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CHEMISTRY

BOOKS - MODERN PUBLISHERS CHEMISTRY (HINGLISH)

STRUCTURE OF ATOM

Solved Examples

1. How many protons, electrons and neutrons are there in the following nuclei?

$(i)_{8}^{17}O \quad (ii)_{12}^{25}Mg \quad (iii)_{35}^{80}Br$

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2. The number of electrons, protons and neutrons in a species are equal to 18, 16 and 16 respectively. Assign the proper symbol of the species.

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3. Complete the following table:

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4. An element with mass number 81 contains 31.7% more neutrons as compared to protons. Assign the atomic symbol.

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5. An ion with mass number 56 contains 3 units of positive charge and 30.4% more neutrons then electrons. Assign the symbol to this ion.

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6. Yellow light emitted from a sodium lamp has a wavelength (λ) of $580nm$. Calculate the frequency (v). Wave number and energy of yellow light photon .

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7. the vividh bharati station of All india Radio, Delhi , broadcasts on a frequency of 1,368 kHz (kilo hertz). Calculate the wavelength of the electromagnetic radiation emitted by transmitter . Which part of the electromagnetic spectrum does it belong to

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8. the wavelength range of the visible spectrum extends from violet (400 nm) to red (750 nm). Express these wavelengths in frequencies (Hz) . (1nm =$10^{-9}m$)

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9. The energy of photon of light having frequency of $3 \times 10^{15} S^{-1}$ is

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10. Calculate and compare the energies of two radiations one with wavelength 800 pm and the other with wavelength 400 pm.

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11. A 100 watt bulb emits monochromatic light of wavelength 400 nm. Calculate the number of photons emitted per second by the bulb.

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12. calculate energy of one mole of photons of radiation whose frequency is $5 \times 10^{14} hz$

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13. Calculate the minimum amount of energy that the photons must posses to eject electorns from cesium metal. The threshold frequency of cesium metal is $4.6 \times 10^{14} s^{-1} \left(h = 6.63 \times 10^{-34} Js\right)$.

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14. Calculate the kinetic energy of the ejected electron when ultra-violet radiation of frequency $1.6 \times 10^{15} s^{-1}$ strikes the surface of potassium metal. Threshold frequency of potassium is $5 \times 10^{14} s^{-1} \left(h = 6.63 \times 10^{-34} Js\right)$.

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15. When light of 470 nm falls on the surface of potassium metal, electrons are emitted with a velocity of $6.4 \times 10^{4} ms^{-1}$. What is the minimum energy required to remove one moles electrons from potassium metal?

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16. When electromagnetic radiation of wavelength 300 nm falls on the surface of sodium, electrons are emitted with kinetic energy of $1.68 \times 10^5 J\mathrm{ml}^{-1}$. What is the minimum energy needed to remove an electron from sodium ? What is the maximum wavelength that will cause a photoelectron to be emitted.

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17. What is the wavelength of light emitted when the electron of a hydrogen atom undergoes a transition from an energy level with $n = 4$ to an energy level with $n = 2$? What is the colour corresponding to this wavelength?

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18. In the Rydberg equation, a spectral line corresponds to $n_1 = 3$ and $n_2 = 5$.

(i) Calculate the wavelength and frequency of this spectral line.

(ii) To which spectral series does this line belong?

(iii) In which region of the electromagnetic spectrum, will this line fall ?

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19. The wavelength of the first spectral line in the Balmer series of hydrogen atom is $6561A^\circ$. The wavelength of the second spectral line in the Balmer series of singly - ionized helium atom is

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20. what are the frequency and wavelength of a photon emitted during a transition from n = 5 state to the n =2 state in the hydrogen atom?

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21. According to Bohr's theory , the electronic energy of hydrogen atom in the n^{th} Bohr's orbit is given by

$$E_n = \frac{-21.76 \times 10^{-19}}{n^2} J$$

Calculate the longest wavelength of electron from the third Bohr's orbit of the $He^{\oplus}$ ion

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22. (i) The energy associated with the first orbit in the hydrogen atom is $-2.17 \times 10^{18} Ja \to m^{-1}$. What is the energy associated with the fifth orbit?

(ii) Calculate the radius of Bohr's fifth orbit for hydrogen atom.

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23. Calculate the energy associated with the first orbit of He^{+} . What is the radius of this orbit?

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24. Radius of the fourth orbit in hydrogen atom is 0.85 nm. Calculate the velocity of the electron in this orbit (mass of electron $= 9.1 \times 10^{-31} kg$).

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25. The radius of first Bohr orbit of hydrogen atom is $0.529 Å$. Calculate the radii of (i) the third orbit of He^{+} ion and (ii) the second orbit of Li^{2+} ion.

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26. The ratio of radius of 2nd and 3rd Bohr orbit is

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27. The electronic energy of H atom is

$$E_n = -\frac{1.312 \times 10^6}{n^2} Jmol^{-1}$$

Calculate

(i) First excitation energy of the electron in the hydrogen atom.

(ii) Ionization energy of the hydrogen atom.

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28. The ionization energy of He^+ is $8.72 \times 10^{-18} J \text{atom}^{-1}$. Calculate the energy of first stationary state of Li^{2+}.

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29. A tennis ball of mass $6.0x10^{-2}kg$ is moving with a speed of $62ms^{-1}$. Calculate the wavelength associated with this moving tennis ball. Will the movement of this ball exhibit a wave character?

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30. Which of the following should be the wavelength of an electron if its mass is $9.1 \times 10^{-31} kg$ and its velocity is $1/10$ of that of light and the value of h is 6.6252×10^{-24} joule second?

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31. Calculate the wavelength of an electron moving with a velocity fo $2.05 \times 10^{7} ms^{-1}$.

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32. Calculate the mass of a photon of sodium light having wavelength $5894Å$ and velocity $3 \times 10^{8} ms^{-1}$. $\left(h = 6.6 \times 10^{-34} kgm^{2} s^{-1}\right)$

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33. A beam of helium atoms moves with a velocity of $2 \times 10^3 ms^{-1}$. Find the wavelength associated with helium atoms.

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34. Two particles A and B are in motion. If the wavelength associated with particle A is $5 \times 10^{-8} m$, calculate the wavelength associated with particle B if its momentum is half of A.

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35. If the velocity of the electron in Bohr's first orbit is $2.19 \times 10^6 ms^{-1}$, calculate the de Broglie wavelength associated with it.

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36. An electron is moving with a kinetic energy of $2.275 \times 10^{25} J$. Calculate its de-Broglie wavelength. (Mass of electron = $9.1 \times 10^{-31} kg, h = 6.6 \times 10^{-34} Js$)

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37. Calculate the kinetic energy of a moving electron which has wavelength of 4.8 pm.

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38. Calculate the wavelength of an electron that has been accelerated in a particle acceleratior through a potential difference of 100 million volts. $\left(1eV = 1.6 \times 10^{-19} C, m_e = 9.1 \times 10^{-31} kg, h = 6.6 \times 10^{-34} Js\right)$.

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39. The mass of an electron is $9.1 \times 10^{-31} kg$. If its kinetic energy is $3.0 \times 10^{25} J$, calculate its wavelength.

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40. Calculate the uncertainty in position of an electron if the uncertainty in its velocity is $5.7 \times 10^{5} ms^{-1}$, $h = 6.6 \times 10^{-34} kgm^{2} s^{-1}$ mass of electron $= 9.1 \times 10^{-31} kg$

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41. Calculate the uncertainty in the velocity of al wagon of mass 2000 kg whose positions is known to an accuracy of $\pm 10m$.

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42. On the basis of Heisenbergs uncertainty principle show that the electron cannot exist within the nucleus.

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43. Calculate the uncertainty in the position of an electron if uncertainty in its velocity is (i) 0.001 % (ii) Zero.

(The mass of electron $= 9.1 \times 10^{-31} kg$, velocity of electron = $300 ms^{-1}$)

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44. An electron has a speed of 500m s^{-1} with uncertainty of 0.02% . What is the uncertainty in locating its position ?

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45. A golf ball has a mass of $40g$ and a speed of $45m/s$. If the speed can be measured within accuracy of 2%, calculate the uncertainty in the position.

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46. If the position of the electron is measured within an accuracy of $\pm 0.02nm$, calculate the uncertainty in the momentum of the electron. If suppose the momentum of the electron is

$$\frac{h}{4\pi \times 0.05nm}$$

is there any problem in defining this value?

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47. (a) If the quantum number 'l' has value of 2, what are permitted values of the quantum number m_l ?

(b) An atomic orbital has n = 3, what are the possible values of l ?

(c) An atomic orbital has l = 3, what are the possible values of m_l ?

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48. List all the values of l and m_1 for $n = 2$.

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49. Using the s,p,d notations, describe the orbital with the following quantum numbers :

$(a) n = 1, l = 0$ $(b) n = 3, l = 2$

$(c) n = 3, l = 1$ $(d) n = 2, l = 1$

$(e) n = 4, l = 3$ $(f) n = 4, l = 2.$

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50. Point out the followings:

(a) How many energy subshells are pssible in $n = 3$ level ?

(b) How many orbitals of all kinds are possible in $n = 3$ level ?

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51. Explain given reasons, which of the following sets of quantum numbers are not possible.

$(a) n = 0, \quad l = 0, \quad m_l = 0, \quad m_s = +1/2$

$(b) n = 1, \quad l = 0, \quad m_l = 0, \quad m_s = -1/2$

$(c) n = 1, \quad l = 1, \quad m_l = -0, \quad m_s = +1/2$

$(d) n = 2, \quad l = 1, \quad m_l = 0, \quad m_s = -1/2$

$(e) n = 3, \quad l = 3, \quad m_l = -3, \quad m_s = +1/2$

$(f) n = 3, \quad l = 2, \quad m_l = 0, \quad m_s = +1/2$

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52. Which of the following are isoelectronic species, i.e., those having the same number of electrons:

$Na^{\oplus}, K^{\oplus}, Mg^{2+}, Ca^{2+}, S^{2-}, Ar$

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53. Write the electronic configuration of elements of atomic numbers 10, 17, 25, 29 and 37 .

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54. How many unpaired electrons are present in the ground state of (i) $P(Z=15)$ (ii) $Fe^{2+}(Z=26)$ (iii) $Cl^{-}(Z=17)$?

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55. What atoms are indicated by the following cofiguration? Are they in the ground state or excited state ?

(a) $1s^2 2s^2 2p_x^2 2p_y^2 2p_z^1$

(b) $1s^2 2s^1 2p_x^1 2p_y^1 2p_z^1$

(c) $1s^2 2s^2 2p^6 3s^2 3p_x^1 3p_y^1$

(d) $1s^2 2s^2 2p^6 3s^1 3p_x^1 3p_y^1 3p_z^1 3d^1$

(e) $[Ar]3d^5 4s^2$

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56. Give the symbol of the atom whose ground state corresponds to each of the following configurations :

$(i) 1s^2 2s^2 2p^6 3s^2 3p^6$

Give two examples of negative and two positive ions corresponding to the above configurations.

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57. Write the electronic configuration of the following ions:

$(i) H^- \quad (ii) Na^+ \quad (iii) O^{2-} \quad (iv) F^-.$

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58. The quantum numbers of six elements are given below. Arrange them in order of increasing energies. If any of these combinations has/have the

same energies, list them.

$(1) n = 4, \quad l = 2, \quad m_l = -2, \quad m_s = -\frac{1}{2}$

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

$(3) n = 4, \quad l = 1, \quad m_l = 0, \quad m_s = +\frac{1}{2}$

$(4) n = 3, \quad l = 2, \quad m_l = -2, \quad m_s = -\frac{1}{2}$

$(5) n = 3, \quad l = 1, \quad m_l = -1, \quad m_s = +\frac{1}{2}$

$(6) n = 4, \quad l = 1, \quad m_l = 0, \quad m_s = +\frac{1}{2}$

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59. Indicate the number of unpaired electrons is

$(i) P (ii) Si (iii) Cr (iv) Fe (v) Kr.$

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60. Which of the following do and which do not make sense ?

$7p, 2d, 3s^3, 3p_y^3, 4f.$

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61. An atom has a electrons in the first (K) shell, 8 electrons in the second (L) shell and 2 electrons in the third (M) shell . Give its electronic configuration and find out the following:

(a) Atomic number

(b) Total number of principal quantum numbers

(c) Total number of sublevels

(d) Total number of s-orbitals

(e) Total number of p-electrons.

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62. What is the maximum number of unpaired electrons in $Cu(Z=29)$, $Br^{-}(Z=35)$ and $K^{+}(Z=19)$?

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Practice Problems

1. How many protons and neutrons are present in the following nuclei ?

$(i)\,{}^{12}_{6}C \qquad (ii)\,{}^{56}_{26}Fe$

$(iii)\,{}^{88}_{38}Sr \qquad (iv)\,{}^{238}_{92}U.$

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2. An atom having mass number 13 has 7 neutrons. What is the atomic number of the atom.

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3. Neutrons are found in atoms of all elements except in

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4. What is the relationship between the following atoms of strontium ?

${}^{87}_{38}Sr$ and ${}^{90}_{38}Sr$

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5. How many electrons, protons and neutrons are present in each of the following ?

$(i)^{137}_{56}Ba^{2+}$ $(ii)^{19}_{9}F^{-}$ $(iii)^{226}_{88}Ra.$

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6. From the following nuclei select the isotopes and isobars :

$^{238}_{92}U, ^{234}_{90}Th, ^{234}_{92}U, ^{234}_{91}Pa$.

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7. An isotope of $^{112}_{50}Sn$ contains 68 neutrons. What will be its mass number?

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8. Species X with mass number 37 contains 11.1 % more neutrons as compared to electrons , then what is the incorrect representation of element x?

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9. The wavelength of a spectral line of cesium is 460 nm. Calculate the frequency of the line.

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10. A certain radio station broadcasts on a frequency of $980kHz$ (kilohertz). What is the wavelength of electromagnetic radiation broadcasts by the radio station ?

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11. Calculate the wave number of radiations having a frequency of $4 \times 10^{-11} kHz$.

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12. Calculate the frequency and wave number of radiations with wavelength 480 nm.

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13. Calculate (a) Wavenumber and (b) frequency of yellow radiation having wavelength $5800 A^{\circ}$.

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14. The wavelength of a beam of light is $25.0 \mu m$. What is its frequency and wave number ?

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15. Find energy of each of the photons which

a. correspond to light of frequency $3 \times 10^{15} Hz$.

b. have wavelength of 0.50Å.

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16. Calculate the energy of one of the photons of a beam of light having wavelength $25.0 \mu m$.

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17. The photons of light having a wavelength 4000Å are necessary to provide $1.00 J$ of energy are.

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18. A photochemical reaction requires $9.6 \times 10^{-16} J$ energy per molecule of light with wavelength 250 nm that is just sufficient to intiate the reaction.

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19. the threashold frequency v_0 for a metal is $7 \times 10^{14} s^{-1}$. Calculate the kinetic energy of an electron emitted when radiation of fequency $v = 1.0 \times 10^{15} s^{-1}$ hits the metal .

