CHEMISTRY

BOOKS - GRB CHEMISTRY (HINGLISH)

ATOMIC STRUCTURE

straight objective

1. When a gold sheet is bombarded by a beam of α- particle , only a few of them get deflected whereas most go straight , undeflected . This is because:

A. The force of attraction exerted on the α - particle by the oppositely charged electrons is not sufficient .

B. A nucleus has much smaller volume than that of atom .

C. The force of repulsion acting on the fast moving α-particle is very small.

D. The neutrons in the nucleus do not have any effect on the α -particles.

Answer: B

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2. Which of the following statements is incorrect for anode rays?

A. They are deflected by electric and magnetic fields.

B. Their e/m ratio depends on the gas in the discharge tube used to produce the anode rays.

C. The e/m ratio of anode rays is constant.

D. They are produced by the ionization of the gas in the discharge tube.

Answer: C

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3. Rutherford's α-particle scattering experiment led to the conclusion that :

A. Mass and energy are related

B. The mass and the positive charge of an atom are concentrated in the nucleus

C. Neutrons are present in the nucleus

D. Atoms are electrically neutral

Answer: B

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4. The radius of Al_{23}^{27} nucleus will be :

A. $1.2 \times 10^{-15} m$

B. $27 \times 10^{-15} m$

C. $10.8 \times 10^{-15} m$

D. $3.6 \times 10^{-15} m$

Answer: D

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5. Rutherford's scattering experiment, which established the nuclear model of the atom, used a beam of

A. β-particle , which impinged on a metal foil and get absorbed.

B. γ-rays , which impinged on a metal foil and ejected electron.

C. Helium atoms , which impinged on a metal foil and got scattered .

D. Helium nuclei , which impinged on a metal foil and got scattered .

Answer: D

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6. Which of the following options is not correct regarding the order of the frequency of electromagnetic radiation?

A. Radio waves $<$ Microwaves $<$ X-rays

B. Green light $<$ UV light $< \gamma$- radiations

C. Far infrared $>$ Radio waves $>$ Cosmic rays

D. Microwaves $<$ Near infrared rays $<$ UV rays

Answer: C

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7. Identify the option which is correct w.r.t structure of an atom .

A. As per Rutherford model if number of particles deviated by an angle of 60° is x then those deviated by 90° will be $\sqrt{2}x$.

B. Specific charge of a particle projected towards the nucleus of atomic number 29 having a closest distance of approach is 2.9Å is $\frac{10^8}{18}$ C/kg if it is projected at an initial speed of 4×10^4.

C. In the Millikan's oil drop experiment of determing charge on the cathode ray particle , 4.8×10^{-19} C cannot be obtained as the charge on the oil drop.

D. An α-particle projected closer to the center of the atom will experience a lesser deviation as compared to the particle projected away from the center.

Answer: B

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8. What will be the ratio of volume of $._{13}Al^{27}$ nucleus to that of $._{11}Na^{23}$?

A. 1.055

B. 1.174

C. Density of atoms should be known for calculations

D. 1

Answer: B

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9. An α-particle accelerated through V volt is fired towards a nucleus . Its distance of closest approach is r . If a proton accelerated through the same potential is fired towards the same nucleus , the distance of closest approach of the proton will be :

A. r

B. 2r

C. $\frac{r}{2}$

D. $\frac{r}{4}$

Answer: A

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10. The fraction of volume occupied by the nucleus with respect to the total volume of an atom is.

A. 10^{-15}

B. 10^{-5}

C. 10^{-30}

D. 10^{-10}

Answer: A

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11. The approximate size of the nucleus of $._{28}^{64}Ni$ is :

A. 3 fm

B. 4 fm

C. 5 fm

D. 2 fm

Answer: C

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12. Which of the following statement is incorrect ?

A. $\frac{e}{m}$ ratio for canal rays is maximum for hydrogen.

B. $\frac{e}{m}$ ratio for cathode rays is independent of the gas taken .

C. The nature of canal rays is dependent on electrode material .

D. The nature of canal rays is dependent on the gas taken .

Answer: C

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13. The increasing order (lowest first) for the values of q/m (charge/mass) for electrons (e) , proton (p), neutron (n) and alpha particles (α) is :

A. e,p,n, α

B. n,p,e,α

C. n,p, α, e

D. n, α, p, e

Answer: D

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14. To whom is the discovery of the nuclear atom attributed ?

A. Neils Bohr

B. Louis de Broglie

C. Robert Millikan

D. Ernest Rutherford

Answer: D

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15. Ernest Rutherford's scattering experiment demonstrated the existence of :

A. alpha particle

B. neutron

C. electron

D. nucleus

Answer: D

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16. Imagine that in any atom about 50% of the space is occupied by the atomic nucleus . If a silver foil is bombarded with α - particles , majority of the α -particles would :

A. get scattered

B. be absorbed by the nuclei

C. pass through the foil undetected

D. get converted into photons

Answer: A

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17. Consider the following nuclear reactions involving X and 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 conversed in nuclear reaction then moles of neutrons in 4.6 g on X :

A. $2.4N_A$

B. 2.4

C. 4.6

D. $0.2N_A$

Answer: B

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18.	$(i),_{26} Fe^{54},_{26} Fe^{56},_{26} Fe^{57},_{26} Fe^{58}$	(a)Isotopes
	$(ii),_{1} H^{3},_{2} H^{3}$	(b)Isotones
	$(iii),_{32} Ge^{76},_{33} As^{77}$	(c)Isodiaphers
	$(iv),_{92} U^{235},_{90} Th^{231}$	(d)Isobars
	$(v)_{1}H^{1},_{1} D^{2},_{1} T^{3}$	

Match the above correct terms :

A. [(i)- (a)] , [(ii) - (d)], [(iii) - (b)], [(iv) - (c)],[(v) - (a)]

B. [(i)- (a)] , [(ii) - (d)], [(iii) - (d)], [(iv) - (c)],[(v) - (a)]

C. [(v) - (a)], [(iv)- (c)], [(iii) - (d)],[(ii) - (b)],[(i)-(a)]

D. None of these

Answer: A

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Planck s Theory

1. A photon of 300 nm is absorbed by a gas and then emits two photons. One photon has a wavelength of 496 nm then the wavelength of second photon in nm is :

A. 759

B. 859

C. 959

D. 659

Answer: A

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2. The energy required to remove an electron from metal X is E = $3.31 \times 10^{-20} J$. Calculate the maximum wavelength of light that can be photoeject an electron from metal X :

A. $4 \mu m$

B. $6 \mu m$

C. $7 \mu m$

D. $5 \mu m$

Answer: B

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3. Photon having wavelength 310 nm is used to break the bond of A_2 molecule having bond energy 288 kJ mol^{-1} then $\%$ of energy of photon converted to the KE is :

[hc = $12400 eV Å$, 1 e V = 96 kJ/mol]

A. 25

B. 50

C. 75

D. 80

Answer: A

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4. A bulb of 40 W is producing a light of wavelength 620 nm with 80% of efficiency , then the number of photons emitted by the bulb in 20 seconds are :

$(1eV = 1.6 \times 10^{-19} J, hc = 12400eV)$

A. 2×10^{18}

B. 10^{18}

C. 10^{21}

D. 2×10^{21}

Answer: D

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5. A certain dye absorbs light of $\lambda = 4000 \text{Å}$ and then flurescences light of $\lambda = 5000 \text{Å}$. Assuming that under given conditions 50 % of the absorbed energy is re-emitted out as fluorescence , calculate the ratio of the number of quanta emitted out to the number of quanta absorbed :

A. $\frac{5}{8}$

B. $\frac{8}{5}$

C. $\frac{3}{8}$

D. $\frac{8}{3}$

Answer: A

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6. The ratio of the energy of a photon of wavelength 3000Å to that of photon of wavelength $6000\text{Å}$is :

A. $\frac{1}{2}$

B. 2

C. 3

D. $\frac{1}{3}$

Answer: B

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7. An Electromagnetic radiation of wavelength 242 nm is just sufficient to ionise a sodium atom .Calculate the ionisation energy of sodium in $KJmol^{-1}$.

A. $494.5Jmol^{-1}$

B. $494.5kJmol^{-1}$

C. $494.5\text{cal}mol^{-1}$

D. $600.5kJmol^{-1}$

Answer: B

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8. The wavelength of the electron emitted by a metal sheet of work function 5 eV when photons from EMR of wavelength 62 nm strike the metal plate .

A. 82.667Å

B. 3.16 nm

C. 0.316 nm

D. 826.67Å

Answer: C

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9. Photoelectric emission is observed from a surface for frequencies $v_1 \text{and} v_2$ of the incident radiation $(v_1 > v_2)$. If maximum kinetic energies of the photo electrons in the two cases are in the ratio $1 : K$, then the threshold frequency is given by:

A. $\dfrac{v_2 - v_1}{K - 1}$

B. $\dfrac{Kv_2 - v_1}{K - 1}$

C. $\dfrac{Kv_2 - v_1}{K}$

D. $\dfrac{Kv_1 - v_2}{K - 1}$

Answer: D

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10. A potential difference of 30 kV is applied across an X-ray tube. Find the minimum wavelength of X-ray generated .

A. $7.07 \times 10^{-2} \text{Å}$

B. $4.133 \times 10^{-10} m$

C. $7.07 \times 10^{-10} m$

D. $4.133 \times 10^{-11} m$

Answer: D

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11. The value of Planck's constant is $6.63 \times 10^{-34} Js$. The velocity of light is $3 \times 10^8 m/\text{sec}$. Which value is closest to the wavelength of quantum of light with frequency of $8 \times 10^{15} \text{sec}^{-1}$?

A. $5 \times 10^{-18} m$

B. $4 \times 10^{-8} m$

C. $3 \times 10^7 m$

D. $2 \times 10^{-25} m$

Answer: B

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12. The MRI (magnetic resonance imaging) body scanners used in hospitals operate with $400MHz$ radio frequency. The wavelength corresponding to this radio frequency is.

A. 0.75 m

B. 0.75 cm

C. 1.5 m

D. 2 cm

Answer: A

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13. Photon of which light has maximum energy :

A. Red

B. Blue

C. Violet

D. Green

Answer: C

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14. Which of the following electromagnetic radiation possesses highest amount of energy ?

A. X- rays

B. Gamma rays

C. Radio waves

D. Cosmis rays

Answer: D

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15. Light of wavelength λ falls on metal having work functions hc/λ_0. Photoelectric effect will take place only if :

A. $\lambda \geq \lambda_0$

B. $\lambda \geq 2\lambda_0$

C. $\lambda \leq \lambda_0$

D. $\lambda \leq \lambda_0/2$

Answer: C

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16. The work function for metals A, B and C are respectively $1.92eV, 2.0eV$ and $5eV$. According to Einstein's equation , the metals which will emit photoelectrons for a radiation of wavelength 4100Å are

A. X only

B. X and Y only

C. X , Y and Z

D. X and Z

Answer: B

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17. The greater the energy of a photon , the :

A. longer the wavelength and the higher the frequency .

B. longer the wavelength and the lower the frequency .

C. shorter the wavelength and the higher the frequency .

D. shorter the wavelength and the lower the frequency .

Answer: C

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18. A photosensitive metallic surfaces has work function $h\upsilon_0$. If photon of $2h\upsilon_0$ fall on the surface ,the electrons come out with a maxiumum velocity of $4 \times 10^6 m/s$. If energy of photon is increased to $5h\upsilon_0$, the maximum velocity of photoelectrons will be :

A. $2 \times 10^7 m/s$

B. $8 \times 10^6 m/s$

C. $2 \times 10^6 m/s$

D. $8 \times 10^5 m/s$

Answer: B

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19. In a photoelectric effect experiment , photons of energy 5.0 eV are incident on metal surface . They liberate electrons which are just stopped by an electrode at a potential of 3.5 eV with respect to metal . The work function of the metal surface in eV is :

A. 5

B. 3.5

C. 1.5

D. 7

Answer: C

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20. What is the energy of photons with a wavelength of 434 nm?

A. $2.\ 76 \times 10^5$ kJ//mole

B. $2.76 \times 10^2 \text{kJ} / \text{mole}$

C. $2.76 \times 10^{-1} \text{kJ} / \text{mole}$

D. $2.76 \times 10^{-4} \text{kJ} / \text{mole}$

Answer: B

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21. The first ionization energy of Na is 495.9 kJ mol^{-1} . What is the longest wavelength of light that could remove an electron from a Na-atom?

A. $2.41 \times 10^{-7} m$

B. $2.41 \times 10^{-4} m$

C. 4.14 m

D. $4.14 \times 10^{3} m$

Answer: A

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22. An acidic solution of methyl red has an absorbance of 0.451 at 530 nm in a 5.00 nm cell . Calculate the molarity of methyl red in this solution .

[Molar absorbtivity = $1.06 \times 10^{5} Lmol^{-1} cm^{-1}$ at 530 nm]

A. 2.31×10^{-6}M

B. 4.26×10^{-6}M

C. 8.51×10^{-6}M

D. 1.05×10^{-5}M

Answer: C

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23. Albert Einstein's explanation of the photoelectric effect confirmed which of the following concepts?

A. Electrons can absorb energy and change levels in atoms .

B. Light energy can be converted into mass of electrons .

C. Electrons have both particle and wave properties .

D. Light has both particle and wave properties.

Answer: D

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24. For which of the following transitions would a hydrogen atom absorb a photon with longest wavelenght ?

A. n = 1 to n = 2

B. n = 3 to n = 2

C. n = 5 to n = 6

D. n = 7 to n = 6

Answer: C

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25. The energy required to break one mole of hydrogen- hydrogen bonds in H_2 is 436kJ. What is the longest wavelength of light with sufficient energy to break a single hydrogen- hydrogen bond?

A. 122 nm

B. 132nm

C. 274 nm

D. 656 nm

Answer: C

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26. What is the energy of photon from a laser that emits light at 632.8 nm

A. $3.14 \times 10^{-19} J$

B. $1.26 \times 10^{-31} J$

C. $2.52 \times 10^{-33} J$

D. $4.19 \times 10^{-40} J$

Answer: A

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27. Which properties of electromagnetic radiation are inversely related?

A. Amplitude and frequency

B. Energy and wavelength

C. Energy and frequency

D. Wavelength and amplitude

Answer: B

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28. Which electronic transition in a hydrogen atom releases the greatest amount of energy?

A. $n = 3 \rightarrow n = 2$

B. $n = 5 \rightarrow n = 3$

C. $n = 6 \rightarrow n = 5$

D. $n = 3 \rightarrow n = 6$

Answer: A

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29. What is the frequency of light with a wavelength of 480 nm

A. $1.60 \times 10^{-6} s^{-1}$

B. $6.25 \times 10^{5} s^{-1}$

C. $6.25 \times 10^{14} s^{-1}$

D. $1.44 \times 10^{20} s^{-1}$

Answer: C

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30. A 124 W bulb converts only 15 % of the energy supplied to it into visible light of wavelength 640 nm . How many photons are emitted by the light bulb in one second ?

A. 4×10^{19}

B. 6×10^{19}

C. 8×10^{18}

D. 3×10^{19}

Answer: B

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31. The first ionization energy of caesium is $6.24 \times 10^{-19} J / \text{atom}$. What is the minimum frequency of light that is required to ionize a caesium atom ?

A. $1.06 \times 10^{-15} s^{-1}$

B. $4.13 \times 10^{14} s^{-1}$

C. $9.42 \times 10^{14} s^{-1}$

D. $1.60 \times 10^{18} s^{-1}$

Answer: C

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32. Two bulbs A and B are emitting monochromatic light of wavelength such that A can just ionise H atom and B can just ionise He^{+} ions. If the power of A and B are 30 W and 40 W respectively , the ratio of number of photons emitted per second by bulb A to bulb B is :

A. 3

B. 4

C. $\frac{1}{4}$

D. $\frac{1}{3}$

Answer: A

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33. An iodine molecule dissociates into atom after absorbing light of wavelength 4500Å. If quantum of radiation is absorbed by each molecule calculate the kinetic energy of iodine (Bond energy of I_2 is $240 kJ mol^{-1}$)

A. $8.6 \times 10^{-36} J$

B. $2.17 \times 10^{-20} J$

C. 433 kJ

D. 4.3 J

Answer: B

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34. A photon of energy hv is absorbed by a free electron of a metal having work- function $\phi < hv$. Choose the correct option(s).

A. Number of electrons coming out depends on magnitude of v .

B. The electron is sure to come out with a kinetic energy $hv - \phi$

C. Either the electron does not come out or it comes out with a kinetic energy $hv - \phi$

D. It may come out with a kinetic energy less than and equal to $hv - \phi$

Answer: D

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35. Minimum accelerating potential (volts) needed to accelerate an electron to produce a yellow line ($\lambda = 310$ nm) in the spectrum , in an electron tube containing some vapours is :

A. 1.2

B. 4

C. 6.4×10^{-19}

D. 2×10^{-15}

Answer: B

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36. If λ_0 is the threshold wavelength for photoelectric emission. λ wavelength of light falling on the surface on the surface of metal, and m mass of electron. Then de Broglie wavelength of emitted electron is :-

A. $\sqrt{\frac{2h(\lambda_0 - \lambda)}{m_e}}$

B. $\sqrt{\frac{2hc(\lambda_0 - \lambda)}{m_e}}$

C. $\sqrt{\frac{2hc}{m_e}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)}$

D. $\sqrt{\frac{2h}{m_e}\left(\frac{1}{\lambda_0} - \frac{1}{\lambda}\right)}$

Answer: C

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37. Wavelength of Radiowaves is :

A. $<$ Microwaves

B. $>$ Microwaves

C. $\leq$ Infrared waves

D. $\geq$ UV rays

Answer: B

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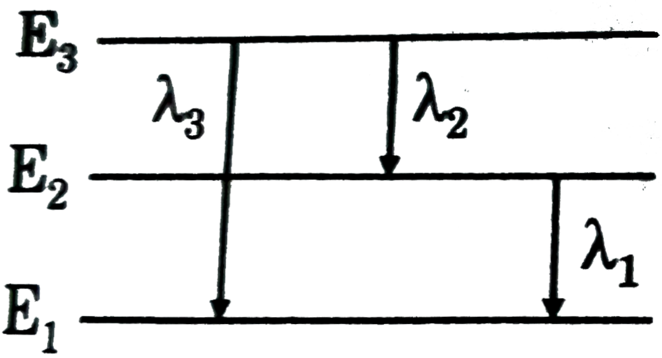
38. In the following transition which statement is correct ?



A. $E_{3-1} = E_{3-2} - E_{2-1}$

B. $\lambda_3 = \lambda_1 + \lambda_2$

C. $v_3 = v_2 + v_1$

D. All of these

Answer: C

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Bohr s Theory

1. The potential energy of the electron present in the ground state of Li^{2+} ion is represented by :

A. $+\frac{3e^2}{4\pi \in_0 r}$

B. $-\frac{3e}{4\pi \in_0 r}$

C. $-\frac{3e^2}{4\pi \in_0 r^2}$

D. $-\frac{3e^2}{4\pi \in_0 r}$

Answer: D

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2. If radius of ground state of H- atom (according to Bohr' model) is 'R' then radius of 3^{rd} energy state of Li^{+2} is :

A. R

B. 3R

C. $\frac{R}{3}$

D. 9R

Answer: B

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3. In a certain electronic transition in the hydrogen atoms from an initial state (1) to a final state (2), the difference in the orbit radius $((r_1 - r_2)$ is 24 times the first Bohr radius. Identify the transition-

A. $4 \rightarrow 1$

B. $4 \rightarrow 2$

C. $4 \rightarrow 3$

D. $3 \rightarrow 1$

Answer: C

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4. the energy levels for $A^{+z=-1}$ can be given by :

A. $E_n \text{for} A^{+(z-1)} = Z^2 \times E_n \text{for} H$

B. $E_n \text{for} A^{+(z-1)} = Z \times E_n \text{for} H$

C. $E_n \text{for} A^{+(z-1)} = \frac{1}{Z^2} \times E_n \text{for} H$

D. $E_n \text{for} A^{+(z-1)} = \frac{1}{Z} \times E_n \text{for} H$

Answer: A

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5. The radii of two of the first four Bohr's orbits of the hydrogen atom are in the ratio $1:4$. The energy difference between them may be :

A. either 12.09 eV or 3.4 eV

B. either 2.55 eV or 10.2 eV

C. either 13.6 eV or 3.4 eV

D. either 3.4 eV or 0.85 eV

Answer: B

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6. The velocity of electrons in the ground state of H- atom is 2.185×10^8 cm/sec . The velocity of electron in the first excited state of Li^{2+} ion in cm/sec would be :

A. 3.276×10^8

B. 2.185×10^8

C. 4.91×10^8

D. 1.638×10^8

Answer: A

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7. The ratio of the radius of two Bohr's orbit of Li^{+2} is $1:9$. What would be their nomenclature.

