Class Room Problems

1. To what minimum distance will an alpha particle with kinetic energy T=0.40 MeV approach in the case of a head-on collision to a stationary Pb nucleus:

Sol. **[0.0216 pm]**

2. A H-like neutral species is in some excited state (A) and on absorbing a photon of energy 3.066 eV gets promoted to a new state B. When the electron from state B return back, photons of a maximum ten different wavelengths can be observed in which some photons have energy smaller than 3.066 eV. Some of the equal energy and only four photon having energy greater than 3.066 eV. Determine the orbit number of states A and B and ionization energy.

Sol. **[n_B = 5, n_A=2, I.E.=14.6 eV]**

3. At what temperature the transitional kinetic energy of atomic hydrogen equal that for n_2 =1 to n_2 =2 transition.

Sol. **[$T = 78.7 \times 10^3 k$]**

4. Calculate for a hydrogen atom and a He^+ ion:

(a) the radius of the first Bohr orbit and the velocity of an electron moving along it:

(b) the kinetic energy and the binding energy of an electron in the ground state :

(c) the ionization potential, the first excitation potential and the wavelength of the resonance line (n' = 2 $\rightarrow$ n =1).

Sol.

5. Calculate the angular frequency of an electron occupying the second Bohr orbit of He^+ ion.

Sol. **[$w = 2.07 \times 10^{16} s^{-1}$]**

6. A hypothetical element "positronium" consists of an electron moving in space around a nucleus consisting a positron. Using the Bohr's atomic model, determine the first Bohr radius, Positron is a subatomic particle similar to electron in all respect except possessing a positive charge.

Sol. **[1.06 Å]**

7. To what series does the spectral line of atomic hydrogen belong if its wave number is equal to the difference between the wave numbers of the following two lines of the balmer series: 486.1 and 410.2 nm? What is the wavelength of that line?

Sol. **[2.63×10^{-4} cm]**

8. The threshold wavelength for photoelectric emission in tungsten is 2300 Å. What wavelength of light must be used to eject electrons with a maximum energy of 1.5 eV?

Sol. **[λ = 179.9 nm]**

9. Determine the de-Broglie wavelength associated with an electron in the 3rd Bohr's orbit of He^+ ion.

Sol. **[5 Å]**

10. Find the velocity of photoelectrons liberated by electromagnetic radiation of wavelength λ = 18.0 nm from stationary He^+ ions in the ground state.

Sol. **[$V = 2.3 \times 10^6 ms^{-1}$]**

11. At what minimum kinetic energy must a hydrogen atom move for its inelastic head-on collision with another, stationary, hydrogen atom to make one of them capable of emitting a photon? Both atoms are supposed to be in the ground state prior to the collision.

Sol. **[20.5 eV]**

12. Calculate the de Broglie wavelengths of an electron, proton, and uranium atom, all having the same kinetic energy 100 eV.

Sol. **[1.23 Å, 2.86×10^{-2} Å, 1.86×10^{-3} Å]**

13. What amount of energy should be added to an electron to reduce its de Brogie wavelengths from 100 to 50 pm?

Sol. **[450 eV]**

14. Find the de Broglie wavelength of hydrogen molecules, which corresponds to their most probable velocity at room temperature.

Sol. **[127 pm]**

15. An automobile of mass 500 kg is moving with speed of 50 ± 0.001 km hr^{-1}. Determine uncertainty in position of moving automobile and interpret the result.

Sol. **[$\Delta V = 2.778 \times 10^{-4}$ m/s, $\Delta X = 3.8 \times 10^{-38}$ m]**

16. Find the quantum number n corresponding to the excited state of He^+ ion if on transition to the ground state that ion emits two photons in succession with wavelengths 108.5 and 30.4 nm.

Sol. **[n = 5]**

17. Estimate the minimum errors in determining the velocity of an electron, a proton, and a ball of mass of 1 mg if the coordinates of the particles and of the centre of the ball are known with uncertainly 1 μm.

Sol.

18. If a photon of wavelength 200 pm strikes an atom and one of the inner bound electrons is injected out with a velocity of 2×10^7 ms^{-1}. Calculate the energy with which it is bound to nucleus?

Sol. **[5075 eV]**

19. When radiation of wavelength 253.7nm falls on a copper surface, electrons are ejected. Calculate work function if the stopping potential is 0.5 V.

Sol. **[w_0 = 4.39 eV]**

20. The size of an atomic nucleus is 10^{-14}m. Calculate uncertainty in momentum of an electron if it were to exist inside the nucleus.

Sol. **[5.27×10^{-21} kgm/s^{-1}]**

21. Calculate de-Brogie wavelength of a hydrogen atom with translational energy corresponding to a temperature of 27°C.

Sol. **[λ = 1.46 Å]**

22. Calculate the electrostatic potential energy of two electrons separated by 3 Å in vacuum?

Sol. **[4.8 eV]**

23. The wave function for electron in ground state of hydrogen atom is $\psi_{1s} = (\pi a_0^3)^{-\frac{1}{2}} e^{-\frac{r}{a_0}}$, where "$a_0$" is radius of Bohr's orbit. Calculate the probability of finding the electrons somewhere between 0 and $2a_0$.

Sol.

24. The normalized wave function of the hydrogen atom for the 1s orbital is $\psi_{1s} = (\pi a_0^3)^{-\frac{1}{2}} e^{-\frac{r}{a_0}}$. Show that in such a state the most probable distance from nucleus to electron is a_0.

Sol.

25. Locate the nodal surfaces in

$$\psi_{310}(r, \theta, \phi) = \frac{1}{81}\left(\frac{2}{\pi}\right)^{1/2}\left(\frac{1}{a_0}\right)^{3/2}\left(6\frac{r}{a_0} - \frac{r^2}{a_0^2}\right)e^{-r/3a_0}\cos\theta$$

Sol.

EXERCISE – I
OBJECTIVE PROBLEMS (JEE MAIN)

Single Correct

1. Radiation of λ = 155 nm was irradiated on Li (work function = 5eV) plate. The stopping potential (in eV) is.
(A) 3eV (B) 4eV
(C) 0.3eV (D) 0.5 eV

Sol.

2. Increasing order of magnetic moment among the following species is __________ .
Na^+, Fe^{+3}, Co^{2+}, Cr^{+2}
(A) $Na^+ < Fe^{+3} < Co^{2+} < Cr^{+2}$
(B) $Na^+ < Co^{2+} < Cr^{2+} < Fe^{+3}$
(C) $Na^+ < Cr^{2+} < Co^{2+} < Fe^{+3}$
(D) $Na^+ < Fe^{3+} < Cr^{2+} < Co^{+2}$

Sol.

3. If in the hydrogen atom P.E. at ∞ is choosen to be 13.6 eV then the ratio of T.E. to K.E. for 1st orbit of H-atom is __________ .
(A) zero (B) 1
(C) 2 (D) 3

Sol.

4. The light radiations with discrete quantities of energy are called ___________ .
(A) photons (B) laser
(C) radar (D) photo electron

Sol.

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

Sol.

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

Sol.

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

Sol.

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

Sol.

9. The orbital angular momentum of an electron in 2s orbital is :

(A) $+\frac{1}{2}.\frac{\hbar}{2\pi}$ (B) Zero

(C) $\frac{\hbar}{2\pi}$ (D) $\sqrt{2}.\frac{\hbar}{2\pi}$

Sol.

10. Which quantum number is not related with Schrodinger equation :

(A) Principal (B) Azimuthal

(C) Magnetic (D) Spin

Sol.

11. The shortest wavelength of He atom in Balmer series is x, then longest wavelength in the Paschene series of Li^{+2} is :

(A) $\frac{36x}{5}$ (B) $\frac{16x}{7}$

(C) $\frac{9x}{5}$ (D) $\frac{5x}{9}$

Sol.

12. An electron in a hydrogen atom in its ground state absrobs energy equal to the ionisation energy of Li^{+2}. The wavelength of the emitted electron is

(A) 3.32×10^{-10} m

(B) 1.17 Å

(C) 2.32×10^{-9} nm

(D) 3.33 pm

Sol.

13. An electron, a proton and an alpha particle have kinetic energies of 16E, 4E and E respectively. What is the qualitative order of their de-Broglie wavelengths?

(A) $\lambda_e > \lambda_p = \lambda_\alpha$ (B) $\lambda_p = \lambda_\alpha > \lambda_e$

(C) $\lambda_p > \lambda_e > \lambda_\alpha$ (D) $\lambda_\alpha < \lambda_e >> \lambda_p$

Sol.

14. Given ΔH for the process $Li(g) \longrightarrow Li^{+3}(g) + 3e^-$ is 19800 kJ/mole & IE_1 for Li is 520 then IE_2 & IE_3 of Li^+ are respectively (approx, value) :

(A) 11775, 7505 (B) 19280, 520

(C) 11775, 19280 (D) Data insufficient

Sol.

15. The ratio of difference in wavelengths of 1st and 2nd lines of Lyman series in H–like atom to difference in wavelength for 2nd and 3rd lines of same series is :

(A) 2.5 : 1 (B) 3.5 : 1

(C) 4.5 : 1 (D) 5.5 : 1

Sol.

16. If radius of second stationary orbit (in Bohr's atom) is R. Then radius of third orbit will be

(A) R/3 (B) 9R

(C) R/9 (D) 2.25R

Sol.

