.** Hydrogen atom excites energy level from the fundamental state to $n$ = 3. Number of spectral lines, according to Bohr, is **[CPMT 1997]**

(a) 4 (b) 3 (c) 1 (d) 2

**104.** Ionization energy of hydrogen is 13.6 *eV*. If $h = 6.6\times10^{31}$ *J-sec*, the value of $R$ will be of the order of **[RPMT 1997]**

(a) $10^{10}\ m^1$ (b) $10^7\ m^{-1}$ (c) $10^4\ m^{-1}$ (d) $10^{-7}\ m^{-1}$

**105.** In a hydrogen atom, which of the following electronic transitions would involve the maximum energy change **[MP PET**

(a) From $n$ = 2 to $n$ = 1 (b) From $n$ = 3 to $n$ = 1 (c) From $n$ = 4 to $n$ = 2 (d) From $n$ = 3 to $n$ = 2

**106.** The Rutherford $\alpha$-particle experiment shows that most of the $\alpha$-particles pass through almost unscattered while some are scattered through large angles. What information does it give about the structure of the atom **[AFMC 1997]**

(a) Atom is hollow

(b) The whole mass of the atom is concentrated in a small centre called nucleus

(c) Nucleus is positively charged

(d) All of the above

**107.** An ionic atom equivalent to hydrogen atom has wavelength equal to 1/4 of the wavelengths of hydrogen lines. the ion will be **[RPET 1997]**

(a) $He^+$ (b) $Li^{++}$ (c) $Ne^{9+}$ (d) $Na^{10+}$

**108.** The required energy to detach one electron from Balmer series of hydrogen spectrum is **[CPMT 1997]**

(a) 13.6 *eV* (b) 10.2 *eV* (c) 3.4 *eV* (d) – 1.5 *eV*

**109.** Number of spectral lines in hydrogen atom is **[CPMT 1997]**

(a) 3 (b) 6 (c) 15 (d) Infinite

**110.** A hydrogen atom in its ground state absorbs 10.2 *eV* of energy. The orbital angular momentum is increased by (Given Planck constant $h = 6.6\times10^{-34}$ *J - sec*) **[MP PET 1995; MP PMT 1997]**

(a) $1.05\times10^{-34}$ *J - sec* (b) $3.16\times10^{-34}$ *J - sec* (c) $2.11\times10^{-34}$ *J- sec* (d) $4.22\times10^{-34}$ *J- sec*

**111.** The ratio of the frequencies of the long wavelength limits of Lyman and Balmer series of hydrogen spectrum is **[Haryana CEE 1996]**

(a) 27 : 5 (b) 5 : 27 (c) 4 : 1 (d) 1 : 4

**112.** An electron in hydrogen and one in singly ionised helium atom are excited to the state $n = 2$. A photon is emitted when these electrons jump back to the ground state in each case. Then **[CPMT 1996]**

(a) Energy of photon is same in both

(b) Radiations emitted by helium ion are shifted towards the red as compared to radiation from hydrogen atom

(c) Radiations emitted by helium ion are shifted towards the violet as compared to radiations from hydrogen atom

(d) None of these

**113.** Ionisation potential of hydrogen atom is 13.6 *eV*. Hydrogen atoms in the ground state are excited by monochromatic radiation of photon energy 12.1 *eV*. The spectral lines emitted by hydrogen atoms according to Bohr's theory will be **[CBSE PMT 1996]**

(a) One (b) Two (c) Three (d) Four

**114.** According to classical physics, the electron orbit in the hydrogen atom is unstable because **[CPMT 1995]**

(a) The electron is an unstable particle (b) The electron has very high kinetic energy

(c) An accelerated electron radiates out E.M. waves (d) An accelerated electron absorbs E.M. waves

**115.** According to Bohr's theory of the hydrogen atom, the diameter of the first orbit is about **[CPMT 1995]**

(a) 0.1 $\mathring{A}$ (b) 1 $\mathring{A}$ (c) 13.6 $\mathring{A}$ (d) 5890 $\mathring{A}$

**116.** The splitting of line into groups under the effect of electric or magnetic field is called **[AFMC 1995]**

(a) Zeeman's effect (b) Bohr's effect (c) Heisenberg's effect (d) Magnetic effect

**117.** The number of revolutions per second made by an electron in the first Bohr orbit of hydrogen atom is of the order of **[AMU 1995]**