A. K and L

B. L and K

C. N and L

D. (b) and (c) both

Answer: D

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8. The ratio of radius of first orbit in hydrogen to the radius of first orbit in deuterium will be :

A. $1:1$

B. $1:2$

C. $2:1$

D. $4:1$

Answer: C

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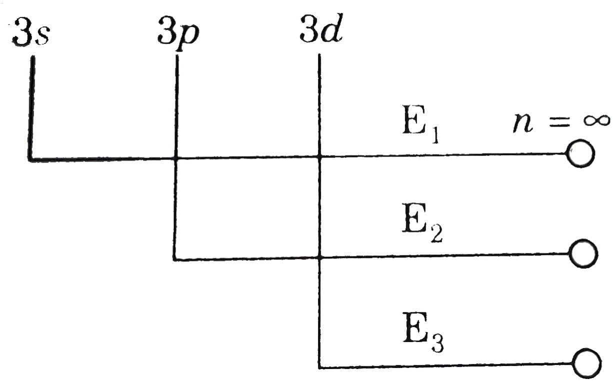
9. For H-atoms , the energy required for the removal of electron from various sub-shells is given as under :



The order of the energies would be :

A. $E_1 > E_2 > E_3$

B. $E_3 > E_2 > E_1$

C. $E_1 = E_2 = E_3$

D. none of these

Answer: C

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10. Which of the following options is incorrect regarding Bohr's Model of an atom ?

A. Ionisation energy (I.E.) order : $I.\ E._{H} < I.\ E._{He^{+}} < I.\ E._{Li^{+2}}$

B. Angular momentum (AM) order of electron in n^{th} shell : $AM_{2nd\text{shell}} < AM_{4th\text{shell}} < AM_{6th\text{shell}}$

C. If PE at the infinity is assigned as 13.6 eV then ratio of magnitude of KE to that of PE of Ist Bohr orbit in hydrogen will be in the ratio $1:2$.

D. Order of speed (v) of electron in nth shell of hydrogen : $V_{2nd\text{shell}} > V_{5th\text{shell}} > V_{6th\text{shell}}$

Answer: C

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11. Which of the following transition will have a wavelength different than that observed in rest of the transitions ?

A. H-atoms , transition from 3rd level to 1st level .

B. He^{1+} ion , transition from 5th excited state to 1st excited state .

C. Li^{2+} ion , transition from 9th level to 3rd level.

D. Be^{+3} ion, transition from 11th excited state to 3rd level .

Answer: D

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12. A substance absorbs electromagnetic radiations of wavelength 12.3 nm and then emits another electromagnetic radiations of wavelength

24.6 nm . If ratio of number of photons absorbed to number of photons emitted is $2:1$ then ratio of energy absorbed to energy emitted will be :

A. $2:1$

B. $1:1$

C. $4:1$

D. $1:4$

Answer: C

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13. A unielectronic species is in some excited state 'A' and on absorbing a photon of energy 'x' eV gets promoted to a new state 'B' . On de-excitation back to the ground state a total of 10 different wavelengths were emitted in which seven have energy greater than 'x' eV . What will be the ionisation energy ?

A. 25 x eV

B. $\frac{225}{16}$ xeV

C. $\frac{25}{16}$ xeV

D. 25×9 x eV

Answer: B

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14. The radii of two Bohr's orbits of hydrogen atom are in the ratio of $4:9$. Which of the following value of energy difference is not possible between the two orbits? [I.E . = 13.6 eV]

A. 1.9 eV

B. 0.472 eV

C. 0.66 eV

D. 0.21 eV

Answer: C

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15. In a hypothetical model of an atoms following Bohr's theory, the potential energy is given by potential energy $= -\frac{Ke^2}{4r^4}$. Which of the following options will be correct ? (Symbols have usual meaning)

A. $KE = -PE$

B. $r = \frac{nhe}{4\pi}\sqrt{\frac{K}{m}}$

C. $v = \frac{n^2h^2}{4\pi^2m^{3/2}e\sqrt{K}}$

D. $TE = \frac{-Ke^2}{2r^4}$

Answer: C

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16. The time period of revolution in the 3rd orbit of Li^{2+} ions is x sec . The time period of revolution in the 2 nd orbit of He^{+} ion , should be :

A. x sec

B. $\frac{3}{2}$ x sec

C. $\frac{2}{3}$ x sec

D. $\frac{8}{27}$ x sec

Answer: C

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17. The charge on the electron and proton in reduced to half . Let the present value of the Rydberg constant is R . What will be the new value of the Rydberd constant ?

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

B. $\frac{R}{4}$

C. $\frac{R}{8}$

D. $\frac{R}{16}$

Answer: D

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18. A hydrogen like species with atomic number Z is present in a higher excited state (n) . This electron can make transition to the first excited level by successively emitting two photons of energy 2.64 eV and 48.36 eV . This electron can also make transition to third excited state by emitting three photons of energy 2.64 eV , 2. 66 eV and 4.9 eV .

Identify the hydrogen like species involved .

A. He^{+}

B. Li^{2+}

C. Be^{+3}

D. B^{+4}

Answer: C

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19. The ratio of $(E_2 - E_1)$ to $(E_4 - E_3)$ for He^+ ion is approximately equal to (where E_n is the energy of nth orbit):

A. 10

B. 15

C. 17

D. 12

Answer: B

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20. 1^{st} excitation Potential of a hydrogen like sample is 15 volt. If all the atoms of the sample are in 2^{nd} excited state then find the $K.E.$ in eV of the electron ejected if a photon of energy $\frac{65}{9}eV$ is supplied to this sample.

A. 54.4 eV

B. 24 eV

C. 122.4 eV

D. 216 eV

Answer: D

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21. If the ionization energy of He^{+} is $19.6 \times 10^{-18} J$ per atom then the energy of Be^{3+} ion in the second stationary state is :

A. $3^2 \times 21.7 \times 10^{-19} J$

B. $21.\ 79 \times 10^{-19} J$

C. $\frac{1}{3} \times 21.79 \times 10^{-19}$J

D. $\frac{1}{3^2} \times 21.79 \times 10^{-19}$ J

Answer: B

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22. The binding energy of e^{-} in ground state of hydrogen atom is 13.6 eV . The energies required to eject out an electron from three lowest states of He^{+} atom will be (in eV):

A. 13.6 , 10.2 , 3.4

B. 13.6, 3.4 , 1.5

C. 13.6 , 27.2 , 40.8

D. 54.4 , 13.6 , 6

Answer: D

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23. Correct order of radius of the first orbit of $H, He^{+}, Li^{2+}, Be^{3+}$ is :

A. $H > He^{+} > Li^{2+} > Be^{3+}$

B. $Be^{3+} > Li^{2+} > He^{+} > H$

C. $He^{+} > Be^{3+} > Li^{2+} > H$

D. $He^{2+} > H > Li^{2+} > Be^{3+}$

Answer: A

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24. What is likely to be principal quantum number for a circular orbit of diameter $20nm$ of the hydrogen atom if we assume Bohr orbit be the same as that represented by the principal quantum number?

(a). 10

(b). 14

(c). 12

(d). 16

A. 10

B. 14

C. 12

D. 16

Answer: B

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25. Which of the correct relationship?

A. $E_1 \text{of} H = \frac{1}{2} E_2 \text{of} He^+ = \frac{1}{3} E_3 \text{of} Li^{2+} = \frac{1}{4} E_4 \text{of} Be^{3+}$

B. $E_1(H) = E_2(He^+) = E_3 \text{of}(Li^{2+}) = E_4(Be^{3+})$

C. $E_1(H) = 2E_2(He^+) = 3E_3 \text{of}(Li^{2+}) = 4E_4(Be^{3+})$

D. None of these

Answer: B

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26. If the value of $E = -78.4 \text{kcal/mol}$, the order of the orbit in hydrogen atom is-

A. 4

B. 3

C. 2

D. 1

Answer: C

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27. If velocity of an electron in 1st orbit of H atoms is V , what will be the velocity in 3rd orbit of Li^{2+} ?

A. v

B. $\frac{v}{3}$

C. 3v

D. 9v

Answer: A

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28. In a certain electronic transition in the hydrogen atoms from an initial state (1) to a final state (2), the difference in the orbit radius $((r_1 - r_2)$ is 24 times the first Bohr radius. Identify the transition-

A. $5 \rightarrow 1$

B. $25 \rightarrow 1$

C. $8 \rightarrow 3$

D. $6 \rightarrow 5$

Answer: A

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29. The species which has its fifth ionization potential equal to 340 V is :

A. B^{+}

B. C^{+}

C. B

D. C

Answer: C

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30. In hydrogen atom an whit has a diemeter of about 16.92Å .What in the maximum number of electron that can be accommodated ?

A. 8

B. 32

C. 50

D. 72

Answer: B

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31. Ratio of frequency of revolution of electron in the second state of $He^{\oplus}$ revolution of electron in the second state He^{Θ} and second state of hydrogen is

A. $\frac{32}{27}$

B. $\frac{27}{32}$

C. $\frac{1}{54}$

D. $\frac{27}{2}$

Answer: A

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32. The number of waves in the fourth bohr orbit of hydrogen is

A. 3

B. 4

C. 9

D. 12

Answer: B

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33. An excited hydrogen atom returns to the ground state . The wavelength of emitted photon is λ The principal quantum number of the excited state will be :

A. $\left[\frac{\lambda R+1}{\lambda R}\right]^{1/2}$

B. $[\lambda R(\lambda R+1)]^{1/2}$

C. $\left[\frac{\lambda R}{\lambda R-1}\right]^{1/2}$

D. $\left[\frac{1}{\lambda R(\lambda R+1)}\right]^{1/2}$

Answer: C

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34. What is the separation energy (in eV) for Be^{3+} in the first excited state ?

A. 13 .6 eV

B. 27.2 eV

C. 40.8 eV

D. 54. 4 eV

Answer: D

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35. When an electron makes a transition from $(n+1)$ state to n state the frequency of emitted radiation is related to n according to $(n > > 1)$

A. $v \propto n^{-3}$

B. $v \propto n^{2}$

C. $v \propto n^{3}$

D. $v \propto n^{2/3}$

Answer: A

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36. Which of the following statements is wrong for H-like atom ?

A. Magnitude of energy of an orbit in H-like species is directly proportional to $1/n^2$

B. Frequency of revolution of an electron in an orbit is proportional to n^3

C. Radius of a Bohr orbit is proportional to n^2

D. Time period of revolution of an electron is proportional to n^3

Answer: B

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37. The angular momentum of electron in an excited H atom is $\frac{h}{\pi}$. The P.E. of electron will be :

A. 6.8 eV

B. 3.4 eV

C. $-6.8eV$

D. $3.4eV$

Answer: C

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38. Potential energy of electron present in 2nd orbit of Li^{2+} is :(r_0 = Radius of 1st Bohr's orbit)

A. $\frac{e^2}{4\pi \in_0 r_0}$

B. $-\frac{3e^2}{4\pi \in_0 r_0}$

C. $-\frac{3e^2}{16\pi \in_0 r_0}$

D. $-\frac{9e^2}{16\pi \in_0 r_0}$

Answer: C

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39. The maximum energy is present in any electron at

A. nucleus

B. ground state

C. first excited state

D. infinite distance from the nucleus

Answer: D

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40. When electron in a Bohr atom is excited then which of the following increases?

A. Potential energy

B. Time period of revolution

C. Angular momentum

D. All of the above

Answer: D

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41. Given ΔH for the process $Li(g) \rightarrow Li^{+3}(g) + 3e^{-}$ is $19800 kJ/\text{mole} \& IE_1$ for Li is 520 then $IE_2 \& IE_1$ of Li^{+} are respectively (approx value) :-

(a). $11775, 7505$

(b). $19280, 520$

(c). $11775, 19280$

(d). data insufficient

A. 7505, 11775

B. 520 , 19280

C. 11775 , 19280

D. data sufficient

Answer: A

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42. For a valid Bohr orbit , its circumference should be :

A. $= n\lambda$

B. $= (n-1)\lambda$

C. $> n\lambda$

D. $< n\lambda$

Answer: A

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43. Let the I.E. of hydrogen like species be 320 eV . Find out the value of quantum number having the energy equal to -20 eV .

A. n = 2

B. n = 3

C. n= 4

D. n = 5

Answer: C

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44. Angular momentum for P-shell electron is :

A. $\frac{3h}{\pi}$

B. zero

C. $\frac{\sqrt{2}h}{2\pi}$

D. none of these

Answer: c

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45. The energy of an electron in the first Bohr orbit is $-13eV$. The energy of Be^{3+} in the first excited state is :

A. $-30.6eV$

B. $-40.8eV$

C. -54.4 eV

D. $+40.8$ eV

Answer: C

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46. How do the energy gaps between successive electron energy levels in an atom very from low to high n values ?

A. All energy gaps are the same .

B. The energy gap decreases as n increases.

C. The energy gap increases as n increases.

D. The energy gap changes unpredictably as n increases .

Answer: B

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47. In a hydrogen atom , which transition produces a photon with the highest energy ?

A. $n=3 \rightarrow n=1$

B. $n = 5 \rightarrow n = 3$

C. $n = 12 \rightarrow n = 10$

D. $n = 22 \rightarrow n = 20$

Answer: A

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48. S_1 : Bohr model is applicable for Be^{2+} ion .

S_2 : Total energy coming out of any light source is integral multiple of energy of one photon.

S_3 : Number of waves present in unit length if wave number .

S_4 : e/m ratio in cathode ray experiment is independent of the nature of the gas .

Select the correct set of True-False for above statement.

A. FFTT

B. TTFF

C. FTTT

D. TFFF

Answer: C

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49. S_1 : Potential energy of the two opposite charge system increase with the decrease in distance .

S_2 : When an electron makes transition from higher orbit to lower orbit it's kinetic energy increases.

S_3 : When an electron make transition from lower energy to higher energy state its potential energy increases.

S_4 : 11 eV photon can free an electron from 1 st excited state of He^+ ion .

Select the correct set of true-false for above statements.

A. TTTT

B. FTTF

C. TFFT

D. FFFF

Answer: B

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50. The energy of hydrogen atom in its ground state is $-13.6eV$. The energy of the level corresponding to the quantum number $n = 5$ is

A. -0.54 eV

B. -5.40eV

C. -0.85eV

D. -2.72eV

Answer: A

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51. The wave number of electromagnetic radiations emitted during the transition of electron in between two levels of Li^{2+} ion having sum of the principal quantum numbers 4 and difference is 2 ,will be:

(R_H = Rydberg constant)

A. $3.5R_H$

B. $4R_H$

C. $8R_H$

D. $\frac{8}{9}R_H$

Answer: C

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52. In Bohr's model of the hydrogen atom the ratio between the period of revolution of an electron in the orbit of $n = 1$ to the period of the revolution of the electron in the orbit $n = 2$ is :-

(a). $1:2$

(b). $2:1$

(c). $1:4$

(d). $1:8$

A. $1:2$

B. $2:1$

C. $1:4$

D. $1:8$

Answer: D

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53. In an atom, two electrons move around nucleus in circular orbits of radii (R) and (4R) . The ratio of the time taken by them to complete one revolution is :

A. $1:4$

B. $4:1$

C. $1:8$

D. $8:1$

Answer: C

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54. If first ionisation potential of a hypothetical atom is $16V$, then the first excitation potential will be :

A. 10.2 V

B. 12V

C. 14 V

D. 16V

Answer: B

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55. The angular momentum of electron in a given orbit is J . Its kinetic energy will be :

A. $\frac{1}{2}\frac{J^2}{mr^2}$

B. $\frac{Jv}{r}$

C. $\frac{J^2}{2m}$

D. $\frac{J^2}{2\pi}$

Answer: A

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56. According to Bohr's model of hydrogen atom the electric current generated due to motion of electron in nth orbit is :

A. $\frac{4\pi^2 mk^2 e^4}{n^2 h^2}$

B. $\frac{4\pi^2 mk^2 e^5}{n^2 h^2}$

C. $\frac{n^2 h^2}{4\pi^2 mk^2 e^5}$

D. $\frac{4\pi^2 mk^2 e^5}{n^3 h^3}$

Answer: D

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57. In a sample of H-atoms , electrons de-excite from a level 'n' to 1 . The total number of lines belonging to Balmer series are two . If the electrons are ionised from level 'n' by photons of energy 13 eV . Then the kinetic energy of the ejected photoelectrons will be :

A. 12.15 eV

B. 11.49 eV

C. 12.46 eV

D. 12.63 eV

Answer: A

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58. The orbit having Bohr radius equal to 1st Bohr orbit of H-atom is :

A. $n = 2 \text{of} He^{+}$

B. n= 2 of B^{+4}

C. n = 3 of Li^{2+}

D. n = 2 of Be^{+3}

Answer: D

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59. Energy of H-atom in the ground state is $-13.6eV$. Hence energy in the second excited state is

A. $-6.8eV$

B. -3.4 eV

C. -1.51 eV

D. -4.53 eV

Answer: C

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60. The wavelength of the radiation emitted , when in a hydrogen atom electron falls from infinity to stationary state 1 , would be :

(Rydberg constant = $1.097 \times 10^{7} m^{-1}$)

A. 91 nm

B. 192 nm

C. 406 nm

D. 9.1×10^{-6} nm

Answer: A

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61. According to Boohr's theory the angular momentum of an electron in 5th orbit is :

A. $25(h/\pi)$

B. $1.0(h/\pi)$

C. $10(h/\pi)$

D. $2.5(h/\pi)$

Answer: D

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62. The ionization enthalpy of hydrogen atom is $1.312 \times 10^6 Jmol^{-1}$. The energy required to excite the electron in the atom from $n = 1$ to $n = 2$ is :

A. $8.51 \times 10^5 Jmol^{-1}$

B. $6.56 \times 10^5 Jmol^{-1}$

C. $7.56 \times 10^5 Jmol^{-1}$

D. $9.84 \times 10^5 Jmol^{-1}$

Answer: D

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63. 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. Energy of a state is halved

Answer: C

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64. 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 , total energy of the electron and angular momentum of the electron respectively (for the same n). In ground state :

A. $r_A > r_B$

B. $u_A > u_B$

C. $E_A > E_B$

D. $L_A > L_B$

Answer: B

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65. The potential energy of the electron present in the ground state of Li^{2+} ion is represented by :

A. $+\frac{e^2}{\pi \in_0 r}$

B. $-\frac{e}{\pi \in_0 r}$

C. $-\frac{e^2}{\pi \in_0 r^2}$

D. $-\frac{e^2}{\pi \in_0 r}$

Answer: D

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66. Photons of equal energy were incident on two different gas samples. One sample containing H-atoms in the ground state and the other sample containing H-atoms in some excited state with a principle quantum number 'n'. The photonic beams totally ionise the H-atoms. If the difference in the kinetic energy of the ejected electrons in the two different cases is $12.75eV$. Then find the principal quantum number 'n' of the excited state.

A. 1

B. 2

C. 3

D. 4

Answer: D

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67. The potential energy of the electron present in the ground state of Li^{2+} ion is represented by :

A. $\frac{3e^2}{8\pi \in_0 r}$

B. $-\frac{3e^2}{8\pi \in_0 r}$

C. $\frac{3e^2}{4\pi \in_0 r}$

D. $-\frac{3e^2}{4\pi \in_0 r}$

Answer: A

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68. Which transition in Li^{2+} would have the same wavelength as the $2 \rightarrow 4$ transition in He^{+} ion ?

A. $4 \rightarrow 2$

B. $2 \rightarrow 4$

C. $3 \rightarrow 6$

D. $6 \rightarrow 2$

Answer: C

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69. Suppose a gaseous mixtures of He, Ne, Ar and Kr is irradiated with photons for frequency appropriate to ionize Ar, What ions will be present in the mixture ?