17. The ratio of wave length of photon corresponding to the α-line of lyman series in H-atom and β-line of Baimer series in He^+ is

(A) 1 : 1 (B) 1 : 2
(C) 1 : 4 (D) 3 : 16

Sol.

18. Three energy levels P, Q, R of a certain atom are such that $E_P < E_Q < E_R$. If λ_1, λ_2, and λ_3, are the wave length of radiation corresponding to transition R $\rightarrow$ Q : Q $\rightarrow$ P and R $\rightarrow$ P respectively. The correct relationship between λ_1, λ_2 and λ_3 is

(A) $\lambda_1 + \lambda_2 = \lambda_3$ (B) $\frac{1}{\lambda_3} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$

(C) $\lambda_3 = \sqrt{\lambda_1 \lambda_2}$ (D) $\frac{2}{\lambda_3} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$

Sol.

19. The Value of $(n_2 + n_1)$ and $\left(n_2^2 - n_1^2\right)$ for He^+ ion in atomic spectrum are 4 and 8 respectively. The wavelength of emitted photon when electron jump from n_2 to n_1 is

(A) $\frac{32}{9} R_H$ (B) $\frac{9}{32} R_H$

(C) $\frac{9}{32 R_H}$ (D) $\frac{32}{9 R_H}$

Sol.

20. Number of possible spectral lines which may be emitted in bracket series in H atom if electrons present 9^{th} excited level returns to ground level, are

(A) 21 (B) 6
(C) 45 (D) 5

Sol.

21. The first use of quantum theory to explain the structure of atom was made by :

(A) Heisenberg (B) Bohr
(C) Planck (D) Einstein

Sol.

22. The wavelength associated with a golf ball weighing 200g 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

Sol.

23. The longest wavelength of He^+ in Paschen series is "m", then shortest wavelength of Be^{3+} in Paschen series is (in terms of m) :

(A) $\frac{5}{36}$ m (B) $\frac{64}{7}$ m

(C) $\frac{53}{8}$ m (D) $\frac{7}{64}$ m

Sol.

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

Sol.

25. Consider the following nuclear reactions involving X & Y.
$X \longrightarrow Y + {}_2He^4$ $\quad Y \longrightarrow {}_8O^{18} + {}_1H^1$
If both neutrons as well as protons in both the sides are conserved in nuclear reaction then moles of neutrons in 4.6 gm of X :
(A) 2.4 N_A (B) 2.4
(C) 4.6 (D) 0.2 N_A

Sol.

26. Electromagnetic radiations having λ = 310 Å are subjected to a metal sheet having work function = 12.8 eV. What will be the velocity of photoelectrons with maximum Kinetic energy.
(A) 0, no emission will occur
(B) 2.18×10^6 m/s
(C) $2.18\sqrt{2} \times 10^6$ m/s
(D) 8.72×10^6 m/s

Sol.

27. Assuming Heisenberg Uncertainity Principle to be true what could be the miniumum uncertainity in de–Broglie wavelength of a moving electron accelerated by Potential Difference of 6V whose uncertainity in position is 7/22 n.m.
(A) 6.25 Å (B) 6 Å
(C) 0.625 Å (D) 0.3125 Å

Sol.

28. A 1-kW radio transmitter operates at a frequency of 880 Hz. How many photons per second does it emit -
(A) 1.71×10^{21} (B) 1.71×10^{33}
(C) 6.02×10^{23} (D) 2.85×10^{26}

Sol.

29. The value of Bohr radius of hydrogen atom is -
(A) 0.529×10^{-7}cm (B) 0.529×10^{-8}cm
(C) 0.529×10^{-9}cm (D) 0.529×10^{-10} cm

Sol.

30. On the basis of Bohr's model, the radius of the 3rd orbit is -
(A) Equal to the radius of first orbit
(B)Three times the radius of first orbit
(C) Five times the radius of first orbit
(D) Nine time the radius of first orbit

Sol.

31. In presence of magnetic field d-sub orbit is -
(A) 5 - Fold degenate
(B) 3-Fold degenerate
(C) 7-Fold degenerate
(D) Non- degenerate
Sol.

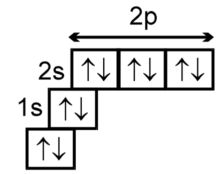
32. In which of the following pairs is the probability of finding the electron in xy-plane zero for both orbitals ?
(A) $3d_{yz}, 4d_{x^2-y^2}$ (B) $2p_z, dz^2$
(C) $4d_{zx}$, $3p_z$ (D) All of these
Sol.

33. The maximum probability of finding electron in the d_{xy} orbital is -
(A) Along the x axis
(B) Along the y axis
(C) At an angle of 45° from the x and y axis
(D) At an angle of 90° from the x and y axis
Sol.

34. The number of unpaired electrons in carbon atom is -
(A) 2 (B) 4 (C) 1 (D) 3
Sol.

35. When 4 d orbital is complete, the newly entering electrons goes in to -
(A) 5f (B) 5s
(C) 5p (D) 6d Orbital
Sol.

36. Which of the following elements is represented by the electronic configuration -



(A) Nitrogen (B) Fluorine
(C) Oxygen (D) Neon
Sol.

37. The number of d-electrons in Fe^{2+} (At. no. 26) is not equal to that of the –-
(A) p-Electrons in Ne (At. No. 10)
(B) s-Electrons in Mg (At No. 12)
(C) d-Electrons in Fe atom
(D) p-Electrons in Cl^- ion (At. No. 17)
Sol.

38. Magnetic moment of X^{3+} ion of 3d series is $\sqrt{35}$ BM. What is atomic number of X^{3+} ?
(A) 25 (B) 26
(C) 27 (D) 28
Sol.

39. An electron is moving with the velocity equal to 10% of the velocity of light. Its de-Broglie wave length will be -
(A) 2.4×10^{-12}cm (B) 2.4×10^{-18}cm
(C) 2.4×10^{-9}Cm (D) None of these
Sol.

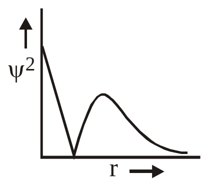
40. Ratio of time period of electron in first and second orbit of H-atom would be -

(A) 1 : 18 (B) 1 : 8

(C) 1 : 2 (D) 2 : 1

Sol.

41. The following graph between Ψ^2 probability density and distance from the nucleus represents -

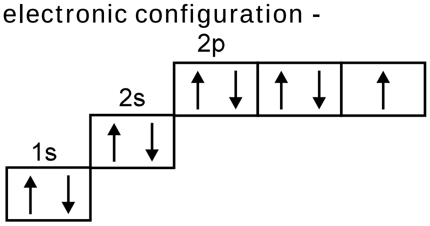


(A) 2s (B) 3s

(C) 1s (D) 2p

Sol.

42. Which element is represented by the following electronic configuration -

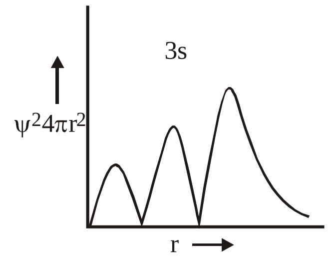


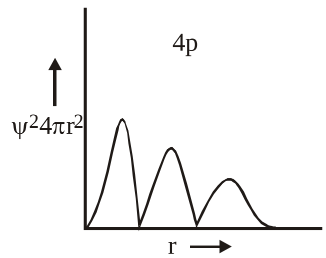
(A) Nitrogen (B) Oxygen

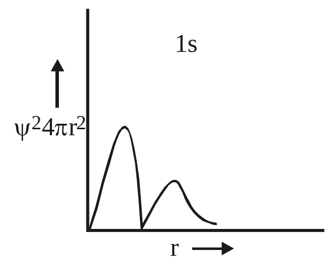
(C) Fluorine (D) Neon

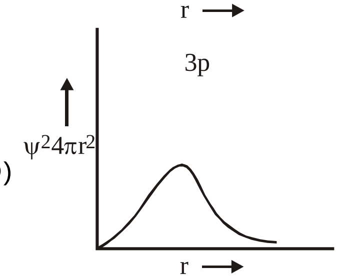
Sol.

43 Which of the following is correct radial probability distribution curve for various orbitals ?

(A) 

(B) 

(C) 

(D) 

Sol.

44. What are the values of the orbital angular momentum of an electron in the orbitals 1s, 3s, 3d, and 2p ?

(A) 0, 0, $\sqrt{6}\hbar$, $\sqrt{2}\hbar$

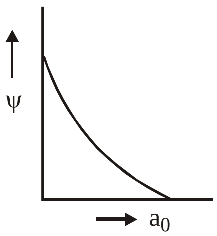
(B) 1, 1, $\sqrt{4}\hbar$, $\sqrt{2}\hbar$

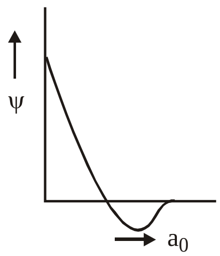
(C) 0, 1 $\sqrt{6}\hbar$, $\sqrt{3}\hbar$

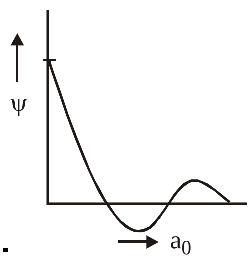
(D) 0, 0, $\sqrt{20}\hbar$, $\sqrt{6}\hbar$

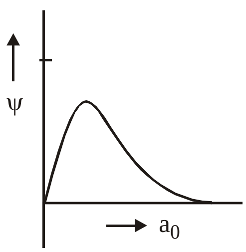
Sol.