(a) $10^{20}$ (b) $10^{19}$ (c) $10^{17}$ (d) $10^{15}$

**118.** Which of the following statements about the Bohr model of the hydrogen atom is false

(a) Acceleration of electron in $n$ = 2 orbit is less than that in $n$ =1 orbit

(b) Angular momentum of electron in $n$ = 2 orbit is more than that in $n$ =1 orbit

(c) Kinetic energy of electron in $n$ = 2 orbit is less than that in $n$ =1 orbit

(d) Potential energy of electron in $n$ = 2 orbit is less than that in $n$ =1 orbit

**119.** An electron makes a transition from orbit $n$ = 4 to the orbit $n$ = 2 of a hydrogen atom. The wave number of the emitted radiations ($R$ = Rydberg's constant) will be

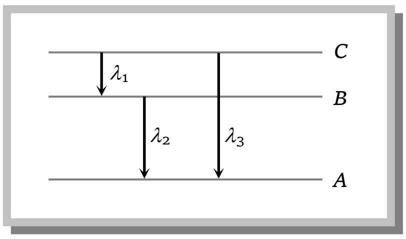
(a) $\frac{16}{3R}$ (b) $\frac{2R}{16}$ (c) $\frac{3R}{16}$ (d) $\frac{4R}{16}$

**120.** Energy levels A, B, C of a certain atom corresponding to increasing values of energy *i.e.*, $E_A < E_B < E_C$. If $\lambda_1, \lambda_2, \lambda_3$ are the wavelengths of radiations corresponding to the transitions $C$ to $B$, $B$ to $A$ and $C$ to $A$ respectively, which of the following statements is correct **[CBSE 1990; AIIMS 1995]**

(a) $\lambda_3 = \lambda_1 + \lambda_2$

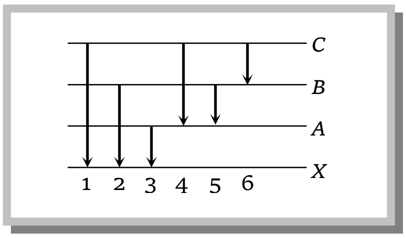
(b) $\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

(c) $\lambda_1 + \lambda_2 + \lambda_3 = 0$



(d) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

**121.** The figure indicates the energy level diagram of an atom and the origin of six spectral lines in emission (*e.g.*, line no. 5 arises from the transition from level $B$ to $A$). The following spectral lines will also occur in the absorption spectrum **[CBSE 1995]**




(a) 1, 4, 6

(b) 4, 5, 6

(c) 1, 2, 3

(d) 1, 2, 3, 4, 5, 6

**122.** If in some atomic orbit, quantum numbers $n$, $l$ and $m_l$ are same, then the maximum number of electrons that can be present there are **[RPMT 1995]**

(a) 2 (b) $2n^2$ (c) $(2l+1)$ (d) $2(2l+1)$

**123.** Which one of these is non-divisible **[KCET 1994]**

(a) Nucleus (b) Photon (c) Proton (d) Atom

**124.** The fact that protons carry energy was established by **[ISM Dhanbad 1994]**

(a) Doppler's effect (b) Compton's effect (c) Bohr's theory (d) Diffraction of light

**125.** The ratio of the speed of the electrons in the ground state of hydrogen to the speed of light in vacuum is **[MNR 1994]**

(a) 1/2 (b) 2/137 (c) 1/137 (d) 1/237

**126.** Bohr's model of $H$-atom predicts that the absorption spectra involves **[CBSE 1993]**

(a) Accelerating electrons (b) Decelerating electrons

(c) Electron going to higher K.E. level (d) Electrons going to lower momentum levels

**127.** X-rays are not emitted from excited hydrogen atoms, because **[RPET 1993]**

(a) Hydrogen atoms contains only one electron

(b) Energy levels of the hydrogen atoms are very closed spaced

(c) There are no neutrons in the nucleus of the $H$-atom

(d) All of the above

**128.** Energy levels of the hydrogen atom are order of energy are –13.6, –3.40, –1.51, –0.85, –0.54,....., 0 *eV*. The ionisation potential for the atom in second excited state is **[CBSE PMT 1993]**

(a) 13.6 *volt* (b) 1.51 *V* (c) 1.51 *eV* (d) 13.6 *eV*

**129.** Which of the following is true **[MP PET 1993]**

(a) Lyman series is a continuous spectrum

(b) Paschen series is a line spectrum in the infrared

(c) Balmer series is a line spectrum in the ultraviolet

(d) The spectral series formula can be derived from the Rutherford model of the hydrogen atom