A. He^{+} only

B. Ne^{+} only

C. He^{+}, Ne^{+}, Ar^{+} only

D. Ne^{+}, Kr^{+}, Ar^{+} only

Answer: D

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70. The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is [a_0 is Bohr radius] :

A. $\frac{h^2}{4\pi^2 m a_0^2}$

B. $\frac{h^2}{16\pi^2 m a_0^2}$

C. $\frac{h^2}{32\pi^2 m a_0^2}$

D. $\frac{h^2}{64\pi^2 m a_0^2}$

Answer: C

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71. Three photons originating from excited atomic hydrogen atoms are found to have energies of 0.66 eV , 1.89 eV and 2.55 eV respectively . The minimum no. of atoms that must be present are :

A. one atom

B. two atoms

C. three atoms

D. can't say

Answer: B

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72. The velocity of electrons in the 3rd excited state of a hydrogen atom is [a_0 is Bohr radius]:

A. $\frac{h^2}{3\pi^2 m a_0}$

B. $\frac{h^2}{3\pi^2 m a_0^2}$

C. $\frac{8h}{\pi m a_0}$

D. $\frac{h}{8\pi m a_0}$

Answer: D

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73. Which of the following is the energy of a possible excited state of hydrogen?

A. $-3.4eV$

B. $+6.8$ eV

C. $+13.6$ eV

D. -6.8 eV

Answer: A

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74. Wavelength of radiation emitted when an electron jumps from a state A and C is $3000Å$ and it is $6000Å$ when the electron jumps from state B to C . Wavelength of the radiation emitted when an electron jumps from state A to B will be :

A. $2000Å$

B. $3000Å$

C. $4000Å$

D. $6000Å$

Answer: D

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75. Difference in wavelength of two extreme lines of Lyman series in emission spectrum of He^{+} would be :

A. $\frac{1}{12R_H}$

B. $\frac{12}{R_H}$

C. $\frac{1}{4R_H}$

D. $\frac{1}{3R_H}$

Answer: A

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76. A collection of H-atoms in 9th excited state returns to ground state . Calculate ratio of total number of spectral lines emitted without emitting any line in Brackett series to number of Brackett series lines .

A. $\frac{36}{6}$

B. $\frac{45}{6}$

C. $\frac{45}{39}$

D. 6

Answer: A

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77. Last line of Lyman series for $H-$ atom has wavelength $\lambda_1 A$, 2^{nd} line of Balmer series has wavelength $\lambda_2 A$ then

A. $\frac{16}{\lambda_1}=\frac{9}{\lambda_2}$

B. $\frac{16}{\lambda_2}=\frac{3}{\lambda_1}$

C. $\frac{4}{\lambda_1}=\frac{1}{\lambda_2}$

D. $\frac{16}{\lambda_1}=\frac{3}{\lambda_2}$

Answer: B

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78. For the Hydrogen spectrum , last line of the Lyman series has frequency v_1 , last line of Lyman series of He^+ ion has frequency v_2 and last line of Balmer series of

A. $2(v_1 + v_3) = v_2$

B. $v_1 = v_3$

C. $4v_1 = v_2$

D. All of these

Answer: D

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79. The number of possible line of Paschen series when electron jumps from seventh excited state up to ground state (in hydrogen like atom) is :

A. 2

B. 5

C. 4

D. 3

Answer: B

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80. The wave number of the first line of Balmer series of hydrogen is $15200 cm^{-1}$ The wave number of the first Balmer line of Li^{2+} ion is

A. $2.4 \times 10^5 cm^{-1}$

B. $24.3 \times 10^5 cm^{-1}$

C. $6.08 \times 10^5 cm^{-1}$

D. $60.8 \times 10^5 cm^{-1}$

Answer: A

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81. The shortest wavelength in Lyman series of Li^{2+} ion is :

A. 10.13Å

B. 135Å

C. 13.5Å

D. 101.3Å

Answer: D

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82. What hydrogen-like ion has the wavelength difference between the first lines of Balmer and Lyman series equal to $59.3nm$? $R_H = 109678cm^{-1}$

A. 2

B. 3

C. 4

D. 1

Answer: B

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83. The longest wavelength of the Lyman series for Hydrogen atom is the same as the wavelength of a certain line in the spectrum of He^{+} when the electron makes a transition from $n \rightarrow 2$ .The value of n is :

A. 3

B. 4

C. 5

D. 6

Answer: B

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84. Ratio of wavelength of series limit of Paschen and Brackett series for a single electronic species is :

A. $\frac{4}{9}$

B. $\frac{12}{7}$

C. $\frac{9}{16}$

D. $\frac{16}{25}$

Answer: C

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85. When electron are de-exciting from nth orbit of hydrogen atoms to ground state, 15 spectral lines are formed . The shortest wavelength among these will be :

A. $\frac{11}{900}R$

B. $\frac{36}{35R}$

C. $\frac{35}{36}R$

D. $\frac{35}{36R}$

Answer: B

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86. Total no of lines in Lyman series of H spectrum will be-

(where n=no. of orbits)

A. n

B. $n-1$

C. $n-2$

D. $n(n+1)$

Answer: B

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87. The wavelngth fo a spectrl line for an electronic transition is inversely related to :

A. number of electrons undergoing transition

B. the nuclear charge of the atom

C. the velocity of an electron undergoing transition

D. the difference in the energy levels involved in the transition

Answer: D

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88. Number of visible lines when an electron returns from 5th orbit to ground state in H spectrum :

A. 5

B. 4

C. 3

D. 10

Answer: C

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89. In a sample of $H-$ atom electrons make transition from 5^{th} excited state to ground state, producing all possible types of photons, then number of lines in infrared region are

A. 4

B. 5

C. 6

D. 3

Answer: C

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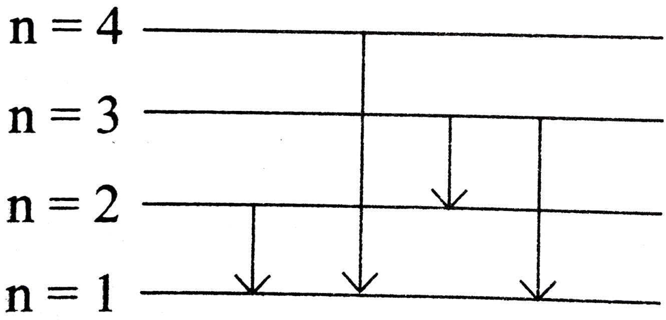
90. Suppose that a hypothetical atom gives a red, green, blue and violet line spectrum. Which jump according to figure would give off the red spectral line.



A. $3 \rightarrow 1$

B. $2 \rightarrow 1$

C. $4 \rightarrow 1$

D. $3 \rightarrow 2$

Answer: D

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91. The difference between the wave number of 1st line of Balmer series and last line of Paschen series for Li^{2+} ion is :

A. $\frac{R}{36}$

B. $\frac{5R}{36}$

C. 4R

D. $\frac{R}{4}$

Answer: D

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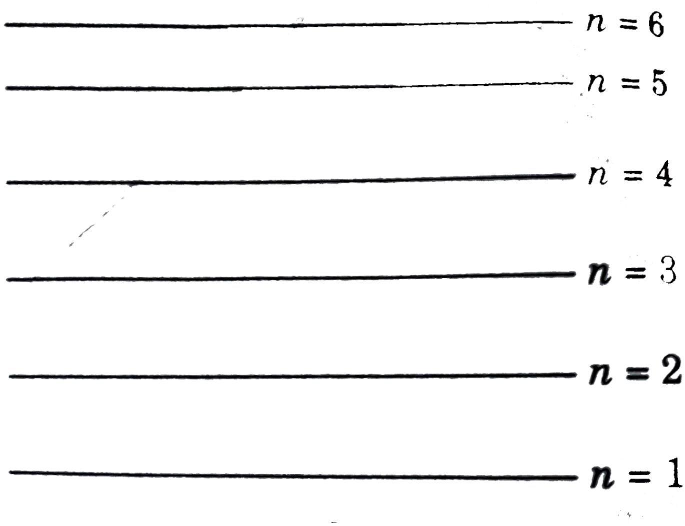
92. What would be the maximum number of emission lines for atomic hydrogen that you would expert to see with the naked eye if the only electronic energy involved are those as shown in figure ?



A. 4

B. 6

C. 5

D. 15

Answer: A

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93. Monochromatic radiation of wavelength λ is incident on a hydrogen sample in ground state. Hydrogen atoms absorb a fraction of light and subsequently emit radiations of six different wavelength . Find the wavelength λ.

A. 97.5 nm

B. 121.6 nm

C. 110.3 nm

D. None of these

Answer: A

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94. Which electronic transition in atomic hydrogen corresponds to the emission of visible light ?

A. $n = 5 \rightarrow n = 2$

B. $n = 1 \rightarrow n = 2$

C. $n = 3 \rightarrow n = 4$

D. $n = 3 \rightarrow n = 1$

Answer: A

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95. The wave number of the first line of Balmer series of hydrogen is $15200 cm^{-1}$ The wave number of the first Balmer line of Li^{2+} ion is

A. $456200 cm^{-1}$

B. $136800 cm^{-1}$

C. $738720 cm^{-1}$

D. $152000 cm^{-1}$

Answer: C

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96. Let ν_1 be the frequency of the series limit of the lyman series ν_2 be the frequency of the first line of th lyman series and ν_3 be the frequency of the series limit of the Balmer series. Then

A. $v_1 - v_2 = v_3$

B. $v_2 - v_1 = v_3$

C. $v_3 = \frac{1}{2}(v_2 - v_3)$

D. $v_1 + v_2 = v_3$

Answer: A

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97. Wave number of spectral line for a given transition is xcm^{-1} for He^{+} , then its value for Be^{3+} (isoelectronic of He^{+}) for same transition is:

A. xcm^{-1}

B. $4x cm^{-1}$

C. $\frac{x}{4} cm^{-1}$

D. $2x cm^{-1}$

Answer: B

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98. An atom has x energy level , then total number of lines in its spectrum are :

A. $1+2+3......(x+1)$

B. $1+2+3..... (x^2)$

C. $1+2+3......(x-1)$

D. $(x+1)(x+2)(x+4)$

Answer: C

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99. The ratio of wavelength of photon corresponding to the α-line of Lyman series in H-atom and β- line of Balmer series in He^{+} is :

A. $1:1$

B. $1:2$

C. $1:4$

D. $3:16$

Answer: A

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100. If the shortest wavelength of H-atom in Lyman series is x, then longest wavelenght in Balmer series of He^{2+} is :

A. $\frac{9x}{5}$

B. $\frac{36x}{5}$

C. $\frac{5x}{9}$

D. $\frac{5x}{36}$

Answer: B

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101. Change in angular momentum when an electron makes a transition corresponding to the 3rd line of the Balmer series in Li^{2+} ion is :

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

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

C. $\frac{3h}{2\pi}$

D. $\frac{4h}{2\pi}$

Answer: C

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102. In Bohr series of lines of hydrogen spectrum, third line from the red end corresponds to which one of the following inner orbit jumps of electron for Bohr orbit in atom in hydrogen :

A. $3 \rightarrow 2$

B. $5 \rightarrow 2$

C. $4 \rightarrow 1$

D. $2 \rightarrow 5$

Answer: B

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103. When an excited hydrogen atom returned to its ground state, some visible quanta were observed along with other quanta. Which of the following transitions must have occurred ?

A. $2 \rightarrow 1$

B. $3 \rightarrow 1$

C. $3 \rightarrow 2$

D. $4 \rightarrow 2$

Answer: A

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104. There are two samples of H and He^{+} atom. Both are in some excited state. In hydrogen atom, total number of lines observed in Balmer series is 4 in He^{+} atom total number of lines observed in Paschen series is 1. Electron in hydrogen sample make transitions to lower states from its excited state, then the photon corresponding to the line of maximum energy line Balmer series of H sample is used to further excite the already excited He^{+} sample. The maximum excitation level of He^{+} sample will be :

A. n= 6

B. n = 8

C. n = 12

D. n = 9

Answer: C

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105. In Bohr series of lines of hydrogen spectrum, third line from the red end corresponds to which one of the following inner orbit jumps of electron for Bohr orbit in atom in hydrogen :

A. $5 \rightarrow 2$

B. $4 \rightarrow 1$

C. $2 \rightarrow 5$

D. $3 \rightarrow 2$

Answer: D

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106. Wavelength of radiation emitted when an electron jumps from a state A and C is 3000Å and it is 6000Å when the electron jumps from state B to C . Wavelength of the radiation emitted when an electron jumps from state A to B will be :

A. 2000Å

B. 3000Å

C. 4000Å

D. 6000Å

Answer: B

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107. Which of the following series of transitions in the spectrum of hydrogen atom falls in visible region?

A. Lyman series

B. Balmer series

C. Paschen series

D. Brackett series

Answer: B

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108. Maximum number of different spectral lines which will be obtained in visible region when in a sample of large number of H-atoms containing atoms in 2nd , 3rd and 5th excited state only is given by :

A. 3

B. 4

C. 15

D. depends on relative number of atoms in 2nd , 3rd and 5th excited state.

Answer: B

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109. With a certain radiation of a particular frequency v , to which hydrogen atoms are exposed , the maximum number of spectral lines obtained is 15. The upper most energy level to which the e^- is excited is n =

A. 4

B. 5

C. 6

D. 7

Answer: C

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110. Which of the following statements is correct ?

A. Indigo light have less energy as compared to yellow

B. Bright lines are formed on dark background of the photographic film in emission spectrum

C. X-rays have more frequency as compared to γ-rays

D. Bright lines are formed on dark background of the photographic film in absorption spectrum

Answer: B

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111. Monochromatic radiation of wavelength λ are incident on a hydrogen sample in ground state. Hydrogen atoms absorb the light and subsequently emit radiations of 10 different wavelength . The value of λ is nearly :

A. 203 nm

B. 95 nm

C. 80 nm

D. 73 nm

Answer: B

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112. The ratio of wavelength of 1st line of Balmer series and 2nd line of Lyman series is :

A. 32/5

B. 2

C. 3

D. 16

Answer: A

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113. Difference in wavelength of two extreme lines of H-atom in Balmer region is (where R_H is Rydberg constant):

A. $\frac{7.2}{R_H}$

B. $\frac{0.25}{R_H}$

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

D. $\frac{3.2}{R_H}$

Answer: D

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114. A hydrogen atom in an excited state emits a photon which has the longest wavelength of the Paschen series . Further emissions from the atom cannot include the :

A. longest wavelength of the Lyman series

B. second longest wavelength of the Lyman series

C. longest wavelength of the Balmer series

D. second longest wavelength of the Balmer series

Answer: D

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115. In collection of H-atom all electrons jump from 5th excited state to ground level finally , without emitting any line in infrared region . Total number of possible different radiations are :

A. 9

B. 15

C. 6

D. 3

Answer: D

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116. Which region of the electronmagnetic spectrum is capable of inducing electron transitions with the greatest energy ?

A. Infrared

B. Microwave

C. Ultraviolet

D. Visible

Answer: C

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117. The emission spectrum of hydrogen in the visible consists of :

A. a continuous band of light .

B. a series of equally spaced lines .

C. a series of lines that are closer at low energies .

D. a series of lines that are closer at high energies .

Answer: D

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118. Which experimental evidence most clearly supports the suggestion that electrons have wave properties ?

A. Diffraction

B. Emission spectra

C. Photoelectric effect

D. Deflection of cathode rays by a magnet

Answer: A

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119. Evidence for the electron arrangement in atoms has been obtained primarily from the study of :

A. isotopes

B. radioactivity

C. stoichiometry

D. atomic spectra

Answer: D

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120. Green light has a wavelength that is slightly shorter than that of :

A. gamma rays

B. orange light

C. violet light

D. X - rays

Answer: B

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121. The energy required to ionize a potassium ion is 419 kJ mol^{-1} . What is the longest wavelength of light that can cause this ionization ?

A. 285 nm

B. 216 nm

C. 200 nm

D. 107 nm

Answer: A

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122. Which type of radiation has the highest frequency ?

A. Infrared

B. Microwave

C. Ultraviolet

D. X-rays

Answer: D

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123. Which statement concerning visible light is correct ?

A. The product of wavelength and frequency is a constant for visible light in a vacuum.

B. As the wavelength of light increases the energy of a photon increases.

C. As the wavelength of light increases its amplitude also increases.

D. Green light has a higher frequency than blue light .

Answer: A

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de Brogile and Heisenberg

1. What is the ratio of the de Broglie wavelength for electrons accelerated through 50 volts and 200 volts?

A. $3:10$

B. $10:3$

C. $1:2$

D. $2:1$

Answer: D

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2. For a ball of mass 198.6 g to be located within 0.1Å , what will be the minimum uncertainity in velocity ?

A. 2.6×10^{-17} cm/s

B. 2.6×10^{-18} m/s

C. 2.6×10^{-21} cm/s

D. 2.6×10^{-21} m/s

Answer: C

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3. In H-atom if $r1$ is the radius fo first Bohr orbit de-Broglie wavelength of an elecrton in 3^{rd} orbit is :

A. $3\pi x$

B. $6\pi x$

C. $\frac{9x}{2}$

D. $\frac{x}{2}$

Answer: B

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4. The wavelength associated with a golf ball 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

Answer: C

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5. An $\alpha-\text{particle}$ is accelerated through a potential difference of V volts from rest. The de-Broglie's wavelengths associated with it is.

A. $\sqrt{\frac{150}{V}}\text{Å}$

B. $\frac{0.286}{\sqrt{V}}\text{Å}$

C. $\frac{0.101}{\sqrt{V}}\text{Å}$

D. $\frac{0.983}{\sqrt{V}}\text{Å}$

Answer: C

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6. During an experiment an α-particle and a proton are accelerated by same potential difference , their de Broglie wavelength ratio will be :

(Take mass of photon = mass of neutron)

A. $1:2$

B. $1:4$

C. $1 : 2\sqrt{2}$

D. $1 : \sqrt{2}$

Answer: C

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7. de Broglie wavelength of electron in second orbit of Li^{2+} ion will be equal to de Broglie's wavelength of electron in :

A. n = 3 of H-atom

B. n = 4 of C^{5+} ion

C. n = 6 of Be^{3+} ion

D. n = 3 of He^{+} ion

Answer: B

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8. The wavelength of a charged particle .... the square root of the potential difference through which it is accelerated .

A. is inversely proportional to

B. is directly proportional to

C. is independent of

D. is unrelated with

Answer: A

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9. The uncertainty in momentum of an electron is $1 \times 10^{-5} kg - m/s$. The uncertainty in its position will be $\left(h = 6.62 \times 10^{-34} kg = m^2/s\right)$.

A. 1.05×10^{-28}m

B. 1.05×10^{-26} m

C. 5.27×10^{-30} m

D. 5.52×10^{-38} m

Answer: C

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10. Uncertainty in position is twice the uncertainty in momentum . Uncertainty in velocity is :

A. $\sqrt{\frac{h}{\pi}}$

B. $\frac{1}{2m}\sqrt{\frac{h}{\pi}}$

C. $\frac{1}{2m}\sqrt{h}$

D. $\sqrt{\frac{h}{4\pi}}$

Answer: C

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11. If wavelength is equal to the distance travelled by the electron in one second , then :

A. $\lambda = \frac{h}{p}$

B. $\lambda = \frac{h}{m}$

C. $\lambda = \sqrt{\frac{h}{p}}$

D. $\lambda = \sqrt{\frac{h}{m}}$

Answer: D

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12. Consider an electron in the n^{th} orbit of a hydrogen atom in the Bohr model . The circumference of the orbit can be expressed in terms of the de Broglie wavelength λ of the electron as :

A. $(0.529)n\lambda$

B. $\sqrt{n}\lambda$

C. $(13.6)\lambda$

D. $n\lambda$

Answer: D

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13. A particle X moving with a certain velocity has a de Broglie wavelength of 1Å. If particle Y has a mass of 25% that of X and velocity 75% that of X ,de Broglie wavelength of Y will be :

A. 3Å

B. 5.33Å

C. 6.88Å

D. 48Å

Answer: B

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14. de Broglie wavelength of an electron after being accelerated by a potential difference of V volt from rest is :

A. $\lambda = \frac{12.3}{\sqrt{h}} \text{Å}$

B. $\lambda = \frac{12.3}{\sqrt{V}} \text{Å}$

C. $\lambda = \frac{12.3}{\sqrt{E}} \text{Å}$

D. $\lambda = \frac{12.3}{\sqrt{m}} \text{Å}$

Answer: B

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15. An electron in a hydrogen like atom makes transition from a state in which itd de Broglie wavelength is λ_1 to a state where its de Broglie wavelength is λ_2 then wavelength of photon (λ) generated will be :

A. $\lambda = \lambda_1 - \lambda_2$

B. $\lambda = \frac{4mc}{h}\left\{\frac{\lambda_1^2\lambda_2^2}{\lambda_1^2 - \lambda_2^2}\right\}$

C. $\lambda = \sqrt{\frac{\lambda_1^2\lambda_2^2}{\lambda_1^2 - \lambda_2^2}}$

D. $\lambda = \frac{2mc}{h}\left\{\frac{\lambda_1^2\lambda_2^2}{\lambda_1^2 - \lambda_2^2}\right\}$

Answer: D

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16. An α- particle has initial kinetic energy of 25 eV and it is accelerated through a potential difference of 150 volt . If a photon has initial kinetic energy of 25 eV and it is accelerated through a potential difference of 25 volt , then find the approximate ratio of the final wavelengths associated with the proton and the α-particle .