45. Which of the following graphs correspond to one node ?

(A)


(B)


(C)


(D)


Sol.

46. Angular and spherical nodes in 3s -

(A) 1, 1 (B) 1, 0

(C) 2, 0 (D) 0, 2

Sol.

47. The magnetic moment of V^{4+} ion -

(A) 1.73 (B) 1.41

(C) 3.46 (D) 2

Sol.

48. Which orbital represents the following set of quantum numbers n = 3, ℓ = 0, m = 0, s = +1/2 -

(A) 3p (B) 2s

(C) 3s (D) 2p

Sol.

49. The number of unpaired electrons in Zn^{+2} -

(A) 0 (B) 1

(C) 2 (D) 3

Sol.

50. In the Bohr's model, for unielectronic species following symbols are used,

$r_{n,z} \longrightarrow$ Radius of n^{th} orbit with atomic number "z".

$U_{n,z} \longrightarrow$ Potential energy of electron in n^{th} orbit with atomic number "z".

$K_{n,z} \longrightarrow$ Kinetic energy of electron in n^{th} orbit with atomic number "z".

$v_{n,z} \longrightarrow$ Velocity of electron in n^{th} orbit with atomic number "z".

$T_{n,z} \longrightarrow$ Time period of revolution of electron in n^{th} orbit with atomic number "z".

Calculate z in all in cases.

(i) $U_{1,2} : K_{1,z} = -8 : 1$ (ii) $r_{1,z} : r_{2,1} = 1 : 8$ (iii) $v_{1,z} : v_{3,1} = 9 : 1$ (iv) $T_{1,2} : T_{2,z} = 9 : 32$

Represent your answer as abcd, where a,b,c and d represent number from 0 to 9. a,b,c and d represents the value of "z" in parts (i), (ii), (iii) & (iv). Suppose your answer is 1,2,3 & 4 then the same must be filled in OMR sheet as 1234.00.

(A) 2233 (B) 1233

(C) 3233 (D) 4233

Sol.

EXERCISE – II — OBJECTIVE PROBLEMS (JEE ADVANCED)

More than one may be correct :

1. When photons of energy 4.25 eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy T_A eV and de Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.70 eV is $T_B = (T_A - 1.50)$ eV. If the de Broglie wavelength of these photoelectrons is $\lambda_B = 2\lambda_A$, then select the correct statement (s)

(A) the work function of A is 2.25 eV.
(B) the work function of B is 4.20 eV.
(C) T_A = 2.00 eV.
(D) T_B = 2.75 eV.

Sol.

2. 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 any chosen direction.
(B) $\psi^2(r)$ give probability density at a particular distance over a spherical surface.
(C) For 's' orbitals $\psi(r)\psi(\theta)\psi(\phi) = \psi(x, y, z)$ is independent of θ and ϕ.
(D) '2p' orbital with quantum numbers. n = 2, l = 1, m = 0, also shows angular dependence

Sol.

3. Correct statement(s) regarding $3p_y$ orbital is/are

(A) Angular part of wave function is independent of angles (θ and ϕ).
(B) No. of maxima when a curve is plotted between $4\pi r^2 R^2(r)$ vs r are '2'.
(C) 'xz' plane acts as nodal plane.
(D) Magnetic quantum number must be '–1'.

Sol.

4. Select the correct statement(s) :

(A) All electromagnetic radiation travel with speed of light in vaccum.
(B) Energy of photon of UV light is lower than that of yellow light.
(C) He^+ and H have similar spectrum.
(D) The total energy of an electron in unielectronic specie is greater than zero.

Sol.

5. Choose the incorrect statement(s) :

(A) Increasing order of wavelength is
Micro waves > Radio waves > IR waves > visible waves > UV waves
(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 of 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 $Be^{3+} > Li^{+2} > He^+ > H$

Sol.

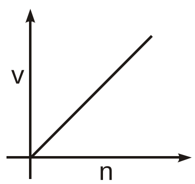
6. Select the correct curve(s) :

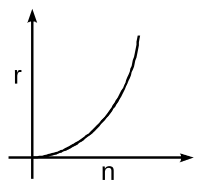
If v = velocity of electron in Bohr's orbit.

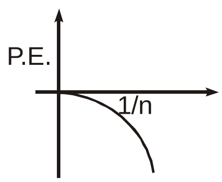
r = Radius of electron in Bohr's orbit.

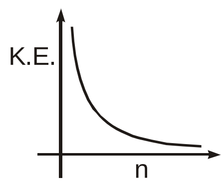
P.E. = Potential energy of electron in Bohr's orbit.

K.E. = Kinetic energy of electron in Bohr's orbit.

(A) 

(B) 

(C) 

(D) 

Sol.

7. Which is/are **correct** statement.

(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, P. E. 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.

Sol.

Assertion and Reason :

8. **It is a data sufficiency problem in which it is to be decided on the basis of given statements whether the given question can be answered or not. No matter whether the answer is yes or no.**

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

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

Statement–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.

Sol.

9. **Statement–1 :** Energy emitted when an electron jump from $5 \rightarrow 2$ (energy level) is less than when an electron jump from $2 \rightarrow 1$ in all 'H' like atom.

Statement–2 : The |total energy difference| between 1st & 2nd energy level is greater than that of any two energy level provided level '1' is not part of those two energy levels.

(A) Statement–1 is true, statement–2 is true and statement–2 is correct explanation for statement–1.

(B) Statement–1 is true, statement–2 is true and statement–2 is not the correct explanation for statement–1.

(C) Statement–1 is true, statement–2 is false.

(D) Statement–1 is false, statement–2 is true.

Sol.

10. **Statement–1 :** Emitted radiations will fall in visible range when an electron jump from higher level to n = 2 in Li^{+2} ion.
Statement–2 : Balmer series radiations belong to visible range in all H–like atoms.
(A) Statement–1 is true, statement–2 is true and statement–2 is correct explanation for statement–1.
(B) Statement–1 is true, statement–2 is true and statement–2 is not the correct explanation for statement–1.
(C) Statement–1 is true, statement–2 is false.
(D) Statement–1 is false, statement–2 is false.

Sol.

11. **Assertion :** The fraction of total number of electrons in p-sub levels of Mg is 50%
Reason : The fraction of total number of electron in p-sub levels of Be is 40%
(A) Statement–1 is true, statement–2 is true and statement–2 is correct explanation for statement–1.
(B) Statement–1 is true, statement–2 is true and statement–2 is not the correct explanation for statement–1.
(C) Statement–1 is true, statement–2 is false.
(D) Statement–1 is false, statement–2 is true.

Sol.

12. **Assertion :** Energy of an electron is determined by its principal quantum number.
Reason : Principal quantum number is a measure of the most probable distance of finding the electrons around the nucleus.
(A) Statement–1 is true, statement–2 is true and statement–2 is correct explanation for statement–1.
(B) Statement–1 is true, statement–2 is true and statement–2 is not the correct explanation for statement–1.
(C) Statement–1 is true, statement–2 is false.
(D) Statement–1 is false, statement–2 is true.

Sol.

13. **Assertion :** Cathode rays do not travel in straight lines.
Reason : Cathode rays can penetrate through a thick metal sheet.
(A) Statement–1 is true, statement–2 is true and statement–2 is correct explanation for statement–1.
(B) Statement–1 is true, statement–2 is true and statement–2 is not the correct explanation for statement–1.
(C) Statement–1 is true, statement–2 is false.
(D) Statement–1 is false, statement–2 is false.

Sol.

14. **Assertion :** Energy of radiation is large if its wavelength is large.
Reason : Energy = hv(v = frequency, v = $\frac{c}{\lambda}$)
(A) Statement–1 is true, statement–2 is true and statement–2 is correct explanation for statement–1.
(B) Statement–1 is true, statement–2 is true and statement–2 is not the correct explanation for statement–1.
(C) Statement–1 is true, statement–2 is false.
(D) Statement–1 is false, statement–2 is true.

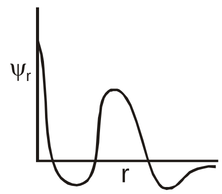
Sol.

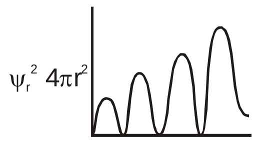
Match the column :

15. Match the column

Column–I and Column–II contain data on Schrondinger Wave–Mechanical model, where symbols have their usual meanings. Match the columns.

Column–I

(A) 

(B) 

(C) $\psi(\theta, \phi)$ = K (independent of θ & ϕ)

(D) atleast one angular node is present

Column–II

(P) 4s

(Q) $5p_x$

(R) 3s

(S) $6d_{xy}$

Sol.

16. Match the column

Column–I

(A) Electron moving in 2nd orbit in He^+ electron is

(B) Electron moving in 3^{rd} orbit in H–atom

(C) Electron moving in 1^{st} orbit in Li^{+2} ion

(D) Electron moving in 2^{nd} orbit in Be^{+3} ion

Column–II

(P) Radius of orbit in which moving is 0.529 Å

(Q) Total energy of electron is (–)13.6 × 9 eV

(R) Velocity of electron is $\frac{2.188 \times 10^6}{3}$ m/s

(S) De–broglie wavelength of electron is $\sqrt{\frac{150}{13.6}}$ Å

Sol.