**130.** Every series of hydrogen spectrum has an upper and lower limit in wavelength. The spectral series which has an upper limit of wavelength equal to 18752 Å is (Rydberg constant $R = 1.097 \times 10^7$ per metre) **[MP PMT 1993]**

(a) Balmer series (b) Lyman series (c) Paschen series (d) Pfund series

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

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

**132.** The wavelength of radiation emanating from transition of an atom

(i) From electronic state A to C and

(ii) From electronic state B to C are 1000 Å and 5000 Å respectively. What is the wavelength of radiation emanating from transition of the atom from state A to B

(a) 4000 Å (b) 2000 Å (c) 1250 Å (d) 500 Å

**133.** The ionization energy of hydrogen atom is 13.6 *eV*. Following Bohr's theory, the energy corresponding to a transition between 3rd and 4th orbit is **[CBSE PMT 1992]**

(a) 3.40 *eV* (b) 1.51 *eV* (c) 0.85 *eV* (d) 0.66 *eV*

**134.** Which of the following pairs, have identical atomic structure **[CBSE PMT 1992]**

(a) $Li^+, Na^+$ (b) $He, Ne^+$ (c) *He, Li* (d) $C, N^+$

**135.** As the electron in Bohr orbit of hydrogen atom passes from state *n* = 2 to *n* = 1, the KE (*K*) and PE (*U*) change as**[NSEP**

(a) *K* two-fold, *U* also two-fold (b) *K* four-fold, *U* also four-fold (c)*K* four-fold, *U* two-fold

**136.** The ionisation energy of 10 times ionised sodium atom is **[DPMT 1991]**

(a) 13.6 *eV* (b) 13.6 × 11 *eV* (c) $\frac{13.6}{11}$ *eV* (d) $13.6 \times (11)^2$ *eV*

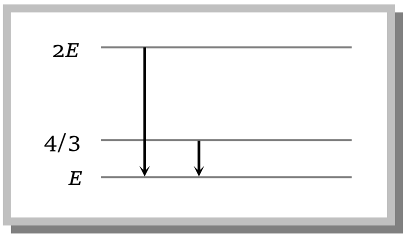
**137.** If the electron in *H* atom radiates a photon of wavelength 4860 Å, the KE of the electron **[CPMT 1991]**

(a) Decreases by $2.0 \times 10^{-19}$ *J* (b) Increases by $4.1 \times 10^{-19}$ *J* (c) Decreases by $4.1 \times 10^{-19}$ *J* (d) Increases by $8.2 \times 10^{-19}$ *J*

**138.** Assume that there exist an atom, according to Bohr model, whose first ionization potential is 20*V*, then the value of first excitation potential for this atom will be **[RPMT 1989]**

(a) 5*V* (b) 10*V* (c) 15*V* (d) 25*V*

**139.** The following diagram indicates the energy levels of a certain atom when the system moves from 2*E* level to *E*. A photon of wavelength $\lambda$ is emitted. The wavelength of photon produced during its transition from $\frac{4E}{3}$ level to *E* is **[CPMT 1989]**



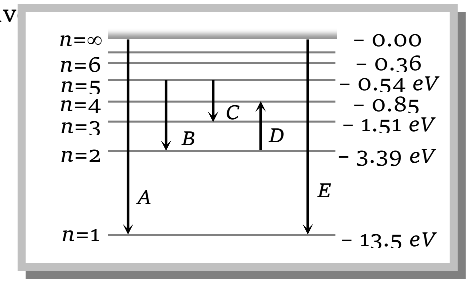

(a) $\lambda / 3$

(b) $3\lambda / 4$

(c) $4\lambda / 3$

(d) $3\lambda$

**140.** The energy levels of the hydrogen spectrum is shown in figure. There are some transitions *A*, *B*, *C*, *D* and *E*. Transition *A*, *B* and *C* respectiv **[CPMT 1986, 88]**




(a) First member of Lyman series, third spectral line of Balmer series and the second spectral line of Paschen series

(b) Ionization potential of hydrogen, second spectral line of Paschen series

(c) Series limit of Lyman series, third spectral line of Balmer series and second spectral line of Paschen series

(d) Series limit of Lyman series, second spectral line of Balmer series and third spectral line of Paschen series

