PRACTICE PROBLEMS

PP-1

Q.1 Infrared lamps are used in restaurants and cafeterias to keep food warm. The infrared radiation is strongly absorbed by water raising its temperature and that of the food in which it is incarporated. How many photons per second of infrared radiation are produced by an infrared lamp that consumes energy at the rate of 100 watt (100 Js^{-1}) and is 12% efficient in converting this energy to infrared radiation? Assume that infrared radiation has a wavelength of 1500 nm.

Q.2 The photochemical decomposition of Br_2 into free radicals takes place by absorption of radiations of 6232 Å. Calculate the bond dissociation energy of Br_2 in kJ/mol.

Q.3 Find the number of photons emitted per second by a 25 watt source of monochromatic of wavelength 6000Å.

Q.4 What is the mass of photon of sodium light having a wavelength of 5890 Å? Given $h = 6.6 \times 10^{-27}$ erg.

Q.5 How much energy will be released when a sodium ion and a chlorine ion, originally at infinite distance are brought closer to a distance of 2.76 Å (The shortest possible distance of approaching each other in NaCl crystal)? Assume that ions act as point charges, each with magnitude of 1.60×10^{-19} C? Permittivity constant of the medium is 9.0×10^9 Nm^2C^{-2}.

Q.6 When light frequency, v is shone on a metal surface with threshold frequency v_0, photoelectrons are emitted with maximum kinetic energy = 1.3×10^{-18} J. If the ratio, $v : v_0 = 3 : 1$, calculate the threshold frequency v_0.

Q.7 Find the frequency of light which ejects electrons from a metal surface fully stopped by a retarding potential of 3 volt. The photoelectric effect begins in this metal at frequency of 6×10^{14} sec^{-1}. What work function of metal?

Q.8 The photo-electric effect consists of the emission of electrons from the surface of metal, when the metal is irradiated with light. A photon with a minimum energy of 3.97×10^{-19} J is necessary to eject electron from Ba.
(a) What is the frequency of radiation s corresponding to this value?
(b) Will a blue light of wavelength 450 nm be able to eject an electron from Ba?
Given $h = 6.625 \times 10^{-27}$ erg sec?

Q.9 When a certain metal was irradiated with light having a frequency of 3.0×10^{16} sec^{-1}, the photoelectrons emitted had twice the kinetic energy as did photoelectrons emitted when the same metal was irradiated with light having a frequency of 2.0×10^{16} sec^{-1}. Calculate v_0 for the metal.

Q.10 Light of wavelength 2000 Å falls on a aluminium surface (work function of aluminium 4.2 eV). Calculate.
(a) The kinetic energy of the fastest and slowest emitted photoelectrons.
(b) Stopping potential.
(c) Cut off wavelength for aluminium.

Q.11 Characteristic x-rays wavelength are related to atomic number by the relation $\sqrt{v} = a(z-b)$, where Z is atomic number and a, b are constants. If $\lambda_1 = = 2.886$ Å and $\lambda_2 = 2.365$ Å corresponds to $Z_1 = 55$ and $Z_2 = 60$ respectively, what is the value of z corresponding $\lambda = 2.660$ Å?

PP-2

Q.1 Light of wavelength 12818Å is emitted when the electron of a hydrogen atom drops from 5th to 3rd quantum level. Find the wavelength of the photon when falls from 3rd to ground level.

Q.2 Calculate the frequency, energy and wavelength of I line of Balmer series for H. Also calculate corresponding line for He+?

Q.3 The series limit for Balmer series of H spectrum occurs at 3664 Å. Calculate
(a) ionisation energy of H atom.
(b) wavelength of the photon that would remove the electron in the ground state of the H atom.

Q.4 Calculate the frequency, energy and wavelength of radiations corresponding to spectral line of lowest frequency in Lyman series in the spectra of H atom. Also calculate the energy of corresponding line in the spectra of Li^{+2}.

$$RH = 1.09678 \times 107\ m^{-1}\ ,\ C = 3 \times 10^{8}\ m\ sec^{-1},\ h\ = 6.625 \times 10^{-34}\ J\text{-sec.}$$

Q.5 What lines of atomic hydrogen spectrum fall within the wavelength range from 94.5 to 130.0 nm?

Q.6 An electron jumps from a certain Bohr's orbit to the V (5th) orbit. The wave no. of radiation emitted is 1340.3 cm^{-1}. Calculate the no. of orbit from which this jump has taken place. $R_H = 109678\ cm^{-1}$.

Q.7 Calculate the missing wavelength of light, if it is focussed on H atom which shows a transition from I energy level to II energy level.

Q.8 How much energy is emitted out when a mole of electron falls in 1 g atom of H from II to I orbit? $R_H = 109678\ cm^{-1}$.

Q.9 Compare the energy of n = 5 to n = 4 transition of an electron plus nucleus Z = 3 with the energy of n = 2 to n = 1 transition for an electron plus nucleus with Z = 2.

Q.10 Electrons of energy 12.2 eV are fired at the hydrogen atoms in a gas discharge tube. Determine the wavelengths of the lines that can be emitted by hydrogen.

PP-3

Q.1 What element has a hydrogen like spectrum whose lines have wavelengths four times shorter than those of atomic hydrogen

Q.2 The predominant yellow line in the spectrum of sodium vapour lamp has a wavelength of 590 nm. What minimum accelerating potential is needed to excite this line in an electron tube containing sodium vapour?

Q.3 The series limit of the Balmer series of hydrogen is given by 3.65×10^{-5} cm. An element is found to give K_α line of wavelength 10^{-8}cm. Find out the atomic number of the element.

Q.4 Light of wavelength 470 nm falls on the surface of potassium metal, electrons are emitted with a velocity $6.4 \times 10^{4}\ m\ sec^{-1}$.
(a) What is the kinetic energy of emitted electron?
(b) What is the minimum amount of energy required to remove an electron from K atom?

Q.5 What change in molar energy in joule would be associated with an atomic transition giving rise to radiation at 1 Hz? Given $h = 6.626 \times 10^{-34}$ J sec.

Q.6 An electron in H atom in its ground state absorbs 1.5 times as much energy as the minimum required for its escape (i.e. 13.6 eV) from the atom. Calculate the wavelength of emitted electron.

Q.7 When ultraviolet light of wavelength 800 Å and 700 Å falls on H atom in ground state, the electrons with kinetic energy 1.8 eV and 4.0 eV are emitted out from H atom repectively. calcualte Planks' constant.

Q.8 Electrons of energies 10.20 eV and 12.09 eV can cause radiation to be emitted from hydrogen atom. Calculate in each case the principal quantum no. of the orbit to which electron belongs and the wavelength of the radiations emitted if it drops back to ground state.

Q.9 Find the velocity of photoelectron liberated by electromagnetic radiations of wavelength 18.0 nm from stationary He^+ ion in the ground state.

Q.10 The wavelength of the photo-electric threshold of metal is 230 nm. Determine the energy of the electrons ejected form the surface by U.V. light of λ 180 nm. Given h = 6.625×10^{-27} erg sec.

PP-4

1. Calcualte total spin, magnetic moment for the atoms having at. no. 7, 24 34 and 36.

2. Wrte down the our quantum numbers for V and VI electrons of carbon atom.

3. Given below are the sets of quantum numbers for given orbitals. Name these orbitals.

(a)	(b)	(c)	(d)	(e)
n = 2	n -= 4	n = 3	n = 4	n = 3
l = 1	l =2	l = 1	l = 0	l = 2
m = –1	m = 0	m = ±1	m =0	m = ± 2

4. What values are assigned to quantum number n, l, m for

(a) 2s (b) $2p_z$ (c) $4d_{x^2-y^2}$ (d) $4d_{z^2}$

5. Write down the electronic configuration of following species and calculate total spin, magnetic moment and unpaired electrons in each (a) 44 Ru (b) $_{25}Mn^+$.

6. Calcualt ethe otal spin for the following ions and atoms.

(a) Cl^- (b) Pd (c) Cr^+ (d) Ni^{2+} (e) V^{3+} (f) Cu^+

7. Two elements P (at wt. 39) and Q (at. wt 80) contain 20 and 45 neutrons respectively in their nucleus;

(a) Write down their electronic configurations.

(b) How their electronic configurations change when P combines with Q and Q combines with Q.

8. An atom has electronic configuration of 2, 8, 18 , 7.]

(a) What is the at. no. of atom?

(b) To which of the following it is chemically similar and why?

$_7N$, $_{17}Cl$, $_{15}P$ and $_{18}Ar$

9. Which atoms have as many as s electrons as p electrons?

10. Write down all the four quantum no. for

(a) 19th electron of $_{24}Cr$ (b) 21 st electron of $_{21}Cr$ (c) p electrons of 7N

PP-5

Q.1 Write the values of all azimuthal and magnetic quantum no. if n = 2.

Q.2 Write down the four quantum no. for 8th electron of oxygen atom,

Q.3 What are the atomic no. of elements whose outermost electrons are represented as

(a) $2p^2$

(b) $3d^6$, $4s^2$?

Q.4 Which of the following orbitals are not possible 1p, 2s, 2p, 3d , 2d?

Q.5 Express the orbitals s, p, d, f of a shell in increasing order of energy.

Q.6 How many electrons may enter the orbitals denoted by

Q.7 Calculate total no. of neutrons in 14 mg of C^{14}.

Q.8 An oxide of N has mol. weight 30. Find out total no. of electrons in one molecule of compound.

Q.9 How many atoms of Mg are present in one mL of Mg? The density of ${}_{12}Mg^{24}$ is 1.74 g mL^{-1}.

Q.10 What is the total no. of electrons in 18 mL H_2O?

PP-6

1. Calculate the wavelength of radiation emitted, producting a line in Lyman series, when an electron falls from fourth stationary state in hydrogen atom.

2. Calculate energy of electron which is moving in the orbit that has its radius. sixteen times the radius of first Bohr orbit for H–atom.