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20. Electrons are emitted with zero velocity from a metal surface when it is exposed to radiation of wavelength 6800 Å . Calculate threshold frequency (v_0) and work function (W_0) of the metal.

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21. The first line in Balmer series corresponds to $n_1 = 2$ and $n_2 = 3$ and the limiting line corresponds to $n_1 = 2$ and $n_2 = \infty$. Calculate the wavelengths of the first and limiting lines in Balmer series.

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22. Calculate the wavelength of spectral line in Lyman series corresponding to $n_2 = 3$.

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23. Calculate the wavelength and energy of radiation emitted for the electron transition from infinite (∞) to first stationary state of the hydrogen atom.

$R = 1.0967 \times 10^7 m^{-1}, h = 6.6256 \times 10^{-34} Js$ and $c = 2.979 \times 10^8 ms^{-1}$

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24. Calculate the wave number for the longest wavelength transition in the Balmer series fo atomic hydrogen . $\left(R_H = 109677 cm^{-1}\right)$.

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25. What is the minimum number of emission lines when the excited electron of a H atom in n = 6 drops to the ground state?

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26. The energy difference between two electronic states is 399.1 kJ mol^{-1}. Calculate the wavelength and frequency of light emitted when an electron drops from a higher to a lower state. (Planck's constant, $h = 3.98 \times 10^{-13} kJmol^{-1}$).

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27. How much energy is required to ionise a H - atom if the electron occupie $n = 5$ orbit ? Compare your answer with the ionization energy of H-atom (energy required to remove the electron from nth orbit).

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28. A light of wavelength 12818Å is emitted when the electron of a hydrogen atom drops from fifth to third quantum level. Find the wavelength of the photon emitted when electron falls from third to ground level.

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29. What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition $n = 4$ to $n = 2$ of $He^{\oplus}$ spectrum ?

A. Ionisation energy of hydrogen atom is 13.6 eV. What will be the ionisation energy of He^{+} and Li^{2+} ions?

B.

C.

D.

Answer: $n = 2$ **to** $n = 1$

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30. The ionisation energy of H atom is 13.6 eV. What will be the ionisation energy of $He^{\oplus}$ and Li^{2+} ions ?

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31. What is the energy in joules required to shift the elertcon of the hydrogen atom from the first Bohr orbit to the fifth Bohr orbit ? And what is the wavelenght of the light emitted when the electron returns to the ground state ? The ground state electron energy is -218×10^{-11} erg.

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32. Calculate the wave number for the longest wavelength transition in the Balmer series fo atomic hydrogen . $\left(R_H = 109677 cm^{-1}\right)$.

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33. The electron energy in hydrogen atom is given by $E_n = \left(-2.18 \times 10^{-18}\right)/n^2 J$. Calculate the energy required to remove an electron completely from the $n = 2$ orbit. What is the longest wavelength of light in cm that can be used to cause this transition?

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34. what will be the wavelength of a ball of mass 0.1 kg moving with a velocity of $10 ms^{-1}$?

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35. calculate the mass of a photon with wavelength 3.6 A

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36. Calculate the momentum of a particle which has de Broglie wavelength of 0.1 nm.

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37. Calculate the kinetic energy of an α- particle which has a wavelength of 12 pm.

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38. The velocity associated with a proton moving in a potential difference of $1000V$ is $4.37 \times 10^{-5} ms^{-1}$. If the hockey ball of mass 0.1 kg is moving with the velocity, calcuate the wavelength associated with this.

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39. What accelerating potential is needed to produce an electron beam with an effecive wavelength of 0.090Å

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40. Calculate the de-Broglie wavelength of an electron that has been accelerated from rest through a potential difference of 1 kV.

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41. The kinetic energy of a subatomic particle is $5.85 \times 10^{-25} J$. Calculate the frequency of the particle wave.

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42. What must be the velocity of a beam of electrons if they are to display a de-Broglie wavelength of 100Å ?

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43. Calculate the wavelength associated with a moving electron having kinetic energy of $1.375 \times 10^{-25} J.$ (mass of $e = 9.1 \times 10^{-31} kg, h = 6.63 \times 10^{-34} kgm^2 s^{-1}$).

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44. A microscope using suitable photons is employed to locate an electron in an atom within a distance of 0.1 Ã.... What is the uncertainty involved in the measurement of its velocity ?

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45. Table-tennis ball has mass 10g and s peed of 90m/s. if speed can be meausred within an accuracy of 4%. What will be the uncertainly in speed and position?

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46. Calculate the minimum uncertainty in velocity of a particle of mass $1.1 \times 10^{-27} kg$ if uncertainty in its position is $3 \times 10^{-10} cm$.

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47. The uncertainty in the position and velocity of a particle are 10^{-10} m and $5.27 \times 10^{-24} ms^{-1}$ respectively. Calculate the mass of the particle.

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48. A proton is accelerated to one tenth of the velocity of light. If its velocity can be measured with a precision $-\pm 1\,\%$. What must be its uncertainty in position?

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49. A proton is accelerated to one tenth of velocity of light. If the velocity can be measured with a precision of $\pm 0.5\,\%$, what must be the uncertainty in its position ? $\left(m_p = 1.675 \times 10^{-27} kg\right)$.

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50. Give all possible values of l, m_l and m_s for electrons when $n = 3$.

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51. How many electrons in a given atom can have the following quantum numbers ?

$(a) n = 3, l = 1 (b) n = 3, l = 2, m_l = 0 (c) n = 3, l = 2, m_l = +2, m_s =$

.

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52. If the principal quantum has a value of 3, what are the permitted values of the quantum number l?

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53. a. An atomic orbital has $n = 3$. What are the possible values of l and m?

b. List the quantum numbers $(m \text{ and } l)$ of electrons for $3d$ orbital.

c. Which of the following orbitals are possible" $1p$, $2s$, $2p$, and $3f$?

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54. How many unpaired electrons does a gaseous atom of phosphorus, P, have in its ground state?

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55. Name the elements which corresponds to each other the following configuration :

(a) $1s^2 2s^2 2p_x^2 2p_y^1 2p_z^1$

(b) $1s^2 2s^2 2p^2 3s^2 3p_x^1$

(c) $1s^2 2s^2 2p^2 3s^2 3p^6 4s^1$

(d) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$.

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56. List the values of n and l for the following orbitals:

(a) 3s (b) 4p (c) 4f (d) 3d

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57. The correct set of four quantum numbers for the outermost electron of sodium (Z = 11) is

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58. What is the maximum number of electron that may be present in all the atomic orbitals with principal quantum number 3 and azimuthal quantum number2?

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59. Write down the values of all the quantum numbers for 19 th electron of $Cr(Z = 24)$.

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60. How many electrons in zinc $(Z = 30)$ have $n + l$ value equal to 4 ?

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61. Write the electronic configuration of chromium (Z = 24) and predict in it

(i) number of subshells

(ii) number of electrons in subshell having l = 0

(iii) number of electrons having $n + l$ value equal to 3

(iv) number of electrons in highest value of n.

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62. How many electrons in p-subshell of argon (Z = 18) have same spin ?

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Conceptual Questions 1

1. What is the difference between a proton and a photon?

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2. Define wave length , frequency and wave number. How is frequency related to wave number ?

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3. Bohr's orbit are calledx stationary state because

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4. Which one of the series of hydrogen spectrum is in the visible region ?

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5. The third in Balmer series corresponds to an electronic transition between which Bohr's orbits in hydrogen

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6. If the energy of an electron in the second Bohr orbit of H-atom is -E, what is the energy of the electron in the Bohr's first orbit?

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7. What do you mean by saying that energy of the electron is quantized ?

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8. The magnitude of charge on the electron is 4.8×10^{-10} e.s.u. What is the charge on the nucleus of a helium atom?

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9. Which of the following relates to photon both as wave motion and as a stream of particles ?

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10. Which transitions between Bohr orbits corresponds to

(i) second line in the Balmer series and (ii) first line in Brackettt series of the hydrogen spectrum ?

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11. Arrange the following type of radiations in increasing order of frequency: (a) radiation from microwave oven (b) amber light from traffic signal (c). radiation from FM radio (d) cosmic rays from outer space and (e) X-rays

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12. Wavelength of different ra diations are given below.

λ (A) $= 300nm\lambda$ (B) =300 $\mu m\lambda$ (C) $= 3nm\lambda$ (D)=$30\overset{\circ}{A}$

Arrange these radiations in the increasing order of their energies.

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13. What is the main difference between electromagnetic wave theory and Planck's quantum theory ?

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14. The energy of the electron in the ground state of H-atom is $-13.6eV$. The energy of the first excited state will be

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15. In a given electric field , the β -particles are deflected more than the α -particles in spite of the α- particle having a larger charge.

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16. What are nucleous ?

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17. X-rays, gamma rays and microwaves travelling in vacuum have

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Conceptual Questions 2

1. What will happen to the wavelength associated with a moving particles if its velocity is reduced to half ?

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2. Can we apply Heisenberg's uncertainty principle to a stationary state ?

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3. An electron beam after hitting a nicket crystal produces a diffraction pattern. What do you conclude ?

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4. A molecule of O_2 and O_3 travel with the same velocity. What is the rates of their wavelength ?

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5. What is the sequence of energies of 4s, 4p, 4d and 4f-orbitals in (i) a hydrogen atom and (ii) a zinc atom ?

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6. Which shell would be the first to have g sub-shell ?

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7. The 4f subshell of an atom contains 12 electrons. What is the maximum number of electrons having same spin in it ?

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8. Which of the following sets of quantum number for orbitals in hydrogen atom has a greater energy of electrons ?

a. $n = 3, l = 2, m = +1$ b. $n = 3, l = 2,$ and $m = -1$

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9. The number of nodes in $3p$ orbital

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10. What is the difference in the angular momentum of an electron present in 2p and that present in 3p-orbital /

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11. What will be the maximum number of electrons having the same spin in an atom with $n + l = 4$?

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12. How many spherical nodes are present in $4s$ orbital in a hydrogen atom ?

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13. The maximum number of electron that can be accommodated in 4^{th} shell is.

(a). 8

(b). 16

(c). 32

(d). 50

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14. How many quantum number are needed in designate an orbital ? Name them

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15. The four quantum number of the valence electron of potassium are.

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16. The orbital angular momentum of an electron in $2s$ orbital is

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17. How many unpaired electrons does a gaseous atom of phosphorus, P, have in its ground state?

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18. In what ways do the spatial distribution of the orbitals in 1s and 2s differ ?

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19. Explain the meaning of the symbol $4d^6$.

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20. Total number of nodes present in 4d-orbitals will be:

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21. What is the lowest shell which has an f-subshell?

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22. Name the quantum number which does not follow from the solution of Schrodinger wave equation ?

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23. What is the angular momentum of 5th orbit according to Bohr's theory ?

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24. How are d^{xy} and $d_{x^2-y^2}$ orbitals related to each other ?

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25. How many electrons can be filled in all the orbitals with $n+l=5$?

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26. Write n, l and m_l values for

$(i)3s(ii)2p_y$, $(iii)4p_z$

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27. d_{z^2} orbital has zero electron density in xy-plane. Comment.

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28. Match the quantum numbers with the information provided by these.

	Quantum number		Information provided
(a)	Principal quantum number	(i)	orientation of the orbital
(b)	Azimuthal quantum number	(ii)	energy and size of orbital
(c)	Magnetic quantum number	(iii)	spin of electron
(d)	Spin quantum number	(iv)	Shape of the orbital

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29. What physical meaning is attributed meaning is attributed to the square of the absolute value of wave function $|\Psi^2|$?

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30. Discuss the similarities and differences between a 1s and 2s orbital.

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31. What is the difference between the notations l and L ?

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32. How many electrons in an atom may have the following quantum number ?

$(i) n = 4, m_s = +1/2 \qquad (ii) n = 3, l = 0$

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33. For each of the following pair of hydrogen orbitals, indicate which is higher in erergy :

$(i) 1s, 2s \qquad (ii) 2p, 3p$

$(iii) 3d_{xy}, 3d_{yz} \qquad (iv) 3s, 3d$

$(v) 4f, 5s.$

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34. Which orbital in each of the following pairs is lower in energy in a many electron atom?

$(i) 2s, 2p$ $(ii) 3p, 3d$

$(iii) 3s, 4s$ $(iv) 4d, 5f$

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35. Nickel atom can lose two electrons to form Ni^{2+} ion. The atomic number of nickel is 28. From which orbital will nickel lose two electrons?

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36. Which of the following orbitals are degernate?

$3d_{xy}, 4d_{xy}, 3d_{z^2}, 3d_{yz}, 4d_{yz}, 4d_{z2}$

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37. Calculate the total number of angular nodes and radical nodes present in 3p orbital.

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38. The arrangement of orbitals on the basis of energy is based upon their (n+l) value. Lower the value of (n+l), lower is the energy . For orbitals having same values of (n+l). The orbital with lower value of n will have lower energy.

I. Based upon the baove information arrange the following orbitals in the increasing order of energy.

(a) 1s,2s,3s,2p (b) 4s,3s,3p,4d

(c) 25p,4d,5d,4f,6s (d) 5f,6d,7s,7p

II. Based upon the above information Solve the question. give below.

(a) hich of the following orbitals has the lowest energy

$4d, 4f, 5s, 5p$

(b) which of the following orbitals has the higher energy?

$5p, 5d, 5f, 6s, 6p$

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Advanced Level Problems

1. When a certain metal was irradiated with light of frequency $3.2 \times 10^{16} s^{-1}$ the photoelectrons emitted had twice the KE as did photoelectrons emitted when the same metal was irradiated with light of frequency$2.0 \times 10^{16} s^{-1}$. Calculate the thereshold frequency of the metal.

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2. Calculate the wavelength emitted during the transition of an electron in between two level of Li^{2+} ion whose sum is 4 and difference is 2.

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3. The angular momentum of electron in a Bohr's orbit of H atom is $4.2178 \times 10^{-34} kgm^2 s^{-1}$. Calculate the wavelength of the spectral line when the electrton falls from this level to the next lower level.

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4. Calculate the ratio of wavelenth of first spectral line of Lyman and Balmer series of hydrogen spectrum.

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5. Calculate frequency, energy and wavelength of the radiation corresponding to the speciral line of the lowest frequency in lyman series in the spectrum of a hydrogen atom .Also calculate the energy for the coresponding line in the spectrum of Li^{2+}. $\left(R_H = 109677 cm^{-1}, c = 3 \times 10^8 ms^{-1}, Z = 3\right)$

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6. Calculate the Rydberg constant R_H if He^+ ions are known to have the wavelength difference between the from (of the longest wavength) lines fo Balmer and Lyman series equal to $133.7 nm$.

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7. Which energy level in Li^{2+} has same energy as the fourth energy level of hydrogen atom?

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8. Energy of an electron in hydrogen atom is given as :

$$E_n = -\frac{2\pi^2 me^4}{n^2h^2} = -\frac{1.312 \times 10^6}{n^2} Jmol^{-1}$$

(i) Calculate the ionisation energy of H-atom.

(ii) Compare the shortest wavelength emitted by hydrogen atom and He^+ ion.

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9. When would wavelength associated with an electron become equal to the wavelength associated with a proton ?