A. 5

B. 4

C. 3

D. 2

Answer: A

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17. Uncertainty in position of particle of 25 g in space is 10^{-15} m . Hence , uncertainty in velocity (ms^{-1}) is :

(Planck's constant , $h = 6.63 \times 10^{-34}$ Js)

A. 2.1×10^{-18}

B. 2.1×10^{-34}

C. 0.5×10^{-34}

D. 5.0×10^{-24}

Answer: A

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18. The de-Broglie wavelength of a tennis ball mass $60g$ moving with a velocity of $10m$ per second is approximately :

A. 10^{-33}m

B. 10^{-31}m

C. 10^{-16} m

D. 10^{-25} m

Answer: A

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19. Uncertainty in the position of an electron mass $(9.1 \times 10^{31} kg)$ moving with a velocity $300ms^{-1}$ accurate uptp 0.001% will be :

A. 19.2×10^{-2} m

B. 5.76×10^{-2} m

C. 1.92 m

D. 3.84×10^{-2} m

Answer: C

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20. Calculate the wavelength (in nanometer) associated with a proton moving at 1.0×10^3 m/s (Mass of proton $= 1.67 \times 10^{-27} kg$ and $h = 6.63 \times 10^{-34} is)$:

A. 0.40 nm

B. 2.5 nm

C. 14.0 nm

D. 0.032 nm

Answer: A

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21. In an atom , an electron is moving with a speed of 600 m/s with an accuracy of $0.05\ \%$. The certainty with which the position of the electron can be located is (h = $6.6 \times 10^{-34} kgm^2 s^{-1}$, mass of electron , $e_m = 9.1 \times 10^{-31}$ kg):

A. 5.10×10^{-3}m

B. 1.75×10^{-3} m

C. 3.83×10^{-3} m

D. 1.52×10^{-4}m

Answer: B

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22. An electron, in a hydrogen like atom , is in excited state. It has a total energy of -3.4 eV, find the de-Broglie wavelength of the electron.

A. $\sqrt{\frac{150}{3.4}}Å$

B. $\sqrt{\frac{150}{6.8}}Å$

C. $\sqrt{\frac{150}{3.4}}$ nm

D. $\sqrt{\frac{150}{6.8}}$ nm

Answer: A

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23. An electron, a proton and an alpha particle have kinetic energy of $16E, 4E$ and E respectively. What is the qualitavtive order of their de Broglie wavelengths :-

A. $\lambda_e > \lambda_p = \lambda_\alpha$

B. $\lambda_p = \lambda_\alpha = \alpha_e$

C. $\lambda_p > \lambda_e > \lambda_\alpha$

D. $\lambda_e > \lambda_\alpha > \lambda_p$

Answer: A

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24. For which of the following particles will it be most difficult to experimentally verify the de Broglie relationship ?

A. A dust particle

B. An electron

C. A proton

D. An α-particle projected closer to the center of the atom will experience a lesser deviation as compared to the particle projected away from the center.

Answer: A

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25. Photon having energy equivalent to the binding energy of 4th state of He^{+} ion is used to eject an electron from the metal with KE/2eV . If electron is further accelerated through a potential difference of 4V then the minimum value of de Broglie wavelength associated with the electron is :

(h = $6.6 \times 10^{-34} J - s, m_e = 9.1 \times 10^{-31}$ kg . 1 eV = 1.6×10^{-19} J)

A. $1.1 Å$

B. $5 Å$

C. $9.15 Å$

D. $11 Å$

Answer: B

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26. The uncertainty in position and velocity of the particle are $0.1 nm$ and $5.27 \times 10^{-27} ms^{-1}$ respectively. Then the mass of the particle is : $(h = 6.625 \times 10^{-34} Js)$.

A. 200g

B. 300 g

C. 100 g

D. 1000 g

Answer: C

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27. The de Broglie wavelength of an object of mass 33 g moving with a velocity of $200ms^{-1}$ is of the order of :

A. 10^{-31}m

B. 10^{-34}m

C. 10^{-37}m

D. 10^{-41}m

Answer: B

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28. For an electron whose x-positional uncertainty is 1.0×10^{-10} m . The uncertainty in the x - component of the velocity in ms^{-1} will be the order of :

A. 10^6

B. 10^9

C. 10^{12}

D. 10^{15}

Answer: A

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29. What is the velocity of an electron (m = 9.11×10^{-28} g) that exhibits a de Broglie wavelength of 10.0 nm ?

$[1J = 1kg{\cdot}m^2 \cdot s^2]$

A. $72.7m{\cdot}s^{-1}$

B. $270 m \cdot s^{-1}$

C. $7.27 \times 10^4 m \cdot s^{-1}$

D. $7.27 \times 10^6 m \cdot s^{-1}$

Answer: C

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30. A particle moving with a velocity of 6.626×10^7 m/s has a de Broglie wavelength of $1Å$ in a circular path of radius $0.529Å$. The angular momentum of particle is (h = $6.626 \times 10^{-34} J \times \text{sec}$):

A. $3.5 \times 10^{-34} kgm^2 \sec^{-1}$

B. $3.5 \times 10^{-35} \text{kg} m^2 \sec^{-1}$

C. $3.5 \times 10^{-31} \text{kg} m^2 \sec^{-1}$

D. $1.053 \times 10^{-34} \text{kg} m^2 \sec^{-1}$

Answer: A

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31. At temperature T , the average kinetic energy of any particles is $\frac{3}{2}$ kT. The de Broglie wavelength follows the order :

A. Visible photon $>$ Thermal electron $>$ Thermal neutron

B. Thermal proton $>$ Thermal electron $>$ Visible photon

C. Visible photon $>$ Thermal neutron $>$ Thermal electron

D. Thermal proton $>$ Visible photon $>$ Thermal electron

Answer: A

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32. What is the de Broglie wavelength of electron , in hydrogen atom , moving in an orbit having maximum magnetic quantum no. $+2$?

A. 9.97Å

B. 2.8Å

C. 6.12Å

D. 3.32Å

Answer: A

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33. What is the potential drop through which an electron , with a de Broglie wavelength of 1.5Å , should be accelerated , if its de Broglie wavelength should be reduced to 1Å ?

A. 110 volts

B. 70 volts

C. 83 volts

D. 55 volts

Answer: C

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34. If $E_1, E_2 \text{and} E_3$ represent respectively the kinetic energies of an electron , an alpha particle and a proton each having same de Broglie wavelength then :

A. $E_1 > E_3 > E_2$

B. $E_2 > E_3 > E_1$

C. $E_1 > E_2 > E_3$

D. $E_1 = E_2 = E_3$

Answer: A

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35. Which of the following matter waves will have the shortest wavelength , if travelling with same kinetic energy ?

A. Electrons

B. Alpha particle

C. Neutrons

D. Proton

Answer: B

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36. If uncertainty in position and momentum are equal then uncertainty in velocity is.

A. $\sqrt{\frac{h}{\pi}}$

B. $\sqrt{\frac{h}{2\pi}}$

C. $\frac{1}{2m}\sqrt{\frac{h}{\pi}}$

D. zero

Answer: C

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37. What will be de Broglie's wavelength of an electron moving with a velocity of $1.2 \times 10^5 ms^{-1}$?

A. 6.044×10^{-9}m

B. 3.133×10^{-37} m

C. 6.626×10^{-9} m

D. 6.018×10^{-7}m

Answer: A

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38. A photon of wavelength 6.2 nm is used to emit an electron from the ground state of Li^{2+} . Calculate de Broglie wavelength of the emitted electron .

A. $\cong 16$ nm

B. $\cong 16$ "Å"

C. $\cong 1.4$ "Å"

D. $\cong 1$ nm

Answer: C

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39. An electron is located with an uncertainity equal to its uncertainity in velocity (symbols have usual meaning)?

A. $\sqrt{\frac{h}{4\pi}}$

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

C. $\frac{1}{2m}\sqrt{\frac{h}{\pi}}$

D. Not possible

Answer: D

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40. A particle of $\frac{e}{m}$ ratio equal to 4×10^5 coul/kg is accelerated from rest through a potential difference of 20 volt . The speed of particle is :

A. 4.0 m/s

B. 4000 km/s

C. 4000 cm/s

D. 4000 m/s

Answer: D

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41. The de Broglie wavelength of an electron moving in a circular orbit is λ . The minimum radius of orbit is :

A. $\frac{\lambda}{4}$

B. $\frac{\lambda}{2\pi}$

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

D. $\frac{\lambda}{3\pi}$

Answer: B

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42. An electron , practically at rest , is initially accelerated through a potential difference of 100 volts . It then has a de Broglie wavelength = $\lambda_1 \text{Å}$. It then gets retarded through 19 volts and then has wavelength $\lambda_2 \text{Å}$. A further retardation through 32 volts changes the wavelength to λ_3 . What is $\frac{\lambda_3 - \lambda_2}{\lambda_1}$?

A. $\frac{20}{41}$

B. $\frac{10}{63}$

C. $\frac{20}{63}$

D. $\frac{10}{41}$

Answer: C

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43. Uncertainty in position of a hypothetical subatomic particle is 1Å and uncertainty in velocity is $\frac{3.3}{4\pi} \times 10^5$ m/s then the mass of the particle is approximately (h = 6.6×10^{-34} Js) :

A. 2×10^{-28} kg

B. 2×10^{-27} kg

C. 2×10^{-29} kg

D. 4×10^{-29} kg

Answer: C

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Schrodinger Wave equation

1. The radial probability distribution curve of an orbital of H has '4' local maxima . If orbital has 3 angular node then orbital will be :

A. 7 f

B. 8f

C. 7d

D. 8d

Answer: A

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2. The Schrodinger wave equation for hydrogen atom of 4s- orbital is given by :

$\Psi(r) = \frac{1}{16\sqrt{4}}\left(\frac{1}{a_0}\right)^{3/2}\left[\left(\sigma^2 - 1\right)\left(\sigma^2 - 8\sigma + 12\right)\right]e^{-\sigma/2}$ where $a_0 = 1^{st}$ Bohr radius and $\sigma = \frac{2r}{a_0}$. The distance from the nucleus where there will be no radial node will be :

A. $r = \frac{a_0}{2}$

B. $r = 3a_0$

C. $r = a_0$

D. $r = 2a_0$

Answer: D

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3. Orbital angular momentum of 3s and 3p are :

A. $\frac{h}{2\pi}, \frac{h}{2\pi}$

B. $\frac{h}{\sqrt{2}\pi}, \frac{h}{\sqrt{2}\pi}$

C. $0, \frac{\sqrt{2}h}{\pi}$

D. $0, \frac{h}{\sqrt{2}\pi}$

Answer: D

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4. The Schrodinger wave equation for hydrogen atom is $\Psi_{2s} = \frac{1}{4\sqrt{2\pi}}\left(\frac{1}{a_0}\right)^{3/2}\left(2-\frac{r}{a_0}\right)e^{-r/a_0}$, where a_0 is Bohr's radius . If the radial node in 2s be at r_0 , then r_0 would be equal to :

A. $\frac{a_0}{2}$

B. $2a_0$

C. $\sqrt{2}a_0$

D. $\frac{a_0}{\sqrt{2}}$

Answer: B

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5. Which of the following options is correct regarding True (T) or False(F) nature of the statements.

Statement - 1 : Angular momentum quantum number determines the three dimensional shape of the orbital .

Statement-2 : No two orbitals can have exactly same wave function .

Statement - 3 : The principal quantum number determines the orientation and energy of the orbital .

Statement - 4 : The orbital wave function of one electron species which obeys Pauli's exclusion priniciple will be dependent on all the four quantum numbers .

A. Statement-2 and statement-4 are the only correct statements.

B. Statement-3 is the only incorrect statement .

C. Statement-1 and 2 are the only correct statements.

D. Statement-3 and 4 are the only correct statements .

Answer: C

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6. For an orbital , having no planar angular nodes following the equation :

$\Psi_{(r)} = Ke^{-r/K'} . r^2(K'' - r)$

Identify the orbital :

A. $4d_{z^2}$

B. 2s

C. $3d_{z^2}$

D. $4d_{xy}$

Answer: A

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7. Choose the correct statement(s) .

A. The orbital wave function or Ψ for an electron has no physical meaning

B. Square of wave function (Ψ^2) at a point gives the probability density of the electron at that point .

C. Boundary surface diagrams of constant probability density for different orbitals give a fairly good representation of the shapes of the orbitals .

D. All of the above

Answer: D

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8. Which orbital is represented by the complete wave function , Ψ_{420} ?

A. 4s

B. 4p

C. 4d

D. 4f

Answer: C

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9. The orbitals amongst the following , having three nodal surfaces:

A. 1s

B. 2s

C. 3s

D. 4s

Answer: B

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10. $\Psi_{(r)} = ke^{-r/k_1}.r^2(r^2 - k_2r + k_3)$. If the orbital has no nodal plane , then , orbital can be :

A. $5d_{xy}$

B. $5d$

C. $4d_{z^2}$

D. $4p_x$

Answer: A

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11. For the wave function

$$\Psi = \frac{\sqrt{2}}{81\sqrt{\pi}a_0^{3/2}}\left[6 - \frac{r}{a_0}\right]\frac{r}{a_0} \times e^{-r/3a_0}\sin\theta\dot{c}os\phi$$

Identify the orbital .

A. $3p_x$

B. $3p_y$

C. $3p_z$

D. $6p_x \text{or} 6p_y \text{or} 6p_z$

Answer: B

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12. For an orbital ,

$$\Psi_{300} = \frac{1}{81\sqrt{3\pi}}\left(\frac{z}{a_0}\right)^{3/2}\left[27 - 18u + 2u^2\right]\exp\left(\frac{-u}{3}\right) \text{ where } u = \frac{zr}{a_0}$$

What is the maximum radial distance of node from nucleus of He^+ ion ?

A. $(3+\sqrt{3})\frac{3a_0}{2}$

B. $(3+\sqrt{3})\frac{3a_0}{4}$

C. a_0

D. $\frac{a_0}{2}$

Answer: B

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13. Given wave function represents which orbital of hydrogen Psi=1/4

1/(sqrt2pi)(1/(alpha_(0)))^(5//2) re^(-r//2alpha)cos 0`

(where 0=angle from z-axis)

A. $2P_y$

B. $2P_z$

C. $3P_y$

D. $3P_Z$

Answer: B

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14. An obital is found ot contain total nodes= 3 and radial nodes = 1. Obital angular momentum for the electron present in this orbital :

A. 0

B. $\frac{h}{2\pi}\sqrt{6}$

C. $\frac{h}{2\pi}\sqrt{2}$

D. $\frac{h}{4\pi}\sqrt{6}$

Answer: B

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15. What is the maximum degeneracy of a level of H-atom, where e^{-} has energy, $E_n = -\frac{Rhc}{9}$?

A. 1

B. 3

C. 5

D. 9

Answer: D

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16. Which statement is not true, regarding 2s orbital?

A. Number of radial nodes is greater than zero

B. Angular nodes is equal ot zero.

C. $\Psi(0, \phi) = \text{constant}.$

D. Probability density is zero at nucleus.

Answer: D

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17. The number of radial nodes fo 3s and 2p orbitals are respectively:

A. 2,0

B. 0,2

C. 1,2

D. 2,1

Answer: A

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18. For an electron, with n=3 has only one radial node.

The orbital angular momentum of the electron will be :

A. 0

B. $\sqrt{6}\frac{h}{2\pi}$

C. $\sqrt{2}\frac{h}{2\pi}$

D. $3\left(\frac{3}{2\pi}\right)$

Answer: C

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19. Angular wave function of P_x orbital is : (Given : 0 is angle from z-axis)

A. $\left(\frac{3}{4\pi}\right)^{1/2}\sin 0 \sin\phi$

B. $\left(\frac{3}{4\pi}\right)^{1/2}\sin 0 \cos\phi$

C. $\left(\frac{3}{4\pi}\right)^{1/2}\cos 0$

D. $\left(\frac{15}{4\pi}\right)^{1/2}\sin 0\ \cos 0\cos\phi$

Answer: B

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20. How many angule nodes does a d-orbital possess?

A. 1

B. 2

C. 3

D. 4

Answer: B

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21. How many radial nodes does a 3d-orbital possess?

A. 0

B. 1

C. 2

D. 3

Answer: A

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22. Which quantum number is not related with Schrodinger equation :-

A. Principal

B. Azimuthal

C. Magnetic

D. Spin

Answer: D

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23. Question : Is the orbital of hydrogen atom $3p_x$?

STATE 1 : The radial function of the orbital is $R(r) = \frac{1}{9\sqrt{6}a_0^{3/2}}(4-\sigma)\sigma e^{-\sigma/2}, \sigma = \frac{r}{2}$

STATE 2 : The orbital has 1 radial node $\&0$ angular node.

(a). Statement (1) alone is sufficient.

(b). Statement (2) alone is sufficient

(c). Both together is sufficient

(d). Neither is sufficient

A. Statement (1) alone is sufficient.

B. Statement (2) alone is sufficient.

C. Both togther is sufficient.

D. Neither is sufficient.

Answer: B

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24. The quatum numbers $+\frac{1}{2}$ and $-\frac{1}{2}$ for the electron spin represent

A. rotation of the electrom in clockwise and anticlockwise direction respectvley.

B. rotation of the electron in anticlockwise and clockwise direction respectivley.

C. magnetic moment of the electron pointing up and down respectivley.

D. two quantum mechanical spin states which have no classical analogue.

Answer: D

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Reasoning Type

1. Assertion (A) : If the potential difference applied to an electron is made 4 time , the de Broglie wavelength associated is halved

Reason (R) : On making potential difference 4 times , velocity is doubled and hence λ is halved

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2. Statement : Wave number of a spectral line for an electronic transition is quantised .

Explanation : Wave number is directly proportional to the velocity of electron undergoing the transition .

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3. Humphry series discovered in $H - \text{atomic}$ spectra has lowest energy radiations among all series.

Lowest state for this series is $n_1 = 6$.

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4. A photon of energy $12eV$ can break three molecules of A_2 into atoms which has bond dissociation energy of $4eV / \text{molecule}$.

Total energy is conserved and interaction is always one to one between photon and molecule.

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5. Statement-1: For 1s-orbital the probaility density is maximum at the nucleus.

Satement-2: Nuclear volume is small.

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6. Statement-1: For a 2p-orbtial the probaility density function is zero on the plane where the two lobes touch each other.

Statement-2: Such a plane is called nodal plane.

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7. Statement-1: The angular momentum of e^{-} $\text{ in } 4f \text{ orbital is } \sqrt{3}\frac{h}{\pi}$.

Statement-2: Augular momentum of electron in 4 th orbit is $\frac{2h}{\pi}$.

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8. Statement-1: K.E. of photoelectrons increases with increases in frequency of incident ligh $(V > V_0)$.

Statement -2: Whenever intensity of light is increases the magnitude of photocurrent always increases.

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9. Satement-1: Spin quantum number can have two values $+\frac{1}{2} \text{ and } -\frac{1}{2}$.

Statement-2: + ve and -ve signs signify the positive and negative wave functions.

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10. Satement-1: The observed magnetic moment of Fe^{2+} is between 5.3-5.5 B.M. instead of 4.9 B.M.

Statement-2: Magnetic moment depends not only on spin but also on orbital angular momentum of e^{-}.