3. Wavelength of the Balmer H_α line is 6565 $\overset{\circ}{A}$. Calculate the wavelength of H_β, line of same hydrogen like atom.

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

5. A photon having $\lambda = 854\,\overset{\circ}{A}$ causes the ionization of a nitrogen atom. Give the I. E. permole of nitrogen in KJ.

6. H-atom is exposed to electromagnetic rdiation of 1028 $\overset{\circ}{A}$ and gives out induced radiations (radiations emitted when e^- returns to ground state). Calculate λ of induced radiations.

7. If the radii of the first and fourth orbits of hydrogen atom are r_1 and r_4 respectively, then how many times r_4 is greater than r_1.

(A) 2 (B) 4 (C) 9 (D) 16

8. Radius of a Bohr's second orbit of H will be

(A) 0.0529 nm (B) 0.0529 × 2 nm (C) 0.0529 × 2^2 nm (D) 0.0529 × 2^{-2} nm,

9. Energy levels A, B and C of a certain atom correspond to increasing values of energy, i.e. $E_A < E_B < E_C$. If λ_1, λ_2 and λ_3 are the wavelength of radiations corresponding to transitions C to B, B and A and C to A respectively, which of the following relations is correct :

(A) $\lambda_3 = \lambda_1 + \lambda_2$ (B) $\lambda_3 = \dfrac{\lambda_1\lambda_2}{\lambda_1 + \lambda_2}$ (C) $\lambda_1 + \lambda_2 + \lambda_3 = 0$ (D) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

10. The wavelength of the first line if balmer series in the hydrogen spectrum is λ. What is the wavelength of the second line ?

(A) $\dfrac{20\lambda}{27}$ (B) $\dfrac{3\lambda}{16}$ (C) $\dfrac{5\lambda}{36}$ (D) $\dfrac{3\lambda}{4}$

PP-7

Q.1 On the basis of Heisenber's uncertainty principle, show that the electron cannot exist within the nucleus.

Q.2 What is the mass of one photon?

Q.3 Two hydrogen atoms collide head on and end up with zero kinetic energy. Each atom then emits a photon of wavelength 121.6 nm. Which transition leads to this wavelength? How fast were the hydrogen atoms travelling before collision?

Q.4 Calculate the wavelength of a 100 g rubber ball moving with a velocity 100 m sec^{-1}. Is the wavelength of ball short enough to be observed?

Q.5 Find the de Broglie wavelength of electron (in $\overset{0}{A}$)accelerated though V volt .

Q.6 The position of a proton is measured with an accuracy of $\pm 1.0 \times 10^{-1}$ m. Find the uncertainty in the position of proton 1 second later. Assume u_{proton} = speed of light.

Q.7 What is the significance of $\psi_{4,2,0}$?

Q.8 What is the relationship between eV and the wavelength in metre of the energetically equivalent photon?

Q.9 The absorption of energy by an atom of hydrogen in ground state, results in the ejection of the electron with de Broglie wavelength $\lambda = 4.70 \times 10^{-10}$ m. Given that the ionisation energy is 13.6 eV, calculate the energy of the photon which caused the ejection of electron.

Q.10 Calculate the wavelength of a neutron moving with a velocity 4×10^8 cm sec^{-1}. Mass of neutron is 1.675×10^{-27} kg.

PP-8

1. Calculate the wavelength in angstrom of photon that is emitted when an e– in Bohr orbit n = 2 returns to the robit n = 1 . The ionization potential of the ground state of hydrogen atom is 2.17×10^{-11} erg/atom.

2. The radius of the an orbit of hydrogen atom is 0.85 nm. Calculate the velocity of electron in this orbit.

3. The velocity of e^- in a certain Bohr orbit of the hydrogen atom bears the ratio 1 : 275 to the velocity of light. What is the quantum no. "n" of the orbit and the wave no. of the radiation emitted for the transition from the quantum state (n + 1) to the ground state.

4. A doubly ionised lithium atom is hydrogen like with atomic number z = 3 . Find the wavelength of the radiation required to excite the electron in Li^{2+} from the first to the third Bohr orbit.

5. 1.8 g hydrogen atoms are excited to radiations. The study of spectra indicates that 27% of the atoms are in 3rd energy level and 15% of atoms in 2 nd energy level and the rest in ground state. If I. P. of H is 21.7×10^{-12} erg. Calculate –

(i) No. of atoms present in III & II energy level.

(ii) Total energy evolved when all the atoms return to ground state.

6. The energy of an excited H-atom is –3.4 eV. Calculate angular moemntum of e^- in the given orbit.

7. The vapours of Hg absorb some electrons accelerated by a potential diff. of 45 volt as a result of which light is emitted. If the full energy of single incident e^- is supposed to be converted into light emitted by single Hg atom, find the wave no. of the light.

8. If the average life time of an excited state of H atom is of order 10^{-8} sec, estimate how many orbits an e^- makes when it is in the state n = 2 and before it suffers a transition to n = 1 state.

9. What should be the ratio of the radii of the second orbit of Li^{+2} ion and the third orbit of Be^{+3} ion?

(A) 3 : 1 (B) 7 : 11 (C) 4 : 9 (D) 3 : 4

10. If the velocity of the first orbit of hydrogen atom is x, then velocity of the third orbit will be:

(A) 3x (B) $\pi/3$ (C) 9x (D) None of these

PP-9

Q.1 Calculate the wavelength of CO_2 molecule moving with velocity of 440 m sec^{-1}.

Q.2 What is de Broglie wavelength for an electron in the inner most orbit of the hydrogen atom?

Q.3 A base ball of mass 20 0 g is moving with velocity 3×10^3 cm sec^{-1}. We can locate the base ball with an error equal to magnitude to the wavelength of ligh tused, i.e,. 4000Å. Calcualte the uncertainty in momentum as compared to the total momentum of the base basll.

Q.4 Find out the wavelength of a track star running 100 meter dash in 10.1 sec if its weight is 75 kg.

Q.5 Calculate the wavelength of a sub-atomic particle of mass 9×10^{-27} g moving with a velocity of 10^6 m sec^{-1}.

Q.6 Calculate the wavelength of proton which is accelerated by a potential of 35 volts.

Q.7 A proton (mass 1.66×10^{-27} kg) is moving with kinetic energy 5×10^{-27} J. What is the wavelength of proton?

Q.8 A moving particle is associated with wavelength 5×10^{-8} m. If its momentum is reduced to half of its value, compute the new wavelength.

Q.9 The ratio of velocities of the electrons in the fifth orbit of Li^{+2} and He^{+} should be

(A) 3 : 2 (B) 2 : 3 (C) 3 : 5 (D) 3 : 4

Q.10 What should be the ratio of the difference between energies of first and second orbits and second and third orbits of hydrogen atom?

(A) 1/3 (B) 27/5 (C) 9/4 (D) 4/9

PP-10

1. Calculate the frequency of e^- in the first Bohr orbit in a H-atom.

2. A single electron orbits around a stationary nucleus of charge +Ze where Z is atomic number and 'e' is the magnitude of the electric charge. The hydrogen like species required 47.2 eV to excite the electron from the second Bohr orbit to the third Bohr orbit. Find

(i) the value of Z and give the hydrogen like species formed.

(ii) the kinetic energy and potential energy of the electron in the first Bohr orbit.

3. A stationary He^+ ion emitted a photon corresponding to a first line of the Lyman series. The photon liberated a photoelecton from a stationary H atom in ground state. What is the velocity of photoelectron

4. To what series does the spectral lines of atomic hydrogen belong if its wave number is equal to the difference between the wave numbers of the following two lines of the Balmer series 486.1 and 410.2 nm. What is the wavelength of this.

5. Calculate the threshold frequency of metal if the binding energy is 180.69 mol^{-1} of electron.

6. Calculate the binding energy per mole when threshold wavelength of photon is 240 nm.

7. A metal was irriadated by light of frequency 3.2×10^{15} S^{-1}. The photoelectron produced had its KE, 2 times the KE of the photoelectron which was produced when the same metal was irriadated with a light of frequency $2.0 \times 10^{15} S^{-1}$. What is work function.

8. U. V. light of wavelength 800 Å & 700 Å falls on hydrogen atom in their ground state & liberates electrons with kinetic energy 1.8 eV and 4 eV respectively. Calcualte planck's constant.

9. A potential difference of 20 KV is applied across an X -ray tube. Find the minimum wavelength of X-ray generated.

10. The K. E. of an electron emitted from tungstan surface is 3.06 eV. Waht voltage would be required to bring the electron to rest.

PP-11

Q.1 An atom of an element contains 13 electrons. Its nucleus has 14 neutrons. Find out its atomic number and approximate atomic mass. An isotope has atomic mass 2 units higher. What will be the number of protons, neutrons and electrons in the isotope?

Q.2 From the following find out groups of isotopes, isobars and isotones:

$^{16}_{8}O, ^{39}_{19}K, ^{14}_{6}C, ^{239}_{92}U, ^{14}_{7}N, ^{40}_{20}Ca, ^{238}_{92}U, ^{77}_{32}Ge,$

$^{77}_{33}As, ^{18}_{8}O, ^{76}_{32}Ge, ^{78}_{34}Se$

Q.3 An element has atomic number 30. Its cation has 2 units positive charge. How many protons and electrons are present in the cation ?

Q.4 Find (i) the total number of neutrons and (ii) the total mass of neutrons in 7 mg of ^{14}C (assuming that mass of neutron = mass of hydrogen atom).

Q.5 Find e/m for He^{2+} ion and compare with that for electron.

Q.6 How many chlorine atoms can you ionize in the process ?
$Cl \rightarrow Cl^{+} + e$ by the energy liberated from the following process:
$Cl + e \rightarrow Cl^{-}$ for 6×10^{23} atoms
given that electron afinity of chlorine is 3.61 eV and ionization energy of chlorine is 17.422 eV.