Comprehension–1(3 questions)

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 relation implies that the wavelength of a particle should decreases as its velocity increases. It also implies that for a given velocity heavier particles should have shorter wavelength than lighter particles. The waves associated with particles in motion are called matter 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 experimental confirmation of the de–Broglie relation was obtained when Davisson and Germer, in 1927, observed that a beam of electrons is diffracted by a nickel crystal. As diffraction is a characteristic property of waves, hence the beam of electron behaves 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 measure the momentum of a particle, the less accurately we can determine its position. The converse is also ture. 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 undertainty in the position, Δx and the uncertainity in the momentum $\Delta(mv)$ must be greater than or equal to $h/4\pi$. i.e.

$$\Delta x \, \Delta(mv) \geq \frac{h}{4\pi}$$

17. The correct order of wavelength of Hydrogen $({}_1H^1)$, Deuterium $({}_1H^2)$ and Tritium $({}_1H^3)$ 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) $\lambda_H < \lambda_D > \lambda_T$

Sol.

18. 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) $1 \rightarrow 2$

Sol.

19. If the uncertainty in velocity & position 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) $\frac{1}{m}\sqrt{\frac{h}{4\pi}}$

Sol.

Comprehension–2 (4 questions)

The only electron in the hydrogen atom resides under ordinary conditions on the first orbit. When energy is supplied, the electron moves to higher energy orbit depending on the amount of energy absorbed. When this electron returns to any of the lower orbits, 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 orbit. Similarly, Paschen, Brackett and Pfund series are formed when electron returns to the third, fourth and fifth orbits from higher energy orbits respectively.

Maximum number of lines produced when an electron jumps from nth level to ground level is equal to $\frac{n(n-1)}{2}$. For examle, in the case of n = 4, number of lines produced is 6. ($4 \rightarrow 3$, $4 \rightarrow 2$, $4 \rightarrow 1$, $3 \rightarrow 2$, $3 \rightarrow 1$, $2 \rightarrow 1$). When an electron returns from n_2 to n_1 state, the number of 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 :

$$E_2 - E_1 = \Delta E, \lambda = \frac{hc}{\Delta E}$$

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

$$\bar{\nu} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right).$$

where R is a Rydberg's constant

($R = 1.1 \times 10^7\ m^{-1}$)

20. The energy photon emitted corresponding to transition n = 3 to n = 1 is

[$h = 6 \times 10^{-34}$ J-sec]

(A) 1.76×10^{-18} J
(B) 1.98×10^{-18} J
(C) 1.76×10^{-17} J
(D) None of these

Sol.

21. In a collection of H–atom, electrons make transition from 5th excited state to 2nd excited state then maximum number of different types of photons observed are :

(A) 3 (B) 4
(C) 6 (D) 15

Sol.

22. The difference in the wavelength of the 1st line of Lyman series and 2nd line of Balmer series in a hydrogen atom is :

(A) $\frac{9}{2R}$ (B) $\frac{4}{R}$
(C) $\frac{88}{15R}$ (D) None

Sol.

23. The wave number of electromagnetic radiation emitted during the transition of electron in between two levels of Li^{2+} ion whose principal quantum numbers sum is 4 and difference is 2 is :

(A) 3.5 R (B) 4 R
(C) 8 R (D) 8/9 R

Sol.

Comprehension–3 (4 questions)

A single electron atom has a nuclear charge +Ze where Z is the atomic number and 'e' is the electronic charge. It requires 47.2ev to excite the electron from 2^{nd} Bohr's orbit to 3^{rd} Bohr's orbit from above given data solve the following question:

24. The atomic no. of the element is:

(A) 4 (B) 3
(C) ∞ (D) 5

Sol.

25. The energy required for transition of electron from third to fourth Bohr's orbit is:

(A) 83×10^{-12} erg
(B) 13.25×10^{-12} erg
(C) 26.5×10^{-12} erg
(D) 10.6×10^{-11} erg

Sol.

26. The wavelength required to remove the electron from first Bohr's orbit to infinity?

(A) 36.5 Å (B) 146 Å
(C) 73 Å (D) 18.5 Å

Sol.

27. The Kinetic energy of electron in first Bohr's orbit is?

(A) 2.25×10^{-12} erg
(B) 11×10^{-12} erg
(C) 5.5×10^{-10} erg
(D) 27.2×10^{-11} erg

Sol.

Integer Type

28. If electron shows transition from $n_2 = 4$ to $n_1 = 2$ Then, number of fine lines in the spectral line according to Sommerfeld model is ?

Sol.

29. If the spin quantum number can have the following values $\left(-\frac{3}{2}, -\frac{1}{2}, 0, +\frac{1}{2}, +\frac{3}{2}\right)$ then, number of elements in 10^{th} period of periodic table.

Sol.

30. What is the atomic number of first atom in which last electron has entered $5g^1$ electronic configuration according to $n + \ell$ rule

Sol.

31. Find the maximum number of electrons in ground state configuration of Zn which have l = any positive integral value and m = any non zero value.

Sol.

32. Find the difference in the value of $(n + \ell)$ for 19^{th} electron of Cr and 21^{st} electron Sc.

Sol.

33. Fe^{+x} ion have spin magnetic moment m = $\sqrt{35}$ B.M.
Find the maximum multiplicity of the electrons in d-subshell in Fe^{+x}.

Sol.

34. Total number of subshell vacant upto outer most of Ca.

Sol.

35. Calculate Z_{eff}(effective nuclear charge) using slater rules on last electron of V^{+4}. **(Periodic)**

Sol.

36. A proton is fired from very far away towards a nucleus with charge Q = 120 e, where e is the electronic charge. It makes a closest approach of 10 fm to the nucleus. The de Broglie wavelength (in units of fm) of the proton at its start is: (take the proton mass, $m_p = (5/3) \times 10^{-27}$ kg; $h/e = 4.2 \times 10^{-15}$ J.s/C; $\frac{1}{4\pi\varepsilon_o} = 9 \times 10^{9}$ m/F; 1 fm = 10^{-15} m)

Sol.

37. In photoelectric effect, stopping potential depends on
(A) frequency of the incident light
(B) intensity of the incident light by varies source distance
(C) emitter's properties
(D) frequency and intensity of the incident light

Sol.

38. In the experiment on photoelectric effect using light having frequency greater than the threshold frequency, the photocurrent will certainly increase when
(A) Anode voltage is increased
(B) Area of cathode surface is increased
(C) Intensity of incident light is increased
(D) Distance between anode and cathode is increased.

Sol.

39. An electron in hydrogen atom first jumps from second excited state to first excited state and then, from first excited state to ground state. Let the ratio of wavelength, momentum and energy of photons in the two cases by x, y and z, then select the wrong answers :
(A) z = 1/x (B) x = 9/4
(C) y = 5/27 (D) z = 5/27

Sol.

40. An electron is in an excited state in hydrogen-like atom. It has a total energy of –3.4 eV. If the kinetic energy of the electron is E and its de-Broglie wavelength is λ, then
(A) E = 6.8 eV, $\lambda = 6.6 \times 10^{-10}$ m
(B) E = 3.4 eV, $\lambda = 6.6 \times 10^{-10}$ m
(C) E = 3.4 eV, $\lambda = 6.6 \times 10^{-11}$ m
(D) E = 6.8 eV, $\lambda = 6.6 \times 10^{-11}$ m

Sol.

41. A particular hydrogen like atom has its ground state binding "energy 122.4 eV. Its is in ground state. Then :
(A) Its atomic number is 3
(B) An electron of 90eV can excite it.
(C) An electron of kinetic energy nearly 91.8 eV can be brought to almost rest by this atom.
(D) An electron of kinetic energy 2.6 eV may emerge from the atom when electron of kinetic energy 125 eV collides with this atom.

Sol.

42. The electron in a hydrogen atom makes a transition $n_1 \longrightarrow n_2$, where n_1 & n_2 are the principal quantum numbers of the two states. Assume the Bohr model to be valid. The time period of the electron in the initial state is eight times that in the final state. The possible values of n_1 & n_2 are :
(A) $n_1 = 4$, $n_2 = 2$ (B) $n_1 = 8$, $n_2 = 2$
(C) $n_1 = 8$, $n_2 = 1$ (D) $n_1 = 6$, $n_2 = 3$

Sol.

43. A beam of ultraviolet light of all wavelengths passes through hydrogen gas at room temperature, in the x-direction. Assume that all photons emitted due to electron transition inside the gas emerge in the y-direction. Let A and B denote the lights emerging from the gas in the x and y directions respectively.
(A) Some of the incident wavelengths will be absent in A
(B) Only those wavelengths will be present in B which are absent in A
(C) B will contain some visible light.
(D) B will contain some infrared light.

Sol.

44. If radiation of allow wavelengths from ultraviolet to infrared is passed through hydrogen gas at room temperature, absorption lines will be observed in the :
(A) Lyman series (B) Balmer series
(C) Both (A) and (B) (D) neither (A) nor (B)

Sol.