$\left(m_e = 9.1095 \times 10^{-28} g \text{ and } m_p = 1.6725 \times 10^{-24} g\right).$

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10. Calculate the ratio between the wavelength of an electron and a proton, if the proton is moving at half the velocity of the electron (mass of the proton $= 1.67 \times 10^{-27} kg$, mass of the electron $= 9.11 \times 10^{-2} m$.

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11. Find out the number of waves made by a Bohr's electron in one complete revolution in its $3rd$ orbit.

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12. An electron in H-atom in its ground state absorbs 1.5 times as much energy as the minimum required for its escape (i. e., 13 . 6 eV) from the atom . Calculate the wavelength of emitted electron.

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Ncert File Solved Text Book Exercises

1. (i) Calculate the number of electrons which will together with one gram

.

(ii) Calculate the mass and charge on one mole of electrons .

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2. (i) Calculate the total number of electrons present in one mole of methane.

(ii) Find (a) the total number and (b) the total mass of neutrons in $7mg$ of ^{14}C. (Assume that mass of a neutron = $1.675 \times 10^{-27} kg$).

(iii) Find (a) the total number and (b) the total mass of protons in $34kg$ of NH_3 at STP.

Will the answer change if the temperature and pressure are changed?

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3. How many neutrons and protons are there in the following nuclei ?

$^{13}_{6}C, ^{16}_{8}C, ^{24}_{12}Mg, ^{26}_{12}Mg, ^{56}_{26}Fe, ^{88}_{38}Sr.$

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4. Write the complete symbol for the atom with the given atomic number (Z) and atomic mass (A).

a. $Z = 17, A = 35,$

b. $Z = 92, A = 233,$

c. $Z = 4, A = 9$

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5. Yellow light emitted from a sodium lamp has a wavelength (λ) of $580nm$. Calculate the frequency (v). Wave number and energy of yellow light photon .

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6. Find energy of each of the photons which

a. correspond to light of frequency $3 \times 10^{15} Hz$.

b. have wavelength of $0.50 Å$.

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7. Calculate the wavelength, frequency, and wave number of a light wave whose period is $2.0 \times 10^{-10} s$.

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8. what is the number of photons of light with a wavelength of 4000 pm that provide 1 J of energy ?

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9. A photon of wavelength $4 \times 10^{-7} m$ strikes on metal surface , the work function fo the metal being $2.13 eV$ Calculate :

(i) the energy of the photon (ev)

(ii) the kinetic energy fo the emission and

the velocity fo the photoelectron $\left(1 eV = 1,6020 \times 10^{-19} J\right)$,

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10. Electromagnetic radiation of wavelength 242 nm is just sufficient to ionise the sodium atom . Calculate the ionisation energy of sodium in kJ mol^{-1}.

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11. A 25 watt bulb emits monochromatic yellow light of wavelength of 0.57μ m. Calculate the rate of emission of quanta per second .

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12. Electrons are emitted with zero velocity from a metal surface when it is exposed to radiation of wavelength 6800 Å . Calculate threshold frequency (v_0) and work function (W_0) of the metal.

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13. what is the wavelength of light emitted when the electron in a hydrogen atom undergoes transition from an energy level with n=4 to and energy level with n=2 ?

$(e) \quad n = 3 \quad l = 3 \quad m_1 = -3 \quad m_s = +1/2$

$(f) \quad n = 3 \quad l = 1 \quad m_1 = 0 \quad m_s = +1/2$

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14. How much energy is required to ionise a H - atom if the electron occupie $n = 5$ orbit ? Compare your answer with the ionization energy of H-atom (energy required to remove the electron from nth orbit).

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15. What is the maximum number of emission lines when the excited electron of a H atom in $n = 6$ drop to the ground state?

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16. a. The energy associated with the first orbit in the hydrogen atom is $-2.18 \times 10^{-18} J \text{atom}^{-1}$. What is the energy associated with the fifth orbit?

b. Calculate the radius of Bohr's fifth orbit for hydrogen atom.

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17. Calculate the wave number for the longest wavelength transition in the Balmer series fo atomic hydrogen . $\left(R_H = 109677 cm^{-1}\right)$.

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18. What is the energy in joules required to shift the elertcon of the hydrogen atom from the first Bohr orbit to the fifth Bohr orbit ? And what is the wavelenght of the light emitted when the electron returns to the ground state ? The ground state electron energy is -218×10^{-11} erg.

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19. The electron energy in hydrogen atom is given by $E_n = \left(-2.18 \times 10^{-18}\right)/n^2 J$. Calculate the energy required to remove an electron completely from the $n = 2$ orbit. What is the longest wavelength of light in cm that can be used to cause this transition?

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20. Calculate the wavelength of an electron moving with a velocity fo $2.05 \times 10^7 ms^{-1}$.

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21. The mass of an electron is $9.1 \times 10^{-31} kg$. If its K.E. is $3.0 \times 10^{-25} J$, calculate its wavelength

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22. Which of the following are isoelectronic species, i.e., those having the same number of electrons:

$Na^{\oplus}, K^{\oplus}, Mg^{2+}, Ca^{2+}, S^{2-}, Ar$

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23. i. Write the electronic conifigurations of the following ions:

a. H^{Θ}, b. $Na^{\oplus}$, c. O^{2-}, d. F^{Θ}

ii. What are the atomic numbers of elements whose outermost electrons are represented by

a. $3s^1$, b. $2p^3$, c. $3p^5$?

iii. Which atoms are indicated by the following configurations?

a. $[He]2s^1$, b. $[Ne]3s^23p^3$, c. $[Ar]4s^23d^1$

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24. What is the lowest value of n that allows g orbitals to exist?

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25. An electron is in one of the $3d$ orbitals. Give the possible values of $n, l,$ and m for this electron.

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26. An atom of an element contains 29 electrons and 35 neutrons. Deduce

a. The number of protons and

b. The elctonic configuration of the element.

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27. Give the number of electrons in the species H_2^+, H_2 and O_2^+.

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28. a. An atomic orbital has $n = 3$. What are the possible values of l and m?

b. List the quantum numbers $(m \text{ and } l)$ of electrons for $3d$ orbital.

c. Which of the following orbitals are possible" $1p$, $2s$, $2p$, and $3f$?

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29. Using s, p, d notations, descibe the orbital with the following quantum numbers.

a. $n = 1, l = 0$, b. $n = 3, l = 1$

c. $n = 4, l = 2$, d. $n = 4, l = 3$

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30. From the following sets of quantum numbers, state which are possible. Explain why the others are not possible.

(i) $n = 0, l = 0, m_l = 0, m_s = +1/2$ (ii)

$n = 1, l = 0, m_l = 0, m_s = -1/2$

(iii) $n = 1, l = 1, m_l = 0, m_s = +1/2$ (iv)

$n = 1, l = 0, m_l = +1, m_s = +1/2$

(v) $n = 3, l = 3, m_l = -3, m_s = +1/2$ (vi)

$n = 3, l = 1, m_l = 0, m_s = +1/2$

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31. How many electron in an atom may have the following quantum number ?

a. $n = 4, m_s = -\frac{1}{2}$

b. $n = 3, l = 0$

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32. Show that the circumference of the Bohr orbit for the hydrogen atom is an integral multiple of the de Broglie wavelength associated with the electron revolving around the orbit.

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33. What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition $n = 4$ to $n = 2$ of $He^{\oplus}$ spectrum ?

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34. Calcultte the enrgy required for the process ,

$He^{+}(g) \rightarrow He^{2+}(g) + e$

The ionization energy for the H-atom in the grounds state is $2.18 \times 10^{-18} J \text{atom}^{-1}$.

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35. If the diameter of a carbon atom is $0.15nm$, calculate the number of carbon atom which can be placed side by side in a straight line length of scale of length $20cm$ long.

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36. 2×10^8 atoms of carbon are arranged side by side. Calculate the radius of carbon atom if the length of this arrangement is $2.4cm$.

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37. The diameter of zinc atom is $2.6A$. Calculate (a) radius of zinc atom in pm and (b) number of atoms present in a length of $1.6cm$ if the zinc atoms are arranged side by side lengthwise.

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38. A certain particle carries $2.5 \times 10^{-16} C$ of static electric charge. Calculate the number of electrons present in it.

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39. In Milikan's experiment, static electrons charge on the oil drops has been obtained by shining X-rays. If the static electric charge on the oil drop is $-1.282 \times 10^{-18} C$, calculate the number of electrons present on it.

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40. In Rutherford's experiment, generally the thin foil of heavy atoms, such as gold, platinum, etc. have been used to be bombarded by the α-particles. If the thin foil of light atoms such as aluminium atc. Is used, what difference would be observed form the above results?

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41. symbols $._{35}^{79}Br$ and ^{79}Br can be writtem whereas symbols $._{79}^{35}Br$ and ^{35}Br ar not acceptable. Answer briefly.

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42. An element with mass number 81 contains $31.7\,\%$ more neutrons as compared to protons. Assign the atomic symbol.

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43. Species X with mass number 37 contains 11.1 % more neutrons as compared to electrons , then what is the incorrect representation of element x?

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44. An ion with mass number 56 contains 3 units of positive charge and $30.4\,\%$ more neutrons then electrons. Assign the symbol to this ion.

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45. Arrange the following type of radiations in increasing order of frequency: (a) radiation from microwave oven (b) amber light from traffic signal (c). radiation from FM radio (d) cosmic rays from outer space and (e) X-rays

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46. Nitrogen laser produces a radiation at a wavelength of 337.1 nm. If the number of photons emitted per second is 5.6×10^{24}, calculate the power of this laser.

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47. Neon gas is generally used in the sign boards. If it emits strongly at $616nm$, calculate

a. The frequency of emission,

b. The distance travelled by this radiation in $30s$

c. The energy of quantum and

d. The number of quanta present if it produces $2J$ of energy.

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48. In astronomical observations, signals observed from the distant stars are generally weak. If the photon detector receives a total of $3.15 \times 10^{-18}J$ from the radiations of $600nm$, calculate the number of photons received by the detector.

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49. Lifetimes of the molecules in the excited states are often measured by using pulsed radiation source of duration nearly in the nano second

range. If the radiation source has the duration of 2 ns and the number of photons emitted during the pulse is 2.5×10^{15}, calculate the energy of the source.

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50. The longest wavelength doublet absorption is observed at 589 and $589.6nm$. Caiculate the frequency of each transition and energy difference between two excited states.

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51. The work function for caesium atom is $1.9eV$. Calculate (a) the threshold wavelength and (b) the threshold frequency of the radiation. If the caesium element is irradiated with a wavelength $500nm$, calculate the kinetic energy and the velocity of the ejected photoelectron.

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52. Following results are observed when sodium metal is irradiated with different wavelengths. Calculate (a) threshold wavelength and (b) Planck's constant.

$\lambda(nm)$	500	450	400
$v \times 10^{-5}\left(cms^{-1}\right)$	2.55	4.35	5.20

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53. The ejection of the photoelectron from the silver metal in the photoelectric effect exeriment can be stopped by applying the voltage of $0.35V$ when the radiation $256.7nm$ is used. Calculate the work function for silver metal.

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54. If the photon of the wavelength $150pm$ strikes an atom and one of its inner bound electrons is ejected out with a velocity of $1.5 \times 10^{7}ms^{-1}$, calculate the energy with which it is bound to the nucleus.

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55. Emission transitions in the Paschen series end at orbit $n = 3$ and start from orbit n and can be represented as $v = 3.29 \times 10^{15}(Hz)\left[1/3^2 - 1/n^2\right]$. Calculate the value of n if the transition is observed at 1285 nm. Find the region of the spectrum.

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56. Calculate the wavelength for the emission transition if it starts from the orbit having radius $1.3225nm$ ends at $211.6pm$. Name the series to which this transition belongs and the region of the spectrum.

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57. Dual behaviour of matter proposed by de Broglie led to the discovery of electron microscope often used for the highly magnified images of biological molecules and other type of material. If the velocity of the

electron in this microcope is $1.6 \times 10^{6} ms^{-1}$. Calculate de Broglie wavelength associated with this electron.

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58. Similar to electron diffraction, neutron diffraction microscope is also used for the determination of the structure of molecules. If the wavelength used here is $800pm$, calculate the characteristic velocity associated with the neutron.

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59. If the velocity of the electron in Bohr's first orbit is $2.19 \times 10^{6} ms^{-1}$, calculate the de Broglie wavelength associated with it.

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60. The velocity associated with a proton moving in a potential difference of $1000V$ is $4.37 \times 10^5 ms^{-1}$. If the hockey ball of mass $0.1kg$ is moving with this velocity, calculate the wavelength associated with this velocity.

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61. If the position of the electron is measured within an accuracy of $\pm 0.02nm$, calculate the uncertainty in the momentum of the electron. If suppose the momentum of the electron is

$$\frac{h}{4\pi \times 0.05nm}$$

is there any problem in defining this value.

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62. The quantum numbers of six electrons are given below. Arrange them in order of increasing energies. If any of these combination(s) has/have the same energy lists:

1. $n = 4, l = 2, m_i = -2, m_s = -1/2$

2. $n = 3, l = 2, m_l = 1, m_s = +1/2$

3. $n = 4, l = 2, m_l = -2, m_s = -1/2$

4. $n = 3, l = 2, m_i = -1, m_s = +1/2$

5. $n = 3, l = 1, m_l = -1, m_s = +1/2$

$n = 4, l = 1, m_l = 0, m_s = +1/2$

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63. The bromine atom possesses $3s$ electrons. It contains six electrons in $2p$ orbitals, six electrons in $3p$ orbitals and five electrons in $4p$ orbitals. Which of these electrons experience the lower effective nuclear charge?

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64. Among the following pairs of orbital which orbital will experience the larger effective nuclear charge?

a. $2s$ and $3s$, b. $4d$ and $4f$, c. $3d$ and $3p$

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65. The unpaired electrons in Al and Si are present in $3p$ orbital. Which electrons will experience more effective nuclear charge from the nucleus?

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66. Indicate the number of unpaired electrons in:

a. P, b. Si, c. Cr,

d. Fe, e. Kr

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67. (a) How many sub-shells are associated wit n = 4 ? (b) How many electrons will be present in the sub-shell having m_s value of $1/2$ for $n = 4$?

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Ncert Exemplar Problems Multiple Choice Questions Type I

1. Which of the following conclusions could not be derived from Rutherford's α-particle scattering experiment?

A. Most of the space in the the atoms is empty

B. The radius of the atoms is about 10^{-10} m while that of nucleus is 10^{-15} m.

C. Electrons move in a circular path of fixed energy called orbits.

D. Electrons and the nucleus are held together by electrostatic forces of attraction.

Answer: C

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2. Which of the following options dose not represent electronic ground state of an atom ?

A. $1s^2 2s^2 2p^6 3p^6 3d^8 4s^2$

B. $1s^2 2s^2 2p^6 3p^6 3d^9 4s^2$

C. $1s^2 2s^2 2p^6 3p^6 3d^{10} 4s^2$

D. $1s^2 2s^2 2p^6 3p^6 3d^5 4s^2$

Answer: B

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3. The probabilty density plotes of 1s and 2s Orbitals are given in Fig. 1 :

The density of dots in a region represents the probabilty density of finding electrons in the region.

on the basis of above digram which of the following statements is incorrect?