Q.7 Find the velocity (ms^{-1}) of electron in first Bohr orbit of radius a_0. Also find the de Broglie wavelength (in 'm'). Find the orbital angular momentum of 2p orbital of hydrogen atom in units of $h/2\pi$.

Q.8 Suppose 10^{-17} J of light energy is needed by the interior of the human eye to see an object. How many photons of green light (λ= 550 nm) are needed to generate this ninimum amount of energy?

Q.9 If h is Planck's constant, the momentum of a photon of wavelength 0.01 Å is:
(a) 10^{-2} h (B) h (C) 10^{2} h (D) 10^{12}h

Q.10 The uncertainty in the momentum of an electron is 10^{-5} kg ms^{-1}. The uncertainty in its position will be:
(A) 1.05×10^{-28}m (B) 1.05×10^{-26}m (C) 5.27×10^{-30}m (D) 5.25×10^{-28}m

PP-12

1. The eyes of certain mumber of the reptile family pass a single visual signal to the brain when the visual receptors are struck by photons of wavelength 850 nm. If a total energy of $3.15 \times ^{-14}$ J is required to trip the signal, what is the minimum number of photons that must strike the receptor.

2. Find the number of photons of radiation of frequency 5×10^{13} s^{-1} that must be absorbed in order to melt one gm ice when the latent heat of fustion of ice is 330 J/g.

3. Suppose 10^{-17} J of light energy is needed by the interior of the human eye to see an object. How many photons of green light (λ= 550 nm) are needed to generated this minimum amount of energy.

4. What is de-Broblie wavelength of a He-atom in a container at 300 K .(Use U_{avg})

5. Through what potential defference must an electron pass to have a wavelength of 500 Å .

6. A proton is accelerated to one-tenth of the velocity of light. If its velocity can be measured with a precision ±1%. What must be its uncertainity in position.

7. To what effective potential a proton beam be subjected to give its protons a wavelength of 1×10^{-10}m.

8. Calculate magnitude of orbital angular momentum of an e^{-} that occupies 1s, 2s, 2p, 3d, 3p.

9. Calculate the number of exchange pairs of electrons present in cofiguration of Cu according to Aufbau Principle considering 3d orbitals only.

10. He atom can be excited to $1s^1$ $2p^1$ by λ = 58.44 nm. If lowest excited state for He lies 4857 cm^{-1} below the above. Calculate the energy for the lower excitation state.

PP-13

1. In which of the following orbits, the angular momentum of an electron of He^+ will be $\frac{h}{\pi}$?
(A) First (B) Second (C) Third (D) Fourth

2. Emission of energy takes place when an electron undergoes transition from
(A) n = 3 to n = 1 (B) n = 2 to n =3 (C) n = 3 to n = 5 (D) None of these

3. An electron has been excited from the first to the fourth energy state in an atom. Which of the following transitions are possible when the electron comes back to the ground state?
(A) $4 \rightarrow 1$ (B) $4 \rightarrow 2, 2 \rightarrow 1$ (C) $4 \rightarrow 3, 3 \rightarrow 2, 2 \rightarrow 1$ (D) All of these

4. Which sublevel energy of hydrogen atom is capable of absorbing photon but is incapable of emitting photon?
(A) 3s (B) 2p (C) 1s (D) 2s

5. Which of the following pairs indicates respective radii of the first and the second orbit of hydrogen atom?
(A) 0.0529 nm, 2.116 Å (B) 0.529 Å, 1.058 Å
(C) 0.059 nm, 1.0858 Å (D) None of these

6. If the radius of the first orbit of hydrogen is x, then the radius of the fourth orbit will be
(A) 4x (B) $\frac{\pi}{4}$ (C) 16 x (D) $\frac{\pi}{16}$

7. Which of the following orbits of hydrogen atom should have the values of their radii in the ratio of 1 : 4 ?
(A) K and L (B) L and N (C) M and N (D) 1 and 2 both are correct

8. Which of the following is the correct expression for the radius of the third orbit of hydrogen atom, if the radii of its first and the third orbits are r_1 and r_3, respectively?
(A) $r_3 = 8$ (B) $r_3 = 9r_1$ (C) $r_1 = 3r_3$ (D) $r_1 = 9r_3$

9. What should be the radius of the third orbit of Li^{+2}?
(A) 3×0.529 Å (B) $(3)^2 \times 0.529$ Å
(C) $\sqrt{9} \times 0.529$ Å (D) 1 and 3 both are correct

10. If $a = \frac{h}{4\pi^2 me^2}$, then the correct expression for calculation of the circumference of the first orbit of hydrogen atom should be
(A) $\sqrt{4h^2}\ \pi a$ (B) $2\pi r$ (C) $\sqrt{4}\ \pi ha$ (D) 1 and 3 both are correct

PP-14

1. The ratio of velocities of the electrons present in the third and fifth orbits of He^+ should be
(A) 5 : 3 (B) 3 : 5 (C) 3 : 2 (D) 2 : 3

2. Which of the following orbits of hydrogen should have higher kinetic energy?

Kinetic energy = $\frac{1}{2}mv^2$

(A) First (B) Second (C) Third (D) Same in all above

3. The ratio of velocities of electrons present in Na^{+10} and H should be
(A) 11 : 1 (B) 11 : 3 (C) 1 : 11 (D) 4 : 11

4. What should be the velocity of the electron present in the fourth orbit of hydrogen atom, if the velocity of the electron present in the third orbit is 7.29×10^7 cm per second?

5. What should be the kinetic energy and total energy of the electron present in hydrogen atom, if its potential energy is – 5.02 eV?

6. What should be the order E_1, E_2, E_3 and E_4 if these are the respective energies of the first, second third and fourth orbits of hydrogen atom?

(A) $E_1 = E_2 = E_3 = E_4$ (B) $E_4 < E_3 < E_2 < E_1$
(C) $E_1 < E_2 < E_3 < E_4$ (D) $E_2 > E_3 < E_4 < E_1$

7. Which orbit of hydrogen atom should have its energy –50 eV, if the energy of its first orbit is – 800 eV?

(A) Fourth orbit (B) Second orbit (C) Third orbit (D) None of these

8. What should be kinetic energy and potential energy, respectively, of the electron present in the third orbit of hydrogen atom?

(A) –1.5 eV, 3.0 eV (B) 1.5 eV, –3.0 eV (C) 1.5 eV, 3.0 eV (D) 3.0 eV, –3.0 eV

9. What should be the energy of the second orbit of hydrogen atom, if the energy of its n = third orbit is –1.5 eV ?

(A) –1.5 eV (B) –3.4 eV (C) + 1.5 eV (D) –13.6 eV

10. What should be the energy of M orbit of hydrogen atom, if the energy of its first orbit is –864 eV?

(A) –96 eV (B) + 96 eV (C) –864 eV (D) +864 eV

12. What should be the energy of the electron present in the second orbit of hydrogen atom?

(A) -5.4×10^{-19} joule (B) -5.4×10^{-12} joule
(C) -21.79×10^{-19} joule (D) -21.79×10^{-12} joule

13. What should be the emitted energy when the electron present in hydrogen atom jumps from n = 4 to n = 2 ?

(A) 4.04×10^{-19} joule (B) 5.4×10^{-19} joule (C) 21.79×10^{-19} joule (D) 3.2×10^{-19} joule

14. What should be the kinetic energy of the first orbit of hydrogen atom?

(A) –13.6 eV (B) + 6.8 eV (C) +13.6 eV (D) –6.8 eV

15. Which of the following should be the energy of an electron present in ground state of hydrogen atom?

(A) –13.6 eV (B) + 3.4 eV (C) –1.5 eV (D) –0.85 eV

PP-15

1. A certain dye absorbs 4530 Å and fluoresces at 5080 Å these being wavelengths of maximum abosorption that under given conditions 47% of the absorbed energy is emitted. Calculate the ratio of the no. of quanta emitted to the number absorbed.

2. The reaction between H_2 and Br_2 to form HBr in presence of light is initiated by the photo decomposition of Br_2 into free Br atoms (free radicals) by absorption of light. The bond dissociation energy of Br_2 is 192 KJ/mole. What is the longest wavelength of the photon that would initiate the reaction.

3. The quantum yield for decomposition of HI is 0.2. In an experiment 0.01 moles of HI are decomposed. Find the number of photons absorbed.

4. Calculate the wavelength of the radiation that would cause photo dissociation of chlorine molecule if the Cl-Cl bond energy is 243 KJ/mol.

5. The dissociation energy of H_2 is 430.53 KJ/mol. If H_2 is exposed to radiant energy of wavelength 253.7 nm, what % of radiant energy will be converted into K.E.

6. X-rays emitted from a copper target and a molybdenum traget are found to contain a line of wavelength 22.85 nm attributed to the K_α line of an impurity element. The K_α lines of copper (Z =29) and molybdenum (Z = 42) have wavelength 15.42 nm and 7.12 nm respectively. Using Moseley's law, $\gamma^{1/2} = a(Z - b)$ calculate the atomic number of the impurity element.

7. What is de Broglie wavelength associated with an e^- accelerated through potential difference = 100 KV.

8. Calculate the de-broglie wavelength associated with motion of earth (mass 6×10^{24}Kg) orbiting around the sun at speed of 3×10^6 m/s.

9. A base ball of mass 200 g is moving with velocity 30×10^2 cm/s. If we can locate the base ball with an error equal in magnitude to the λ of the light used (5000 Å), how will the uncertainty in momentum be compared with the total momentum of base ball.