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11. Satement-1: Emitted radiation will fall in visible range when an electron jumps from higher level ot $n = 2 \text{in} Li^{+2} \text{ion}.$

Statement-2: Balmer series radiations belong to visible range in all H-atoms.

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Multiple Objective Type

1. Monochromatic light of wavelength λ strikes a metal surface with intensity 'a' emitting 'b' electrons per second with 'c' as the maximum kinetic energy of electrons .Which of the following options will happen if 'a' is halved without changing wavelength and area of exposure?

A. Photo emission will stop.

B. New maximum kinetic energy will be same as 'c'

C. Number of photoelectrons emitted per second will be less than 'b'

D. Rate at which charge will be acquired on metal will decrease.

Answer: B::C::D

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2. Which of the statement (s) is / are correct regarding cathode rays?

A. They come out normal to the surface of cathode.

B. They travel in straight line in presence of electric field.

C. The $\frac{e}{m}$ ratio depends on the nature of gas

D. They are stream of negatively charged particles.

Answer: A::D

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3. Which of the following wavelengths are not possible for an electron of He^{+} in any of its Bohr orbit?

$\left[\text{Assume}: h = 6.626 \times 10^{-34} J - \sec, M_e = 9.1 \times 10^{-3}\right]$

A. 1.5"Å"

B. $\sqrt{\frac{150}{10.2}}$Å

C. $\sqrt{\frac{150}{3.5}}nm$

D. $\frac{h}{m_e \times 3 \times 10^8}M$

Answer: A::B::C::D

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4. Chose the currect on the basis of Bohr's theory

A. Velocity of electron $\propto \frac{1}{n}$

B. Frequency of revolution $\propto \frac{1}{n^3}$

C. Radius of orbit $\propto n^2 Z$

D. Force on electron $\propto \frac{1}{n^4}$

Answer: A::B::D

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5. The spectrum of He is expected to be similar to that of

A. Li^{2+}

B. He

C. H

D. Na

Answer: A::C

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6. A hydrogen-like atom has ground state binding energy $122.4eV$. Then :

(a). its atomic number is 3

(b). an electron of $90eV$ can excite it to a higher state

(c). an $80eV$ electron cannot excite it to a higher state

(d). an electron of $8.2eV$ and a photon of $91.8eV$ are emitted when a $100eV$ electron interacts with it

A. Its atomic number is 3

B. a photon of 90 eV can excite it to a higher state

C. a 80 eV photon cannot excite it to a higher state

D. to excite an e^{-} minimum 91.8 eV photon is required

Answer: A::C::D

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7. A sodium street light gives off yellow light that has a wavelength of 600 nm.

Then (For energy of a photon take $E = \frac{12400 eV - \text{Å}}{\lambda(\text{Å})}$:

A. frequency of this light is $7 \times 10^{14} s^{-1}$

B. frequency of this light is $5 \times 10^{14} s^{-1}$

C. wave number of the light is $3 \times 10^{6} m^{-1}$

D. energy of the photon is approximately 2.07 eV

Answer: B::D

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8. The qualitative order of de Broglie wavelength for electron, proton and α perticle is $\lambda_e > \lambda_P > \lambda_\alpha$:

A. if kinetic energy is same for all particles

B. if the accelerating potential difference 'V' is same for all the particles (from rest)

C. if velocities are same for all particles

D. never possible

Answer: A::B::C

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9. If there are only two H-atoms each is in 3rd excited state then:

A. maximum number of different photons emitted is 4

B. maximum number of different photons emitted is 3

C. minimum number of different photons emitted is 1

D. minimum number of different photons emitted is 2

Answer: A::C

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10. In a H- like sample electron makes transition from 4th excited state of 2nd state then:

A. 10 different spectral lines are observed

B. 6 different spectral lines are observed

C. number of lines belonging to the Balmer series is 3

D. number of lines belonging to Paschen series is 2

Answer: B::C::D

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11. Identify the correct statement (s)

A. Wavelength associated with the 1 kg ball moving with the velocity 100 m/s can't be calculated.

B. Wave nature of the running trains is difficult ot observe because wavelength is extremely small.

C. Wavelength associated with the electron can be calculated using the formulae $E = \frac{hc}{\lambda}$.

D. If an electron is accelerated through 20 V potential difference and if it has already 5 eV kinetic energy then wavelength of the electron is approximately $\sqrt{6}$Å

Answer: B::D

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12. 1st excitation potential for the H-like (hypothetical) sample is 24 V. Then:

A. ionisation energy of the sample is 36 eV

B. ionisation energy of the sample is 32 eV

C. binding energy of 3rd excited state is 2 eV

D. 2nd excitation potential of the sample is $\frac{32 \times 8}{9}V$

Answer: B::C::D

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13. From the $\alpha -$ particle scattering experiment, Rutherford concluded that:

A. $\alpha -$ particle can come within a distance of the order of 10^{-14}m from the nucleus

B. the radius of the nucleus is less than 10^{-14} m

C. scattering followed Coulomb's law

D. the positively charged parts of the atom move with extremely high velocities

Answer: a,b,c

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14. Which of the following statement (s) are incorrect?

A. Photons having energy 400 kJ will break 4 mole bonds of a molecule A_2 where A-A bond dissociation energy is $100kJ/\text{mol}$.

B. Two bulbs are emitting light having wavelength $2000\text{Å}\text{and}3000\text{Å}$ respectively. If the bulbs A and B are 40 watt and 30 watt respectively then the ratio of no. of photons emitted by A and B per day is $\frac{1}{2}$.

C. When an electron make transition from lower to higher orbit photon is emitted.

D. 4 eV is sufficient to excite an e^- from ground state of H-atom.

Answer: a,b,c,d

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15. Bohr's theory is not applicable to-

(a). He

(b). Li^{2+}

(c). He^{2+}

(d). the H-atom

A. He

B. Li^{2+}

C. He^{2+}

D. the H-atom

Answer: a,c

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16. In which transition, one quantum of energy is emitted -

(a). $n = 4 \rightarrow n = 2$

(b). $n = 3 \rightarrow n = 1$

(c). $n = 4 \rightarrow n = 1$

(d). $n = 2 \rightarrow n = 1$

A. $n = 4 \rightarrow n = 2$

B. $n = 3 \rightarrow n = 1$

C. $n = 4 \rightarrow n = 1$

D. $n = 2 \rightarrow n = 1$

Answer: a,b,c,d

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17. The magnitude of the spin angular momentum corresponding to an electron in Balmer transition inside a hydrogen atom cam be:

A. $S = \sqrt{s(s+1)}\frac{h}{2\pi}$

B. $S = s\frac{h}{2\pi}$

C. $S = \frac{\sqrt{3}}{2} \times \frac{h}{2\pi}$

D. $S = \pm \frac{1}{2} \times \frac{h}{2\pi}$

Answer: a,c

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18. The change in orbital angular momentum corresponding to an electron transition inside a hydrogen atom can be-

(a). $\frac{h}{4\pi}$

(b). $\frac{h}{\pi}$

(c). $\frac{h}{2\pi}$

(d). $\frac{h}{8\pi}$

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

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

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

D. $\frac{h}{8\pi}$

Answer: b,c

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19. In a hydrogen like sample two different types of photons A and B are produced by electronic transition. Photon B has its wavelength in infrared region. If photon A has more energy than B, then the photon may belong to the region:

A. ultraviolet

B. visible

C. infrared

D. far infrared

Answer: a,b,c

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20. In Bohr's model of the hydrogen atom:

A. The radius of the nth orbit is inversely proportional to n^2.

B. The total energy of the electron in the nth orbit is inversely proportional to 'n'.

C. The angular momentum of the electron in an orbit is an intergral multiple of $h/2\pi$.

D. The magnitude of potential energy of the electron in any orbit is greater than its KE.

Answer: c,d

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21. Which of the following statement (s) is /are true?

A. If H-atoms are in 3rd energy level then number of maximum different spectral lines produced by 2 atoms will be equal to number of maximum spectral lines produced by 3 H-atoms.

B. For third excited state, He^+ ions and maximum number of different spectral line produced by 4 H-atoms are equal.

C. Energy evolved from 3rd to 2nd energy level transition in He^+ can be used ot ionise Li^{2+} from ground level.

D. Energy evolved by a He^+ ion which is in its 1st excited state can ionise a hydrogen atom which is in its ground state.

Answer: a,b,d

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22. Which of the following statements (regarding an atom of H) are correct?

A. Kinetic energy of the electron is maximum in the first orbit

B. Potential energy of the electron is maximum in the first orbit

C. Radius of the second orbit is four times the first orbit

D. Various energy levels are equally spaced on energy scale

Answer: a c

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23. Choose the correct statements from the following

A. A node is a point in space where the wave function (Ψ) has zero amplitude.

B. Total number of nodes in an orbital is equal to (n-1).

C. Ψ^2 represents the probability density of finding an electron.

D. Total no. of angular nodes in $2p_x$ orbital is one .

Answer: a b c d

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24. If electron of hydrogen atom is replaced by another particle of same charge but of double mass then:

A. Radii of orbits will increase

B. Ionisation energy will increase

C. Velocity of new particle will be more

D. Energy gap between two levels will be doubled

Answer: b d

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25. The wave function of 3s and $3p_z$ orbitals are given by :

$$\Psi_{3s}=\frac{1}{9\sqrt{3}}\left(\frac{1}{4\pi}\right)^{1/2}\left(\frac{Z}{\sigma_0}\right)^{3/2}(6=6\sigma+\sigma)e^{-\sigma/2}$$

$$\Psi_{3s_z}=\frac{1}{9\sqrt{6}}\left(\frac{3}{4\pi}\right)^{1/2}\left(\frac{Z}{\sigma_0}\right)^{3/2}(4-\sigma)\sigma e^{-\sigma/2}\cos 0,$$

$$\sigma=\frac{2Zr}{n\alpha_0}$$

where$\alpha_0=1st$ Bohr radius , Z= charge number of nucleus, r= distance from nucleus.

From this we can conclude:

A. Total number of nodal surface is same for 3s and $3p_x$ orbitals

B. The angular nodal surface of $3p_z$ orbital occur at $0 = \frac{\pi}{2}$

C. The radial nodal surface of 3s and $3p_z$ orbitals are at equal distance from nucleus.

D. 3s electrons have greater penetrating power into the nucleus compared to $3p_z$ electron.

Answer: a b d

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26. The orbital angular momentum of an electron is $\sqrt{3}\frac{h}{\pi}$. Which of the following should not be the permissible value of orbit angular momentum of this electron revolving in Bohr orbit ?

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

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

C. $3.\ \frac{h}{2\pi}$

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

Answer: a b c

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27. Select correct statement(s) about photoelectric effect.

A. If green light ejects photoelectron from metal M then red light can never eject photoelectrons from metal M.

B. If green light ejects photoelectron from metal M then red light may not eject photoelectrons even if it has high intensity for metal M.

C. If green light ejects photoelectron from metal M with low photocurrent then more photo intense blue light must have high photocurrent for metal M.

D. If green light ejects photoelectron then blue light must eject photoelectron with more energy for metal M.

Answer: b c d

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28. Bohr model can be applied on :

A. H atom

B. He^{+} ion

C. H^{-} ion

D. Li^{2+} ion

Answer: a b d

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29. Which of the following statements (s) is/are true?

A. $\frac{(U_{rms}o_2TK)}{(U_{av}o_2TK)}, is fixed$

B. Wavelength of ejected photoelectron can be calculated by $\lambda = \frac{hc}{E}$, Where E is kinetic energy of ejected photoelectron.

C. Ozone gas can be absorbed by alkaline pyrogallol solution.

D. Oxygen gas can be absorbed by alkaline pyrogallol solution.

Answer: a d

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30. For two Bohr orbits $n_1 \text{and} n_2$ which follow the relationships, $(n_2^2 = n_1^2) = 21$ and $(n_2 - n_1) = 3$.

If an electron makes transition from $n_2 \text{to} n_1$ directly then :

A. third longest wavelength of Balmer series is emitted

B. longest frequency of Lyman series is amitted

C. longest frequency of Balmer saries is emitted

D. only one spectral line is emitted

Answer: a d

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31. Select the correct statement about electromagnetic waves.

A. They have different wavelength velocity and frequency in vacuum.

B. No medium is required for their propagation.

C. perpendicular constant electric and magnetic field generates it .

D. It consists of transverse vibrations produced from a combination of electric and magnetic fields perpendicular to each other .

Answer: b d

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32. Whenever a hydrogen atom emits photon in the Balmer series:

A. it may emit another photon in the Balmer series

B. it may emit another photon in the Lyman series

C. the second photon if emitted will have a wavelength of about 122 nm

D. it may emit a second photon, but the wavelength of this photon cannot be predicted

Answer: b c

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33. Radiatonal wavelength $(\lambda) = 124nm$ falls on a metallic surface then the kinetic energy of the ejected photo electron(s) can be : [Given that threshold wavelength $(\lambda_0) = 248nm$]

A. 1 eV

B. 2 eV

C. 3 eV

D. 5 eV

Answer: a b c d

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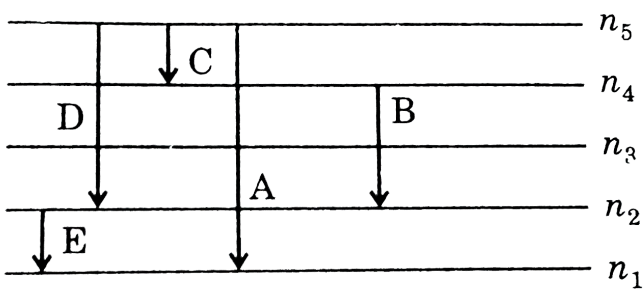
34. For a H-like atom which Bohr's model some spectral lines were observed as shown If it is known that line E belongs to visible region then the correct statement(s) is/are for following transition.



A. There cannot be any line in UV region

B. only line possibly belonging to ultraviolet region is A

C. Line having shortest wavelength is A

D. Line having least energy is C.

Answer: c d

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35. Select the correct statement .

A. Over a boundary surface, value of probability density $|\Psi|^2$ is constant for an orbital.

B. Probability of finding an electron is 100% in an orbital.

C. Number of angular nodes are $n - l - 1$.

D. For 1s orbital the probability density is maximum at the nucleus.

Answer: a d

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36. Choose the correct statements regarding $'\Psi'$.

A. If probability density $|\Psi|^2$ is also constant over the surface.

B. The boundary surface ofr $|\Psi|^2 \text{and} |\Psi|$ are indentical.

C. Boundary surface diagram for an s-orbital is actually a sphere centered on the nucleus.

D. 2s-orbital probability density first decreases sharply to zero and again starts increasing .

Answer: a b c d

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37. (i) A plot of $4\pi r^2 R^2$ vs r has a total three maximas.

(ii) The orbital has two angular nodes.

(iii) One angular node is the XY plane.

The orbital stisfying the above three conditions cannot be:

A. 3s

B. $4p_z$

C. $5d_{xy}$

D. $5d_{x^2 - y^2}$

Answer: a b c d

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38. The orbit angular momentum of 3d and 4d are:

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39. Identify the correct statement (s) regarding $3p_z$ orbital.

A. Angular part of wave function has $0 = 90^{\circ}$

B. No. of maximum in $R^2(r)us(r)$ curve is 3.

C. Total 3 nodal planes are possible.

D. No. of radial nodes = 1

Answer: a d

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40. Maximum probability region $(r_{\max} \text{values})$ for an orbital increases as 'r' value the probability becomes maximuml then it falls down with the increases of r More than one value of 'r' appear in all orbitals, except:

A. 1s

B. 2p

C. 3d

D. 4f

Answer: a b c d

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41. If $r_{\max}$ represents the longest maximum probability region and $< r_{\max} >$ represents avergae $r_{\max}$, then which of the following holds true for multi-electron species?

A. $r_{\max}$ order : $3s > 3p > 3d$

B. $< r_{\max} >$ order : $3s < 3p < 3d$

C. penetrating power : $3s > 3p > 3d$

D. $r_{\max}$ order : $3s < 3p < 3d$

Answer: a b c d

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42. Select the correct statement (s)

A. Radial function $[R(r)]$ part of Ψ depends only on principal quantum number 'n'

B. Angular function $[y(0, \phi)]$ part of Ψ is independent of 'n'.

C. Ψ^2 gives the probability density of finding electron at a perticular point in space.

D. R.D.F $(4\pi r^2 R^2)$ gives the probability of the electron being present at a distance r form the nucleus.

Answer: b c d

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43. Select correct statement(s).

A. In Bohr model it is possible to determine both position and momentum of electron simultaneously.

B. Energy of electron in second excited state of He^+ is $-13.6eV$

C. Angular momentum of electron moving in third orbit of H-atom is 3

D. There are 3 radial nodes in 5p orbital.

Answer: c d

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44. The wave function for 2s orbital is given as:

$$\Psi = \left(\frac{1}{\sqrt{2}}\right)\left(\frac{1}{\alpha_0}\right)^{3/2}\left(2 - \frac{r}{\alpha_0}\right).\, e^{-r/2\alpha_0}$$

Where α_0= First Bohr's radius in H-atom =0.529 "Å" Read the given statement and pick out the correct statement(s).

A. The number of radial nodes is equal to three.

B. The probability density is independent of direction.

C. The probability density of finding electron at nucleus is non-zero.

D. The radial node occur at a distance $2\alpha_0$ from nucleus.

Answer: b c d

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45. A hydrogen like atom in ground state absorbs n photon having the same energy and its emits exacity $n`$ photon when electrons transition takes placed .Then the energy of the absorbed photon may be

A. 91.8 eV

B. 40.8 eV

C. 48.4eV

D. 54.4 eV

Answer: a b

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46. Choose the correct statement among the following

A. Radial distribution function $(\Psi^2 . 4\pi r^2 dr)$ give probability at a particular distance along one chosen direction.

B. $\Psi^2(r)$ give probability density at a particular distance over a spherical surface.

C. For 's' orbitals $\Psi(r)\Psi(0)\Psi(\phi) = \Psi(x, y, z)$ is independent of 0 and ϕ.

D. 2p' orbital with quantum numbers, $n = 2, l = 1m = 0,$ also shows angular dependence.

Answer: c d

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47. Correct statement (s) regarging $3p_y$ orbital is / are :

A. Angular part of wave function is independent of angles $(0 \text{and} \phi)$.

B. No. of maximum when a curve is plotted between $4\pi r^2(r)\text{us r are'2'}$.

C. xz' plane acts as nodal plane.

D. Magnetic quantum number must be '-1'.

Answer: b c

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48. Choose the incorrect statement (s) :

A. Increasing order of wavelength is :

$\text{Microwaves} > \text{Radio waves} > \text{IR waves} > \text{Visible waves} > \text{UV wav}$

B. The order of Bohr radius is (r_n : where n is orbit number for a given atom)

$r_1 < r_2 < r_3 < r_4$

C. The order or total energy is (E_n : where n is orbit number for a given atom)

$E_1 > E_2 > E_3 > E_4$

D. The order of velocity of electron in $H, He^{+}, Li^{+}, Be^{3+}$ species in second Bohr orbit is

$Be^{3+} > Li^{+2} > He^{+} > H$

Answer: a c

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49. Which of the following is/are correct statement (s).

A. The difference in angular momentum associated with the electron present in consecutive orbits of H-atom is $(n-1)\frac{h}{2\pi}$.

B. Energy difference between energy levels will be changed if PE at infinity assigned value other than zero.

C. Frequency of spectral line in a H-atom is in the order of $(2 \rightarrow 1) < (3 \rightarrow 1) < (4 \rightarrow 1)$.