A. 1s and 2s orbitals are sphericlal in shape .

B. The probabilty of finding the electron is maximum near the nucleus.

C. The probabiltyof finding the electron at a given distance is equal in all direction is equal in all directions .

D. The probabilty density of electrons for 2s orbital decreases uniformly as distance frome the nucleus increases .

Answer: D

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4. Which of the following statement is not correct about the characterstics of cathode rays

A. They start from the cathode and move towards the anode.

B. They travel in straight line in the absence of an external electrical or magnetic field.

C. Characteristics of cathode rays do not depend upon the material of electrodes in cathode ray tube.

D. Characteristics of cathode rays depends upon the nature of gas present in the cathode ray tube.

Answer: D

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5. Which of the following statements about the electron is incorrect?

A. It is a negatively charged particle

B. The mass of electron is equal to the mass of neutron

C. It is a basic constituent of all atoms

D. It is a constituent of cathode rays

Answer: B

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6. Which of the following properties of atom could be explained correctly by Thomson model of atom?

A. Overall neutrality of atom

B. Spectra of hydrogen atom

C. Position of electrons, protons and neutrons in atom.

D. Stability of atom.

Answer: A

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7. Two atoms are said to be isobars is

A. they have same atomic number but different mass number

B. they have same number of electrons but different number of neutrons

C. they have same number of neutrons but different number of electrons.

D. sum of the number of protons and neutrons is same but the number of protons is different.

Answer: D

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8. The number of radial nodes for 3p orbital is.....

A. 3

B. 4

C. 2

D. 1

Answer: D

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9. Number of angular nodes for 4d orbtial is.....

A. 4

B. 3

C. 2

D. 1

Answer: C

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10. Which of the following is responsible to rule out the existence of definite paths or trajectories of electrons?

A. Pauli exclusion principle

B. Heisenberg's uncertainty principle

C. Hund's rule of maximum multiplicity

D. Aufbau principle

Answer: B

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11. Total number of orbitals associated with thrid shell will be.....

A. 2

B. 9

C. 4

D. 3

Answer: C

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12. Orbital angular momentum depends on .....

A. l

B. n and l

C. n and m

D. m and s

Answer: A

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13. Chlorine exists in two isotopic forms $Cl-37$ and Cl-35 but its atomic mass is 35.5. this indicates the ratio of Cl-37 and Cl-35 is approximately

A. $1:2$

B. $1:1$

C. $1:3$

D. $3:1$

Answer: C

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14. The pair of ions having same electronic configuration is_____.

A. Cr^{3+}, Fe^{3+}

B. Fe^{3+}, Mn^{2+}

C. Fe^{3+}, Co^{3+}

D. Sc^{3+}, Cr^{3+}

Answer: B

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15. For the electrons of oxygen atom, which of the following statement is correct ?

A. Z_{eff} for an electron in a $2s$ orbital is the same as Z_{eff} for an electron in a $2p$ orbital.

B. An electron in the $2s$ orbital has the same energy as an electron in the $2p$ orbital

C. Z_{eff} for an electron in $1s$ orbital is the same as Z_{eff} for an electron in a $2s$ orbital.

D. The two electrons present in the 2s orbital have spin quantum numbers m_s but of opposite sign.

Answer: D

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16. If travelling at same speeds, which of the following mater waves have the shortest wavelength?

A. Electron

B. Alpha particle $\left(He^{2+}\right)$

C. Neutron

D. Proton

Answer: B

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Ncert Exemplar Problems Multiple Choice Questions Type Ii

1. Identify the paris which are not of isotopes?

A. ${}_{6}^{12}X, {}_{6}^{13}Y$

B. ${}_{17}^{35}X, {}_{17}^{87}Y$

C. ${}_{6}^{14}X, {}_{7}^{14}Y$

D. ${}_{4}^{8}X, {}_{5}^{8}Y$

Answer: C::D

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2. Out of the folowing paris of electorns, identify the pairs of electrons present in degenrate orbitals.

A. (i) $n = 3, l = 2, m_l = -2, m_s = -\frac{1}{2}$

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

B. (i) $n = 3, l = 1, m_l = 1, m_s = +\frac{1}{2}$

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

C. (i) $n = 4, l = 1, m_l = 1, m_s = +\frac{1}{2}$

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

D. (i) $n = 3, l = 2, m_l = +2, m_s = -\frac{1}{2}$

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

Answer: A::D

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3. Which of the following sets of quantum numbers are correct?

n l m n l m

A. $\begin{matrix} n & l & m_l \\ 1 & 1 & 2 \end{matrix}$

B. $\begin{matrix} n & l & m_l \\ 2 & 1 & +1 \end{matrix}$

C. $\begin{matrix} n & l & m_l \\ 3 & 2 & -2 \end{matrix}$

D. $\begin{matrix} n & l & m_l \\ 3 & 4 & -2 \end{matrix}$

Answer: B::C

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4. In which of the following pairs, the ions are iso-electronic ?

A. Na^+, Mg^{2+}

B. Al^{3+}, O^-

C. Na^+, O^{2-}

D. N^{3-}, Cl^-

Answer: A::C

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5. Which of the following statements concerning the quantum numbers are correct?

A. Angular quantum number determines the three dimensional shape of the orbital.

B. The principal quantum number determines the orientation and energy of the orbital.

C. Magnetic quantum number determines the size of the orbital.

D. Spin quantum number of an electron determines the orientation of the spin of electron relative to the chosen axis.

Answer: A::D

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Ncert Exemplar Problems Short Answer Questions

1. Arrange s,p and d subshells of a shell in the increasing order of effective nuclear charge $\left(Z_{eff}\right)$ experienced by the electron present in them.

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2. Show the distribution of electrons in oxygen atom (atomic number 8) using orbital diagram.

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3. Nickel atom can lose two electrons to form Ni^{2+} ion. The atomic number of nickel is 28. From which orbital will nickel lose two electrons?

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4. Which of the following orbitals are degernate?

$3d_{xy}$, $4d_{xy}$, $3d_{z^2}$, $3d_{yz}$, $4d_{yz}$, $4d_{z2}$

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5. Calculate the total number of angular nodes and radical nodes present in 3p orbital.

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6. The arrangement of orbitals on the basis of energy is based upon their (n+l) value. Lower the value of (n+l), lower is the energy . For orbitals having same values of (n+l). The orbital with lower value of n will have lower energy.

I. Based upon the above information arrange the following orbitals in the increasing order of energy.

(a) 1s,2s,3s,2p (b) 4s,3s,3p,4d

(c) 25p,4d,5d,4f,6s (d) 5f,6d,7s,7p

II. Based upon the above information Solve the question. give below.

(a) which of the following orbitals has the lowest energy

$4d, 4f, 5s, 5p$

(b) which of the following orbitals has the higher energy?

$5p, 5d, 5f, 6s, 6p$

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7. Which of the following will not show deflection from the path on passing through an electric field?

Proton,cathode rays, electron,neutron.

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8. An atom having mass number 13 has 7 neutrons. What is the atomic number of the atom.

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9. Wavelength of different ra diations are given below.

λ (A) $= 300nm\lambda$ (B) =300 $\mu m\lambda$ (C) $= 3nm\lambda$ (D)=$30\overset{\circ}{A}$

Arrange these radiations in the increasing order of their energies.

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10. The electronic configuration of valence shell of Cu is $3d^{10}4s^1$ and not $3d^94s^2$. How is this configuration explained?

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11. The Balmer series in the hydrogen spectrum corresponds to the transition from $n_1 = 2$ to $n_2 = 3, 4.....$ This series lies in the visible region. Calculate the wave number of line associated with the transition in Balmer series when the electron moves to n=4 orbit.

$\left(R_H = 109677cm^{-1}\right)$

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12. According to de-Brogile, matter should exhibit dual behaviour, that is both particle and wave like properties. However, a cricket ball of mass 100 g does not move like a wave when it is thrown by a b owler at a speed of 100km/h. calculate the wavelength of the ball and explain why it does not show wave nature.

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13. What is the experimental evidence in support of the diea that electronic energies in an atom are quantized?

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14. Out of electron and proton which one will have, a higher velocity to produce matter waves of the same wavelength ? Explain it.

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15. A hypothetical electromagnetic wave is shown in Fig .1. Find out the wavelength of the radiation.

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16. Chlorophyll present in green leaves of plants absorbs light at $4.620 \times 10^{14} Hz$. Calculate the wavelength of radiation in nanometer. Which part of the electromagnetic spectrum does it belong to?

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17. What is the difference between the terms orbit and orbital?

Watch Video Solution

18. Table-tennis ball has mass 10g and s peed of 90m/s. if speed can be meausred within an accuracy of 4%. What will be the uncertainly in speed

and position?

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19. The effect of uncertainty principle is significant only for motion of microscopic particles and is negligible for the macroscopic particles. Justify the statement with the help of a suitable example.

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20. Hydrogen atom has only one electron, So, mutual repulsion between electrons is absent. However, in multielectron atoms mutual repulsion between the electrons is significant. How does this affect the energy of an electron in the orbitals of the same prinicipal quantum number in multielectron atoms?

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Ncert Exemplar Problems Matching Type Questions

1. Match the following :

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2. Match the following :

View Text Solution

3. Match species given in column I with the electronic configuration given in Column II.

View Text Solution

Ncert Exemplar Problems Assertion And Reason Type Questions

1. Assertion(A): All isotopes of a given element show the same type of chemical behaviour.

Reason(R) The chemical properties of an atom are controlled by the numb er of electron s in the atom.

A. Both A and R are true and R is the correct explanation of A.

B. Both A and R are true but R is not the correct explanation of A.

C. A is true but R is false

D. Both A and R are false.

Answer: A

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2. Assertion(A) Black body is an ideal body that emits and absorbs radiations of all frequencies.

Reason(R) The frequency of radiation emitted by a body goes from a lower frequency to higher frequency with an increase in temperature.

A. Both A and R are true and R is the correct explanation of A.

B. Both A and R are true but R is not the correct explanation of A.

C. A is true but R is false

D. Both A and R are false.

Answer: B

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3. Assertion (A) It is impossible to determine the exact position and exact momentum of an electron simultaneously.

Reason (R) The path of an electron in an atom is clearly defined.

A. Both A and R are true and R is the correct explanation of A.

B. Both A and R are true but R is not the correct explanation of A.

C. A is true but R is false

D. Both A and R are false.

Answer: C

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Ncert Exemplar Problems Long Answer Questions

1. What is photoelectric effect ? State the result of photoelectric effect experiment that could not be explained on the basis of laws of classical physics. Explain this effect on the basis of quantum theory of electromagnetic radiations.

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2. Thershold frequency, v_0 is the minimum frequency which a photon must possess to eject an electron from a metal. It is different for different metals. When a photon of frequency $1.0 \times 10^{15} s^{-1}$ was allowed to hit a metal surface, an electron having $1.988 x 10^{-19} J$ of kinetic energy was

emitted. Calculated the threshold frequency of this metal.

equal to 600nm hits the metal surface.

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3. When an electric discharge is passed through hydrogen gas, the hydrogen molecules dissociate to produce excited to produce excited hydrogen atoms. These excited atoms emit electromagnetic radiation of discrete frequencies which can be given by the general formula

$$\overrightarrow{v} = 109677\left[\frac{1}{n_i^2} - \frac{1}{n_f^2}\right]$$

What points of Bohr's model of an atom can be used to arrive at this formula? Based on these points derive the above formula giving description of each step and each term.

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4. Calculate the energy and frequency of the radiation emitted when an electron jumps from n=3 to n=2 ina hydrogen atom.

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5. Why was a change in the Bohr Model of atom required? Due to which important development concept of movement of an electron in an orbit was replaced by the concept of probabiltiy of finding electron in an orbital?what is the name given to the changed model of atom?

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Revision Exercises Objective Very Short Answer Questions

1. Calculate the enegry of an electron in the second Bohr orbit of an H atom.

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2. Bohr's model enables us to derive the energy of an electron revolving in nth orbit. For H-atom and hydrogen like species :

$$E_n = \frac{2\pi^2 me^4 Z^2}{n^2 h^2}$$

or $= -\frac{13.6Z^2}{n^2} eV\text{atom}^{-1} = \frac{21.8 \times 10^{-19} Z^2}{n^2} J\text{atom}^{-1}$

This helps to calculate the radius of an orbit,

$$r_n = \frac{0.529 n^2}{Z} \text{Å}$$

Bohr's model also explains the occurrence of different spectral lines. The wavelengths of difference line can be given as :

$$\frac{1}{\lambda} = \bar{v}(\text{in} cm^{-1}) = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$R = 109678 cm^{-1}$ and $n_2 > n_1$.

Which series of hydrogen spectrum lies in the visible region ?

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$R = 109678 cm^{-1}$ and $n_2 > n_1$.

What is the ratio of radius of 4th orbit of hydrogen and 3rd orbit of Li^{2+} ion ?

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$R = 109678 cm^{-1}$ and $n_2 > n_1$.

Which transition between Bohr's orbits corresponds to third line in Lyman series?

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5. Bohr's model enables us to derive the energy of an electron revolving in nth orbit. For H-atom and hydrogen like species :

$$E_n = \frac{2\pi^2 me^4 Z^2}{n^2 h^2}$$

or $= -\frac{13.6Z^2}{n^2} eV \text{atom}^{-1} = \frac{21.8 \times 10^{-19} Z^2}{n^2} J \text{atom}^{-1}$

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$R = 109678 cm^{-1}$ and $n_2 > n_1$.

What is the experimental evidence in support of the fact that electronic energies in an atom are quantized ?

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6. The electron are distributed around the nucleus in various energy levels shells, subshells and orbitals. A set of quantum numbers completely describe the position and total energy of electron in an atom. The various permitted values of quantum numbers are :

principal, $n = 1, 2, 3, 4.....$

azimuthal , $l = 0, 1, 2, ... (n - 1)$

magnetic, $m_l = -l.... .0.... . +l$

spin, $m_s = +1/2$ and $-1/2.$

Is the following set of quantum numbers possible or not ?

$n = 3, l = 2, m = 0, s = -1/2.$

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The various permitted values of quantum numbers are :

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magnetic, $m_l = \ -l.... .0.... . \ +l$

spin, $m_s = \ +1/2 \text{ and } \ -1/2.$

What is the value of n that allows g subshell?

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8. The electron are distributed around the nucleus in various energy levels shells, subshells and orbitals. A set of quantum numbers completely describe the position and total energy of electron in an atom.

The various permitted values of quantum numbers are :

principal, $n = 1, 2, 3, 4.....$

azimuthal , $l = 0, 1, 2, ... (n - 1)$

magnetic, $m_l = \ -l.... .0.... . \ +l$

spin, $m_s = \ +1/2 \text{ and } \ -1/2.$

How many orbital (of all kind) are possible for n = 3 energy level?