10. An electron has a speed of 40 m/s, accurate up to 99.99%. What is the uncertainity in locating its position.

PP-16

1. Which of the following should be the energies of the first, second and third excited states of hydrogen atom?
(A) –13.6 eV, –3.4 eV, –0.85 eV (B) –13.6 eV, –3.4 eV, –1.5 eV
(C) –3.4 eV, –1.5 eV, –0.8 eV (D) –0.85 eV, –3.4 eV, –13 eV

2. What should be the energy of the second excited state of Li^{+2}?
(A) –13.6 eV (B) –30.6 eV (C) –3.4 eV (D) –1.5 eV

3. What should be the energy in the first excited state of Be^{+3}?
(A) –54.4 eV (B) –3.4 eV (C) –0.85 eV (D) –13./6 eV

4. What should be the first, second and third excitation potentials of hydrogen atom?
(A) +10.2 eV, + 12.1 eV, 12.25 eV (B) + 3.4 eV, +1.5 eV, +0.85 eV
(C) + 13.6 eV –3.4 eV, + 1.5 eV (D) –0.86 eV, + 1.5 eV, +3.4 eV

5. How much minimum energy should be absorbed by a hydrogen atom in ground state to reach excited state?
(A) + 10.2 eV (B) +13.4eV (C) +3.4 eV (D) + 1.5 eV

6. What should be the first excitation potential of Li^{+2}?
(A) + 91.8eV (B) +132.4eV (C) 13.6 eV (D) +54.4 eV

7. What should be the first excitation potential of Be^{+3}?
(A) 16.3 eV (B) +91.8 (C) +132 eV (D) +54.4 eV

8. The energy emitted in the transition of electron from n= 6 to 1, in the H-atom, will be
(A) 8.711 Kcal (B) 74.414 Kcal (C) 304.889 Kcal (D) 313.6 Kcal

9. Ionization potential of which of the following will be minimum than the remaining three?
(A) N (B) Na (C) Ne (D) C

10. The maximum energy absorbed by hydrogen atom in its ground state will be:
(A) 13.6 eV (B) 3.4 eV (C) 10.2 eV (D) 0 eV

11. The energy required in the process $He^{+2} \longrightarrow He^{+3}$ will be
(A) 0 eV (B) +13.6 eV (C) + 3.4 eV (D) + 1.5 eV

12. What should be the ionization potential of Li^{+2}?

13. What should be the respective ionization energies of He^+ and Li^{+2} ions, if ionization energy of hydrogen atom is 13.6 eV?

(A) 54.4 eV, 122.4 eV (B) 13.6 eV, 54.4 eV

(C) 54.4 eV, 30.0 eV (D) 122.4 eV, 54.4 eV

14. Which of the following transition should require minimum energy in the case of He^{+1} ion?

(A) n = 1 to n = 3 (B) n = 3 to n = 4 (C) n = 2 to n = 3 (D) n = 1 to n = ∞

15. What should be the maximum number of lines obtained in the spectrum, if total number of energy levels are four?

(A) 4 (B) 6 (C) 2 (D) 3

PP-17

1. How many emission spectral lines in all should be visible, if an electron is present in the third orbit of hydrogen atom?

(A) 6 (B) 3 (C) 5 (D) 15

2. Which of the following transitions in hydrogen atom should emit a radiation of highest frequency?

(A) n = 5 to n = 2 Balmer (B) n = 3 to n = 2 Balmer

(C) n = 4 to n = 2 Balmer (D) n = 3 to n = 1 Lymen

3. In hydrogen atom which of the following transitions should be associated with highest absorption of energy?

(A) n = 1 to n = 4 (B) n = 2 to n = 3 (C) n = 4 to n = 1 (D) n = 3 to n = 2

4. What should be the value of wave number of the radiation produced when electron jumps from the second orbit to first orbit in hydrogen atom?

(A) 82276 cm^{-1} (B) 3200 cm^{-1} (C) 52276 cm^{-1} (D) 83376 cm^{-1}

5. Which of the following should be the wavelength of a radiation of frequency of 6×10^{16} cycle/second in ultraviolet region?

(A) 5×10^{-7} cm^{-1} (B) 5×10^{9} cm (C) 5.0×10^{-3} cm (D) None of these

6. Which electronic transition is hydrogen atom is accompanied by maximum release of energy ?

(A) n = 2 to n = 1 (B) n = 3 to n = 2 (C) n = 4 to n = 3 (D) n = 4 to n = 2

7. The ionization potential for an electron in the ground state of the hydrogen atom is 13.6 eV. What would be the ionization potential for the electron in the first excited state of the H_2 atom.

(A) 13.6 eV (B) 6.8 eV (C) 3.4 eV (D) 27.2 eV

8. For ionising an excited hydrogen atom, the energy required in eV will be

(A) 3.4 or less (B) more than 13.6 (C) little less than 13.6 (D) 13.6

9. What electronic transition in Li^{2+} produces the radiation of the same wavelength as the first line in the Lyman series of hydrogen ?

(A) n = 4 to n = 2 (B) n = 9 to n = 6 (C) n = 9 to n = 3 (D) n = 6 to n = 3

10. Electromagnetic radiation (photon) with highest wavelength results when an electron in the hydrogen atom falls from n = 5 to

(A) n = 1 (B) n = 2 (C) n = 3 (D) n = 4

11. What should be the energy of the electron in its first excitation state of Li^{+2}, if the first separation energy of He^+ is 19.6×10^{-18} joule per atom?

(A) -44.1×10^{-18} joule/atom (B) -19.6×10^{-18} joule/atom

(C) -2.17×10^{-18} joule/atom (D) None of these

12. What should be the value of wave number of emitted radiation with respect to R, when the electron present in hydrogen atom jumps from M orbit to K orbit?

(A) R × 8/9 (B) R ×5/8 (C) R × 3/4 (D) R × 5/16

13. What should be the ratio of the energies of radiations whose wavelengths are 3000 Å and 6000 Å?
(A) 1 : 2 (B) 2 : 1 (C) 1 : 3 (D) 3 : 4

14. What should be the wave number and wavelength of the emitted light when the electron present in hydrogen atom undergoes transition from n_3 to n_2 energy level, If R = 109678.6 cm^1?
(A) 15233.13 cm^{-1} 6560 Å (B) 82200 cm^{-1} and 1215 Å
(C) 13339.5 cm^{-1} and 7460Å (D) 1339.5 cm^{-1} and 746 Å

15. Calculate the velocity of an electron in the inner most orbit of hydrogen atom.

PP-18

1. Calculate the velocity (cm/S) of an electron placed in the third orbit of the hydrogen atom. Also calculate the no. of revolution per second that this electron makes around the nucleus.

2. The ionisation energy of He^+ is 19.6×10^{-18} J $atom^{-1}$. Calculate the energy of first stationary state of dipositive lithium ion.

3. The radius of the first orbit of hydrogen is 0.53 Å. The radius of second orbit of He^+ would be
(A) 1.06 Å (B) 2.12 Å (C) 0.53Å (D) 0.26 Å

4. The radius of the first orbit of hydrogen is 0.53 Å. The radius of the second orbit would be
(A) 1.06 Å (B) 2.12 Å (C) 0.53 Å (D) 0.26 Å

5. The ionization energy of hydrogen atom is 13.6 eV. The third ionization energy of lithium would be
(A) 13.6 eV (B) 27.2 eV (C) 40.8 eV (D) 122.4 eV

6. The energy of the second orbit of hydrogen is equal to the energy of
(A) fourth orbit of He^+ (B) Fourth orbit of Li^{2+} (B) second orbit of He^+ (D) second orbit of Li^{2+}

7. Calculate the ratio of time required for an electron in complete one revolution in first and second orbit of hydrogen atom.

8. Prove that light travels 137 times as fast as the electron in the first Bohr orbit of hydrogen atom.

9. Assuming the velocity to be same, the wavelength of the waves associated with which of the following particles would be maximum ?
(A) an electron (B) a proton (C) an α-particle (D) a deuteron

10. Calculate the de Broglie wavelength of an electron travelling at 1% of the speed of light.

11. If a stationary proton and α-particles are accelerated through 200 volt then calculate the ratio of their wave length.

12. Find out the number of waves made by Bohr electron in one complete revolution in its third orbit. Also calculate the number of revolutions per second that this electron makes around the nucleus.

13. Through uncertainty concept prove the absence of electron in the nucleus.

14. Calculate the uncertainty in velocity of a cricket ball of mass 150 gram , if its uncertanity in position is of the order of 1 Å C.

15. A microscope using suitable photons is used to locate an electron in an atom within a distance of 0.1 Å what would be the uncertainty involved in measurement of its velocity.

PP-19

1. The uncertainty in momentum of a particle is 2.5×10^{-16} gm cm sec^{-1} with what accuracy can its position be determined.

2. The uncertainty in position and velocity of a microscopic particle in 1×10^{-10} m and 5.27×10^{-24} ms^{-1}. Calculate the mass of the particle.

3. Calculate the momentum of electron moving with 1/3rd velocity of light.

4. $\frac{h}{\pi}$ is the angular momentum of the electron in the _________ orbit of He^+.

5. Calculate energy of electron which is moving in the orbit that has its rad. sixteen times the rad. of first Bohr orbit.

6. Calculate the no. of revolutions per second made by electron in second shell of hydrogen atom.

7. Calculate the wavelength in angstrom of photon that is emitted when an e^- in Bohr orbit n=2 returns to the orbit n=1. The ionization potential of the ground state of hydrogen atom is 2.17×10^{-11} erg/atom.