D. On moving away from the nucleus, kinetic energy of electron decreases.

Answer: c d

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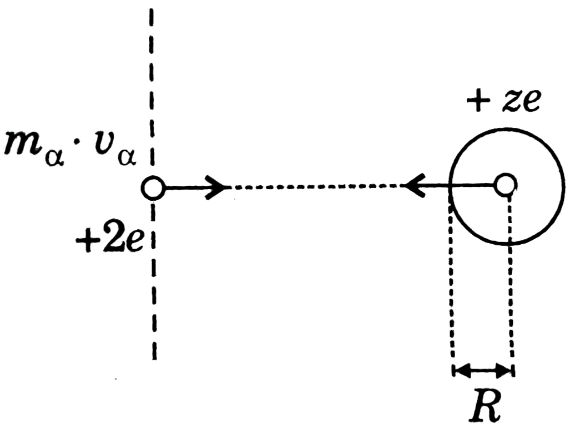
Comprehesion Type

1. Read the following passage carefully and answer the questions



The approximate size of the nucleus can be calculated by using energy conservation theorem in Rutherford's $\alpha -$ scattering experiment. If an

$\alpha -$ perticle is projected from infinity with speed v, towards the nucleus having z protons then the $apha -$ perticle which is reflected back or which is deflected by 180° must have approach closest to the nucleus. It can be approximated that $\alpha -$ particles collides with the nucleus and gets back. Now if we apply the energy conservation at initial and collision point then:

$$(\text{Total Energy})_{\text{initial}} = (\text{Total Enregy})_{\text{final}}$$

$$(KE)_i + (PE)_i = (KE)_f + (PE)_f$$

$(PE)_i = 0, \text{since} PE$ of two charge system separated by infinite distance is zero, finally the particle stops and then starts coming back.

$$\frac{1}{2} m_\alpha v_\alpha^2 + 0 = 0 + \frac{k q_1 q_2}{R}$$

$$\Rightarrow \frac{1}{2} m_\alpha v_\alpha^2 = k \frac{2e \times ze}{R} \Rightarrow R = \frac{4kze^2}{m_\alpha v_\alpha^2}$$

Thus the radius of nucleus can be calculated using above equation. The nucleus is so small a particle that we can't define a sharp boundary for it . Experiments show that the average radius R fo a nucleus may be written as

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

where $R_0 = 1.2 \times 10^{-15} m$

A= atomic mass number

R=radius of nucleus

If the diameter of two different nuclei are in the ratio 1:2 then their mass number are in the ratio:

A. 0.0430555555555556

B. 0.334027777777778

C. 0.0472222222222222

D. 0.0444444444444444

Answer: c

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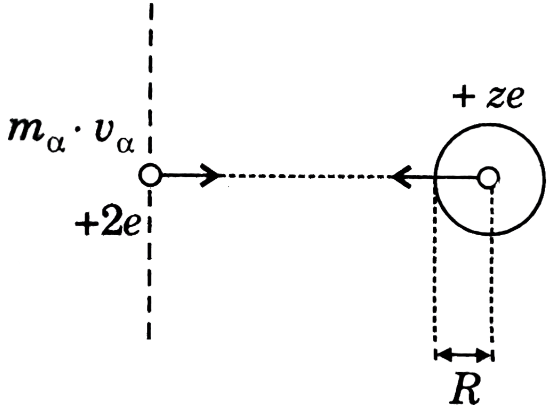
2. Read the following passage carefully and answer the questions



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$$\Rightarrow \frac{1}{2}m_\alpha v_\alpha^2 = k\frac{2e \times ze}{R} \Rightarrow R = \frac{4kze^2}{m_\alpha v_\alpha^2}$$

Thus the radius of nucleus can be calculated using above equation. The nucleus is so small a particle that we can't define a sharp boundary for it . Experiments show that the average radius R fo a nucleus may be written as

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

where $R_0 = 1.2 \times 10^{-15}m$

A= atomic mass number

R=radius of nucleus

If $\alpha -$ particle with speed v_0 is projected from infinity and it approaches upto r_0 distance from the nuclei. Then the speed of $\alpha -$ particle which approaches $2r_0$ distance from the nucleus is

A. $\sqrt{2}v_0$

B. $\frac{v_0}{\sqrt{2}}$

C. $2v_0$

D. $\frac{v_0}{2}$

Answer: b

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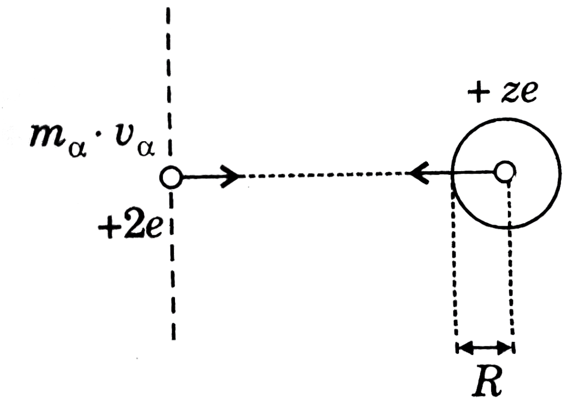
3. Read the following passage carefully and answer the questions



The approximate size of the nucleus can be calculated by using energy conservation theorem in Rutherford's $\alpha -$ scattering experiment. If an $\alpha -$ perticle is projected from infinity with speed v, towards the nucleus having z protons then the $apha -$ perticle which is reflected back or which is deflected by 180° must have approach closest to the nucleus. It can be approximated that $\alpha -$ particles collides with the nucleus and gets back. Now if we apply the energy conservation at initial and collision point then:

$(\text{Total Energy})_{\text{initial}} = (\text{Total Enregy})_{\text{final}}$

$(KE)_i + (PE)_i = (KE)_f + (PE)_f$

$(PE)_i = 0, \text{since} PE$ of two charge system separated by infinite distance

is zero, finally the particle stops and then starts coming back.

$$\frac{1}{2} m_\alpha v_\alpha^2 + 0 = 0 + \frac{kq_1 q_2}{R}$$

$$\Rightarrow \frac{1}{2} m_\alpha v_\alpha^2 = k \frac{2e \times ze}{R} \Rightarrow R = \frac{4kze^2}{m_\alpha v_\alpha^2}$$

Thus the radius of nucleus can be calculated using above equation. The nucleus is so small a particle that we can't define a sharp boundary for it . Experiments show that the average radius R fo a nucleus may be written as

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

where $R_0 = 1.2 \times 10^{-15} m$

A= atomic mass number

R=radius of nucleus

Radius of a particular nucleus is calculated by the projection of $\alpha -$ particle from infinity at a particular speed. Let this radius be the true radius. If the radius calculation for the same nucleus is made by , $\alpha -$ particle with half of the earlier speed then the percentage error involved in the radius calculation is :

A. 0.75

B. 1

C. 3

D. 4

Answer: c

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4. One of the major requirement in atomic structure is determination of location of electron inside an atom. The wave mechanical model establishes this in accordance with Heisenberg's uncertainity principle through the concept of orbitals. The orbitals are defined as that '3D' space in which probability of finding electron is maximum and are represented by wave functions $\Psi_{n,l,m}$ where n,l and m are quantum number. The variation of Ψ is analysed in terms of polar coordinates and hence $\Psi = f(r, 0, \phi)$ where 'r' represents radius vector and 0 and ϕ represents angle $(\angle)$ Which the radius vector with x-axis respectively. The expressions of $\Psi_{r,0,\phi}$ are often given in terms of σ instead of r where $\sigma = \frac{2Zr}{n\alpha_0}$ and Z = atomic number and n= shell number.

Which of the following wave function cannot represent an atomic orbital of H-atom?

A. $\Psi = \frac{1}{18\sqrt{8\pi}}\left(\frac{1}{\alpha_0}\right)^{3/2}.\sigma^2.e^{-\sigma/2}.\sin^2 0.\cos 2\phi$

B. $\Psi = \frac{1}{\sqrt{2\pi}}.\left(\frac{1}{\alpha_0}\right)^{3/2}.\sigma.e^{-\sigma/2}.\sin 0.\sin\phi$

C. $\Psi = \frac{1}{18}\sqrt{\frac{5}{\pi}}.\left(\frac{1}{\alpha_0}\right)^{3/2}(6 - 6\sigma + \sigma^2)$

$.e^{-\sigma/2}.\sin 0.\cos\phi$

D. $\Psi = \frac{1}{\sqrt{32\pi}}.\left(\frac{1}{\alpha_0}\right)^{3/2}(2-\sigma).e^{-\sigma/2}$

Answer: c

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5. One of the major requirement in atomic structure is determination of location of electron inside an atom. The wave mechanical model establishes this in accordance with Heisenberg's uncertainity principle through the concept of orbitals. The orbitals are defined as that '3D' space in which probability of finding electron is maximum and are represented by wave functions $\Psi_{n,l,m}$ where n,l and m are quantum number. The variation of Ψ is analysed in terms of polar coordinates and hence $\Psi = f(r, 0, \phi)$ where 'r' represents radius vector and 0 and ϕ represents angle $(\angle)$ Which the radius vector with x-axis respectively. The expressions of $\Psi_{r,0,\phi}$ are often given in terms of σ instead of r where $\sigma = \frac{2Zr}{n\alpha_0}$ and Z = atomic number and n= shell number.

Which of the following statement is incorrect with respect to $\Psi_{(r)}\, us.$ r graph for H-atom?

A. For a 3d orbital, the graph will not intersect the x-axis at any finite, non-zero value.

B. For a 4s orbital, the graph will intersect at exactly three distinct, non-zero finite points.

C. For 1s orbital the sign of the $\Psi_{(r)}$ will not change after at any radial distance.

D. For 3p orbital , the graph will intersect x-axis at two non-zero distinct points.

Answer: d

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6. One of the major requirement in atomic structure is determination of location of electron inside an atom. The wave mechanical model establishes this in accordance with Heisenberg's uncertainity principle through the concept of orbitals. The orbitals are defined as that '3D' space in which probability of finding electron is maximum and are represented by wave functions $\Psi_{n,l,m}$ where n,l and m are quantum number. The variation of Ψ is analysed in terms of polar coordinates and hence $\Psi = f(r, 0, \phi)$ where 'r' represents radius vector and 0 and ϕ represents angle $(\angle)$ Which the radius vector with x-axis respectively. The expressions of $\Psi_{r,0,\phi}$ are often given in terms of σ instead of r where $\sigma = \frac{2Zr}{n\alpha_0}$ and Z = atomic number and n= shell number.

If an orbital is represented as:

$$\Psi_{r,0,\phi} = \frac{2}{3}\left(\frac{1}{3\alpha_0}\right)^{3/2}. (\sigma - 1)(\sigma^2 - 8\sigma + 12)$$

$. \sigma^{-\sigma/2}. \cos 0$

belong to which orbital?

A. $6d_{x^2} - y^2$

B. $5p_z$

C. $5p_y$

D. $6d_{z^2}$

Answer: b

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7. A hydrogen like species is in a spherical symmetrical orbital S_1 having 3 radial nodes. It gets de-excited to another level S_2 having no radial node. Energy of S_2 orbital is 2.25 times energy of 1st Bohr robit of hydrogen atom.

Identify the species involvedgt

A. He^{+}

B. Be^{+3}

C. Li^{+2}

D. B^{+4}

Answer: c

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8. A hydrogen like species is in a spherical symmetrical orbital S_1 having 3 radial nodes. It gets de-excited to another level S_2 having no radial node. Energy of S_2 orbital is 2.25 times energy of 1st Bohr robit of hydrogen atom.

What is the orbital angular momentum quantum number of S_2?

A. 1

B. 0

C. 2

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

Answer: a

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9. A hydrogen like species is in a spherical symmetrical orbital S_1 having 3 radial nodes. It gets de-excited to another level S_2 having no radial node. Energy of S_2 orbital is 2.25 times energy of 1st Bohr robit of hydrogen atom. ltbr. What is the combined total number of nodes $(\text{radial} + \text{angular})\text{ is} S_1 \text{ and } S_2$?

A. 4

B. 3

C. 5

D. 6

Answer: a

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10. Let us assume a different atomic model in which electron revolves around the nucleus (proton) at a separation r under the action of force which is different from electro-static force of attraction. The potential energy between an electron and the proton due to this force is given by $U = -\frac{k}{r^4}$ where k is a constant.

Find the radius of n th Bohr's orbit.

A. $r = \frac{\pi}{nh}\sqrt{km}$

B. $r = \frac{2\pi}{nh}\sqrt{km}$

C. $r = \frac{4\pi}{nh}\sqrt{km}$

D. $r = \frac{8\pi}{nh}\sqrt{km}$

Answer: c

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11. Let us assume a different atomic model in which electron revolves around the nucleus (proton) at a separation r under the action of force which is different from electro-static force of attraction. The potential energy between an electron and the proton due to this force is given by $U = -\frac{k}{r^4}$ where k is a constant.

Find the radius of n th Bohr's orbit.

A. $u = \frac{nh}{8\pi^2 m\sqrt{km}}$

B. $u = \frac{n^2 h}{8\pi^2 m\sqrt{km}}$

C. $u = \frac{nh^2}{4\pi^2 m\sqrt{km}}$

D. $u = \frac{n^2 h^2}{8\pi^2 m\sqrt{km}}$

Answer: d

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12. Let us assume a different atomic model in which electron revolves around the nucleus (proton) at a separation r under the action of force which is different from electro-static force of attraction. The potential energy between an electron and the proton due to this force is given by $U = -\frac{k}{r^4}$ where k is a constant.

Find the radius of n th Bohr's orbit.

A. $\frac{-n^4h^4}{128\pi^4m^2k}$

B. $\frac{n^4h^4}{128\pi^4m^2k}$

C. $\frac{n^4h^4}{256k\pi^4m^2}$

D. $\frac{-n^4h^4}{256\pi^4m^2}$

Answer: c

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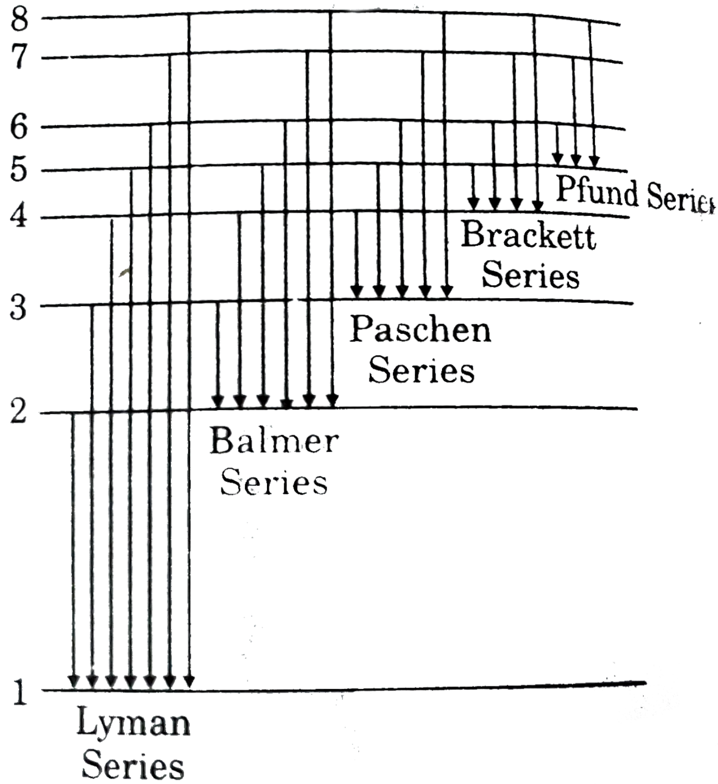
13. the only electron in the hydrogen atom resides under ordinary conditions in the first orbit. When energy is supplied the electron moves to higher energy orbit depending on the amount of energy absorbed. It emits energy. Lyman series is formed when the electron returns to the lowest orbit while Balmer series is formed when the electron returns to second. Similarly, Paschen, Breakett and Pfund series are formed when electron returns to the third, fourth and fifth orbits from higher energy orbits respectively (as shown in figure).



Maximum number of different lines produced when electron jump from nth level to ground level is equal to

$$\frac{n(n-1)}{2}.$$

For example in the case of $n = 4$, number of lines produced is 6. $(4 \to 3, 4 \to 2, 4 \to 1, 3 \to 2, 3 \to 1, 2 \to 1)$. When an electron returns from $n_2 \text{to} n_1$ state, the number of different

lines in the spectrum will be equal to $\frac{(n_2-n_1)(n_2-n_1+1)}{2}$

If the electron comes back from energy level having energy E_2 to energy level having energy $E_1,$ then the difference may be expressed in terms of energy of photon as:

$$E_2-E_1=\Delta E, \lambda=\frac{hc}{\Delta E}, \Delta E=hv(v-\text{frequency})$$

Since h and c are constants ΔE corresponds to definite energy: thus each transition from one energy level to another will produce a light of definite wavelength. This is actually observed as a line in the spectrum of hydrogen atom.

Wave number of line is given by the formula:

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

where R is a Rydberg constant $\left(R=1.1\times10^7 m^{-1}\right)$.

(i) First line of a series : It is called line of longest wavelength of line of smallest energy'.

(ii) Series limit or last line of a series : It is the line of shortest wavelength or line of highest energy.

Last line of breakett series for H-atom has wavelength $\lambda_1 \mathring{A}$ and 2nd line of Lyman series has wavelength $\lambda_2 \mathring{A}$then:

A. $\frac{128}{\lambda_1} = \frac{9}{\lambda_2}$

B. $\frac{16}{\lambda_1} = \frac{9}{\lambda_2}$

C. $\frac{4}{\lambda_1} = \frac{1}{\lambda_2}$

D. $\frac{128}{\lambda_1} = \frac{1}{\lambda_2}$

Answer: a

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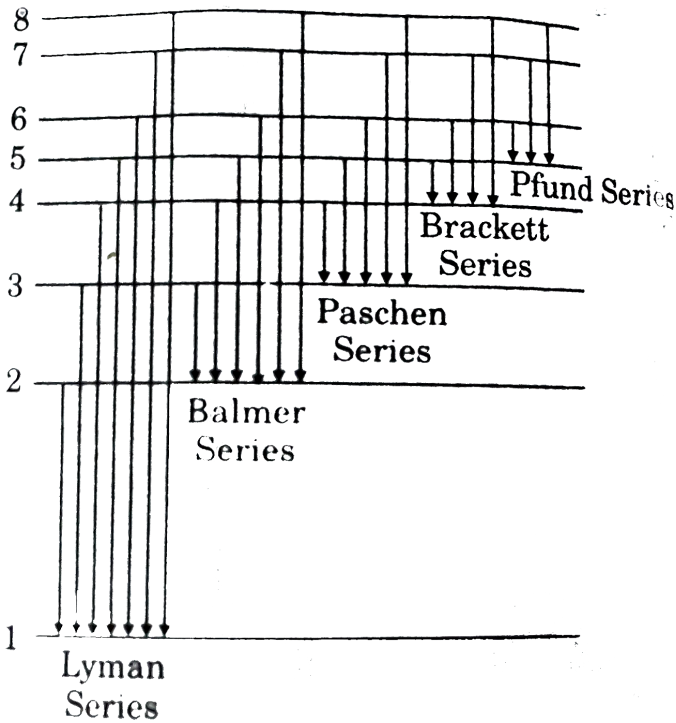

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(i) First line of a series : It is called line of longest wavelength of line of smallest energy'.

(ii) Series limit or last line of a series : It is the line of shortest wavelength or line of highest energy.

Consider the following statements

(i) Spectral lines of He^+ ion belonging to Balmer series are not in visible range.

(ii) In the Balmer series of H-atom maximum lines are in ultraviolet ragion.

(iii) 2nd line of Lyman series of He^+ ion has energy $48.35 eV$

The above statement (i), (ii), (iii) respectively are $(T = True, F = False)$:

A. TFF

B. FTT

C. TFT

D. TTT

Answer: d

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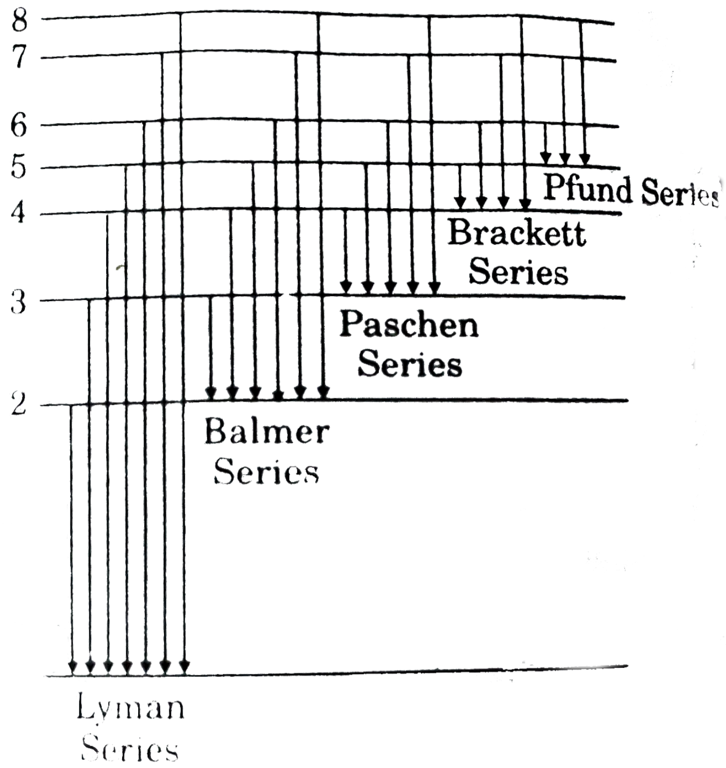
15. the only electron in the hydrogen atom resides under ordinary conditions in the first orbit. When energy is supplied the electron moves to higher energy orbit depending on the amount of energy absorbed. It emits energy. Lyman series is formed when the electron returns to the lowest orbit while Balmer series is formed when the electron returns to second. Similarly, Paschen, Breakett and Pfund series are formed when electron returns to the third, fourth and fifth orbits from higher energy orbits respectively (as shown in figure).