45. In the hydrogen atom, if the reference level of potential energy is assumed to be zero at the ground state level. Choose the incorrect statement.
(A) The total energy of the shell increases with increase in the value of n
(B) The total energy of the shell decrease with increase in the value of n.
(C) The difference in total energy of any two shells remains the same.
(D) The total energy at the ground state becomes 13.6 eV.

Sol.

46. Choose the correct statement(s) for hydrogen and deuterium atoms (considering motion of nucleus)

(A) The radius of first Bohr orbit of deuterium is less than that of hydrogen

(B) The speed of electron in the first Bohr orbit of deuterium is more than that of hydrogen.

(C) The wavelength of first Balmer line of deuterium is more than that of hydrogen

(D) The angular momentum of electron in the first Bohr orbit of deuterium is more than that of hydrogen.

Sol.

47. Let A_n be the area enclosed be the n^{th} orbit in a hydrogen atom. The graph of ln (A_n/A_1) agains ln (n).

(A) will pass through origin

(B) will be a stright line will slope 4

(C) will be a monotonically increasing nonlinear curve

(D) will be a circle.

Sol.

48. A free hydrogen atom in ground state is at rest. A neutron of kinetic energy 'K' collides with the hydrogen atom. After collision hydrogen atom emits two photons in succession one of which has energy 2.55 eV. (Assume that the hydrogen atom and neutron has same mass)

(A) minimum value of 'K' is 25.5 eV.

(B) minimum value of 'K' is 12.75 eV.

(C) the other photon has energy 10.2 eV

(D) the upper energy level is of excitation energy 12.75 eV.

Sol.

49. A neutron collides head-on with a stationary hydrogen atom in ground state. Which of the following statements are correct (Assume that the hydrogen atom and neutron has same mass)

(A) If kinetic energy of the neutron is less than 20.4 eV collision must be elastic

(B) If kinetic energy of the neutron is less than 20.4 eV collision may be inelastic

(C) Inelastic collision may be take place only when initial kinetic energy of neutron is greater than 20.4 eV.

(D) Perfectly inelastic collision can not take place.

Sol.

50. A hydrogen atom in a state having a binding energy 0.85 eV

makes a transition to a state of excitation energy 10.2 eV. The wave length of emitted photon is .... nm.

Sol.

Paragraph for Questions 51 to 53

When a particle is restricted to move along *x*-axis between $x = 0$ and $x = a$, where *a* is of nanometer dimension, its energy can take only certain specific values. The allowed energies of the particle moving in such a restricted region, correspond to the formation of standing waves with nodes at its ends $x = 0$ and $x = a$. The wavelength of this standing wave is related to the linear momentum *p* of the particle according to the de Broglie relation. The energy of the particle of mass *m* is related to its linear momentum as $E = \frac{p^2}{2m}$. Thus, the energy of the particle can be denoted by a quantum number '*n*' taking values 1, 2, 3 ... ($n = 1$, called the ground state) corresponding to the number of loops in the standing wave. Use the model described above to answer the following three questions for a particle moving in the line $x = 0$ to $x = a$. Take $h = 6.6 \times 10^{-34}$ Js and $e = 1.6 \times 10^{-19}$ C. **[JEE 2009]**

51. The allowed energy for the particle for a particular value of *n* is proportional to

(A) a^{-2} (B) $a^{-3/2}$
(C) a^{-1} (D) a^{2}

Sol.

52. If the mass of the particle is $m = 1.0 \times 10^{-30}$ kg and $a = 6.6$ nm, the energy of the particle in its ground state is closest to

(A) 0.8 meV (B) 8 meV
(C) 80 meV (D) 800 meV

Sol.

53. The speed of the particle, that can take discrete values, is proportional to

(A) $n^{-3/2}$ (B) n^{-1}
(C) $n^{1/2}$ (D) n

EXERCISE – III OBJECTIVE PROBLEMS (JEE ADVANCED)

Bohr's Model

1. Calculate the wavelength of radiation emitted, producing a line in Lyman series, when an electron falls from fourth stationary state in hydrogen atom.
(A) 9.6×10^{-8} m (B) 9.7×10^{-8} m
(C) 9.7×10^{-8} m (D) 9.6×10^{-8} cm

Sol.

2. Calculate energy of electron which is moving in the orbit that has its radius sixteen times the radius of first Bohr orbit for H–atom.
(A) 4.36×10^{18} J
(B) -1.36×10^{-19} J
(C) -1.36×10^{-29} KJ
(D) -1.36×10^{-4} J

Sol.

3. The wavelength of a certain line in the Paschen series in 1093.6 nm. What is the value of n_{high} for this line. [$R_H = 1.0973 \times 10^{+7}\ m^{-1}$]
(A) 10 (B) 5
(C) 6 (D) 8

Sol.

4. Wavelength of the Balmer H_α line is 6565 Å. Calculate the wavelength of H_β, line of same hydrogen like atom.
(A) 4863 Å (B) 48.63 Å
(C) 4.863 Å (D) 4563 Å

Sol.

5. Calculate the Rydberg constant R if He^+ ions are known to have the wavelength difference between the first (of the longest wavelength) lines of Balmer and Lyman series equal to 133.7 nm.
(A) $1.96 \times 10^{-8}\ m^{-1}$
(B) $1.096 \times 10^{7}\ m^{-1}$
(C) $1.096 \times 10^{8}\ m^{-1}$
(D) $1.4 \times 10^{2}\ m^{-1}$

Sol.

6. What transition in the hydrogen spectrum would have same wavelength as the Balmer transition, n = 4 to n = 2 of He^+ spectrum.
(A) $n_1 = 4, n_2 = 2$
(B) $n_1 = 5, n_2 = 6$
(C) $n_1 = 1, n_2 = 3$
(D) $n_1 = 1, n_2 = 2$

Sol.

7. Calculate the total energy emitted when electrons of 1.0g atom of hydrogen undergo transition giving the spectral line of lowest energy in the visible region of its atomic spectrum.
(A) 1.827×10^5 J/mol
(B) 2.827×10^5 J/mol
(C) 18.27×10^5 J/mol
(D) 28.27×10^5 J/mol

Sol.

8. A photon having λ = 854 Å causes the ionization of a nitrogen atom. Give the I.E. per mole of nitrogen in kJ.
(A) 1503 KJ/mole
(B) 1603 KJ/mole
(C) 1403 KJ/mole
(D) 1504 KJ/mole

Sol.

9. The radius of the an orbit of hydrogen atom is 0.85 nm. Calculate the velocity of electron in this orbit.
(A) 6.44×10^5 m/s
(B) 5.44×10^5 m/s
(C) 5.44×10^3 m/s
(D) 5.44×10^2 m/s

Sol.

10. A doubly ionised lithium atom is hydrogen like with atomic number z = 3. Find the wavelength of the radiation required to excite the electron in Li^{2+} from the first to the third Bohr orbit.
(A) 114.74 Å (B) 113.74 Å
(C) 112.74 Å (D) 111.74 Å

Sol.

11. The energy of an excited H–atom is –3.4 eV. Calculate angular momentum of e^- in the given orbit.
(A) $h/2\pi$ (B) h/π
(C) $2h/\pi$ (D) $h/5\pi$

Sol.

12. The vapours of Hg absorb some electrons accelerated by a potential difference of 4.5 volt as a result of which light is emitted. If the full energy of single incident e^- is supposed to be converted into light emitted by single Hg atom, find the wave number of the light.
(A) 3.63×10^6 m^{-1}
(B) 36.3×10^6 m^{-1}
(C) 3.63×10^5 m^{-1}
(D) 3.63×10^7 m^{-1}

Sol.

13. If the average life time of an excited state of H atom is of order 10^{-8} sec, estimate how many orbits an e^- makes when it is in the state n = 2 and before it suffers a transition to n = 1 state.
(A) 8×10^6 (B) 10^3
(C) 10^6 (D) 0.8×10^6

Sol.

14. Calculate the frequency of e^- in the first Bohr orbit in a H–atom.
(A) 6530×10^{12} Hz
(B) 6.530×10^{12} Hz
(C) 6530×10^{10} Hz
(D) 6530×10^7 Hz

Sol.

15. A stationary He^+ ion emitted a photon corresponding to a first line of the Lyman series. The photon liberated a photoelectron from a stationary H atom in ground state. What is the velocity of photoelectron.
(A) 3.10×10^8 cm/sec
(B) 3.09×10^8 cm/sec
(C) 3.10×10^8 cm/sec
(D) 3.8×10^8 cm/sec

Sol.

16. Find the number of photons of radiation of frequency 5×10^{13} s^{-1} that must be absorbed in order to melt one gm ice when the latent heat of fusion of ice is 330 J/g.
(A) 10^{23} (B) 10^{21}
(C) 10^{40} (D) 10^{22}

Sol.

17. Suppose 10^{-17}J of light energy is needed by the interior of the human eye to see an object. How many photons of green light (λ = 550 nm) are needed to generate this minimum amount of energy.
(A) 25 photon (B) 20 photon
(C) 28 photon (D) 30 photon

Sol.

18. Through what potential difference must an electron pass to have a wavelength of 500 Å.
(A) 6.03×10^{-3} volt
(B) 6.03×10^{-4} volt
(C) 6.03×10^{-2} volt
(D) 6.03×10^{-6} volt

Sol.