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9. The electron are distributed around the nucleus in various energy levels shells, subshells and orbitals. A set of quantum numbers completely describe the position and total energy of electron in an atom. The various permitted values of quantum numbers are :

principal, $n = 1, 2, 3, 4.....$

azimuthal , $l = 0, 1, 2, ... (n - 1)$

magnetic, $m_l = \ -l.... .0.... . \ +l$

spin, $m_s = \ +1/2 \text{ and } \ -1/2.$

What is the difference in angular momentum of an electron present in 2p and 3p orbital?

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10. The electron are distributed around the nucleus in various energy levels shells, subshells and orbitals. A set of quantum numbers completely describe the position and total energy of electron in an atom. The various permitted values of quantum numbers are :

principal, $n = 1, 2, 3, 4.....$

azimuthal , $l = 0, 1, 2, ... (n - 1)$

magnetic, $m_l = \ -l.... .0.... . \ +l$

spin, $m_s = \ +1/2 \text{ and } \ -1/2.$

How many electrons are possible in all sub-shells with $n + l = 4$?

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11. The shapes of orbital may be represented by boundary surface diagrams. These boundary surface diagram give the most probable regions. S-orbitals are non-directional while p-, d- and f-orbitals have different orientations given by m_l values. These boundary surfaces also have sperical nodes or radial nodes and nodal planes which depend upon the values of n and l.

How many orbitals are possible for l = 2 subshell ?

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12. The shapes of orbital may be represented by boundary surface diagrams. These boundary surface diagram give the most probable regions. S-orbitals are non-directional while p-, d- and f-orbitals have different orientations given by m_l values. These boundary surfaces also have sperical nodes or radial nodes and nodal planes which depend upon the values of n and l.

How many spherical nodes are present in 3p - orbital?

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13. The shapes of orbital may be represented by boundary surface diagrams. These boundary surface diagram give the most probable regions. S-orbitals are non-directional while p-, d- and f-orbitals have different orientations given by m_l values. These boundary surfaces also have sperical nodes or radial nodes and nodal planes which depend upon the values of n and l.

How do 3s and 4s orbitals differ in terms of nodes present in these ?

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14. The shapes of orbital may be represented by boundary surface diagrams. These boundary surface diagram give the most probable regions. S-orbitals are non-directional while p-, d- and f-orbitals have different orientations given by m_l values. These boundary surfaces also have sperical nodes or radial nodes and nodal planes which depend upon the values of n and l.

Does d_z^2 orbital has zero electron density in xy plane ?

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15. The shapes of orbital may be represented by boundary surface diagrams. These boundary surface diagram give the most probable regions. S-orbitals are non-directional while p-, d- and f-orbitals have different orientations given by m_l values. These boundary surfaces also have sperical nodes or radial nodes and nodal planes which depend upon the values of n and l.

How many angular nodes are present in $3d_{yz}$ orbital?

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Revision Exercises True Or False Questions

1. Predict which of the following statements are true or false.

2s orbital has one node.

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2. Predict which of the following statements are true or false.

Phosphorus (Z = 15) has three unpaired electrons.

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3. Write electronic configuration of Fe^{2+} and Fe^{3+} ions. Which of these has more number of unpaired electrons? Atomic no. of Fe is 26.

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4. How many nodes are there in 5f orbitals?

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5. Predict which of the following statements are true or false.

It takes less energy to ionize (or remove) an electron from first excited state than the ground state of H-atom.

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6. Predict which of the following statements are true or false.

Paschen, Brackett and Pfund series fall in infra red region.

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7. The phenomenon of splitting of spectral lines under the influence of the electric field is known as

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8. Electronic energy is a negative energy because

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9. Predict which of the following statements are true or false.

Ψ^2 represents probability density .

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10. Predict which of the following statements are true or false.

Heisenberg principle is applicable to microscopic objects.

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11. Predict which of the following statements are true or false.

3s and 4p orbitals have same number of radial nodes.

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12. Predict which of the following statements are true or false.

Angular momentum for 2p and 3p orbital is same.

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13. Copper (I) is diamagnetic while copper (II) is paramagnetic . Explain.

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

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15. Predict which of the following statements are true or false.

The de-Broglie wavelength associated with hydrogen atom is large than that of deuterium atom if both are travelling at the same speed.

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Revision Exercises Fill In The Blanks Questions

1. Our of 5d, 2f, 3d, 5s , the subshell which does not make sense is .....

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2. What is the toal number of orbitals associated with the principal quantum number $n = 3$?

Hint : The total number of orbitals in a shell is given by formula $= n^2$?

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3. There are .....orbitals corresponding to l = 2.

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4. EXPERIMENTAL VERIFICATION OF THE DUAL NATURE OF ELECTRONS

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5. Which one of the series of hydrogen spectrum is in the visible region ?

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6. (a) Define Pauli Exclusion Principle .

(b) Write the electronic configuration and the number of unpaired electrons in Fe^{2+} ion.

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7. The limiting line of any spectral series in the hydrogen spectrum is the line when n_2 in the Rydberg's formula is ..... .

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8. The Lyman series of hydrogen spectrum lies in the region :

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9. Which quantum number defines the orientation of orbital in the space around the nucleus?

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10. The quantum number which describes the subshells present in any main shell is called ..... .

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Revision Exercises Assertion Reason Questions

1. Assertion (A) : Hydrogen has only one electron in its 1s orbital but it produces several spectral lines.

Reason (R) : There are many excited energy levels available in H atoms.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: A

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2. Assertion : The 19^{th} electron in potassium atom enters into 4s-orbital than in 3d-orbital.

and

Reason : $(n + l)$ rule is followed for determining the orbital of lowest energy state.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: A

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3. Assertion : The energy of an electron is mainly determined by principal quantum number.

Reason : The principal quantum number is the measure of the most probable distance of finding the electron around the nucleus.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: A

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4. Assertion : For the outermost electron in Na atom, the orbital angular momentum is zero.

Reason : For 3s electron , l = 0 and orbital angular momentum is zero.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: A

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5. Assertion : The configuration of C cannot be $1s^2 2s^2 2p_x^2$.

Reason : According to Pauli exclusion principle an orbital can have

maximum of two electrons.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: B

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6. Assertion : 2s-orbital has one node.

Reason : Number of nodes in an orbital is equal to $(n - l - 1)$ value.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: A

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7. Assertion : All microsopic bodies in motion have wave character.

Reason : Microscopic bodies have very large mass.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: C

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8. Assertion : Cl^- ions and K^+ ions are isoelectronic.

Reason : Isoelectronic ions have same charge.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: C

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9. Assertion (A) It is impossible to determine the exact position and exact momentum of an electron simultaneously.

Reason (R) The path of an electron in an atom is clearly defiened.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: C

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10. Statement-1: Photoelectric effect is easily pronounced by caesium metal.

Statement-2: Photoelectric effect is easily pronounced by the metals having high ionization energy.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: C

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Revision Exercises Very Short Answer Questions

1. What is difference between a quantum and a photon?

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2. Can an electron have the quatum number values as $n = 2, l = 2$ and $m = +2$?

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3. How many sub-levels are there in M shell ? What are their designations?

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4. Give the sets of quantum number that describe an electron in a $3p$ orbital

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5. The electronic configuration of chromium (Z=24) is:

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6. An atom of an element has 19 electrons. What is the total number of p-electrons?

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7. What is the sequence of energies of 3s, 3p and 3d-orbitals in

(i) a hydrogen atom, and

(ii) a multielectron atom?

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8. According to which principle an orbital cannot have more than two electrons?

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9. Describe the orbital with following quantum numbers:

(i) n=3, l=2

(ii) n=4, l=3

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10. If the principal quantum has a value of 3, what are the permitted values of the quantum number l?

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11. What is the relation between the shapes of $3d_{xy}$ and $3d_{x^2y^2}$ orbitals?

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12. How many electron are present in 3d orbitals in chromium (Z = 24) ?

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13. If a quantum number l has value of 2, what are the permitted values of quantum number $'m_1'$?

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14. The maximum number of electrons in s, p and d-subshell are

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15. Which energy levels do not have p-orbital ?

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16. What do you mean by saying that energy of electron is quantized?

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17. Out of electron and proton which one will have, a higher velocity to produce matter waves of the same wavelength ? Explain it.

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18. What is the toal number of orbitals associated with the principal quantum number $n = 3$?

Hint : The total number of orbitals in a shell is given by formula $= n^2$?

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19. Arrange the following in order of increasing energy for hydrogen atom

1s 2s 2p 3s 3p 3d 4s 4p

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20. How many electrons in calcium have l = 0 ?

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21. What is Hund's rule of maximum multiplicity ? Explain by taking example of nitrogen.

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22. (a) Define Pauli Exclusion Principle .

(b) Write the electronic configuration and the number of unpaired electrons in Fe^{2+} ion.

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Revision Exercises Short Answer Questions

1. What are the postulates of Bohr's model of an atom?

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2. How does the existance of line spectra support for the Bohr model of the atom ?

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3. Why was Bohr model abandoned ?

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4. In Bohr's atomic model, the electrons do not fall into the nucleus because

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5. Name the three quantum numbers which are necessary to describe an orbital. What are the permitted values for these ?

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6. What is the maximum number of electron in :

(i) a principal quantum number

(ii) an orbital

(iii) p-subshell

(iv) s, p and d-subshells in an atom ?

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7. Give the number of orbitals in :

(i) a p-subshell

(ii) a d-subshell

(iii) second shell.

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8. Describe the orbital with the following quantum numbers :

$(i) n = 1, l = 0$ $(ii) n = 2, l = 1, m = 0$

$(iii) n = 3, l = 2$ $(iv) n = 4, l = 1$

$(v) n = 3, l = 0, m = 0$ $(vi) n = 3, l = 1.$

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9. Give the electronic configurations of :

(i_ Scandium (Z = 21)

(ii) Chromium (Z = 24)

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10. How many orbital and how many electron are there in each of the first two principal quatum numbers ?

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11. Give the electronic configurations of the following ions :

$(i) H^-$ $(ii) Na^+$

$(iii) F^-$ $(iv) Mg^{2+}$.

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12. Fill in the blanks :

(i) The size of an orbital is dependent on the value of ..... .

(ii) The orbitals having the same energies are called ..... .

(iii) The number of unpaired electrons in carbon is .....and in nitrogen is ..... .

(iv) The shape of 1s-orbital is ..... .

(v) .....filled orbitals have extra stability .

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13. Define Aufbau principle. Which of the following orbitals are possible ?

1p, 2s, 2p and 3f.

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14. With the help of Pauli's exclusion principle and the concept of atomic numbers for orbtials, show that an M shell can not accommodate more than 18 electrons.

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15. What is an orbital ? How will you differentiate between an orbit and orbital ?

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16. Compare the shapes of 1s- and 2s-orbitals.

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17. What is the difference between the notations l and L ?

Watch Video Solution

18. How many electrons are there in the valence quantum level of copper (atomic number = 29) atom ? Give reasons.

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19. Write the electronic configuration of the following elements :

Carbon (Z = 6) , neon (Z = 10) , magnesium (Z = 12), Chlorine (Z = 17), calcium (Z = 20) , chromium (Z = 24), iron (Z = 26) and rubidium (Z = 37).

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20. Identify the atoms that have the following ground state electronic configurations :

$(i) 1s^2 2s^2 2p^6 3s^2$

$(ii) 1s^2 2s^2 2p^5$

$(iii) 1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}.$

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21. Why does in the building of an atom, the filling of 4s orbital takes place before filling in 3d orbital ?

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22. The electronic configuration of copper is $[Ar]4s^1 3d^{10}$ and not $[Ar]4s^2 3d^9$. Justify.

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23. An atom of an element has 19 electrons. Find out :

(a) its atomic number

(b) total number of s-electrons

(c) total number of p-electrons.

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24. Define atomic orbital. Give the shapes of s and p orbitals.

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25. What is Hund's rule of maximum multiplicity ? Illustrate this by taking the example of carbon.

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26. Half-filled and fully-filled orbital orbitals are more stable

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27. What is Aufbau principle ? Write the electroni configurations of the elements of atomic numbers 16,20,24 and 35.

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28. Draw the shape of an orbital which has l = 0.

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29. State Aufbua principle. Write electronic configurations of the elements with atomic numbers 17 and 24.

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30. Why does in the building of an atom, the filling of 4s orbital takes place before filling in 3d orbital ?

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31. State and explain Pauli's exclusion principle. Write the electronic configuration of the element with atomic number 24.

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32. What is Hund's rule of maximum multiplicity ? Explain by taking example of nitrogen.

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33. The magnetic quantum number specifies.

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34. What is the experimental evidence in support of the diea that electronic energies in an atom are quantized?

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35. The effect of uncertainty principle is significant only for motion of microscopic particles and is negligible for the macroscopic particles. Justify the statement with the help of a suitable example.

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Revision Exercises Long Answer Questions

1. Give the essential postulates of Bohr's model of an atom. How did it explain.

(i) the stability of a atom

(ii) origin of spectral lines in hydrogen atom ?

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2. What are quantum numbers ? What permitted values can these have ? Give the significance of each quantum number.

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3. LAWS OF PHOTOELECTRIC EFFECT

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4. Why was a change in the Bohr Model of atom required? Due to which important development concept of movement of an electron in an orbit was replaced by the concept of probabiltiy of finding electron in an orbital?what is the name given to the changed model of atom?

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5. (a) What is radial probability distribution curve ? Draw radial probability distribution curves for 1s and 2s orbitals.

(b) Discuss the similarities and difference between 1s and 2s orbitals.

(c) How many nodes are present in 1s and 2s orbitals ?

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6. (a) How many orbitals are possible for a d-subshell ?

(b) Draw the shapes of d_{xy} and $d_{x^2-y^2}$ orbitals? What is common

between these and what is difference between these orbitals ? What is the angle between the lobes of these orbitals ?

(c) Name a 3d orbitals which has electron density along all the three axes.

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Revision Exercises Numerical Problems

1. What is the wavelength of light emitted when the electron in a hydrogen atom undergoes transition from the energy level with n = 4 to the energy level with n = 1 ? In which region of the electromagnetic spectrum does this radiation fall ?

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2. Using Bohr's model , calculate the wavelength of the radiation emitted when an electron in a hydrogen atom makes a transition from the fourth

energy level to the second energy level.

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3. In the Balmer series of atomic spectra of hydrogen atom, a line corresponding to wavelength 656.4 nm was obtained. Calculate the number of higher orbit from which the electron drops to produce this line.

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4. Calculate the wavelength (in nanometers) emitted by a photon during a transition from n =6 to n = 4 state in the H -atom.

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5. Calculate the wavelenght associated with a H-atom (mass = $1.676 \times 10^{-27} kg$) moving with velocity of $8.0 \times 10^{2} cms^{-1}$.

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6. According to Heisenberg's uncertainly principle, the product of uncertainties in position and velocities for an electron of mass $9.1 \times 10^{-31} kg$ is.

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Higher Order Thinking Skills Advanced Level Questions With Answers

1. How did wave mechanical model of an atom overruled the circular orbital proposed by Bohr ?

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2. Which of the following sets of orbitals are degenerate and why ?

(i) $1s, 2s \text{ and } 3s$ in Mg atom

(ii) $2p_x$, $2p_y$ and $2p_z$ in C atom

(iii) $3s$, $3p_x$ and $3d$ orbitals in H atom.