8. If uncertainty in position of electron is zero, the uncertainty in its momentum would be:
(A) Zero (B) $h/2\pi$ (C) $h/4\pi$ (D) Infinity

9. Assuming the velocity be same, which sub-atomic particle possesses smallest de Broglie wave length:
(A) An electron (B) A proton (C) An α-particle (D) All have same λ

10. De Broglie equation describes the relationship wavelength associated with the motion of an electron and the:
(A) Mass only (B) Velocity and mass (C) Position (D) Distance from the nucleus

11. The de Broglie equation suggests that an electron has:
(A) Particle nature (B) Wave nature (C) Particle-wave nature (D) Radiation behaviour

12. De broglie equation is a relationship between:
(A) Position of an electron and its momentum (B) wavelength of an electron and its momentum
(C) Mass of an electron and its energy (D) Wavelength of an electron and its frequency

13. The velocity of electron in the hydrogen atom is 2.2×10^6 m/s. The de Broglie wavelength for this electron.
(A) 33 nm (B) 45.6 nm (C) 23.3 nm (D) 0.33 nm

PP-20

Q.1 A ball of mass 200 g is moving with a velocity of 10 m sec^{-1}. If the error in measurement of velocity is 0.1%, the uncertainty is its position is:
(A) 3.3×10^{-31} m (B) 3.3×10^{-27} m (C) 5.3×10^{-25} m (D) 2.64×10^{-32} m

2. The de Broglie wavelength of a particle with mass 1 g and velocity 100 m/s is:
(A) 6.63×10^{-33} m (B) 6.63×10^{-34} m (C) 6.63×10^{-35} m (D) 6.65×10^{-35} m

3. In 'aufbau principle', the term aufbau represents :
(A) the name of scientist (B) German term meaning for building up
(C) the energy of electron (D) the angular momentum of electron

4. The nucleus of the atom (Z > 1) consists of :
(A) proton and neutron (B) proton and electron
(C) neutron and electron (D) proton , neutron and electrons

5. Two electrons A and B in an atom have the following set of quantum numbers ,

A :	3	2	– 2	+ 1/2
B :	3	0	0	+ 1/2

Which statement is correct for A and B ?
(A) A and B have same energy (B) A has more energy than B
(C) B has more energy than A (D) A and B represents same electron

6. The number of electrons in a neutral atom of an element is equal to its :
(A) atomic weight (B) atomic number
(C) equivalent weight (D) electron affinity

7. In an atom no two electrons can have the same value for all the quantum numbers . This was proposed by :
(A) Hund (B) Pauli (C) Dalton (D) Avogadro

8. The electronic configuration of Cu (atomic number 29) is :
(A) $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6\ 3d^9, 4s^2$ (B) $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6\ 3d^{10}, 4s^1$
(C) $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6, 4s^2\ 4p^1$ (D) none of these

9. The maximum number of unpaired electrons present in $4f$-energy level is :
(A) 5 (B) 7 (C) 10 (D) 6

10. The maximum sum of the number of neutrons and protons in an isotope of hydrogen is :
(A) 6 (B) 5 (C) 4 (D) 3

11. Non-directional orbital is :
(A) 3 s (B) 4 f (C) 4 d (D) 4 p

12. Which principle/rule limits the maximum number of electrons in an orbital to two
(A) Aufbau principle (B) Pauli's exclusion principle
(C) Hund's rule of maximum multiciplity (D) Heisenberg's uncertainty principle

13. The $n + l$ value for the 3 p - energy level is :
(A) 4 (B) 7 (C) 3 (D) 1

14. In a set of degenerate orbitals , the electrons distribute themselves to have like spins as far as possible . This statement is known as :
(A) Pauli's exclusion principle (B) Aufbau principle
(C) Hund's rule (D) Slater rules

15. The orbital angular momentum of an electron in 2 s - orbital is :
(A) $\frac{h}{4\pi}$ (B) zero (C) $\frac{h}{2\pi}$ (D) $\sqrt{2}\ \frac{h}{2\pi}$

PP-21

1. The ratio of the energy of a photon of 2000 Å wavelength radiation to that of 4000 Å radiation is
(A) 1/4 (B) 4 (C) 1/2 (D) 2

2. The energy of electron is maximum at
(A) Nucleus (B) Ground state (C) First excited state (D) Infinite distance from the nucleus

3. Which electronic level would allow the hydrogen atom to absorb a photon but not to emit a photon
(A) 3s (B) 2p (C) 2s (D) 1s

4. The third line in Balmer series corresponds to an electronic transition between which Bohr's orbits in hydrogen
(A) $5 \rightarrow 3$ (B) $5 \rightarrow 2$ (C) $4 \rightarrow 3$ (D) $4 \rightarrow 2$

5. Correct set of four quantum numbers for valence electron of rubidium (Z = 37) is
(A) $5, 0, 0, +\frac{1}{2}$ (B) $5, 1, 0, +\frac{1}{2}$ (C) $5, 1, 1, +\frac{1}{2}$ (D) $6, 0, 0, +\frac{1}{2}$

6. The correct set of quantum numbers for the unpaired electron of chlorine atom is

	n	l	m		n	l	m
(A)	2	1	0	(B)	2	1	1
(C)	3	1	1	(D)	3	0	0

7. The total number of neutrons in dipositive zinc ions with mass number 70 is
(A) 34 (B) 40 (C) 36 (D) 38

8. Principal quantum number of an atom represents

(A) Size of the orbital (B) Spin angular momentum

(C) Orbital angular momentum (D) Space orientation of the orbital

9. Which of the following set of quantum numbers represent an impossible arragement

	n	l	m	m_s		n	l	m	m_s
(A)	3	2	–2	$\frac{1}{2}$	(B)	4	0	0	$\frac{1}{2}$
(C)	3	2	–3	$\frac{1}{2}$	(D)	5	3	0	$\frac{1}{2}$

10. The explanation for the presence of three unpaired electrons in the nitrogen atom can be given by

(A) Pauli's exclusion principle (B) Hund's rule

(C) Aufbu's principle (D) Uncertainty principle

11. The maximum number of electrons that can be accommodated in the M^{th} shell is

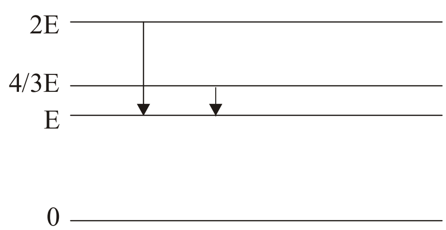
(A) 2 (B) 8 (C) 18 (D) 32

PP-22

1. If λ_p and λ_e denote the de-Broglie wavelength of proton and electron after they are accelerated from rest through the same potential difference, then;

(A) $\lambda_e = \lambda_p$ (B) $\lambda_e < \lambda_p$ (C) $\lambda_e > \lambda_p$ (D) $\lambda_e = \lambda_p /2$

2. When the electron in hydrogen atom jumps from the second orbit to the first orbit, the wavelength of the radiation emitted is λ. When the electron jumps from the third to the first orbit, the wavelength of the radiation emitted is:



(A) $\frac{9}{4}\lambda$ (B) $\frac{4}{9}\lambda$ (C) $\frac{27}{32}\lambda$ (D) $\frac{32}{27}\lambda$

3. The given diagram indicates the energy levels of a certain atom. When the system moves from 2E level to E, a photon of wevelength λ is emitted. The wavelength of photon produced during its transition from 4E/3 level to E is :

(A) λ/3 (B) 3λ/4 (C) 4λ/3 (D) 3λ

4. The ground state energy of hydrogen atom is –13.6 eV. The kinetic energy of the electron in this state is:

(A) 1.85 eV (B) 13.6 eV (C) 6.8 eV (D) 3.4 eV

5. The number of photons of wavelength 540 nm emtted per second by an elctric bulb of power 100 W is : (Taking $h = 6 \times 10^{-34}$ j-s)

(A) 100 (B)1000 (C) 3×10^{20} (D) 3×10^{18}

6. Atomic hydrogen is excited from the ground state to the nth state. The number of lines in the emission spectrum will be:

(A) $\frac{n(n+1)}{2}$ (B) $\frac{n(n-1)}{2}$ (C) $\frac{(n-1)^2}{2}$ (D) $\frac{(n+1)^2}{2}$

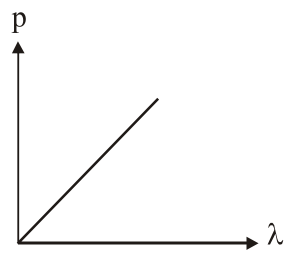
7. In a photoelectric experiment, the stopping potential Vs is plotted against the frequency v of incident light. The resulting curve is a straight line which makes an angle θ with the v–axis. The tan θ will be equal to (ϕ = work function of surface):

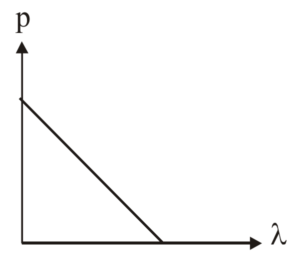
(A) h/e (B) e/h (C) $-\phi/e$ (D) eh/ϕ

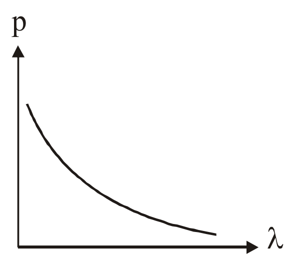
8. In hydrogen atom, if the difference in the energy of the electrton in n = 2 and n = 3 orbits is E, the ionization energy of hydrogen atom is :

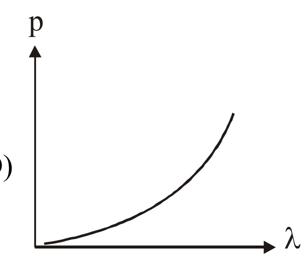
(A) 13.2 E (B) 7.2E (C) 5.6E (D) 3.2E

9. Which of the following graphs represents the variation of the particle momentum and the associated de-Broglie wavelength?