19. A proton is accelerated to one–tenth of the velocity of light. If its velocity can be measured with a precision ±1%. What must be its uncertainty in position.
(A) 4.05×10^{-4} m
(B) 3.05×10^{-4} m
(C) 2.05×10^{-3} m
(D) 1.05×10^{-3} m

Sol.

20. To what effective potential a proton beam be subjected to give its protons a wavelength of 1×10^{-10} m.
(A) 1826 volt (B) 082.6 volt
(C) 0.0826 volt (D) 826 volt

Sol.

21. He atom can be excited to $1s^1\ 2p^1$ by λ = 58.44nm. If lowest excited state for He lies 4857 cm^{-1} below the above. Calculate the energy of the lower excitation state.
(A) 6.3×10^{-15} J (B) 3.3×10^{-14} J
(C) 3.3×10^{-16} J (D) 6.3×10^{-16} J

Sol.

22. A certain dye absorbs 4530 Å and fluoresces at 5080 Å these being wavelengths of maximum absorption that under given conditions 47% of the absorbed energy is emitted. Calculate the ratio of the number of quanta emitted to the number absorbed.
(A) 0.527 (B) 05.27
(C) 052.7 (D) 1.527

Sol.

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

(A) 6485 Å (B) 6415 Å
(C) 6425 Å (D) 6235 Å

Sol.

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

(A) 3×10^{20} (B) 3×10^{22}
(C) 5×10^{22} (D) 5×10^{20}

Sol.

25. Calculate the wavelength of the radiation that would cause photo dissociation of chlorine molecule if the Cl–Cl bond energy is 243 kJ/mole.

(A) 4.9×10^{-5} m (B) 4.9×10^{-7} m
(C) 4.9×10^{-6} m (D) 5.9×10^{-6} m

Sol.

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

(A) 8.08% (B) 8.68%
(C) 8.18% (D) 7.88%

Sol.

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

(A) 24 (B) 12
(C) 18 (D) 22

Sol.

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

(A) 3.88 pm (B) 3.068 pm
(C) 4.88 pm (D) 5.68 pm

Sol.

29. Calculate the de–Broglie wavelength associated with motion of earth (mass 6×10^{24} kg) orbiting around the sun at a speed of 3×10^6 m/s.

(A) 3.68×10^{-65} m
(B) 5.68×10^{-65} m
(C) 2.68×10^{-60} m
(D) 6.68×10^{-60} m

Sol.

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

(A) 2.0144 m (B) 1.2244 m
(C) 1.0144 m (D) 0.0144 m

Sol.

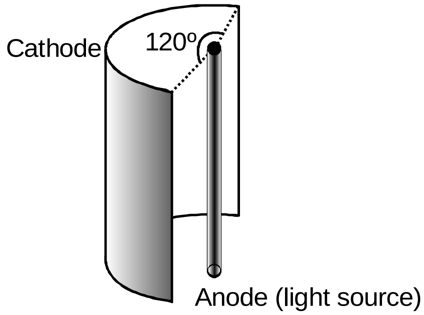
31. The electrons identified by quantum numbers 'n' and ℓ :
(a) n = 4, ℓ = 1
(b) n = 4, ℓ = 0
(c) n = 3, ℓ = 2
(d) n = 3, ℓ = 1
can be placed in order of increasing energy as
(A) (b) < (d) < (a) < (c)
(B) (a) < (c) < (b) < (d)
(C) (c) < (d) < (b) < (a)
(D) (d) < (b) < (c) < (a)

Sol.

32. Find the wavelength of the first line of He^+ ion spectral series whose interval between extreme line is $\left[\frac{1}{\lambda_1} - \frac{1}{\lambda_2} = 2.7451 \times 10^4 cm^{-1}\right]$.
(A) 4559 Å (B) 5689 Å
(C) 4689 Å (D) 5689 Å

Sol.

33. A cylindrical source of light which emits radiation radially (from curved surface) only, placed at the centre of a hollow, metallic cylindrical surface, as shown in diagram.
The power of source is 90 watt and it emits light of wavelength 4000 Å 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 is [Given : h = 6.4 × 10^{-34} J/sec]



(A) 12 amp (B) 10 amp
(C) 11 amp (D) 15 amp

Sol.

34. Mr. Santa has to decode a number "ABCDEF" where each alphabet is represented by a single digit. Suppose an orbital whose radial wave functional is represented as :

$$\Psi_{(r)} = k_1 \cdot e^{-r/k_2} \quad (r^2 - 5k_3 r + 6k_3^2)$$

From the following information given about each alphabet then write down the answers in the form of "ABCDEF", for above orbital.
Info A = Value of n where "n" is principal quantum number.
Info B = No. of angular nodes
Info C = Azimuthal quantum number of subshell to orbital belongs
Info D = No. of subshells having energy between (n + 5)s to (n + 5)p where n is principal quantum number.
Info E = Orbital angular momentum of given orbital.
Info F = Radial distance of the spherical node which is farthest from the nucleus.
(Assuming k_3 = 1)
(A) 300203 (B) 200103
(C) 300303 (D) 300103

Sol.

EXERCISE – IV PREVIOUS YEARS PROBLEMS

LEVEL – I JEE MAIN

Q.1 An atom has a mass of 0.02 kg & uncertainity in its velocity is 9.218×10^{-6} m/s then uncertainity in position is
($h = 6.626 \times 10^{-34}$ J - s) **[AIEEE- 2002]**
(A) 2.86×10^{-28} m (B) 2.86×10^{-32} cm
(C) 1.5×10^{-27} m (D) 3.9×10^{-10} m

Sol.

Q.2 Energy of H–atom in the ground state is –13.6 eV , Hence energy in the second excited state is – **[AIEEE- 2002]**
(A) –6.8 eV (B) –3.4 eV
(C) –1.51 eV (D) –4.3 eV

Sol.

Q.3 Unertainty in position of a particle of 25 g in space is 10^{-5} m. Hence uncertainty in velocity (ms^{-1}) is (Planck's constant $h = 6.6 \times 10^{-34}$ Js) **[AIEEE- 2002]**
(A) 2.1×10^{-28} (B) 2.1×10^{-34}
(C) 0.5×10^{-34} (D) 5.0×20^{-24}

Sol.

Q.4 The orbital angular momentum for an electron revolving in an orbit is given by $\sqrt{l(l+1)}.\frac{h}{2\pi}$. This momentus for an s-electron will be given by - **[AIEEE- 2003]**

(A) $\frac{h}{2\pi}$ (B) $\sqrt{2}.\frac{h}{2\pi}$

(C) $+\frac{1}{2}.\frac{h}{2\pi}$ (D) zero

Sol.

Q.5 In Bohr series of lines of hydrogen spectrum, third line from the red end corresponds to where one of the following inter-orbit jumps of electron for Bohr orbits in an atom of hydrogen. **[AIEEE- 2003]**
(A) $4 \rightarrow 1$ (B) $2 \rightarrow 5$
(C) $3 \rightarrow 2$ (D) $5 \rightarrow 2$

Sol.

Q.6 The de Broglie wavelength of a tennis ball mass 60 g moving with a velocity of 10 mt. per second is approximately - **[AIEEE- 2003]**
(A) 10^{-16} metres (B) 10^{-25} metres
(C) 10^{-33} metres (D) 10^{-31} metres

Sol.

Q.7 Which of the following sets of quantum numbers is correct for an electron in 4f orbital ? **[AIEEE- 2004]**

(A) $n = 4, l = 3, m = +4, s = +\frac{1}{2}$

(B) $n = 4, l = 4, m = -4, s = -\frac{1}{2}$

(C) $n = 4, l = 3, m = +1, s = +\frac{1}{2}$

(D) $n = 4, l = 3, m = -2, s = +\frac{1}{2}$

Sol.

Q.8 Consider the ground state of Cr atom (Z = 24). The numbers of electrons with the azimuthal quantum numbers, l =1 and 2 are, respectively **[AIEEE- 2004]**

(A) 12 and 4 (B) 12 and 5
(C) 16 and 4 (D) 16 and 5

Sol.

Q.9 The wavelength of the radiation emitted, when in a hydrogen atom electron falls from infinity to stationary state 1, would be (Rydberg constant = $1.097 \times 10^7\ m^{-1}$) **[AIEEE- 2004]**

(A) 91 nm (B) 192 nm
(C) 406 nm (D) 9.1×10^{-8} nm

Sol.

Q.10 Which one of the following sets of ions represents the collection of isoelectronic species ? **[AIEEE- 2004]**

(A) K^+, Ca^{2+}, Sc^{3+}, Cl^-
(B) Na^+, Ca^{2+}, Sc^{3+}, F^-
(C) K^+, Cl^-, Mg^{2+}, Sc^{3+}
(D) Na^+, Mg^{2+}, Al^{3+}, Cl^-
(Atomic nos.: F = 9, Cl = 17, Na = 11, Mg = 12, Al = 13, K = 19, Ca = 20 , Sc = 21)

Sol.

Q.11 In a multi-electron atom, which of the following orbitals described by the three quantum members will have the same energy in the absence of magnetic and electric fields ? **[AIEEE- 2005]**

(a) n = 1, l = 0, m = 0 (b) n = 2, l = 0, m = 0
(c) n = 2, l = 1, m = 1 (d) n = 3, l = 2, m = 1
(e) n = 3, l = 2, m = 0
(A) (b) and (c) (B) (a) and (b)
(C) (d) and (e) (D) (c) and (d)

Sol.