**141.** The orbital quantum number of subshell which contains 7 orbitals is **[RPMT 1986]**

(a) $l = 7$ (b) $l = 3$ (c) $l = 0$ (d) None of these

**142.** When alpha particles are sent through a thin metal foil most of them go straight through the foil because**[IIT-JEE 1984]**

(a) Alpha particles are much heavier than electrons (b) Alpha particles are positively charged
(c) Most of the atom is empty space (d) Alpha particles move with high velocity

**143.** A hydrogen atom moving with velocity $4 m/s$ absorbs a photon of wavelength $\lambda$ and stops. The value of $\lambda$ will be
(a) 1000 $\mathring{A}$ (b) 2000 $\mathring{A}$ (c) 3000 $\mathring{A}$ (d) 4000 $\mathring{A}$

**144.** A hydrogen atom moving with velocity $u$ collides inelastically with another hydrogen atom at rest. Both the atoms are in the ground state before collision. The minimum value of $u$, so that one of the atoms get excited, will be
(a) $3.12 \times 10^6\ m/s$ (b) $9.36 \times 10^5\ m/s$ (c) $6.24 \times 10^4\ m/s$ (d) $5 \times 10^3\ m/s$

**145.** The angular momentum of electron in hydrogen atom is proportional to
(a) $\sqrt{r}$ (b) $1/r$ (c) $r^2$ (d) $1/\sqrt{r}$

**146.** The frequency of revolution of electron in $n$th orbit is $f_n$. If the electron makes a transition from $n$th orbit to $(n - 1)$th orbit, then the relation between the frequency ($\nu$) of emitted photon and $f_n$ will be
(a) $\nu = f_n^2$ (b) $\nu = \sqrt{f_n}$ (c) $\nu = \dfrac{1}{f_n}$ (d) $\nu = f_n$

**147.** Two photons from excited atomic hydrogen are detected. Their energies are 10.2 $eV$ and 1.9 $eV$. These photons must come from
(a) A single atom (b) Two different atoms
(c) Either a single atom or two atoms (d) None of these

**148.** Goudsmit and Uhelenbeck postulated the concept of electron spin in order to explain
(a) Hydrogen spectra (b) Fine structure of hydrogen spectra
(c) Doublet structure of Alkali metal spectra (d) Elliptical orbit motion of electrons in atom

**149.** The angular momenta of electrons in an atom produces
(a) Magnetic moment (b) Zeeman effect (c) Light (d) Nuclear fission

**150.** For an atom situated in a magnetic field, the number of possible orientations for orbit with $n = 3$ are
(a) 9 (b) 7 (c) 5 (d) 3

**151.** In Bohr model of hydrogen atom, the force on the electron depends on the principal quantum number as
(a) $F \propto 1/n^3$ (b) $F \propto 1/n^4$ (c) $F \propto 1/n^5$ (d) Does not depend on $n$

**152.** A proton and an electron, both at rest initially, combine to form a hydrogen atom in the ground state. A single photon is emitted in this process. Then the wavelength of this photon is
(a) 912 $\mathring{A}$ (b) 3646 $\mathring{A}$ (c) 8201 $\mathring{A}$ (d) None of these

**153.** When a hydrogen atom emits a photon in going from $n = 5$ to $n = 1$, its recoil speed is almost
(a) $10^{-4}\ m/s$ (b) $2 \times 10^{-2}\ m/s$ (c) $4\ m/s$ (d) $8 \times 10^2\ m/s$

**154.** The ratio between total acceleration of the electron in singly ionized helium atom and doubly ionized lithium atom (both in ground state) is
(a) $\dfrac{2}{3}$ (b) $\dfrac{4}{9}$ (c) $\dfrac{8}{27}$ (d) 1

**155.** Suppose the potential energy between electron and proton at a distance $r$ is given by $-\dfrac{ke^2}{3r^3}$. Application of Bohr's theory to hydrogen atom in this case shows that
(A) Energy in the $n$th orbit is proportional to $n^6$ (B) Energy is proportional to $m^{-3}$ ($m$ = mass of electron)
(a) Only (A) is correct (b) Only (B) is correct
(c) Both (A) and (B) are correct (d) None are correct

**156.** An electron with kinetic energy 5 $eV$ is incident on a hydrogen atom in its ground state. The collision

(a) Must be elastic
(b) May be partially elastic
(c) Must be completely inelastic
(d) May be completely inelastic