(A)


(B)


(C)


(D)


10. An electron revolves round a nucleus of charge Ze. In order to excite sthe electron from the state n = 2 to n = 3, the energy required is 47.2 eV. Z is equal to :

(A) 3 (B) 4 (C) 5 (D) 2

11. An excited bydrogen atom emits a photon of wavelength λ in returning to the ground state. The quantum number n of the excited state is given by: (R = Rydberg constant)

(A) $\sqrt{\lambda R(\lambda R-1)}$ (B) $\sqrt{\frac{\lambda R}{(\lambda R-1)}}$ (C) $\sqrt{\frac{(\lambda R-1)}{\lambda R}}$ (D) $\sqrt{\frac{1}{\lambda R(\lambda R-1)}}$

12. Moseley's law for characteristic X-rays is $\sqrt{v}=a(Z-b)$.In this :

(A) both a and b are independent of the material
(B) a is independent but b depends on the material
(C) b is independent but a depends on the material
(D) both a and b depends on the material

13. If elements with principal quantum number n > 4 were not allowed in nature, the number of possible elemnts would be :

(A) 60 (B) 32 (C) 4 (D) 64

14. Consider the spectral line resulting from the transition n = 2 $\rightarrow$ n = 1 in the atoms and ions given below. The shortest wavelength is produced by :

(A) Hydrogen atom (B) deuterium atom
(C) singly ionized helium (D) doubly ionized lithium

PP-23

1. Which quantum number will determine the shape of the subshell
(A) Principal quantum number (B) Azimuthal quantum number
(C) Magnetic quantum number (D) Spin quantum number

2. Which of the following has maximum number of unpaired electron (atomic number of Fe 26)
(A) Fe (B) Fe(II) (C) Fe(III) (D) Fe(IV)

3. Which quantum number is not related with Schrodinger equation
(A) Principal (B) Azimuthal (C) Magnetic (D) Spin

4. It is known that atom contain protons, neutrons and electrons. If the mass of neutron is assumed to half of its original value where as that of proton is assumed to be twice of its original value then the atomic mass of ${}^{16}_{6}C$ will be
(A) same (B) 25% more (C) 14.28% more (D) 28.5% less

5. the shortest wavelength of He atom in Balmer series is x, then longest wavelength in the paschene series of Li^{+2} is
(A) $\frac{36x}{5}$ (B) $\frac{16x}{7}$ (C) $\frac{9X}{5}$ (D) $\frac{5x}{9}$

6. An electron in a hydrogen atom in its ground state abosorbs energy equal to the ionisation energy of Li^{+2}, The wavelength of the emitted electron is :
(A) 3.32×10^{-10} m (B) 1.17 Å (C) 2.32×10^{-9} nm (D) 3.33 pm

7. An electron, a proton and an alpha particle have kinetic energies of 16E, 4E, and E respectively. What is the qualitative order of their de Broglie wavelengths?
(A) $\lambda_e > \lambda_p = \lambda_\alpha$ (B) $\lambda_p = \lambda_\alpha > \lambda_e$ (C) $\lambda_p > \lambda_e > \lambda_\alpha$ (D) $\lambda_\alpha < \lambda_e >> \lambda_p$

8. Given ΔH for the process $Li(g) \rightarrow Li^{+3}(g) + 3e^-$ is 19800 kJ/mole& IE_1 for Li is 520 then IE_2&IE_3 of Li^+ are respectively (approx, value)
(A) 11775, 7505 (B) 19280, 520 (C) 11775, 19280 (D) Date insufficient

9. The ratio of difference in wavelengths of 1st and 2nd lines of Lyman series in H–like atom to difference in wavelength for 2nd and 3rd lines of same series is:
(A) 2.5 : 1 (B) 3.5 : 1 (C) 4.5 : 1 (D) 5.5 : 1

10. The quantum numbers of four electrons (e1 to e4) are given below

	n	l	m	s		n	l	m	s
e1	3	0	0	+1/2	e2	4	0	0	1/2
e3	3	2	2	–1/2	e4	3	1	–1	1/2

The correct order of decreasing energy of these electrons is :
(A) e4 > e3 > e2 > e1 (B) e2 > e3 > e4 > e1 (C) e3 > e2 > e4 > e1 (D) none

PP-24

1. The X-ray beam coming from an X-ray tube will be:
(A) monochromatic
(B) having all wavelengths smaller than a certain maximum wavelength
(C) having all wavelengths larger than a certain minimum wavelength
(D) having all wavelengths lying between a minimum and a maximum wavelength

2. As per Bohr model, the minimum energy (in eV) required to remove an electron from the ground state of doubly ionized Li atom (Z = 3) is:
(A) 1.51 (B) 13.6 (C) 40.8 (D) 122.4

3. A particle of mass M at rest decays into two particles of masses m_1 and m_2 having non-zero velocities. The ratio of the de-Broglie wavelengths of the particles λ_1/λ_2 is:
(A) m_1/m_2 (B) m_2/m_1 (C) 1 (D) $\sqrt{m_2}/\sqrt{m_1}$

4. Imagine an atom made up of proton and a hypothetical particle of double the mass of the electron but having the same charge as the electron.Apply the Bohr atom model and consider all possible transitions of this hyphothetical particle to the first excited level. The longest wavelength photon that will be emitted has wavelength λ(given in terms of the Rydberg constat R for the hydrogen atom) equal to :
(A) It kinentic energy increases and aits potential and total energy decreases
(B) Its kinetic energy decreases, kpotential energy increses and its total energy remains the same
(C) Its kinetic and total energy decreases and its potential energy increases
(D) Its kinetic, potential and total energy decreases

5. The transition from the state n = 4 to n = 3 in a hydrogen like atom results in ultraviolent radiation. Infrared radiation will be obtained in the transition:
(A) $2 \to 1$ (B) $3 \to 2$ (C) $4 \to 2$ (D) $5 \to 4$

6. The electric potential between a proton and an electron is given by $V = V_0 \text{ in } \frac{r}{r_0}$, 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?
(A) $r_n \propto N$ (B) $r_n \propto \frac{1}{n}$ (C) $r_n \propto n^2$ (D) $r_n \propto \frac{1}{n^2}$

7. The energy of a photon is equal to the kinetic energy of a proton. The energy of the photon is E. Let λ_1 be the de-Broglie wavelength of the proton and λ_2 be the wavelength of the photon. The ratio $\frac{\lambda_1}{\lambda_2}$ is proportional to :
(A) E^o (B) $E^{1/2}$ (C) E^{-1} (D) E^{-2}

8. A photon collides with a stationary hydrogen atom in ground state inelastically. Energy of the colliding photon is 10.2 eV. After a time interval of the order of mocro second another photon collides with same hydrogen atom inelastically with an energy of 15 eV. What will be obsered by the deterctor?
(A) 2 photon of energy 10.2 eV
(B) 2 photon of energy 1.4 eV
(C) One photon of energy 10.2 eV and an electron of energy 1.4 eV
(D) One photon of energy 10.2 eV and another photon of energy 1.4 eV

9. In the Bohr model of the hydrogen atom:
(A) the radius of the n^{th} orbit is proportaional n^2
(B) the total energy of the electron in the n^{th} orbit is inversely proportional to n
(C) the angular momenttum of the electron in an orbit is an integral multiple of $h/2\pi$.
(D) the magnitude of the potential energy of the electron in amy orbit is greater than its kinetic energy

10. The electron in a hydrogen atom makes a transition $n_1 \to n_2$, where n_1 and n_2 are athe principal quantum numbers of 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
(A) $n_1 = 4, n_2 = 2$ (B) $n_1 = 8, n_2 = 2$ (C) $n_1 = 8, n_2 = 1$ (D) $n_1 = 6, n_2 = 3$

11. In a hydrogen atom, the electron is in nth excited state. It comes down to first excited state by emitting ten different wavelengths. The value of n is:
(A) 6 (B) 7 (C) 8 (D) 9

PP-25

1. If a_0 is the Bohr radius, the radius of then n = 2 electrons orbit in triply ionized beryllium is
(A) $4a_0$ (B) a_0 (C) $a_0/4$ (D) $a_0/16$

2. When Z is doubled in an atom, which of the following statements are consistent with Bohr's theory ?
(A) energy of a state is doubled (B) radius of an orbit is doubled
(C) velocity of electron in an orbit is doubled (D) radius of an orbit is halved

3. Let A_n be the area enclosed by the n^{th} orbit in a hydrogen atom. The graph of $ln(A_n/A_1)$ against $ln(n)$
(A) will pass through the origin
(B) will be certain points lying on a straight line with slope 4
(C) will be a monotonically increasing nonlinear curve
(D) will be a circle

4. Ionization energy of a hydrogen like ion A is greater than that of another hydrogen-like ion B. Let r, u, E and L represent the radius of the orbit, speed of the electron, energy of the atom and orbital angular momentum of the electron respectively. In ground state
(A) $r_A > r_B$ (B) $u_A > u_B$ (C) $E_A > E_B$ (D) $L_A > L_B$

5. Which energy state of doubly ionized lithium (Li^{++}) has the same energy as that the of ground state of hydrogen ? (Given Z for lithium = 3)
(A) n = 1 (B) n = 2 (C) n = 3 (D) n = 4

6. What is the ratio of the electron orbital radius of Li^{++} to that of hydrogen ?
(A) 1 (B) 2 (C) 3 (D) 4

7. In Bohr's model of hydrogen atom, the centripetal force is provided by the coulombic attraction between the proton and the electron. If a_0 is the radius of the ground state orbit, m is the mass and e the charge of an electron and ε_0 is the absolute permittivity, the speed of the electron is
(A) zero (B) $\frac{e}{\sqrt{\varepsilon_0 a_0 m}}$ (C) $\frac{e}{\sqrt{4\pi\varepsilon_0 a_0 m}}$ (D) $\frac{\sqrt{4\pi\varepsilon_0 a_0 m}}{e}$

8. If an orbital electron of the hydrogen atom jumps from the ground state to higher energy state, its orbital speed reduces to half its initial value. If the radius of the electron orbit in the ground state is r, then the radius of the new orbit would be
(A) 2r (B) 4r (C) 8r (D) 16r

9. In which of the following systems will the wavelength corresponding to n = 2 to n = 1 be minimum ?
(A) hydrogen atom (B) deuterium atom
(C) singly ionized helium (D) doubly ionized lithium

10. In a hypothetical atom, if transition from n = 4 to n = 3 produces visible light then the possible transition to obtain infrared radiation is
(A) n = 5 to n = 3 (B) n = 4 to n = 2 (C) n = 3 to n = 1 (D) none of these

11. The ionization energy of hydrogen atom is 13.6 eV. Hydrogen atoms in the ground state are excited by electromagnetic radiation of energy 12.1 eV. How many spectral lines will be emitted by the hydrogen atoms ?
(A) one (B) two (C) three (D) four

PP-26

1. What amount of energy should be added to an electron to reduce its de Broglie wavelength from 100 to 50 pm?

2. Light of wavelength 180 nm ejects photoelectrons from a plate of a metal whose work function is 2 eV. If a uniform magnetic field of 5×10^{-5} tesla is applied parallel to plate, what would be the radius of the path followed by electrons ejected normally from the plate with maximum energy.