Q.12 Of the following sets which one does NOT contain isoelectronic species ? **[AIEEE- 2005]**

(A) CN^-, N_2, C_2^{2-}
(B) PO_4^{3-}, SO_4^{2-}, ClO_4^-
(C) BO_3^{3-}, CO_3^{2-}, NO_3^-
(D) SO_3^{2-}, CO_3^{2-}, NO_3^-

Sol.

Q.13 According to Bohr's theory, the angular momentum of an electron in 5^{th} orbit is - **[AIEEE 2006]**

(A) 1.0 h/π (B) 10 h/π

(C) 2.5 h/π (D) 25 h/π

Sol.

Q.14 Uncertainty in the position of an electron (mass = 9.1×10^{-31} kg) moving with a velocity 300 m/s, accurate upto 0.001 %, will be ($h = 6.63 \times 10^{-34}$ Js) **[AIEEE 2006]**

(A) 5.76×10^{-2} m (B) 1.92×10^{-2} m

(C) 3.84×10^{-2} m (D) 19.2×10^{-2} m

Sol.

Q.15 Which of the following sets of quantum numbers represents the highest energy of an atom ? **[AIEEE 2007]**

(A) $n = 3, \ell = 1, m = 1, s = +½$

(B) $n = 3, \ell = 2, m = 1, s = +½$

(C) $n = 4, \ell = 0, m = 0, s = +½$

(D) $n = 3, \ell = 0, m = 0, s = +½$

Sol.

Q.16 The ionization enthalpy of hydrogen atom is 1.312×10^6 J mol^{-1}. The energy required to excite the electron in the atom from n = 1 to n = 2 is **[AIEEE 2008]**

(A) 6.56×10^5 J mol^{-1}

(B) 7.56×10^5 J mol^{-1}

(C) 9.84×10^5 J mol^{-1}

(D) 8.51×10^5 J mol^{-1}

Sol.

Q.17 In an atom, an electron is moving with a speed of 600m/s with an accuracy of 0.005%. Certainity with which the position of the electron can be located is ($h = 6.6\times10^{-34}$ kg m^2s^{-1} ,mass of electron, $e_m = 9.1\times10^{-31}$ kg)

(A) 1.52×10^{-4}m (B) 5.10×10^{-3}m

(C) 1.92×10^{-3}m (D) 3.84×10^{-3}m

Sol. **[AIEEE 2009]**

Q.18 Calculate the wavelength (in nanometer) associated with a proton moving at $1.0\times10^3 ms^{-1}$ (Mass of proton = 1.67×10^{-27} kg and h = 6.63×10^{-34} Js) :

(A) 0.032 nm (B) 0.40 nm

(C) 2.5 nm (D) 14.0 nm

Sol. **[AIEEE 2009]**

Q.19 The energy required to break one mole of Cl–Cl bonds in Cl_2 is 242 kJ mol^{-1}. The longest wavelength of light capable of breaking a single Cl – Cl bond is
($c = 3 \times 10^8\ ms^{-1}$ and $N_A = 6.02 \times 10^{23}\ mol^{-1}$)
(A) 594 nm (B) 640 nm
(C) 700 nm (D) 494 nm

Sol. **[AIEEE 2010]**

Q.20 Ionisation energy of He^+ is 19.6×10^{-18} J $atom^{-1}$. The energy of the first stationary state (n = 1) of Li^{2+} is **[AIEEE 2010]**
(A) 4.41×10^{-16} J $atom^{-1}$
(B) -4.41×10^{-17} J $atom^{-1}$
(C) -2.2×10^{-15} J $atom^{-1}$
(D) 8.82×10^{-17} J $atom^{-1}$

Sol.

Q.21 Iron exhibits +2 and +3 oxidation states. Which of the following statements about iron is incorrect ?
(A) Ferrous compounds are less volatile than the corresponding ferric compounds.
(B) Ferrous compounds are more easily hydrolysed than the corresponding ferric compounds.
(C) Ferrous oxide is more basic in nature than the ferric oxide.
(D) Ferrous compounds are relatively more ionic than the corresponding ferric compounds.

Sol. **[AIEEE 2012]**

Q.22 The electrons identified by quantum numbers 'n' and ℓ :
(a) n = 4, ℓ = 1
(b) n = 4, ℓ = 0
(c) n = 3, ℓ = 2
(d) n = 3, ℓ = 1
can be placed in order of increasing energy as :
(A) (b) < (d) < (a) < (c)
(B) (a) < (c) < (b) < (d)
(C) (c) < (d) < (b) < (a)
(D) (d) < (b) < (c) < (a)

Sol. **[AIEEE 2012]**

Q.23 The standard reduction potentials for Zn^{2+}/Zn, Ni^{2+}/Ni, and Fe^{2+}/Fe are –0.76, –0.23 and –0.44 V respectively. The reaction $X + Y^{2+} \rightarrow X^{2+} + Y$ will be spontaneous when:
(A) X = Fe, Y = Zn
(B) X = Zn, Y = Ni
(C) X = Ni, Y = Fe
(D) X = Ni, Y = Zn

Sol. **[AIEEE 2012]**

Q.24 The first ionisation potential of Na is 5.1 eV. The value of electron gain enthalpy of Na^+ will be:
(A) – 10.2 eV (B) + 2.55 eV
(C) – 2.55 eV (D) – 5.1 eV

Sol. **[AIEEE 2013]**

Q.25 Energy of an electron is given by

$E = -2.178 \times 10^{-18} \left(\frac{Z^2}{n^2}\right)$.Wavelength of ligh required to excite an electron in an hydrogen atom from level n = 1 to n = 2 will be
($h = 6.62 \times 10^{-34}$ Js and $c = 3.0 \times 10^8\ ms^{-1}$)
(A) 8.500×10^{-7} m (B) 1.214×10^{-7} m
(C) 1.816×10^{-7} m (D) 6.500×10^{-7} m

Sol. **[AIEEE 2013]**

Q.26 Which of the following is the wrong statement ?
(A) Ozone is diamagnetic gas
(B) ONCl and ONO^- are not isoelectron
(C) O_3 molecule is bent
(D) Ozone is violet black in solid state

Sol. **[AIEEE 2013]**

Q.27 Which of the following arrangements does not represent the correct order of the property stated against it?
(A) Se < Ti < Cr < Mn : number of oxidation states.
(B) $V^{2+} < Cr^{2+} < Mn^{2+} < Fe^{2+}$: Paramagnetic behaviour.
(B) $Ni^{2+} < Co^{2+} < Fe^{2+} < Mn^{2+}$: ionic size
(D) $Co^{3+} < Fe^{3+} < Cr^{3+} < Sc^{3+}$ stability in aqueous solution.

Sol. **[AIEEE 2013]**

28. In a hydrogen like atom electron make transition from an energy level with quantum number n to another with quantum number (n – 1). If n >> 1, the frequency of radiation emitted it proportional to **[AIEEE 2013]**

(A) $\frac{1}{n^{3/2}}$ (B) $\frac{1}{n^3}$

(C) $\frac{1}{n}$ (D) $\frac{1}{n^2}$

Sol.

LEVEL – II

JEE ADVANCED

1. With what velocity should an α–particle travel towards the nucleus of a Cu atom so as to arrive at a distance 10^{-13} m. **[JEE 1997]**

Sol.

2. A compound of Vanadium has magnetic moment of 1.73 BM work out electronic configuration of Vanadium Ion in the compound. **[JEE 1997]**

Sol.

3. The energy of an electron in the first Bohr orbit of H atom is –13.6 eV. The possible energy value(s) of the excited state(s) for electrons in Bohr orbits of hydrogen is/are : **[JEE 1998]**

(A) –3.4 eV (B) –4.2 eV
(C) –6.8 eV (D) +6.8 eV

Sol.

4. Which of the following statement(s) is (are) correct ? **[JEE 1998]**

(A) The electronic configuration of Cr is [Ar] $3d^5 4s^1$ (Atomic Number of Cr = 24)
(B) The magnetic quantum number may have a negative value
(C) In silver atom, 23 electron have a spin of one type and 24 of the opposite type. (Atomic Number of Ag = 47)
(D) The oxidation state of nitrogen in HN_3 is -3.

Sol.

5. **Assertion:** Zn^{2+} is diamagnetic. **[JEE 1998]**
Reason: The electrons are lost from 4s orbital to form Zn^{2+}.

(A) Both assertion and reason are correct and reason is the correct explanation of the assertion.
(B) Both assertion and reason are correct but the reason is not the correct explanation of the assertion.
(C) Assertion is correct but reason is incorrect.
(D) Assertion is incorrect but reason is correct.

Sol.

6. The electrons, identified by quantum numbers n and l (i) n = 4, l = 1, (ii) n = 4, l = 0 (iii) n = 3, l = 2 and (iv) n = 3, l = 1 can be placed in order of increasing energy, from the lowest to highest, as **[JEE 1999]**

(A) (iv) < (ii) < (iii) < (i)
(B) (ii) < (iv) < (i) < (iii)
(C) (i) < (iii) < (ii) < (iv)
(D) (iii) < (i) < (iv) < (ii)

Sol.