**157.** Suppose, the electron in a hydrogen atom makes transition from $n$ = 3 to $n$ = 2 in $10^{-8}s$. The order of the torque acting on the electron in this period, using the relation between torque and angular momentum as discussed in the chapter on rotational mechanics is

(a) $10^{-34}$ $N$-$m$
(b) $10^{-24}$ $N$-$m$
(c) $10^{-42}$ $N$-$m$
(d) $10^{-8}$ $N$-$m$

**158.** The distance of the closest approach of an alpha particle fired at a nucleus with momentum $p$ is $r_0$. The distance of the closest approach when the alpha particle is fired at the same nucleus with momentum 2$p$ will be

(a) $2r_0$
(b) $4r_0$
(c) $\frac{r_0}{2}$
(d) $\frac{r_0}{4}$

**159.** Radiations of wavelengths $\lambda$ are incident on atoms of hydrogen in ground state. These atoms absorb fraction of these radiation. The excited atoms have ten different wavelengths in the emission spectrum. Then value of $\lambda$ is

(a) 570 $\mathring{A}$
(b) 750 $\mathring{A}$
(c) 590 $\mathring{A}$
(d) 950 $\mathring{A}$

**160.** Potential energy between a proton and an electron is given by $U = \frac{Ke^2}{3R^3}$, then radius of Bohr's orbit can be given by

(a) $\frac{Ke^2m}{h^2}$
(b) $\frac{6\pi^3}{n^3}\frac{Ke^2m}{h^2}$
(c) $\frac{2\pi}{n}\frac{Ke^2m}{h^2}$
(d) $\frac{4\pi^2Ke^2m}{n^2h^2}$

**161.** The minimum kinetic energy of an electron, hydrogen ion, helium ion required for ionization of a hydrogen atom is $E_1$ in case electron is collided with hydrogen atom. It is $E_2$ if hydrogen ion is collided and $E_3$ when helium ion is collided. Then

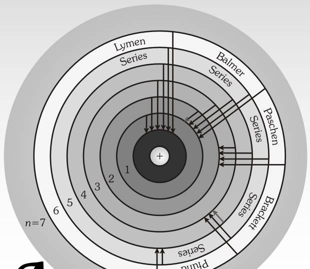
(a) $E_1 = E_2 = E_3$
(b) $E_1 > E_2 > E_3$
(c) $E_1 < E_2 < E_3$
(d) $E_1 > E_3 > E_2$

**162.** The wave number of first line of Balmer series in hydrogen atom is $1.52 \times 10^6\ m^{-1}$. The wave number of first line of Lyman series in $Be^{3+}$ will be

(a) $2.43 \times 10^8\ m^{-1}$
(b) $1.31 \times 10^8\ m^{-1}$
(c) $5.44 \times 10^8\ m^{-1}$
(d) $6.83 \times 10^8\ m^{-1}$

**163.** A photon of energy 10.2 $eV$ corresponds to light of wavelength $\lambda_0$. Due to an electron transition from $n$ = 2 to $n$ = 1 in a hydrogen atom, light of wavelength $\lambda$ is emitted. If we take into account the recoil of the atom when the photon is emitted

(a) $\lambda = \lambda_0$
(b) $\lambda < \lambda_0$
(c) $\lambda > \lambda_0$
(d) The data is not sufficient to reach a conclusion




# Answer Sheet

## Assignments

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| a | d | a | b | a | d | b | c | b | a | b | a | c | c | a | a | d | c | a | d |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| b | c | d | c | b | b | a | c | d | d | d | b | a | d | b | a | d | a | c | b |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| a | c | b | c | b | a | c | c | d | b | d | d | d | b | d | a | b | b | d | c |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| a, d | c | a | d | c | d | c | d | a | d | b | b | c | d | a | a | c | b | a | b |
| 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| c | a | a | c | a | c | c | b | c | d | a | a | d | a | b | b | a | d | c | d |
| 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| b | b | b | b | b | d | a | c | d | a | a | c | c | c | b | a | d | d | c | b |
| 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| c | a | b | c | c | d | b | b | b | c | d | c | d | d | b | d | c | c | d | c |
| 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| b | c | a | c | a | d | c | c | b | a | b | a | c | c | c | a | b | d | d | d |
| 161 | 162 | 163 | | | | | | | | | | | | | | | | | |
| c | b | c | | | | | | | | | | | | | | | | | |