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wave number of the first line of Paschen series in Be^{3+} ion is :

A. $\frac{7R}{16}$

B. $\frac{7R}{144}$

C. $\frac{7R}{9}$

D. $\frac{R}{144}$

Answer: c

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16. de Broglie proposed dual nature for electron by putting his famous equation $\lambda = \frac{h}{mv}$. Later on, Heisenberg proposed uncertainty principle as $\delta p \Delta x \geq \frac{h}{4\pi}$. On the contrary,

Particle nature of electron was established on the basis of photoelectric effect. When a photon strikes the metal surface it gives up its energy to the electron. Part of this energy (say W) is used by the electrons to escape from the metal and the remaining energy imparts kinetic energy $\left(1/2mv^2\right)$ to the ejected photoelectron. The potential applied on the surface to reduce the velocity of photoelectron to zero is known as stopping potential .

When a beam of photons of a particular energy was incident on a surface of a particular pure metal having work function =(40 eV), some emitted photoelectrons had stopping potential equal to 22 V. some had 12V and rest had lower values. Calculate the wavelength of incident photons assuming that at least one photoelectron is ejected with maximum possible kinetic energy :

A. 310Å

B. 298Å

C. 238Å

D. 200Å

Answer: d

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17. de Broglie proposed dual nature for electron by putting his famous equation $\lambda = \frac{h}{mv}$. Later on, Heisenberg proposed uncertainty principle as $\delta p \Delta x \geq \frac{h}{4\pi}$. On the contrary,

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The circumference of third orbit of a single electron species is 3 nm. What may be the approximate wavelength of the photon required to just ionize electron from this orbit?

A. 91.1 nm

B. 364.7 nm

C. 821 nm

D. 205 nm

Answer: c

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18. Excited atoms emit radiations consisting of only certain discrete frequencise or wavelengths. In spectroscopy it is often more convenient to use freuquencies and wave numbers are proportional ot energy and spectroscopy involves transitions between different energy levels . The line spectrum shown by a single electron excited atom (a finger print of an atom) can be given as

$$\frac{1}{\lambda} = \bar{\upsilon} R_H . Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$$

where Z is atomic number of single electron atom and n_1, n_2 are integers and if $n_2 > n_1,$ then emission spectrum is noticed and if $n_2 < n_1,$ then absorption spectrum is noticed.

Every line in spectrum can be represented as a difference of two terms $\frac{R_H Z^2}{n_1^2} \text{and} \frac{R_H Z^2}{n_2^2}.$

The ratio of wavelength for II line fo Balmer series and I line of Lyman series for H-like species is :

A. $\frac{1}{4}$

B. 2

C. 3

D. 4

Answer: d

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Every line in spectrum can be represented as a difference of two terms $\frac{R_H Z^2}{n_1^2} \text{and} \frac{R_H Z^2}{n_2^2}$.

H-atoms in ground state (13.6 eV) are excited by monochromatic radiations of photon of energy 12.09 eV. The number of different spectral lines emitted in H-atoms will be:

A. 1

B. 2

C. 3

D. 6

Answer: c

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20. In an atom when an electron jumps from higher energy level to lower energy level it amits energy in form of elecromagnetic radiations. When these elecromagnetic radiations are passed through a prism and received on a photographic film some lines are observed on that film and those lines are called spectral lines.

For hydrogen like species when jump takes from any excited state to ground state $(n = 1)$, line produced in that case is called a Lyman series line.

If transition occurs from 3rd or above level to second level then corresponding lines produced are called Balmer lines. Similarly, for next level it is called Paschen series line.

The wavelength of photon corresponding ot second least energy of Lyman series in H-atom is :

A. 102 nm

B. 121 nm

C. 91 nm

D. 486 nm

Answer: a

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If transition occurs from 3rd or above level to second level then corresponding lines produced are called Balmer lines. Similarly, for next level it is called Paschen series line.

If there are 3 atoms of a hydrogen like species one in 2nd one in 3rd and one in 4th excited state, then how many maximum total different Balmer and Paschen lines can be produced ?

A. 2

B. 3

C. 4

D. 5

Answer: d

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22. From hydrogen gas discharge tube, light is emitted. Emitted light is used to emit electron from sodium metal of work function $\phi = 1.82 eV$ If the fastest photoelectron has KE of 0.73 eV, the wavelength of incident radiation on the sodium metal is :

A. $5627.63 Å$

B. $4862.74 Å$

C. $3384 Å$

D. $9872 Å$

Answer: b

Watch Video Solution

23. From hydrogen gas discharge tube, light is emitted. Emitted light is used to emit electron from sodium metal of work function $\phi = 1.82 eV$

the transition in hydrogen atom takes place from:

A. $n_1 = 4 \text{to} n_2 = 1$

B. $n_1 = 4 \text{to} n - (2) = 3$

C. $n_1 = 3 \text{to} n_2 = 1$

D. $n_1 = 4 \text{to} n_2 = 2$

Answer: d

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24. In a H-like species there are two energy levels A and B above the ground state having principal quantum numbers of $n_1 \text{and} n_2$ respectively. A sample of this H-like species has all atoms / ions in excited levels A or B only and none in any other energy level. Energy of level B is greater than that of level A and a total of 15 different lines are emitted from this sample on returning to ground state out of which 6 lines are emitted due to electronic transitions between the level $n_1 \text{and} n_2$ only. Also energy difference between levels $n_2 \text{and} n_1$, $E_{n_2} - E_{n_2} = 4.53 eV$

The correct option is :

A. $n_2 = 2, n_1 = 5$

B. $n_2 = 6, n_1 = 3$

C. $n_2 = 5, n_1 = 2$

D. $n_2 = 3, n_1 = 6$

Answer: b

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25. In a H-like species there are two energy levels A and B above the ground state having principal quantum numbers of $n_1 \text{and} n_2$ respectively. A sample of this H-like species has all atoms / ions in excited levels A or B only and none in any other energy level. Energy of level B is greater than that of level A and a total of 15 different lines are emitted from this sample on returning to ground state out of which 6 lines are emitted due to electronic transitions between the level $n_1 \text{and} n_2$ only. Also energy difference between levels $n_2 \text{and} n_1$, $E_{n_2} - E_{n_2} = 4.53 eV$

Calculate minimum wavelength of the above transition:

A. $\frac{4}{3R_H}$

B. $\frac{9}{8R_H}$

C. $\frac{900}{11R_H}$

D. $\frac{36}{35R_H}$

Answer: d

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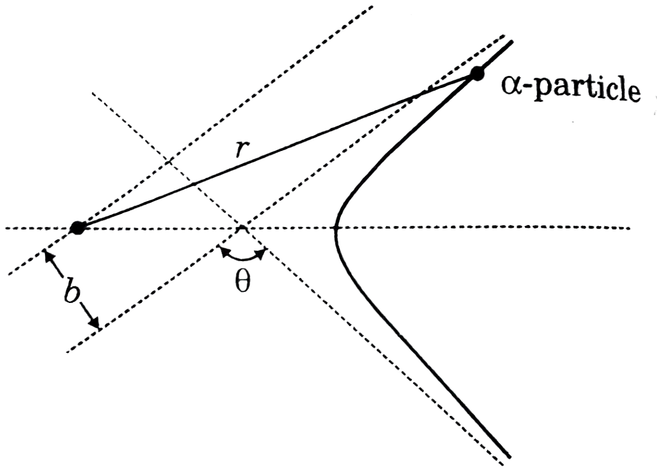
26. The following text gives a qualitative idea about Rutherford's $\alpha -$ particle scattering experiment.



Scattering of α-particles

Applying some trigonometry and calculus, Rutherford got the following equation:

$$\cot\left(\frac{0}{2}\right) = \frac{K \times (KE)}{Ze^2} \times b$$

$$\text{where, } K = \text{constant} = \left(\frac{1}{9 \times 10}\right)\frac{c^2}{N - m^2}$$

KE = initial kinetic energy of $\alpha -$ particle,

$$e = 1.6 \times 10^{-19} C$$

Identify the incorrect statement.

A. Scattering angle increases as impact parameter increases.

B. Scattering angle decreases as impact parameter increases.

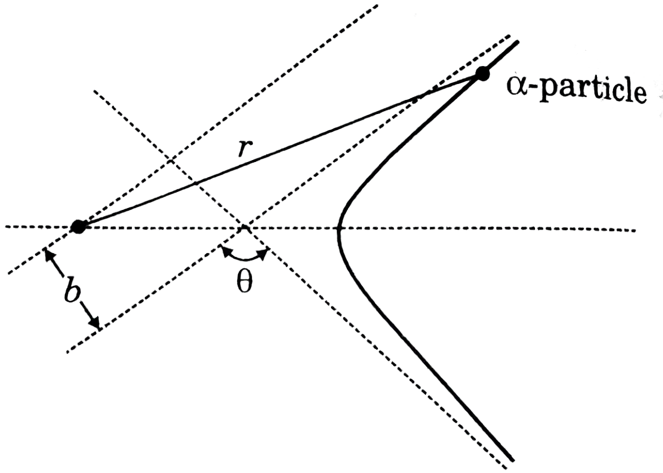
C. As the initial kinetic energy of $\alpha -$ particle increases, scattering angle decreases.

D. Keeping all the other factor same , the scattering angle obtained from gold nucleus is larger than the scattering angle obtained from copper nucleus.

Answer: a

View Text Solution

27. The following text gives a qualitative idea about Rutherford's $\alpha -$ particle scattering experiment.



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where, $K = \text{constant} = \left(\frac{1}{9 \times 10}\right)\frac{c^2}{N - m^2}$

KE = initial kinetic energy of α − particle,

$e = 1.6 \times 10^{-19} C$

In an experment with gold nucleus (assume Z=80) with impact parameter equal to $10^{-4} m$ the scattering angle was found to be 90°, What should be the initial KE of α − particle?

A. $1.84 \times 10^{-12} J$

B. $184 \times 10^{-12} J$

C. $1.44 \times 10^{-12} J$

D. $14.4 \times 10^{-12} J$

Answer: a

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28. In three dimension wave function may be expressed in spherical co-ordinate system $(r, 0, \phi), r =$ distance of electron from the nucleus

0= Angle from 'z' axis varying from 0 to π

$\phi =$ Angle from 'x' axis ...... 0 to 2π ltbr. Ψ may be represented as

$\Psi(r, 0, \phi) = R(r). A(0, \phi)$

The R(r) is detemind by 'n' and 'l'. The A $(0, \phi)$ is determined by 'l' and 'm'.

Which of the following is R(r) part of '3p' atomic orbital of hydrogen atom $\left[\text{Given}\alpha_0 = 0.529 \text{Å}\right]$?

A. $\dfrac{2}{(a_0)^{3/2}} e^{-r/a_0}$

B. $\dfrac{2}{27}\left(\dfrac{1}{3a_0}\right)^{3/2}\left(27 - 18\dfrac{r}{a_0} + 2\dfrac{r}{a_0^2}\right)e^{-r/3a_0}$

C. $\frac{2}{(2a_0)^{3/2}}\left(2-\frac{r}{a_0}\right)e^{-r/2a_0}$

D. $\frac{1}{81\sqrt{3}}\left(\frac{2}{a_0}\right)^{3/2}\left(6-\frac{r}{a_0}\right)e^{-r/3a_0}$

Answer: d

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29. In three dimension wave function may be expressed in spherical co-ordinate system $(r, 0, \phi)$, $r =$ distance of electron from the nucleus

0= Angle from 'z' axis varying from 0 to π

$\phi =$ Angle from 'x' axis ...... 0 to 2π ltbr. Ψ may be represented as

$\Psi(r, 0, \phi) = R(r).\ A(0, \phi)$

The R(r) is detemind by 'n' and 'l'. The A $(0, \phi)$ is determined by 'l' and 'm'. Angular part of 'H' atom wave equation $A(0, \phi) = \frac{1}{\sqrt{4\pi}}$. Hence , atomic orbital is:

A. $'d_{xz}'\text{orbital}$

B. $'p_x'\text{orbital}$

C. $'p_y'$orbital

D. s-orbital

Answer: d

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30. During one of its ambitious project "ISRP" gathered information through its stallites for a planet in another galaxy. As far as structure of atoms is considered , it is very similar to the structure of an atom in our planet except that

energy of an orbit in which electron resides is $(E_n) = \frac{45 \times Z}{n = 1} eV / \text{atom}.$

Calculate wavelength $(\text{in} \text{Å})$ of photon emitted when electron makes transition from 7th excited state to 1st excited state in H-atom of that planet:

A. 1240Å

B. 12400Å

C. 310Å

D. 3100Å

Answer: a

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31. During one of its ambitious project "ISRP" gathered information through its stallites for a planet in another galaxy. As far as structure of atoms is considered , it is very similar to the structure of an atom in our planet except that

energy of an orbit in which electron resides is $(E_n) = \frac{45 \times Z}{n = 1} eV / \text{atom}.$

If photon of wavelength 7nm strikes on an atom of hydrogen on that planet, then wavelength of ejected electron will be approximately:

A. 0.1Å

B. 1Å

C. 5Å

D. 11Å

Answer: b

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32. During one of its ambitious project "ISRP" gathered information through its stallites for a planet in another galaxy. As far as structure of atoms is considered , it is very similar to the structure of an atom in our planet except that

energy of an orbit in which electron resides is $(E_n) = \frac{45 \times Z}{n = 1} eV / \text{atom}.$

If collection of H-atom and He^+ ion makes transition from 2nd orbit and 5th orbit respectively, then total different spectral lines emitted will be :

A. 10

B. 11

C. 6

D. 9

Answer: a

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33. A H-like species Be^{3+} is in a spherically symmetric state S_1 with two radial nodes. Upon absorbing light the ion undergoes transition to a state S_2. The state S_2 has one radial node and its energy is equal to the ground state energy of the H-atom.

The state`S_(1) is :

A. 2s

B. 2p

C. 3s

D. 4s

Answer: c

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34. A H-like species Be^{3+} is in a spherically symmetric state S_1 with two radial nodes. Upon absorbing light the ion undergoes transition to a state S_2. The state S_2 has one radial node and its energy is equal to the ground state energy of the H-atom.

Energy of state S_1 in units of He^{+} ground state energy is :

A. 0.75

B. 1.33

C. 0.44

D. 2.25

Answer: c

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35. A H-like species Be^{3+} is in a spherically symmetric state S_1 with two radial nodes. Upon absorbing light the ion undergoes transition to a state S_2. The state S_2 has one radial node and its energy is equal to the ground state energy of the H-atom.

The orbital angular momentum of hte state S_2 is :

A. $\sqrt{1.5h}$

B. $\sqrt{2}h$

C. 0

D. h

Answer: a

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36. The French physicist Louis de Broglie in 1924 postulated that matter like radiation , should exhibit a dual behaviour. He proposed the following relationship between the wavelength . λ of a material particle,its linear momentum P and Planck constant h.

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

The de Broglie relaion that the wavelength of a particle should decrease as its velocity increases. It also implies that for a given velocity heavier particles should have shorter wavelength than lighter particles.The waves or de Broglie waves. These waves differ from the electromagnetic waves as they:

(i) have lower velocities

(ii) have no electrical and magnetic fields and

(iii) are not emitted by the particle under consideration.

The expermental confirmation of the de Broglie relation was obtained when Davission and Germer in 1927, observed. As diffraction is a characteristic property of waves, hence the beam of electrons behave as a wave as proposed by de Broglie.

Werner Heisenberg considered the limits of how precisely we can measure properties of an electron or other microscopic particle like electron . He determined that there is a fundamental limit of how closely we can measure both position and momentum. The more accurately we can determine its position. The converse is also true. This is summed up in what we now call the "Heisenberg uncertainty principle" : It is impossible to determine simultaneously and precisely both the momentum and position of a particle. The product of uncertainty in the position, Δx and the uncertainty in the momentum $\Delta(mv)$ must be greater than or equal to $\frac{h}{4\pi}, i.e.,$

$\Delta x \Delta(mv) \geq \frac{h}{4\pi}$

The correct order of wavelength of Hydrogen $\left(._1 H^1\right)$ Deuterium $\left(._1 H^2\right)$ and Tritium $\left(._1 H^3\right)$ moving with same kinetic energy is :

A. $\lambda_H > \lambda_D > \lambda_T$

B. $\lambda_H = \lambda_D = \lambda_T$

C. $\lambda_H < \lambda_D < \lambda_T$

D. $\lambda_H < \lambda_D > \lambda_T$

Answer: a

Watch Video Solution

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$$\Delta x \Delta(mv) \geq \frac{h}{4\pi}$$

The transition so that the de Broglie wavelength of electron becomes 3 times of its initial value in He^{+} ion will be :

A. $2 \rightarrow 5$

B. $3 \rightarrow 2$

C. $2 \rightarrow 6$

D. $1 \rightarrow 2$

Answer: c

38. The French physicist Louis de Broglie in 1924 postulated that matter like radiation , should exhibit a dual behaviour. He proposed the following relationship between the wavelength . λ of a material particle,its linear momentum P and Planck constant h.

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$\Delta x \Delta(mv) \geq \frac{h}{4\pi}$

If the uncertainty in velocity and posititon is same then the uncertainty in momentum will be :

A. $\sqrt{\frac{hm}{4\pi}}$

B. $m. \sqrt{\frac{h}{4\pi}}$

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

D. $\frac{1}{m}\sqrt{\frac{h}{4\pi m}}$

Answer: a

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Match the column type

1. Match the following columns

Column-I		Column-II	
(a)	Frequency	(p)	Length of one complete wave per time period
(b)	Wavelength	(q)	Number of waves passing through a point in one second
(c)	Time period	(r)	Length of one complete wave
(d)	Speed	(s)	Time taken for one complete wave to pass through a point

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2. Match the following columns

	Column-I		Column-II
(a)	Binding energy of 5th excited state Li^{++} sample	(p)	10.2 V
(b)	1st excitation potential of H-atom	(q)	3.4 eV
(c)	2nd excitation potential of He^{+}	(r)	13.6 eV
(d)	*IE* of H-atom	(s)	48.4 V

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3. Match the following columns

	Column-I		Column-II
(a)	$n = 6 \rightarrow n = 3$ (in H-atom)	(p)	10 lines in the spectrum
(b)	$n = 7 \rightarrow n = 3$ (in H-atom)	(q)	Spectral lines in *visible* region
(c)	$n = 5 \rightarrow n = 2$ (in H-atom)	(r)	6 lines in the spectrum
(d)	$n = 6 \rightarrow n = 2$ (in H-atom)	(s)	Spectral lines in infrared region

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4. $E_n =$ total energy , l_n angular momentum

$K_n = K.E.$, $V_n = P.E.$,

$T_n =$ time period , $r_n =$ radius of nth orbit

Column-I		Column-II	
(a)	$E_n^{-y} \propto r_n$ then y is	(p)	$\frac{1}{2}$
(b)	$l_n \propto n^x$ then x is	(q)	–2
(c)	$\frac{E_n}{V_n}$	(r)	–3
(d)	$T_n \propto \frac{Z^t}{n^m}$; t and m are respectively	(s)	1

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5.