3. When a certain metal was irradiated with light of frequency 3.2×10^{16} Hz, the photoelectrons emitted had twice the kinetic energy as did photoelectrons emitted when the same metal was irradiated with light of frequency 2.0×10^{16} Hz. Calculate υ_0 for the metal.

4. Calculate for a hydrogen atom and a He^+ ion:
(a) the radius of the first Bohr orbit and the velocity of an electron moving along it;
(b) the kinetic energy and the binding energy of an electron in the ground state;
(c) the ionization potential, the first excitation potential and the wavelength of the resonance line $n = 2 \rightarrow n = 1$.

5. The work function of sodium is 2.3 eV. Calculate the maximum wavelength (in nm) for the light that may cause photoelectrons to be emitted from sodium. [$h = 6.63 \times 10^{-34}$ J-s; $c = 3 \times 10^8$ m/s]

6. Find the maximum velocity of photoelectrons emitted by radiation of frequency 3×10^{15} Hz from a photoelectric surface having work function of 4.0 eV.

7. Light described at a place by the equation $E = (100\ V/m)\ [\sin(5 \times 10^{15} s^{-1}]t + \sin(8 \times 10^{15}\ s^{-1})\ t]$ falls on a metal surface having work function 2.0 eV. Calculate the maximum kinetic energy of the photoelectrons.

8. The maximum kinetic energy of photoelectrons emitted from a certain metallic surface is 30eV when monochromatics radiation of wavelength λ are incident on it. When the same surface is illuminated with light of wavelength 2λ, the maximum kinetic energy of photoelectron is observed to be 10eV. Calculate the wavelength λ and determine the maximum wavelengths of incident radiation for which photoelectrons can be emitted . [$h = 6.6 \times 10^{-34}$ J-s and $c = 3 \times 10^8$ m/s]

9. What retarding potential is necessary to stop the emission of photoelectrons, if the work function of the target material is 1.24 eV and wavelength of incident light is 4.36×10^{-7} m?

10. In an experiment on photoelectric emission if for incident light of wavelength 1.98×10^{-7} m, stopping potential is found to be 2.5 V, find (a) energy of photoelectrons with maximum speed (b) work function and (c) threshold frequency. Given : $h = 6.6 \times 10^{-34}$ J-s and $c = 3 \times 10^8$ m/s.

11. A silver ball is suspended by a string in vacuum chamber and ultraviolet light of wavelength 200nm is directed at it. What electrical potential will the ball acquire as a result of it, if work function of silver is 4.7 eV? [$h = 6.6 \times 10^{-34}$ J-s and $c = 3 \times 10^8$ m/s.]

12. In a photoelectric experiment, it was found that the stopping potential decreases from 1.85 V to 0.82 V as the wavelength of the incident light is varied from 300nm to 400nm. Calculate the value of the Planck constant from these data.

PP-27

1. A proton, a deutron and an alpha particle are accelerated through potentials of V, 2V and 4V respectively. Their velocities will bear a ratio
(A) 1 : 1 : 1 (B) $1:\sqrt{2}:1$ (C) $\sqrt{2}:1:1$ (D) $1:1:\sqrt{2}$

2. If an electron and a proton have the same de Broglie wavelength then :
(A) the proton has greater momentum (B) the electron has greater momentum
(C) both have zero momentum (D) both have equal momentum

3. The maximum kinetic energy of photoelectrons emitted from a surface when photons of energy 6 eV fall on it is 4 eV. The stopping potential in volts is :
(A) 2 (B) 4 (C) 6 (D) 10

4. Light coming from a discharge tube filled with hydrogen falls on the cathode of the photoelectric cell. The work function of the surface of cathode is 4eV. Which of the following values of the anode voltage (in volts) with respect to the cathode will likely to make the photo current zero ?
(A) –4 (B) –6 (C) –8 (D) –10

5. In which of the following systems will the radius of the first orbit $(n = 1)$ be a minimum?
(A) hydrogen atom (B) deuterium atom
(C) singly ionized helium (D) doubly ionized lithium.

6. In a hydrogen atom, the electron is in nth excited state. It may come down to second excited state by emitting ten different wavelengths. What is the value of n ?
(A) 6 (B) 7 (C) 8 (D) 5

7. The electron in a hydrogen atom makes a transition $n_1 \to n_2$ whose n_1 and n_2 are the principal quantum numbers of the two states. Assume the Bohr model to be valid. The frequency of orbital motion of the electron in the initial state is 1/27 of that in the final state. The possible values of n_1 and n_2 are
(A) $n_1 = 4, n_2 = 2$ (B) $n_1 = 3, n_2 = 1$ (C) $n_1 = 8, n_2 = 1$ (D) $n_1 = 6, n_2 = 3$

8. When a hydrogen atom, initially at rest emits, a photon resulting in transition $n = 5 \to n = 1$, its recoil speed is about
(A) 10^{-4} m/s (B) 2×10^{-2} m/s (C) 4.2 m/s (D) 3.8×10^{-2} m/s

9. In photoelectric effect the frequency is doubled, keeping intensity and photometal unchanged. Then
(A) photocurrent is doubled
(B) maximum kinetic energy of photo-electrons is doubled
(C) maximum kinetic energy of photo-electrons increases but remains less than double kinetic energy
(D) maximum kinetic energy of photo-electrons becomes more than double kinetic energy.

10. The ratio of de–broglie wavelength of a photon and a proton of mass m having same energy is:
(A) $\sqrt{\frac{E}{mC^2}}$ (B) $\sqrt{\frac{mC^2}{E}}$ (C) $\sqrt{\frac{2mC^2}{E}}$ (D) $\sqrt{\frac{mC^2}{2E}}$

11. If the frequency of light in a photoelectric experiment is doubled the stopping potential will be
(A) doubled (B) more than doubled (C) halved (D) less than doubled

12. Radiation of two photon energies twice and five times the work function of metal are incident successively on the metal surface. The ratio of the maximum velocity of photoelectrons emitted is the two cases will be
(A) 1 : 2 (B) 2 : 1 (C) 1 : 4 (D) 4 : 1

PP–28

1. If radius of second stationary orbit (in Bohr's atom) is R. Then radius of third orbit will be
(A) R/3 (B) 9R (C) R/9 (D) 2.25 R

2. The first use of quantum theory to explain the structure of atom was made by :
(A) Heisenburg (B) Bohr (C) Planck (D) Einstein

3. The wavelength associated with a golf weighing 200 g and moving at a speed of 5m/h is of the order
(A) 10^{-10} m (B) 10^{-20} m (C) 10^{-30} m (D) 10^{-40} m

4. If the nitrogen atom had electronic configuration $1s^7$, it would have energy lower that of normal ground state configuration $1s^2 2s^2 2p^3$, because the electrons would be closer to the nucleus. Yet $1s^7$ is not observed because it violates : –
(A) Heisenberg uncertainity principle (B) Hunds rule
(C) Pauli's exclusion principle (D) Bohr postulate of stationary orbits

5. The longest wavelength of He^+ in Paschen series is "m", then shortest wavelength of Be^{+3} in Paschen series is (in terms of m) :
(A) $\frac{5}{36}$m (B) $\frac{64}{7}$m (C) $\frac{53}{8}$m (D) $\frac{7}{64}$m

6. What is uncertainity in location of a photon of wavelength 5000 Å if wavelength is known to an accuracy of 1 pm?
(A) 7.96×10^{-14}m (B) 0.02 m (C) 3.9×10^{-8}m (D) none

7. Consider the following nuclear reactions involving X & Y.

$X \rightarrow Y + {}_{2}^{4}He$

$Y \rightarrow {}_{8}O^{18} + {}_{1}H^{1}$

If both neutrons as well as protons in both the sides are conserved in nuclear reaction then ideantify periond number of X & moles of neutrons in 4.6 gm of X

(A) 3, 2.4 N_A (B) 3, 2.4 (C) 2, 4.6 (D) 3, 0.2 N_A

8. Electromagnetic radiations having $\lambda = 310$ Å are subjected to a metal sheet having work function = 12.8 eV. What will be the velocity of photoelectrons with maximum Kinetic Energy.

(A) 0, no emission will occur (B) 2.18×10^6 m/s

(C) $2.18\sqrt{2} \times 10^6$ m/s (D) 8.72×10^6 m/s

9. Assuming Heisenberg Uncertainity Principle to be true what could be the minimum uncertainty in de-broglie wevelength of a moving electron accelerated by Potential Difference of 6V whose uncertainty in position is $\frac{7}{22}$ n.m.