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3. An electron in a hydrogen atom is excited from the ground state to the n = 4 state. Predict which of the following statements are true or false :

(i) $n = 4$ is the first excited state.

(ii) It takes more energy to ionize (remove) the electron from n = 14 than in the ground state.

(iii) The wavelength of light emitted when the electron drops from $n = 4$ to $n = 2$ is longer than that from $n = 4$ to $n = 1$.

(iv) The wavelength which the atom absorbs in going from $n = 1$ to $n = 4$ is the same as emitted when it goes from $n = 4$ to $n = 1$.

(v) The electron is farther from the nucleus (on average) in n = 4 than in the ground state.

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4. If the uncertainty in the position of a moving electron is equal to its de Broglie wavelength, then its velocity will be completely uncertain. Explain.

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5. Show that ground state energy of an electron in H-atom is equal to the first excited state energy of electron in He^+ ion (assuming their Rydberg's constants to be equal).

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6. What is the difference in the orbital angular momentum of 2p and 3p electron ? Explain.

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7. Predict the number of nodes and nodal planes in $(i)3p_x (ii)4s$ and $(iii)3d_{x^2-y^2}$ orbital .

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8. What will become to the wavelength a moving particle if its velocity is doubled ?

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9. Cu^{2+} is more stable than Cu^{+} in aqueous solution. Explain.

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10. How do $d_{x^2-y^2}$ and d_{xy} orbitals differ in their orientation is space ?

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11. For H atom the Bohr radius first orbit is 0.529Å and the radius of maximum probability for H-atom according to wave mechanical model is

also 0.529Å. How do the two approaches differ?

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12. For a mutielectron atom, the maximum of 2p-orbital in radial probability distribution graph is nearer the nucleus than that of 2s-orbital . Therefore, 2p-orbital should be closer to the nucleus and lower in energy than 2s-orbital. But 2s-orbital has lower energy than 2p-orbital. Explain.

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13. What hydrogen-like ion has the wavelength difference between the first lines of the Balmer Lyman series equal to $59.3nm$?

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14. Calculate the wavelength of radiation emitted producing a line in the Lyman series ,when an electron falls from fourth stationary level in hydrogen atom $\left(R_H = 1.1 \times 10^7 m^{-1}\right)$

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15. Calculate the velocity of an electron present in third orbit of H atom. Also calculate number of revolutions per second round the nucleus.

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16. Calculate the energy emitted when electrons of 1.0 g atom of hydrogen undergo transition giving the spectral line of largest energy in the visible region of its atomic spectrum. $\left(R_H = 1.1 \times 10^7 m^{-1}, c = 3 \times 10^8 m s^{-1}, h = 6.62 \times 10^{-34} Js\right)$

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17. What is the distance of separation between second and third orbits of H-atom is given as :

$r_n = 0.529 \times n^2 \text{Å}$

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18. Calculate the product of uncertainty in displacement and velocity for an electron of masss 9.1×10^{-31}kg according to Heisenberg's uncertainty principle.

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19. Which state of triply ionised Beryllium $\left(Be^{+++}\right)$ the same orbital radius as that of the ground state hydrogen ?

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20. The threshold wavelength for emitting photons from a metal is $6.0 \times 10^3 \text{Å}$. What would be the wavelength of radiation to produce photoelectrons having twice the kinetic energy of those produced by radiation of wavelength $3 \times 10^3 \text{Å}$?

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21. The angular momentum of an electron in Bohr's orbit of H-atom is $3.02 \times 10^{-34} kgm^2 s^{-1}$. Calculate the wavelength of the spectral line emitted when the electron jumps this level to the next lower level.

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22. The velocity of electron in a certain Bohr's orbit of H-atom bears the ratio $1:275$ to the velocity of light. What is the number of orbit ?

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Competition File Objective Type Questions A Multiple Choice Questions

1. In the Bohr's orbit, what is the ratio of total kinetic energy and total energy of the electron

A. -2

B. -1

C. $+2$

D. 0

Answer: B

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2. The number of spectral lines produced when an electron jumps from 5^{th} orbit to 2^{nd} orbit in the hydrogen atom is.

A. Lyman series

B. Balmer series

C. Paschen sereis

D. Pfund series.

Answer: B

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3. In H-atom electron jumps from 3^{rd} to 2^{nd} energy level, the energy released is -

A. $329.7kJ$

B. $3.03 \times 10^{-19}J$

C. $182.2kJ$

D. $145.7kJ$

Answer: B

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4. What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition $n = 4$ to $n = 2$ of He^+ spectrum ?

A. $n = 2$ to $n = 1$

B. $n = 3$ to $n = 1$

C. $n = 3$ to $n = 2$

D. $n = 4$ to $n = 2$

Answer: A

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5. The ionisation energy of H atom is $13.6eV$ The inoisation energy of Li^{2+} law will be

A. $54.5eV$

B. $40.8eV$

C. $27.2eV$

D. $122.4eV$

Answer: D

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6. The radius of first orbit of hydrogen is `0.53 Å. The radius of second orbit would be :

A. $1.06Å$

B. $0.26Å$

C. $0.53Å$

D. $2.12Å$

Answer: D

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7. How many spectrual lines are emitted by atomic Hydrogen, when an electron jumps from 5th energy level to ground state ?

A. 5

B. 10

C. 15

D. 4

Answer: B

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8. According to Bohr's theory, the radius of the n^{th} orbit of an atom of atomic number Z is proportional

A. n

B. n^2

C. n^{-1}

D. n^{-2}

Answer: B

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9. What transition in $He^{\oplus}$ ion shall have the same wave number as the first line in Balmer series of H atom ?

A. $7 \rightarrow 5$

B. $5 \rightarrow 3$

C. $6 \rightarrow 4$

D. $4 \rightarrow 2$

Answer: C

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10. The ratio of the differrence between the first and second Bohr orbit energies to that between second and third Bohr orbit energies is

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

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

C. $\frac{27}{5}$

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

Answer: C

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11. Which of the following transitions have minimum wavelength

A. $n_2 \rightarrow n_1$

B. $n_3 \rightarrow n_1$

C. $n_4 \rightarrow n_2$

D. $n_4 \rightarrow n_1$

Answer: D

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12. In a hydorgen atom, enegry of the first excited state is $-3.4eV$. Find out the kinetic enegry of the same orbit of H atom.

A. $+3.4eV$

B. $6.8eV$

C. $-13.6eV$

D. $+13.6eV$

Answer: A

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13. The ratio of the radii of the first three Bohr orbit in H atom is

A. $1:2:3$

B. $1:4:9$

C. $1:3:27$

D. $1:\sqrt{2}:\sqrt{3}$

Answer: B

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14. The ratio of the frequency corresponding to the third line in the lyman series of hydrogen atomic spectrum to that of the first line in Balmer series of Li^{2+} spectrum is

A. $\frac{4}{5}$

B. $\frac{5}{4}$

C. $\frac{4}{3}$

D. $\frac{3}{4}$

Answer: D

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15. Three energy levels E_1, E_2 and E_3 and the wave lengths produced by transitions are shown below :

Which one of the following relationship is correct ?

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

B. $\lambda_1 + \lambda_2 + \lambda_3 = 0$

C. $\lambda_3 = \dfrac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

D. $\lambda_3 = \dfrac{\lambda_1 + \lambda_2}{\lambda_1 \lambda_2}$

Answer: C

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16. The de-Broglie wavelength of an electron is $600nm$. The velocity of the electron is:

$(h = 6.6 \times 10^{-34} J\text{sec}, m = 9.0 \times 10^{-31} kg)$

A. $1.8 \times 10^{3} ms^{-1}$

B. $1.2 \times 10^{5} ms^{-1}$

C. $5.4 \times 10^{3} ms^{-1}$

D. $1.2 \times 10^{3} ms^{-1}$

Answer: D

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17. It travelling at same speeds, whichof the following mater waves have the shortest wavelength?

A. Electron

B. Alpha particle $\left(He^{2+}\right)$

C. Neutron

D. Proton

Answer: B

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18. If uncertainty in possition of electron is zero, then the uncertainty in its momentum would be .....

A. zero

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

C. $< \frac{h}{4\pi}$

D. infinite

Answer: D

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19. Which of the following orbitals does not make sense ?

A. 6s

B. 3p

C. 2d

D. 4f

Answer: C

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20. Two electrons occupying the same orbital are distinguished by :

A. spin quantum number

B. azimuthal quantum number

C. magnetic quantum number

D. principal quantum number

Answer: A

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21. The designation of a sub-shell with $n = 4$ and $l = 3$ is

A. 4s

B. 4p

C. 4d

D. 4f

Answer: D

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22. For a given value of quantum number l , the number of allowed values of m is given by

A. $2l$

B. nl

C. $2l + l$

D. $n - l$

Answer: C

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23. The maximum number of 4d - electrons having spin quatum number $s = +\frac{1}{2}$ are :

A. 10

B. 7

C. 1

D. 5

Answer: D

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24. The maximum number of electrons in a subshell is given by the expression

A. $4l - 2$

B. $4l + 2$

C. $2l + 1$

D. $2n^2$

Answer: B

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25. A subshell with n=6 , l= 2 can accommodate a maximum of

A. 10 electrons

B. 12 electrons

C. 36 electrons

D. 72 electrons.

Answer: A

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26. For which of the following set of quantum numbers, an electron will have the highest energy ?

A.
n	l	m	s
3	2	1	$1/2$

B.
n	l	m	s
4	1	0	$-1/2$

C.
n	l	m	s
4	2	-1	$1/2$

D.
n	l	m	s
5	0	0	$1/2$

Answer: C

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27. An electron having the quantum numbers $n = 4$, $l = 3$, $m = 0$, $s = -\frac{1}{2}$ would be in the orbital

A. $3s$

B. $3p$

C. $4d$

D. $4f$

Answer: D

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28. Which of the following orbital designations is not correct corresponding to quantum numbers ?

A. $n = 5, l = 2 \rightarrow 5d$

B. $n = 2, l = 0 \rightarrow 2s$

C. $n = 4, l = 3 \rightarrow 4f$

D. $n = 7, l = 2 \rightarrow 7p$

Answer: D

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29. The orbital angular momentum for an electron revolving in an orbit for an s-electron is

A. zero

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

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

D. $\frac{1}{2} \cdot \frac{h}{2\pi}$

Answer: A

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30. The following quantum numbers are possible for how many orbitals $(s) n = 3, l = 2, m = +2$?

A. 1

B. 2

C. 3

D. 4

Answer: A

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31. The correct ground state electronic configuration of chromium atom is :

A. $[Ar]3d^5 4s^1$

B. $[Ar]3d^4 4s^2$

C. $[Ar]3d^6 4s^0$

D. $[Ar]4s^6 4p^5$

Answer: A

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32. In manganese atom , $Mn(Z = 25)$, the total number of orbitals populated by one or more electrons (in ground state) is :

A. 15

B. 14

C. 12

D. 10

Answer: A

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33. Which of the following has maximum number of unpaired electrons?

A. Mg^{2+}

B. Ti^{3+}

C. V^{3+}

D. Fe^{3+}

Answer: D

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34. Azimuthal quantum number of last electron of $._{11}Na$ is

A. 1

B. 0

C. 2

D. 3

Answer: B

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35. Orbital angular momentum depends on .....

A. l

B. n and l

C. n and m

D. m and s

Answer: A

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36. How many electrons in Argon have $m = 0$?

A. 12

B. 10

C. 8

D. 6

Answer: B

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37. The four quantum number of the valence electron of potassium are.

A. 0

B. 1

C. 2

D. 7

Answer: A

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38. Consier the following ions

1. Ni^{2+}

2. Co^{2+}

3. Cr^{2+}

4. Fe^{3+}

Atomic number : $Cr = 24, Fe = 26, Co = 27, Ni = 28.$

The correct sequence of increasing order of the number of unpaired electrons in these ions is

A. $1, 2, 3, 4$

B. $4, 2, 3, 1$

C. $1, 3, 2, 4$

D. $3, 4, 2, 1$

Answer: A

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39. If the value of $(n+l)$ is more than 3 and less than 6, then what will be the possible number of orbitals ?

A. 6

B. 9

C. 10

D. 13

Answer: D

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40. In an orbital, the signs of lobes indicate the

A. sign of charges

B. sign of probability distribution

C. sign of wave function

D. presence or absence of electron

Answer: C

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

A. 3

B. 1

C. 2

D. 0

Answer: D

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42. The raidal part of wave function dependds on the quantum numbers

A. n,l

B. n only

C. l, m_l

D. l only

Answer: A

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43. The number of radial and angular nodes in $3p$ orbital are

A. 1,0

B. 2,1

C. 1,1

D. 2,0

Answer: C

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44. Consider the ground state Cr atom $(Z = 24)$. The number of electron with the azimuthal number $l = 1$ and 2 ,respectively are

A. 16 and 4

B. 12 and 5

C. 12 and 4

D. 16 and 5

Answer: B

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45. The 3d-orbitals having electron density in all the three axes is

A. $3d_{xy}$

B. $3d_{x^2-y^2}$

C. $3d_{z^2}$

D. $3d_{yz}$

Answer: C

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46. How many spherical nodes are present in $4s$ orbital in a hydrogen atom ?

A. 0

B. 2

C. 3

D. 4

Answer: C

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Competition File Objective Type Questions B Multiple Choice Questions

1. Consider the following sets of quantum numbers.

(i)
n	l	m	s
3	0	0	$+1/2$

(ii)
n	l	m	s
2	2	1	$+1/2$

(iii)
n	l	m	s
4	3	-2	$-1/2$

(iv)
n	l	m	s
1	0	-1	$-1/2$

(v)
n	l	m	s
3	2	3	$+1/2$

Which of the following sets of quantum number is not possible ?

A. A, B, C and D

B. B,D and E

C. A and C

D. B,C and D

Answer: B

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2. The maximum kinetic energy of photoelectrons ejected from a metal, when it is irradiated with radiation of frequency $2 \times 10^{14} s^{-1}$ is 6.63×10^{-20}J. the threshold frequency of the metal is:

A. $2 \times 10^{14} s^{-1}$

B. $3 \times 10^{14} s^{-1}$

C. $2 \times 10^{-14} s^{-1}$

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

Answer: D

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

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

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

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

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

Answer: A

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4. The measurement of the electron position is associated with an uncertainty in momentum, which is equal to $1 \times 10^{-18} g cm s^{-1}$. The uncertainty in electron velocity is (mass of an electron is $9 \times 10^{-28} g$)

A. $1 \times 10^{9} cm s^{-1}$

B. $1 \times 10^{6} cm s^{-1}$

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

D. $1 \times 10^{11} cm s^{-1}$

Answer: A

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5. The velocity of particel A is 0.1 m/s and that of particle B is 0.5 m/s. If the mass of particle B is five times that of particle A, then the ratio of de-Broglie wavelength associated with particles A and B is

A. $25:1$

B. $3:4$

C. $6:4$

D. $5:2$

Answer: D

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6. Maximum number of electrons in a sub-shell of an atom is determined by the following.

A. $2l+1$

B. $4l - 2$

C. $2n^2$

D. $4l + 2$

Answer: D

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7. Which of the following is not permissible arrangement of electrons in an atom ?