7. Ground state electronic configuration of nitrogen atom can be represented by **[JEE 1999]**

(A) ↑↓ ↑↓ ↑ ↑ ↑

(B) ↑↓ ↑↓ ↑ ↓ ↑

(C) ↑↓ ↑↓ ↑ ↓ ↓

(D) ↑↓ ↑↓ ↓ ↓ ↓

Sol.

8. Electronic configuration of an element is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$. This represents its **[JEE 2000]**

(A) excited state (B) ground state
(C) cationic form (D) anionic form

Sol.

9. The wavelength associated with a golf ball weighing 200 g and moving at a speed of 5 m/h is of the order **[JEE 2001]**

(A) 10^{-10} m (B) 10^{-20} m
(C) 10^{-30} m (D) 10^{-40} m

Sol.

10. The number of nodal planes in a p_x orbital is : **[JEE 2000]**

(A) one (B) two
(C) three (D) zero

Sol.

11. Calculate the energy 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 is 436 kJ mol^{-1}.

Sol.

12. The quantum numbers +1/2 and –1/2 for the electron spin represent :

(A) rotation of the electron in clockwise and anticlockwise direction respectively.
(B) rotation of the electron in anticlockwise and clockwise direction respectively.
(C) magnetic moment of the electron pointing up and down respectively.
(D) two quantum mechanical spin states which have no classical analogue. **[JEE 2001]**

Sol.

13. Rutherfords experiment, which established the nuclear model of atom, used a beam of :

(A) β–particles, 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 nuclie, which impinged on a metal foil and got scattered. **[JEE 2002]**

Sol.

14. The magnetic moment of cobalt of the compound $Hg[Co(SCN)_4]$ is [Given : Co^{+2}]

(A) $\sqrt{3}$ (B) $\sqrt{8}$

(C) $\sqrt{15}$ (D) $\sqrt{24}$

[JEE 2004]

Sol.

15. The radius of which of the following orbit is same as that of the first Bohr's orbit of hydrogen atom?

(A) He^{+} (n = 2) (B) Li^{2+} (n = 2)
(C) Li^{2+} (n = 3) (D) Be^{3+} (n = 2)

[JEE 2004]

Sol.

16. The Schrodinger wave equation for hydrogen atom is

$$\Psi_{2s} = \frac{1}{4\sqrt{2\pi}}\left(\frac{1}{a_0}\right)^{3/2}\left(2 - \frac{r_0}{a_0}\right)e^{-\frac{r_0}{a_0}}$$

Where a_0 is Bohr's radius. If the radial node is 2s be at r_0, then find r_0 in term of a_0.

[JEE 2004]

Sol.

17. A ball of mass 100 g is moving with 100 m/s. Find its wavelength **[JEE 2004]**

Sol.

18. The number of radial nodes of 3s and 2p orbitals are respectively. **[JEE 2004]**

(A) 2,0 (B) 0,2
(C) 1,2 (D) 2,1

Sol.

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

[JEE 2004]

Sol.

20. Given in hydrogenic 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. **[JEE 2006]**

Column-I

(A) $U = V_n / K_n$

(B) $\frac{1}{r_n} \propto E^x$

(C) $r_n \propto Z^y$ (Z = atomic number)

(D) v = (Orbital angular momentum of electron in its lowest energy.)

Column-II

(P) 1

(Q) –2

(R) –1

(S) 0

Sol.

21. Match the entries is Column–I with the correctly related quantum number(s) in Column–II. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS. **[JEE 2008]**

Column–I

(A) Orbital angular momentum of the electron in a hydrogen-like atomic orbital

(B) A hydrogen-like one-electron wave function function obeying Pauli principle

(C) Shape, size and orientation of hydrogen like atomic orbitals

(D) Probability density of electron at the nucleus in hydrogen-like atom

Column–II

(P) Principal quantum number

(Q) Azimuthal quantum number

(R) Magnetic quantum number

(S) Electron spin quantum number

Sol.

22. Assuming that Hund's rule is violated, the bond order and magnetic nature of the diatomic molecular B_2 is **[JEE 2010]**

(A) 1 and diamagnetic

(B) 0 and diamagnetic

(C) 1 and paramagnetic

(D) 0 and paramagnetic

Sol.

Paragraph for questions 23 to 25

The hydrogen-like species Li^{2+} is in a spherically symmetric state S_1 with one radial node. 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 hydrogen atom. **[JEE 2010]**

23. The state S_1 is

(A) 1 s (B) 2s

(C) 2p (D) 3s

Sol.

24. Energy of the state S_1 in units of the hydrogen atom ground state energy is

(A) 0.75 (B) 1.50

(C) 2.25 (D) 4.50

Sol.

25. The orbital angular momentum quantum number of the state S_2 is

(A) 0 (B) 1

(C) 2 (D) 3

Sol.

26. The maximum number of electrons that can have principal quantum number, n = 3, and spin quantum number, $m_s = -1/2$, is: **[JEE 2011]**

Sol.

27. 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 **[JEE 2011]**

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

Sol.

28. The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is [a_0 is Bohr radius] **[JEE 2012]**

(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) $\frac{h^2}{64\pi^2 m a_0^2}$

Sol.

29. The work functions of Silver and Sodium are 4.6 and 2.3 eV, respectively. The ratio of the slope of the stopping potential versus frequency plot for Silver to that of Sodium is **[JEE 2013]**

Sol.

30. The radius of the orbit of an electron in a Hydrogen-like atom is 4.5 a_0, where a_0 is the Bohr radius. Its orbital angular momentum is $\frac{3h}{2\pi}$. It is given that h is Planck constant and R is Rydberg constant. The possible wavelength(s), when the atom de-excites, is (are) **[JEE 2013]**

(A) $\frac{9}{32R}$ (B) $\frac{9}{16R}$

(C) $\frac{9}{5R}$ (D) $\frac{4}{3R}$

Sol.

31. The atomic masses of He and Ne are 4 and 20 a.m.u. respectively. The value of the de Broglie wavelength of He gas at –73 °C is "M" times that of the de Broglie wavelength of Ne at 727 °C. M is **[JEE 2013]**

Sol.

ANSWER-KEY

Answer Ex–I — OBJECTIVE PROBLEMS (JEE MAIN)

1. A	**2.** B	**3.** A	**4.** A	**5** D	**6** D
7 D	**8** B	**9** B	**10** D	**11** B	**12** B
13 A	**14** A	**15** B	**16** D	**17** A	**18** B
19 C	**20** B	**21** B	**22** C	**23** D	**24** B
25 B	**26** C	**27** C	**28** B	**29** B	**30** D
31 A	**32** C	**33** C	**34** A	**35** C	**36** D
37 D	**38** B	**39** C	**40** B	**41** A	**42** C
43 A	**44** A	**45** B	**46.** D	**47.** A	**48.** C
49. A	**50.** B				

Answer Ex–II — OBJECTIVE PROBLEMS (JEE ADVANCED)

1. ABC	**2.** ACD	**3.** BC	**4.** AC	**5** AC	**6** BCD
7 CD	**8** B	**9** A	**10** D	**11** C	**12** D
13 D	**14** D	**15.** A-P, B-P,Q,S, C-P,R, D-Q,S		**16.** A-S, B-R, C-Q, D-P	
17 A	**18** C	**19** A	**20** A	**21** C	**22** B
23 C	**24** D	**25** C	**26** A	**27** C	**28** 8
29 180	**30** 121	**31** 16	**32** 1	**33** 5	**34** 4
35 5	**36** 7	**37.** A,C	**38.** B, C	**39.** B	**40.** B
41. A,C,D	**42.** A, D	**43.** A,C,D	**44.** A	**45.** B	**46.** A
47. A,B	**48.** A,C,D	**49.** A,C	**50.** 487.06 nm	**51.** A	

52. B **53.** D

Answer Ex–III SUBJECTIVE PROBLEMS (JEE ADVANCED)

1. B	**2.** B	**3.** C	**4.** A	**5** B	**6** D
7 A	**8** C	**9** B	**10** B	**11** B	**12** A
13 A	**14** A	**15** B	**16** D	**17** C	**18** B
19 B	**20** C	**21** C	**22** A	**23** D	**24** B
25 B	**26** B	**27** A	**28** A	**29** A	**30** D
31 D	**32** C	**33** B	**34** C		

Answer Ex–IV PREVIOUS YEARS PROBLEMS

LEVEL – I JEE MAIN

1. A	**2.** C	**3.** A	**4.** D	**5** B	**6** C
7 CD	**8** B	**9** A	**10** A	**11** C	**12** D
13 C	**14** B	**15** B	**16** C	**17.** C	**18.** B
19. D	**20.** B	**21.** B	**22.** D	**23.** B	**24.** D
25. B	**26.** C	**27.** B	**28.** B		

LEVEL – II JEE ADVANCED

1. 6.3×10^{8} m/s **2.** $_{23}V^{+2}$: [Ar] $3d^1$ **3.** A **4.** ABC **5.** B

6. A **7.** AD **8.** B **9.** C **10.** A

11. 98.2 kJ **12.** D **13.** D **14.** C **15.** D **16.** $2a_0$

17. 6.6×10^{-35} s^{-1} **18.** A **19.** 3.34×10^{-10} m

20. A-Q, B-P, C-R, D-S **21.** A–QR; B–P,Q,RS ; C–P,Q,R; D–P,Q **22.** A **23.** B

24. C **25.** B **26.** 0009 **27.** 0004 **28.** C **29.** 1

30. AC **31.** 0005