(A) 6.25 Å (B) 6 Å (C) 0.625 Å (D) 0.3125 Å

ANSWERS PRACTIC PROBLEMS

PP-1

1. 9.05×10^{17} photon s^{-1} **2.** 192.0 kJ mol^{-1} **3.** 7.55×10^{19}

4. 3.735×10^{-33} g **5.** 8.3×10^{-19} J **6.** 9.81×10^{14} Hz

7. W.F. = 39.78×10^{-20}J, $v = 13.2 \times 10^{14}$ Hz **8.** (a) 5.99×10^{14} Hz, (b) yes

9. 1.0×10^{16} sec^{-1} **10.** (a) 2.0 eV, 0 (b) 2.0 V (c) 2970 Å **11.** 57

PP-2

1 1025 Å

2 v = 4.56 × 1014 sec^{-1}, E = 3.02×10^{-12} erg, λ for He^+ = 1641 Å, l for H = 6564 Å

3 (a) 21.79 × 10–12 erg, (b) 916 Å

4 v = 2.467×10^{15} Hz, $E_H = 16.36 \times 10^{-19}$, l = 1215.6 Å, $E_{Li^{+3}} = 14.7 \times 10^{-18}$ J

5 97.3, 102.6, 121.6 nm **6** 6th **7** 1216 Å

8 9.85×10^5 J **9** $E_1/E_2 = 0.0675$ **10** 1014, 1213, 6187 Å

PP-3

1. He^+ **2.** 2.11 V **3.** Z = 35

4. (a) 1.86×10^{-21} J, (b) 4.2×10^{-19} J **5.** 3.99×10^{-10} J mol^{-1}

6. 4.69 Å **7.** { 6.578×10^{-34}Js **8.** n = 2 and 3; λ = 1216 Å and 1020 Å

9. 2.3×10^6 m sec^{-1} **10.** 2.44×10^{-19} J

PP-4

1. **2.**

3. (a) $2p_x$ or $2p_y$ (b) $4d_{z^2}$ (c) $3p_x$ (e) $3d_{x^2-y^2}$ or $3d_{xy}$

4. **5.** (a) ± 2, $\sqrt{24}$ (b) ± 3, $\sqrt{48}$, 6 **6.**

7. **8.** (a) 35 (b) $_{17}Cl$ **9.** Oxygen and Mg

10. (a) n = 4, l = 0, m = 0, s = + $\frac{1}{2}$ or $-\frac{1}{2}$ (b) n = 3, l = 2, m = –2 or +2, s = $+\frac{1}{2}$ or $-\frac{1}{2}$

(c) n = 2, l = 1, m = –1, 0, +1, s = $+\frac{1}{2}$ for each m

PP-5

1 l = 0, 1; m = ± 1, 0 **2** n =2, l = 1, m = +1, or –1, s = $+\frac{1}{2}$ or $-\frac{1}{2}$

3 26 **4** 1p and 2d **5** s < p < d < f **6** 6, 2, 6, 10

7 48.16×10^{20} **8** 15 **9** 4.3×10^{22} **10** 6.023×10^{24}

PP-6

1. 9.7×10^{-8}m **2.** -1.36×10^{-19}Joules **3.** 4863 Å

4. $1.096 \times 10^7 m^{-1}$ **5.** 1403 KJ/mol **6.** 6563 Å ;1216 Å ; 1026 Å

7. D **8.** C **9.** B **10.** A

PP-7

1 5.79×10^{12} m/sec **2** h/mu **3** 4.43×10^4 m sec^{-1}

4 6.625×10^{-35} m **5** $\left[\frac{150}{V}\right]^{1/2}$ **6** 3.15×10^3 m

7 **8** 12.40×10^{-7} m **9** 3.27×10^{-18} J

10 9.8×10^{-12} cm

PP-8

1. 1220 Å 1215 Å **2.** 5.44×10^{-5} m/s **3.** 2; 9.75×10^{4} cm^{-1}

4. 113.74 Å **5.** 292.68×10^{21} atoms, 162.60×10^{21} atoms, 832.50 KJ

6. h/π **7.** 3.63×10^{6} m^{-1} **8.** 8×10^{6} **9.** B **10.** B

PP-9

1 2.06×10^{-11} meter **2** 2.193×10^{6} m sec^{-1} **3** 1.75×10^{-29}

4 8.92×10^{-37} m **5** 7.36×10^{-11} m **6** 4.8×10^{-12} m

7 1.62×10^{-7} m **8** 10^{-7} m **9** A **10** B

PP-10

1. 6530×10^{12} Hz **2.** 340 eV, –680 eV **3.** 3.09×10^{8} cm/sec

4. Brackett ; 2.63×10^{-4} cm, PHOTOELECTRIC EFFECT

5. 4.5×10^{14} s^{-1} **6.** 497 KJ/mol **7.** 319.2 KJ/mol

8. 6.57×10^{-34} Js **9.** 0.62 Å **10.** 3.06 V

PP-11

1. At. No. = 13, atomic mass = 27, the isotope will have same number of protons and electrons = 13 but neutrons will be 14 + 2 = 16

2. Isotopes = ${}^{16}_{8}O, {}^{18}_{8}O; {}^{239}_{92}U, {}^{238}_{92}U; {}^{77}_{32}Ge, {}^{76}_{32}Ge$; Isobar = ${}^{14}_{6}C, {}^{14}_{7}N; {}^{77}_{32}Ge, {}^{77}_{33}As$

Isotones = ${}^{16}_{8}O, {}^{14}_{6}C; {}^{39}_{19}K, {}^{40}_{20}Ca, {}^{77}_{33}As, {}^{78}_{34}Se$

3. Protons = 30, electrons = 28 **4.** (i) 24.08×10^{20} and (ii) 4 mg

5. 4.87×10^{7} coulomb kg^{-1} **6.** 1.24×10^{23} atoms

7. $= \sqrt{2}\dfrac{h}{2\pi}$ **8** 28 **9.** B **10** C

PP-12

1. 1.35×10^{5} **2.** 10^{22} **3.** 28 photons

4. 0.79 Å **5.** 6.03×10^{-4} volt **6.** 6.03×10^{-4} volt

7. 0.0826 volts **8.** $0 ; 0 ; \sqrt{2}\dfrac{h}{2\pi} ; \sqrt{6}\dfrac{h}{2\pi} ; \sqrt{2}\dfrac{h}{2\pi}$

9. 16 **10.** 3.3×10^{-18} J

PP-13

1. B **2.** A **3.** D **4.** C **5.** A **6.** C

7. D **8.** B **9.** D **10.** D

PP-14

1. A **2.** A **3.** A **4.** 5.46×10^{7} cm per second

5. – 2.51 eV, + 2.51 eV **6.** C **7.** A **8.** B **9.** B

10. A **12.** A **13.** A **14.** C **15.** A

PP-15

1. 0.527 **2.** 6235Å **3.** 3×10^{22} **4.** 4.9×10^{-7} m

5. 8.68 % **6.** 24 **7.** 3.88 pm **8.** 3.68×10^{-65} m

9. 1.75×10^{-29} **10.** 0.0144 m

PP-16

1. C **2.** A **3.** A **4.** A **5.** A **6.** A

7. A **8.** C **9.** B **10.** A **11.** A **12.** + 122.4 eV

13. A **14.** B **15.** B

PP-17

1.	B	**2.**	D	**3.**	A	**4.**	A	**5.**	A	**6.**	A
7.	C	**8.**	A	**9.**	D	**10.**	D	**11.**	A	**12.**	A
13.	B	**14.**	A	**15.**	$V = 2.177 \times 10^6$ m/sec						

PP-18

1. 7.29×10^7 cm/sec , 2.44×10^{14} rev/sec **2.** 44.1×10^{-18} J atm^{-1}
3. A **4.** B **5.** D **6.** A **7.** 1/8
8. **9.** A **10.** 2.4 Å **11.** 2.822 : 1
12. 3 , 2.4×10^{14} rev/sec **13.** **14.** 3.51×10^{-24} m sec^{-1}
15. 5.79×10^6

PP-19

1. 2.11×10^{-12} cm **2.** 0.1 kg **3.** 9.69×10^{-18} g cm sec^{-1}
4. 2^{nd} **5.** 4 times **6.** 8.18×10^{14} rev/sec **7.** 1221 Å
8. D **9.** C **10.** B **11.** C **12.** B **13.** D

PP-20

1	D	**2.**	A	**3.**	B	**4.**	A	**5.**	B	**6.**	B
7.	B	**8.**	B	**9.**	B	**10.**	D	**11.**	A	**12.**	B
13.	A	**14.**	C	**15.**	B						

PP-21

1.	D	**2.**	D	**3.**	D	**4.**	B	**5.**	A	**6.**	C
7.	B	**8.**	A	**9.**	C	**10.**	B	**11.**	C		

PP-22

1.	C	**2.**	C	**3.**	D	**4.**	B	**5.**	C	**6.**	B
7.	A	**8.**	B	**9.**	C	**10.**	C	**11.**	B	**12.**	A
13.	A	**14.**	D								

PP-23

1.	B	**2.**	C	**3.**	D	**4.**	C	**5.**	B	**6.**	B
7.	A	**8.**	A	**9.**	B	**10.**	C				

PP-24

1.	C	**2.**	D	**3.**	C, D	**4.**	C	**5.**	D	**6.**	A
7.	B	**8.**	C	**9.**	A, D	**10.**	A, D	**11.**	A		

PP-25

1.	B	**2.**	C D	**3.**	A B	**4.**	B	**5.**	C	**6.**	C
7.	C	**8.**	B	**9.**	D	**10.**	D	**11.**	C		

PP-26

1. 0.45 KeV **2.** 0.148 metre **3.** 8.0×10^{15} Hz
4. $\lambda_{0\,cu} = 276$ nm, $\lambda_{0\,Na} = 540$ nm, $\lambda_{0\,Cs} = 654$ nm, **5.** $\lambda_{max} = 540$ nm,
6. $V_{max} = 1.7 \times 10^6$ m/s **7.** $K_{max} = 3.27$ eV **8.** $\lambda = 310.5$ Å $\lambda_{max} = 1242$ Å
9. $V_s = 1.6$ V **10.** (A)$K_{max} = 2.5$ eV B $\phi = 3.77$ eV C $v = 9.1 \times 10^{14}$ kg
1. 1.5 V **12.** $h = 6.6 \times 10^{-34}$ J-s

PP-27

1.	D	**2.**	D	**3.**	B	**4.**	D	**5.**	D	**6.**	A
7.	B	**8.**	C	**9.**	D	**10.**	C	**11.**	D	**12.**	A

PP–28

1.	D	**2.**	B	**3.**	C	**4.**	C	**5.**	D	**6.**	B
7.	B	**8.**	C	**9.**	C						