A. $n = 5, l = 3, m = 0, s = +1/2$

B. $n = 3, l = 2, m = -3, s = -1/2$

C. $n = 3, l = 2, m = -2, s = -1/2$

D. $n = 4, l = 0, m = 0, s = -1/2$

Answer: B

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8. Which one of the following ions has electronic configuration $[Ar]3d^6$?

$(At.\ Nos.\ Mn = 25, Fe = 26, Co = 27, Ni = 28)$

A. Fe^{3+}

B. Co^{3+}

C. Ni^{3+}

D. Mn^{3+}

Answer: B

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9. The total number of atomic orbitals in fourth energy level of an atom is.

A. 8

B. 16

C. 32

D. 4

Answer: B

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10. The energies E_1 and E_2 of two radiations are $25eV$ and $50eV$ respectively. The relation between their wavelengths, i.e., λ_1 and λ_2 will be.

A. $\lambda_1 = \lambda_2$

B. $\lambda_1 = 2\lambda_2$

C. $\lambda_1 = 4\lambda_2$

D. $\lambda_1 = \frac{1}{2}\lambda_2$

Answer: B

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11. If $n = 6$, the correct sequence for filling of electrons will be.

A. $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$

B. $ns \rightarrow (n-1)d \rightarrow (n-2)f \rightarrow np$

C. $ns \rightarrow (n-2)f \rightarrow np \rightarrow (n-1)d$

D. $ns \rightarrow np(n-1)d \rightarrow (n-2)f$

Answer: A

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12. Maximum number of electrons in a sub-shell with $l = 3$ and $n = 4$ is.

A. 14

B. 16

C. 10

D. 12

Answer: A

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13. The correct set of four quantum numbers for valence electrons of rubidium atom (Z=37) is

A. $5, 1, 1, +1/2$

B. $6, 0, 0, +1/2$

C. $5, 0, 0, +1/2$

D. $5, 1, 0, +1/2$

Answer: C

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14. What is the maximum number of electrons that can be associated with a following set of quantum numbers ?

$(n = 3, l = 1 \text{ and } m = -1)$.

A. 4

B. 2

C. 10

D. 6

Answer: B

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15. Based on equation $E = -2.178 \times 10^{-18} J\left(\frac{Z^2}{n^2}\right)$, certain conclusions are written. Which of them is not correct ?

A. Equation can be used to calculate the change in energy when the electron change orbit.

B. For n = 1, the electron has a more negative energy than it does for $n = 6$ which means that the electron is more loosely bound in the

smallest allowed orbit.

C. The negative sign in equation simply means that the energy of electron bound to the nucleus is lower than it would be if the electrons were at the infinite distance from the nucleus.

D. Larger the value of n, the larger is the orbit radius.

Answer: B

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16. The value of Planck's constant is $6.63 \times 10^{-34} Js$. The speed of light is $3 \times 10^{17} nms^{-1}$. Which value is closest to the wavelength of quantum of light with frequency of $6 \times 10^{15} \sec^{-1}$?

A. 50

B. 75

C. 10

D. 25

Answer: A

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17. The ratio of de Broglie wavelengths of a deuterium atom to that of an α- particle, when the velocity of the former is five times greater than that of the latter, is

A. 4

B. 0.2

C. 2

D. 0.4

Answer: D

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18. The uncertainty in the velocity of a particle of mass $6.626 \times 10^{-31} kg$ is $1 \times 10^{6} ms^{-1}$. What is the uncertainty in its position (in nm) ? $\left(h = 6.626 \times 10^{-34} Js\right)$

A. $\left(\frac{1}{2\pi}\right)$

B. $\left(\frac{2.5}{\pi}\right)$

C. $\left(\frac{4}{\pi}\right)$

D. $\left(\frac{1}{4\pi}\right)$

Answer: D

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19. What is the maximum number of orbitals that can be identified with the following quantum numbers ? $n = 3, l = 1, m_l = 0.$

A. 1

B. 2

C. 3

D. 4

Answer: A

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20. Calculate the energy in joule corresponding to light of wavelength $45nm$:

(Planck' constant $h = 6.63 \times 10^{-34} Js$, speed of light $c = 3 \times 10^{8} ms^{-1}$)

A. 6.67×10^{15}

B. 6.67×10^{11}

C. 4.42×10^{-15}

D. 4.42×10^{-18}

Answer: D

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21. Which one of the following sets of quantum numbers is possible ?

A. $n = 3, l = 3, m_l = -3, m_s = +1/2$

B. $n = 2, l = 1, m_l = 2, m_s = -1/2$

C. $n = 2, l = 0, m_l = 0, m_s = 0$

D. $n = 3, l = 2, m_l = 3, m_s = -1/2$

Answer: C

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22. The angular momentum of electrons in d orbital is equal to

A. $2\sqrt{3}h$

B. $0h$

C. $\sqrt{6}h$

D. $\sqrt{2}h$

Answer: C

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23. Which is the correct order of increasing energy of the listed orbitals in the atom of titanium ?

A. $3s3p3d4s$

B. $3s3p4s3d$

C. $3s4s3p3d$

D. $4s3s3p3d$

Answer: A

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24. The number of d-electrons in Fe^{2+} (Z=26) is not equal to the number of electrons in which one of the following ?

A. d-electrons in $Fe(Z = 26)$

B. p-electron in $Ne(Z = 10)$

C. s-electrons in $Mg(Z = 12)$

D. p-electrons in $Cl(Z = 17)$

Answer: D

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25. Two electrons occupying the same orbital are distinguished by :

A. azimuthal quantum number

B. spin quantum number

C. principle quantum number

D. magnetic quantum number

Answer: B

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26. How many electrons can fit in the orbital for which n = 3 and l = 1 ?

A. 2

B. 6

C. 10

D. 14

Answer: A

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27. Which of the following pairs of d-orbitals will hare electron density along the axes ?

A. d_{z^2}, d_{xy}

B. d_{xy}, d_{yz}

C. $d_{z^2}, d_{x^2-y^2}$

D. $d_{zy}, d_{x^2-y^2}$

Answer: C

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28. Which one is the wrong statement ?

A. The uncertainty principle is $\Delta x \times \Delta v \geq \frac{h}{4\pi m}$

B. Half-filled and fully-filled orbitals have greater stability due to greater exchange energy, energy symmetry and more balanced arragement.

C. The energy of 2s-orbital is less than the energy of 2p-orbital in case of hydrogen like atoms.

D. de-Broglie's wavelength is given by $\lambda = \frac{h}{mv}$, where m = mass of the particle, v = velocity of the particle.

Answer: C

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29. Which one is a wrong statement ?

A. Total orbital angular momentum of electron in s-orbital is equal to zero.

B. An orbital is designated by three quantum numbers while an electron in an atom is designated by four quantum numbers.

C. The electronic configuration of N atom is

D. The value of m for d_{z^2} is zero.

Answer: C

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30. 4d, 5p, 5f and 6p orbitals are arranged in the order of decreasing energy. The correct option is :

A. $5f > 6p > 4d > 5p$

B. $5f > 6p > 5p > 4d$

C. $6p > 5f > 5p > 4d$

D. $6p > 5f > 4d > 5p$

Answer: B

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

A. Brackett series

B. Lyman series

C. Balmer series

D. Paschen series

Answer: C

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32. Which of the following sets of quantum numbers represents the highest energy of an atom?

A. $n = 3, l = 2, m = 1, s = +1/2$

B. $n = 4, l = 0, m = 0, s = +1/2$

C. $n = 3, l = 0, m = 0, s = +1/2$

D. $n = 3, l = 1, m = 1, s = +1/2$

Answer: A

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33. The ionisation energy of hydrogen atom is $1.312 \times 10^6 J\text{mol}^{-1}$. Calculate the energy required to excite an electron in a hydrogen atom from the ground state to the first excited state.

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

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

C. $6.65 \times 10^5 Jmol^{-1}$

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

Answer: A

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34. In an atom, an electron is moving with a speed of $600 m/s$ with an accuracy of $0.005\ \%$. Certainty with which the position of the electron can be localized is :

$\left(h = 6.6 \times 10^{-34} kgm^2 s^{-1}\right.$,

mass of electron $\left.(e_m) = 9.1 \times 10^{-31} kg\right)$.

A. $1.52 \times 10^{-4} m$

B. $5.10 \times 10^{-3} m$

C. $1.92 \times 10^{-3} m$

D. $3.84 \times 10^{-3} m$

Answer: C

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35. 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. 0.032 nm

B. 0.40 nm

C. 2.5 nm

D. 14.0 nm

Answer: B

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36. What is the maximum number of emission lines obtained when the excited electron of a H atom in n = 5 drops to the ground state?

A. 10

B. 5

C. 12

D. 15

Answer: A

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37. The wave number of the spectral line in the emission spectrum of hydrogen will be equal to $\frac{8}{9}$ times the Rydberg's constant if the electron

jumps from .....:-

A. $n = 3$ to $n = 1$

B. $n = 10$ to $n = 1$

C. $n = 9$ to $n = 1$

D. $n = 2$ to $n = 1$

Answer: A

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38. Ionisation energy of He^+ is $19.6 \times 10^{-18} J \text{atom}^{-1}$. The energy of the first stationary state $(n = 1)$ of Li^{2+} is.

A. $-2.2 \times 10^{-15} J \text{atom}^{-1}$

B. $8.82 \times 10^{-17} J \text{atom}^{-1}$

C. $4.41 \times 10^{-16} J \text{atom}^{-1}$

D. $-4.41 \times 10^{-17} J \text{atom}^{-1}$

Answer: D

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39. What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition $n = 4$ to $n = 2$ of $He^{\oplus}$ spectrum?

A. $n = 4$ to $n = 3$

B. $n = 3$ to $n = 2$

C. $n = 4$ to $n = 2$

D. $n = 2$ to $n = 1$

Answer: D

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40. For balmer series in the spectrum of atomic hydrogen the wave number of each line is given by

$\overline{V} = R_H \frac{1}{n_1^2} - \frac{1}{n_2^2}$ where R_H is a constant and n_1 and n_2 are integers which of the following statement (S) is / are correct

1 as wavelength decreases the lines in the series converge

2 The integer n_1 is equal to 2

3 The ionization energy of hydrogen can be calculated from the wave number of these lines

4 The line of longest wavelength corresponds to $n_2 = 3$

A. 1,2 and 3

B. 2,3 and 4

C. 1,2 and 4

D. 2 and 4 only

Answer: C

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41. The frequency of light emitted for the transition $n = 4$ to $n = 2$ of He^+ is equal to the transition in H atom corresponding to which of the

following ?

A. $n = 2$ to $n = 1$

B. $n = 3$ to $n = 2$

C. $n = 4$ to $n = 3$

D. $n = 3$ to $n = 1$

Answer: A

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42. The ratio of the frequency corresponding to the third line in the lyman series of hydrogen atomic spectrum to that of the first line in Balmer series of Li^{2+} spectrum is

A. $\frac{4}{5}$

B. $\frac{5}{4}$

C. $\frac{4}{3}$

D. $\frac{3}{4}$

Answer: D

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43. The electronic, identified by quantum numbers n and l, (i) $n = 4, l = 1$, (ii) $n = 4, l = 0$, (iii) $n = 3, l = 2$, (iv) $n = 3, l = 1$ can be placed in order of increasing energy, from the lowest to highest, as

A. $(4) < (2) < (3) < (1)$

B. $(2) < (4) < (1) < (3)$

C. $(1) < (3) < (2) < (4)$

D. $(3) < (4) < (2) < (1)$

Answer: A

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44. The electronic configuration of Cu^{2+} ion is :

A. $[Ar]3d^5 4s^1$

B. $[Ar]3d^4 4s^1$

C. $[Ar]3d^7 4s^s$

D. $[Ar]3d^8 4s^0$

Answer: B

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45. The ionization enthalpy of He^+ ion is $19.60 \times 10^{-18} J \text{atom}^{-1}$. The ionization enthalpy of Li^{2+} ion will be

A. $84.2 \times 10^{-18} J \text{atom}^{-1}$

B. $44.10 \times 10^{-18} J \text{atom}^{-1}$

C. $63.20 \times 10^{-18} J \text{atom}^{-1}$

D. $21.20 \times 10^{-18} Ja \to m^{-1}$

Answer: B

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46. Energy of an electron is givem by $E = -2.178 \times 10^{-18} J\left(\frac{Z^2}{n^2}\right)$. Wavelength of light required to excited 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. $8.500 \times 10^{-7} m$

B. $1.214 \times 10^{-7} m$

C. $2.816 \times 10^{-7} m$

D. $6.500 \times 10^{-7} m$

Answer: B

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47. As per de Broglie's formula, a macroscopic particle of mass 100 g and moving at a velocity of $100 cm s^{-1}$ will have a wavelength of

A. $6.6 \times 10^{-29} cm$

B. $6.6 \times 10^{-30} cm$

C. $6.6 \times 10^{-31} cm$

D. $6.6 \times 10^{-32} cm$

Answer: C

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48. The shortest wavelength in hydrogen spectrum of Lyman series when $R_H = 109678 cm^{-1}$ is :-

A. $1002.7 Å$

B. $1215.67 Å$

C. $1127.30 Å$

D. 911.7Å

Answer: D

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49. The correct set of four quantum numbers for valence electrons of rubidium atom (Z=37) is

A. $5, 0, 1, +\frac{1}{2}$

B. $5, 0, 0, +\frac{1}{2}$

C. $5, 1, 0, +\frac{1}{2}$

D. $5, 1, 1, +\frac{1}{2}$

Answer: B

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

A. $-3.4eV$

B. $+6.8eV$

C. $+13.6eV$

D. $-6.8eV$

Answer: A

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51. Which of the following is not permissible arrangement of electrons in an atom ?

A.

n	l	m	s
4	0	0	$-1/2$

B.

n	l	m	s
5	3	0	$+1/2$

C.

n	l	m	s
3	2	-2	$-1/2$

D.
n	l	m	s
3	2	-3	$+1/2$

Answer: D

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52. A stream of electrons from a heated filament was passed between two charged plates kept at a potential difference V esu. If c and m are charge and mass of an electron repectively, then the value of h/λ (where λ is wavelength associated with electron wave) is given by :

A. meV

B. $2meV$

C. $\sqrt{meV}$

D. $\sqrt{2meV}$

Answer: D

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53. The electronic, identified by quantum numbers n and l, (i) $n = 4, l = 1$, (ii) $n = 4, l = 0$, (iii) $n = 3, l = 2$, (iv) $n = 3, l = 1$ can be placed in order of increasing energy, from the lowest to highest, as

A. $(iv) < (ii) < (iii) < (i)$

B. $(ii) < (iv) < (i) < (iii)$

C. $(i) < (iii) < (ii) < (iv)$

D. $(iii) < (i) < (iv) < (ii)$

Answer: A

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54. Write down all the four quantum numbers for (i) 19th electron of $._{24}Cr$ (ii) 21st electron for $._{21}Sc$.