Column-I		Column-II	
(a)	Aufbau principle	(p)	Line spectrum in visible region
(b)	de Broglie	(q)	Maximum multiplicty of electron
(c)	Angular momentum	(r)	Photon
(d)	Hund's rule	(s)	$\lambda = h/(mv)$
(e)	Balmer series	(t)	Electronic configuration
(f)	Planck's law	(u)	mvr

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6. Match the following columns

Column-I		Column-II	
(a)	Cathode rays	(p)	Helium nuclei
(b)	Dumb-bell	(q)	Uncertainty principle
(c)	Alpha particles	(r)	Electromagnetic radiation
(d)	Moseley	(s)	p-orbital
(e)	Heisenberg	(t)	Atomic number
(f)	X-rays	(u)	Electrons

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7. Frequancy $= f_1$, Time period = T, Energy of n^{th} orbit $= E_n$, radius of n^{th} orbit $= r^n$, Atomic number = Z, Orbit number = n :

	Column-I		Column-II
(A)	f	(p)	n^3
(B)	T	(q)	Z^2
(E)	E_n	(r)	$\frac{1}{n^2}$
(D)	$\frac{1}{r_n}$	(s)	Z

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8. Match the following columns

Column-I		Column-II	
(a)	Lyman series of H-atom	(p)	Maximum number of different spectral lines observed = 6
(b)	Balmer series of H-atom	(q)	Maximum number of different spectral lines observed = 3
(c)	In a sample of H-atom for 5→2 transition	(r)	2nd line has wave number $\frac{8R}{9}$
(d)	In a single isolated H-atom for 5→2 transition	(s)	2nd line has wave number $\frac{3R}{16}$
		(t)	Total number of different spectral lines is 10

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9. Given in hydrogen atom r_n, V_n, E, K_n stand for radius, potential energy, total energy and kinetic energy in n^{th} orbit. Find the value of

U,v,x,y.

(A)	$u = \frac{V_n}{K_n}$	(P)	1
(B)	$\frac{1}{r_n} \propto E^x$	(Q)	-2
(C)	$r_n \propto Z^y$ ($Z =$ Atomic number)	(R)	-1
(D)	$v =$ (Orbital angular momentum of electron) (in its lowest energy)	(S)	0

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10. Match the following columns

Column-I		Column-II	
(a)	Energy of ground state of He^+	(p)	+ 6.04 eV
(b)	Potential energy of 1st orbit of H-atom	(q)	– 27.2 eV
(c)	Kinetic energy of 2nd excited state of He^+	(r)	54.4 V
(d)	Ionisation potential of He^+	(s)	–54.4 eV

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	Column-I		Column-II
(a)	Electron moving in 2nd orbit of He^{+} ion	(p)	Radius of orbit which e^{-} is moving is 0.529 Å
(b)	Electron moving in 3rd orbit of H-atom	(q)	Total energy of electron is (–)13.6 × 9 eV
(c)	Electron moving in 1st orbit in Li^{+2} ion	(r)	Velocity of electron is $\frac{2.188 \times 10^{6}}{3}$ m/sec
(d)	Electron moving in 2nd orbit in Be^{+3} ion	(s)	de Broglie wavelength of electron is $\sqrt{\frac{150}{13.6}}$ Å

11.

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12. $r_{n,z} =$ Radius of nth orbit of a single electron species having atomic number 'z'

$u_{n,z} =$ Velocity of electron in nth orbit of a single electron specie having atomic number 'z'

$E_{n,z} =$ Magnitude of total energy of electron in nth orbit of a single electron species having atomic number 'z'.

$K_{n,z} =$ Magnitude of kinetic energy of electron in nth orbit of a single electron species having atomic number 'z'

$P_{n,z} =$ Magnitude of potential energy of electron in nth orbit of a single electron species having atomic number 'z'

$f_{n,z}=$ Frequency of electron in nth orbit of a single electron species having atomic number 'z'.

$T_{n,z}=$ Time period of electron in nth orbit of a single electron species having atomic number 'z'

	Column-I		Column-II
(a)	$\frac{f_{1,2}}{f_{1,1}}$	(p)	$\frac{r_{2,3}}{r_{1,3}}$
(b)	$\frac{\lvert E_{3,2}\rvert}{K_{3,1}}$	(q)	$\frac{T_{1,1}}{T_{1,2}}$
(c)	$\left(\frac{1}{\sqrt{2}}\right)\left(\sqrt{\frac{P_{2,1}}{E_{3,1}}}\right)$	(r)	$2\left(\sqrt{\frac{K_{2,3}}{\lvert E_{1,2}\rvert}}\right)$
(d)	$\left(\frac{E_{1,4}}{E_{2,2}}\right)$	(s)	$\frac{v_{2,3}}{v_{1,1}}$
		(t)	$4\left(\frac{v_{2,5}-v_{2,1}}{v_{2,3}-v_{2,2}}\right)$

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13. If the shortest wavelength of spectral line of H-atom in Lyman series is x, then match the following for Li^{2+} and select the correct code.

	List-I		List-II
(p)	Shortest wavelength in Lyman series	(1)	$\frac{4x}{5}$
(q)	Longest wavelength in Lyman series	(2)	$\frac{4x}{9}$
(r)	Shortest wavelength in Balmer series	(3)	$\frac{x}{9}$
(s)	Longest wavelength in Balmer series	(4)	$\frac{4x}{27}$

Codes :

p q r s " "p q r s

A. 2 4 1 3

B. 3 4 2 1

C. 3 4 1 2

D. 2 1 4 3

Answer: (b)

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14. In a scale of $10^{-18}m$, match the particle with respect to their probable size:

List-I		List-II	
(p)	Atom	(1)	1,000
(q)	Nucleus	(2)	10,000
(r)	Proton	(3)	100,000,000

Codes :

p q r " "p q r

A. 1 2 3

B. 3 2 1

C. 1 3 2

D. 2 3 1

Answer: (b)

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15. Match the entries in column- I with the correctly related quantum number (s) in column-II.

Column-I		Column-II	
(a)	Orbital angular momentum of the electron in a H-like system	(p)	Principal quantum number
(b)	A H-like one e^- wave function obeying Pauli's principle	(q)	Azimuthal quantum number
(c)	Shape, size and orientation of H-like atomic orbitals	(r)	Magnetic quantum number
(d)	Probability density of electron at the nucleus in H-like atom	(s)	Electron spin quantum number

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16. $\Psi_r = k_1 e^{-r/k_2}\left(r^2 - 5k_3 r + 6K_3^2\right)$

For the above orbital match the column-I with column-II (assuming , $k_3 = 1$)

Column-I		Column-II	
(a)	Principal quantum number, n	(p)	3
(b)	Number of radial nodes	(q)	2
(c)	Number of sub-shells having energy between $(n+6)s$ to $(n+6)p$ for multi-electron system	(r)	4
(d)	Orbital angular momentum of given orbital	(s)	0

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Subjective Type

1. Assume that 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 $(\lambda = 495nm)$ are needed to generate this minimum energy .

$\left[h = 6.6 \times 10^{-34} Js\right]$

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2. Average life time of a hydrogen atom excited to $n = 2$ state is $10^{-8}s$. Find the number of revolutions made by the electron on an average before it jumps to the ground state. If your answer in scientific notation is $x \times 10^{y}$, then find the value of y.

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3. Calculate ratio of wavelength for a proton and $\alpha -$ particle . If their KE are same.

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4. With what velocity should an alpha (α)- particle travel towards the nucleus of a copper atom arrive at a distance of $10^{-13}m$ from the nucleus of the copper atom ?

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5. For a broadcasted electromagnetic wave having frequency of 1200 kHz, calculate number of waves that will be formed in 1 km distance (wave number per km).

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6. Visible spectrum contains light of following colours "Violet - Indigo - Blue - Green - Yellow - Orange - Red" (VIBGYOR).

Its frequency ranges from violet $(7.5 \times 10^{14} Hz)$ to re $(4 \times 10^{14} Hz.)$

Find out the maximum wavelength $(\text{in} \text{Å})$ in this range.

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7. For a wave frequency is 10 Hz and wavelength is 2.5 m. How much distance (in metres) it will travel in 40 seconds?

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8. Calculate minimum value of uncertainity in position of a particle whose de broglie wavelength is $\sqrt{\pi}\text{Å}$ and uncertainity in de broglie wavelength is 0.05"Å". Express your asnwer in Angstrom ("Å").

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9. In a sample of H-atoms in ground state electrons make transition from ground state to a particular excited state where path length is 5 times de Broglie wavelength , electrons make back transition to the ground state producing all possible photons. If photon having 2nd highest energy of this sample can be used to excite the electron in a particular excited state of Li^{2+} ion then find the final excited state of Li^{2+} ion .

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10. A particular transition in hydrogen atom from a higher level 'A' to lower level 'B' causes a change in de Broglie wavelength which is 3 times the de Broglie wavelength in first Bohr orbit . Calculate total different wavelength possible if all possible transitions between level 'A' and level 'B' occur .

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11. Calculate frequency of revolution of electron in 4th Bohr orbit Be^{+3} ion .

Given that $\frac{\pi^2 me^4 k^2}{h^3} = 1.62 \times 10^{15} \sec^{-1}$, symbols have usual meaning.

Express your answers in terms of $10^{15} \sec^{-1}$.

Write the answer upto one significant figure.

Watch Video Solution

12. If radiation corresponding to first line of "Balmer series" of He^{+} ion is subjected to a smaple of Ki^{+2} ion (containing atoms in different energy states) and it causes ejection of photoelectron with non-zero kinetic energy then calculate least shell number in which the electron must be present in Li^{+2}.

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13. A sample of hydrogen contains equal number of $H^{1}, H^{2} \text{and} H^{3}$ atoms. The ratio of total number of protons and neutrons $\left(\frac{p}{n}\right)$ in the sample is :

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14. A Li^{2+} ion is in a higher excited state of quantum number 'n' This excited ion can make a transition to the first excited state by successively emitting two photons of energies 10.2 eV and 17.0 eV respectivley . The value of 'n' is :

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15. Two bulbs 'A' and 'B' emit red light and yellow light at 8000 "Å" and 4000 "Å" respectively. The number of photons emitted by both the bulbs per second is the same. If the red bulb is labelled as 100 watts, find the wattage of the yellow bulb.

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16. Which state of triply ionised Beryllium (Be^{+++}) the same orbital radius as that of the ground state hydrogen ?

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17. Consider Bohr's theory for hydrogen atom . The magnitude of orbit angular momentum orbit radius and velocity of the electron in nth energy state in a hydrogen atom are l , r and v respectively. Find out the value of 'x' if product of v, r and l (vrl) is directly proportional to n^x.

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18. when an electron falls from (n +2) state to (n) state in a He^+ ion the photon emitted has energy 6.172×10^{-19} joules. What is the value of n?

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19. At what atomic number would a transition from $n = 2$ to $n = 1$ energy level result in emission of photon of $\lambda = 3 \times 10^{-8} m$?

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20. In a container a mixture is prepared by mixing of three samples of hydrogen helium ion (He^{+}) and lithium ion (Li^{2+}). In sample , all the hydrogen atoms are in 1st excited state and all the He^{+} ions are in third excited state and all the $Li^{2+})$ ions are in fifth excited state. Find the total number of spectral lines observed in the emission spectrum of such a sample when the electrons return back to the ground state.

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21. The uncertainty in position and velocity of the particle are 0.1 nm and $5.27 \times 10^{-24} ms^{-1}$ respectively then find the approximate integral mass of the particle (in g) . $(h = 6.625 \times 10^{-34} Js)$

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22. Wavelenth of the Balmer H_{α} line is 6565 "Å". Calculate the wavelength (in "Å") of H_{β} line of same hydrogen like atom.

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23. Electrons in a sample of H-atoms make transition from state n=x to some lower excited state. The emission spectrum from the sample is found to contain only the line belonging to a particular series. If one of the photons has an energy of 0.6375 eV . Find the value of x.

$$\left[\text{Take} 0.6375 eV = \frac{3}{4} \times 0.85 eV\right]$$

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24. An electron in Li^{2+} ion makes a transition from higher state n_2 to lower state $n_1 = 6$. The emitted photons is used to ionize an electron in H-atom from 2nd excited state. The electron on leaving the H-atom has a de Broglie wavelength $\lambda - 12.016 Å$.Find the value of n_2.

Note : Use $(12.016)^2 = \frac{150 \times 144}{13.6 \times 11}, \lambda_{Å} = \sqrt{\frac{150}{KE_{eV}}}$

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25. Nitrogen has an atomic number of 7 and oxygen has an atomic number of 8. The total number of electron in the nitrate ion $\left(NO_3^-\right)$ is :

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26. $\frac{h}{\pi}$ is the angular momentum of the electron in the $n = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$ Orbit of He^+.

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27. Electrons in the H-atoms jumps from some higher level to 3rd energy level . If six spectral lines are possible for the transition find the initial position of electron.

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28. A light source of wavelength λ illuminates a metal and ejects photoelectron with $(KE)^{\max} = 1eV$.

Another light source of wave length $\frac{\lambda}{3}$, ejects photoelectrons from same metal with $(KE)^{\max} = 5eV$.

Find the value of work function (eV) of metal.

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29. Wavelength of rediowaves is 124 nm. Total number of photons per second produced by a source that consumes energy at the rate of $16\text{W is x} \times 10^{19}$. the value of x is :

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30. The ionisation potential of a hydrogen like species is 36 volt. What is the value of excitation energy from ground state to 1st excited state (in eV)?

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Watch Video Solution

31. The circumference of the second orbit of an atom or ion having single electron is 4 nm the de Broglie wavelength of electron (in nm) revolving in this orbit si :

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32. The speed fo this dust particle $\left(\text{mass} = n10^{-3}g\right)$ is measured with the uncertainty of $\frac{3.313}{\pi} \times 10^{-3} m/s$.

The minimum uncertainty in position of the dust particle $\left(\text{in order of} 10^{-26} m\right)$ is :

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33. X-rays emitted from a copper target and a molybdenum target are found to contains a line of wavelength $22.85 nm$ attributed to the K_{α} line of an impurity element. The K_{α} lines of a 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.

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34. de Broglie wavelength $'\lambda'$ of an ideal gas molecule at any given temperature is given as $\lambda \propto m^{-x} \times T^{-y}$.

Where $m =$ mass of one gas molecule, $T =$ temperature (K).

$\text{Given} x + y = ?$

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35. Wavelength of electron waves in two Bohr orbits is in ratio3:5 the ratio of kinetic energy of electron is 25 : x, hence x is :

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36. Total different spectral lines observed in between 11th excited state and 3rd energy level in H-atom emission spectrum are:

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37. On a metal with work function 2.0 eV light of wavelength 400 nm falls, maximum velocity of ejected photoelectron are $6.22 \times 10^x m/s.$. Hence x is :

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38. By a sample of ground state atomic hydrogen ,UV light of energy $\frac{13.6 \times 48}{49}\frac{eV}{\text{quanta}}$ is absorbed. How many different wavelengths will be observed in Balmer region of hydrogen spectrum?

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39. $'\alpha$ particle' of 3.6 MeV are fired toward nucleus $._Z^A X$, at point of closest separation distance between $'\alpha$particle' and 'X' is $1.6 \times 10^{-14} m$.

Calculate atomic number of 'X'.

$$\left[\text{Given: } \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \text{in S.I.units}\right]$$

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40. Find the number of spectral lines in Paschen series emitted by atomic H, when electron is excited from ground state to 7th energy level returns back .

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41. Calculate the minimum kinetic energy in eV of photoelectron produced in caesium by 400 nm light . The critical (maximum) wavelength for the photoelectric effect in caesium is 660 nm, when the potential difference is 1.78 V.

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42. A beam of light has three λ, $4144\text{Å}, 4972\text{Å} \text{and} 6216\text{Å}$ with a total intensity of $3.6 \times 10^{-3} Wm^{-2}$ equally distributed amongst the three λ. The beam falls normally on an area $1.0 cm^2$ of a cleam metallic surface of work function 2.3 eV. Assume that there is no loss of light by reflection etc. Calculate the no. of photoelectrons emitted in 2 sec, in scientific notation,$x \times 10^y$ find the value of y.

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43. A particle of charge equal to that of electron and mass 208 times the mass of the electron moves in a circular orbit around a nucleus of charge $+3e$. Assuming that the Bohr model of the atom is applicable to this system find the value of n for which the radius of the orbit is approximately the same as that of the first Bohr orbit of the hydrogen atom.

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44. Calculate the wavelength of a rested electron (in "Å") after it absorbs a photon of wavelength 9 nm.

$\left[\text{Given} h = 6 \times 10^{-34} J - \text{sec}, m = 9 \times 10^{-31} kg\right]$.

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45. A hydrogen like species with atomic number 'Z' is in higher excited state 'n' and emits photons of energy 25.7 and 8.7 eV when making a transition to 1st and 2nd excited state respectively. Calculate value of 'n'.

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46. $\bar{r}$, average distance also described as expectation value of the distance of the electron from the nucleus is different from $r_{\max}$. For 1s orbital of H-atom, $r_{\max} = a_0, \bar{r} = \frac{3}{2}a_0$. For 2s orbital of H-atom $r_{\max} = 0.77a_0 \text{and} 5.23a_0$. Find $\bar{r} \text{for} r_{\max} = 5.23a_0$.

Also find $\bar{r}_2$ for 1s orbital of Li^{2+} ion. Hence find the value of $\frac{(\bar{r}_1 \times \bar{r}_2)}{a_0^2}$.

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47. The number of lines of Balmer series of H-atom that belong to visible region.

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48. In a sample of three H-atoms , all in the 5th excited state, electrons make a transition to 1st excited state. The maximum number of different spectral lines observed will be :

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49. If a metal is exposed with light of wavelength λ, the maximum kinetic energy produced is found to be 2 eV. When the same metal is exposed to a

wavelength $\frac{\lambda}{5}$ the maximum kinetic energy was found to be 14 eV. Find the value of work function (in eV).

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50. If $n_1 + n_2 = 4 \text{and} n_2^2 - n_1^2 = 8,$ then calculate maximum value of wavelength emitted in transition form $n_2 \rightarrow n_1 \text{for} Li^{2+} \text{in nm} [\text{Given} R_H = 10^7 m^{-1}]$.

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51. Suppose the potential energy between electron and proton at a distance r is given by $\frac{ke^2}{3r^3}$. Use Bohr's theory to obtain energy of such a hypothetical atom.

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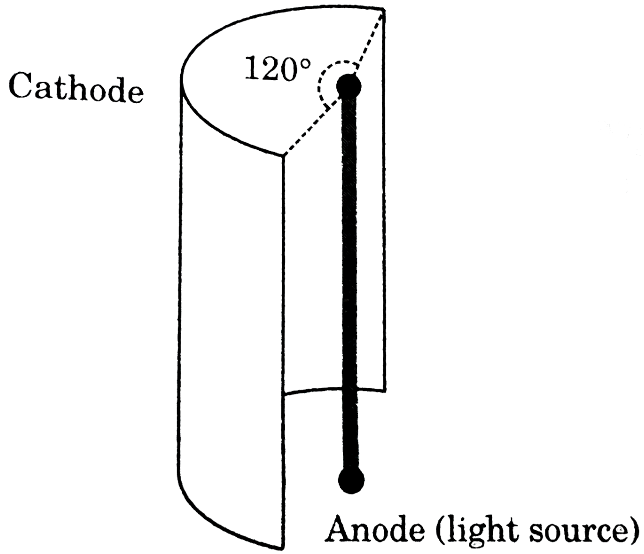
52. A cylindrical source of light which emits radiation radially (from curved surface) only , placed at the centre of hollow, metallic cylindrical surface, as shown in diagram.



The power of source is 90 watt and it emits light of wavelength 4000Å only . The emitted photons strike the metallic cylindrical surface which results in ejection of photoelectrons. All ejected photoelectrons reaches to anode (light source). The magnitude of photocurrent (in amp) is :

$\left[\text{Given}: h = 6.4 \times 10^{-34} J/\text{sec}\right]$

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53. Calculate the energy (in KJ) required to excite one litre of hydrogen gas at 1 atm and 298 K to the first excited state of atomic hydrogen. The energy for the dissociation of $H - H$ id 436 KJ mol^{-1}. Give your answer excluding decimal places.

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54. The work function (ϕ) of some metals is listed below . The number of metals which will show photoelectric effect when light of 300 nm wavelength falls on the metal is :

Metal	Li	Na	K	Mg	Cu	Ag	Fe	Pt	W
ϕ (eV)	2.4	2.3	2.2	3.7	4.8	4.3	4.7	6.3	4.75

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55. The atomic masses of He and Ne are 4 and 20 amu respectively . The value of the de Broglie wavelength of He gas at $-73.^{\circ} C$ is "M" times that of the de Broglie wavelength of Ne at $727.^{\circ} C.$ M is

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