A. $\left(4, 1, -1, +\frac{1}{2}\right)$

B. $\left(4, 0, 0, +\frac{1}{2}\right)$

C. $\left(3, 2, 0, -\frac{1}{2}\right)$

D. $\left(3, 2, -2, +\frac{1}{2}\right)$

Answer: B

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

A. $2, 0, 0, +\frac{1}{2}$

B. $3, 0, 0, \pm\frac{1}{2}$

C. $2, 1, -1, +\frac{1}{2}$

D. $3, 1, 1, +\frac{1}{2}$

Answer: D

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56. The energy of an electron in the 3s orbital (excited state) of H - atom is

A. $-1.5eV$

B. $-13.6eV$

C. $-3.4eV$

D. $-4.53eV$

Answer: A

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57. The radius of the second Bohr orbit for hydrogen atom is :

(Planck's constant, $h = 6.6262 \times 10^{-34} Js$, mass of electron = $9.1091 \times 10^{-31} kg$, charge of electron $e = 1.60210 \times 10^{-19} C$, permittivity of vaccum $\in_0 = 8.854185 \times 10^{-12} kg^{-1} m^{-3} A^2$)

A. 1.65Å

B. 4.76Å

C. 0.529Å

D. 2.12Å

Answer: D

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58. Which of the following set of quantum numbers is not possible ?

A. $n = 3, l = 0, m = 0$

B. $n = 3, l = 1, m = -1$

C. $n = 2, l = 0, m = -1$

D. $n = 2, l = 1, m = 0$

Answer: C

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59. The number of unpaired electrons in a nickel atom (ground state) are (At. No. of Ni=28)

A. 0

B. 2

C. 4

D. 8

Answer: B

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60. With respect to atomic spectrum, each line in the Lyman series is due to electrons returning

A. from a particular higher energy level to n = 3

B. from a particular higher energy level to n = 2

C. from a particular higher energy level to n = 1

D. from a particular higher energy level to n = 4

Answer: C

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61. The orbital nearest to the nucleus is

A. 4f

B. 5d

C. 4s

D. 7p

Answer: C

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62. what is the work fuction of the metal if the light of wavelength 4000Å generates photoelectrons of velocity $6 \times 10^5 ms^{-1}$ from it ?

(Mass o felectron $= 9 \times 10^{-31}$kg

Velocity of light $= 3 \times 10^8 ms^{-1}$

Planck's constant $= 6.626 \times 10^{-34} Js$

Charge of electron $= 1.6 \times 10^{-19} jeV^{-1}$

A. 4.0 eV

B. 2.1 eV

C. 3.1 eV

D. 0.9 eV

Answer: B

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63. Two particles A and B are in motion. If the wavelength associated with the particle A is $33.33nm$, the wavelength associated with 'B' whose

momentum is $1/3rd$ of 'A' is

A. $1.0 \times 10^{-8}m$

B. $2.5 \times 10^{-8}m$

C. $1.25 \times 10^{-7}m$

D. $1.0 \times 10^{-7}m$

Answer: D

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64. Maximum number of photons emitted by a bulb capable of producing monochromatic light of wavelength 550 nm is ....., if 100 V and 1A is supplied for one hour.

A. 1×10^{24}

B. 5×10^{24}

C. 1×10^{23}

D. 5×10^{23}

Answer: A

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65. what is the work fuction of the metal if the light of wavelength 4000Å generates photoelectrons of velocity $6 \times 10^5 ms^{-1}$ from it ?

(Mass o felectron $= 9 \times 10^{-31}$kg

Velocity of light $= 3 \times 10^8 ms^{-1}$

Planck's constant $= 6.626 \times 10^{-34} Js$

Charge of electron $= 1.6 \times 10^{-19} jeV^{-1}$

A. $4.0eV$

B. $2.1eV$

C. $3.1eV$

D. $0.9eV$

Answer: B

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66. The 71^{st} electron of an element X with an atomic number of 71 enters into the orbital

A. $4f$

B. $6p$

C. $6s$

D. $5d$

Answer: D

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67. The ratio of te shortest wavelength of two spectral series of hydrogen spectrum is found to be about 9. The spectral series are:

A. Paschen and Pfund

B. Lyman and Paschen

C. Brackett and Pfund

D. Balmer and Brackett

Answer: B

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68. In which of the following energy of 2s orbital minium

A. K

B. Na

C. Li

D. H

Answer: A

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69. The quantum number of four electrons are given below:

I. $n = 4, l = 2, m_l = -2, m_s = -\frac{1}{2}$ II. $n = 3, l = 2, m_l = 1, m_s = +\frac{1}{2}$

III. $n = 4, l = 1, m_l = 0, m_s = +\frac{1}{2}$

IV. $n = 3, l = 1, m_l = 1, m_s = -\frac{1}{2}$

The correct order of their increasing energies will be

A. IV lt III lt II lt I

B. I lt II lt III lt IV

C. IV lt II lt III lt I

D. I lt III lt II lt IV

Answer: C

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70. What is the ratio of $\Delta v = = v_{\max} - v_{\min}$ for spectral lines corresponding to lyman & Balmer series for hydrogen

A. $27:5$

B. $4:1$

C. $5:4$

D. $9:4$

Answer: D

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71. The de Broglie wavelenght (λ) associated with a photoelectron varies with the frequency (v) of the incident radiation as,[v_0 is threshold frequency]:

A. $\lambda \propto \frac{1}{(v-v_0)^{\frac{3}{2}}}$

B. $\lambda \propto \frac{1}{(v-v_0)^{\frac{1}{2}}}$

C. $\lambda \propto \frac{1}{(v-v_0)^{\frac{1}{4}}}$

D. $\lambda \propto \frac{1}{(v-v_0)}$

Answer: B

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72. For emission line of atomic hydrogen from $n_i = 8$ to $n_f = n$, the plot of wave number $(\bar{v})$ against $\left(\frac{1}{n^2}\right)$ will be (The Rydberg constant, R_H is in wave number unit)

A. Linear with slope - R_H

B. Linear with intercept - R_H

C. Non linear

D. Linear with slope R_H

Answer: D

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73. Which of the graphs shown below does not represent the relationship between incident light and the electron ejected from metal surface?

A. 

B. 

C. 

D. 

Answer: C

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74. 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. $Be^{3+}(n=2)$

Answer: D

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75. The numbers of radial nodes of $3s$ and $2p$ orbitals are respectively:

A. 2,0

B. 0,2

C. 1,2

D. 2,1

Answer: A

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76. 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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77. P is the probability of finding the Is electron of hydrogen atom in a spherical shell of infitesimal thickness, dr, at a distance r from the nucleus. The volume of this shell is $4\pi r^2 dr$. The qualitative sketch of the dependence of P on r is

A. 

B. 

C. 

D. 

Answer: C

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Competition File Objective Type Questions C Multiple Choice Questions

1. Which of the following statements are correct?

A. Radial wave functions gives the shape of the orbital

B. Radial wave function depends upon n and l.

C. 3p orbital has two spherical nodes

D. 3d orbital has no sperical node

Answer: B::D

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2. Which of the following are correct notations for the orbitals ?

A. $n = 3, l = 2 \rightarrow 3d$

B. $n = 4, l = 1 \rightarrow 4p$

C. $n = 4, l = 3 \rightarrow 4d$

D. $n = 6, l = 1 \rightarrow 6f$

Answer: A::B

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3. The orbitals having the same number of spherical nodes are :

A. 4p, 3d

B. 3p , 4d

C. 4s, 5p

D. 2s, 3d

Answer: B::C

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4. Which of the following set of ions have the same number of electrons ?

A. Cr^{3+}, Fe^{2+}

B. Cu^{+}, Zn^{2+}

C. Mn^{2+}, Fe^{3+}

D. Sc^{3+}, V^{3+}

Answer: B::C

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5. Which of the following atoms have same number of unpaired electrons ?

A. Copper (Z = 29)

B. Scandium (Z = 21)

C. Manganese (Z = 25)

D. Chromium (Z = 24)

Answer: A::B

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6. In which of the following the first orbital has higher energy than the second in H-aotm?

A. $n = 4, l = 3$ and $n = 5, l = 0$

B. $n = 3, l = 2$ and $n = 3, l = 1$

C. $n = 3, l = 1$ and $n = 3, l = 2$

D. $n = 3, l = 2$ and $n = 2, l = 1$

Answer: A::D

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7. Identify the correct statement(s).

The findings from the Bohr model for H-atom are

A. angular momentum of the electron is expressed as integral multiples of $\frac{h}{2\pi}$

B. the first Bohr radius is 0.529Å

C. the energy of the n^{th} level, E_n is proportional to $\frac{1}{n^2}$

D. the spacing between adjacent levels increases with increase in 'n'

Answer: A::B::C

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8. The ground state energy of hydrogen atom is $-13.6eV$. Consider an electronic state Ψ of He^+ whose energy, azimuthal quantum number and magnetic quantum number are -3.4 eV , 2 and 0, respectively . Which of the following statement(s) is (are) true for the state Ψ?

A. It is a 4d state.

B. The nuclear charge experienced by the electron in this state is less than 2e, where e is the magnitude of the electronic charge

C. It has 3 radial nodes

D. It has 2 angular nodes

Answer: A::D

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Competition File Objective Type Questions D Multiple Choice Questions

1. In 1924, de-Broglie proposed that every particle possesses wave properties with a wavelength , λ given by $\lambda = \frac{h}{mv}$ where m is the mass of the particle, v is its velocity and h is Planck's constant. The de-Broglie prediction was confirmed experimentally when it was found that an electron beam undergoes diffraction , a phenomenon characteristic of waves. The de-Broglie wavelength can be estimated by measuring kinetic energy of an electron accelerating by a potential V as :

$\frac{1}{2}mv^2 = eV \text{where} 1eV = 1.6 \times 10^{-19} J, h = 6.6 \times 10^{-34} Js.$

The mass of a photon moving with velocity of light having wavelength same as that of an α - particle (mass = $6.6 \times 10^{-27} kg$) moving with velocity of $2.5 \times 10^2 ms^{-1}$ is

A. $7.92 \times 10^{-21} kg$

B. $5.5 \times 10^{-33} kg$

C. $5.65 \times 10^{-31} kg$

D. $7.92 \times 10^{-28} kg$

Answer: B

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2. In 1924, de-Broglie proposed that every particle possesses wave properties with a wavelength , λ given by $\lambda = \frac{h}{mv}$ where m is the mass of the particle, v is its velocity and h is Planck's constant. The de-Broglie prediction was confirmed experimentally when it was found that an electron beam undergoes diffraction , a phenomenon characteristic of waves. The de-Broglie wavelength can be estimated by measuring kinetic energy of an electron accelerating by a potential V as :

$\frac{1}{2}mv^2 = eV \text{where} 1eV = 1.6 \times 10^{-19} J, h = 6.6 \times 10^{-34} Js.$

The wavelength of matter wave associated with an electron passing through an electric potential of 100 million volts is

A. $10^2(2me)^{1/2}h$

B. $\frac{h \times 10^{-4}}{(2me)^{1/2}}$

C. $\frac{10^{-3}h}{(2me)^{1/2}}$

D. $\frac{h \times 10^{-4}}{(2me)^{-1/2}}$

Answer: B

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3. In 1924, de-Broglie proposed that every particle possesses wave properties with a wavelength , λ given by $\lambda = \frac{h}{mv}$ where m is the mass of the particle, v is its velocity and h is Planck's constant. The de-Broglie prediction was confirmed experimentally when it was found that an electron beam undergoes diffraction , a phenomenon characteristic of waves. The de-Broglie wavelength can be estimated by measuring kinetic energy of an electron accelerating by a potential V as :

$\frac{1}{2}mv^2 = eV \text{where} 1eV = 1.6 \times 10^{-19} J, h = 6.6 \times 10^{-34} Js.$

The proton and He^{2+} are accelerated by the same potential, then their de-Broglie wavelengths $\lambda_{He^{2+}}$ and λ_p are in the ratio of $(m_{He^{2+}} = 4m_p)$:

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

B. $\frac{1}{2\sqrt{2}}$

C. $2\sqrt{2}$

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

Answer: D

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4. In 1924, de-Broglie proposed that every particle possesses wave properties with a wavelength , λ given by $\lambda = \frac{h}{mv}$ where m is the mass of the particle, v is its velocity and h is Planck's constant. The de-Broglie prediction was confirmed experimentally when it was found that an electron beam undergoes diffraction , a phenomenon characteristic of waves. The de-Broglie wavelength can be estimated by measuring kinetic energy of an electron accelerating by a potential V as :

$\frac{1}{2}mv^2 = eV \text{where} 1eV = 1.6 \times 10^{-19} J, h = 6.6 \times 10^{-34} Js.$

If λ is the wavelength associated with the electron in the 4th circular orbit of hydrogen atom, then radius of the orbit is

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

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

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

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

Answer: C

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5. In 1924, de-Broglie proposed that every particle possesses wave properties with a wavelength , λ given by $\lambda = \frac{h}{mv}$ where m is the mass of the particle, v is its velocity and h is Planck's constant. The de-Broglie prediction was confirmed experimentally when it was found that an electron beam undergoes diffraction , a phenomenon characteristic of waves. The de-Broglie wavelength can be estimated by measuring kinetic energy of an electron accelerating by a potential V as :

$\frac{1}{2}mv^2 = eV \text{where} 1eV = 1.6 \times 10^{-19} J, h = 6.6 \times 10^{-34} Js.$

The wavelength of particles constituting a beam of helium atoms moving with a velocity of $2.0 \times 10^4 ms^{-1}$ is

A. 4.99pm

B. 49.9 pm

C. $499nm$

D. 499 pm

Answer: A

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6. The position and energy of an electron is specified with the help of four quantum numbers namely, principal quantum number (n), azimuthal quantum number (l), magnetic quantum number (m_l) and spin quantum number (m_s) . The permissible values of these are :

$n = 1, 2.... .$

$l = 0, 1, ... (n - 1)$

$m_l = \ -l, ...0, ... + l$

$m_s = \ + \frac{1}{2}$ and $\ - \frac{1}{2}$ for each value of m_l.

The angular momentum of electron is given as $\sqrt{l(l+1)} \cdot \frac{h}{2\pi}$

While spin angular momentum is given as $\sqrt{s(s+1)} \cdot \left(\frac{h}{2\pi}\right)$ where $s = \frac{1}{2}$

The electrons having the same value of n, l and m_l are said to belong to the same orbital. According to Pauli's exclusion principle, an orbital can have maximum of two electrons and these two must have opposite spin.

For an electron having $n = 3$ and $l = 0$, the orbital angular momentum is

A. $\frac{\left(\sqrt{3}\right)h}{\pi}$

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

C. zero

D. $2\sqrt{3}\frac{h}{\pi}$

Answer: C

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7. The position and energy of an electron is specified with the help of four quantum numbers namely, principal quantum number (n), azimuthal quantum number (l), magnetic quantum number (m_l) and spin quantum number (m_s) . The permissible values of these are :

$n = 1, 2.... .$

$l = 0, 1, ... (n - 1)$

$m_l = \ -l, ...0, ... + l$

$m_s = \ + \frac{1}{2}$ and $\ - \frac{1}{2}$ for each value of m_l.

The angular momentum of electron is given as $\sqrt{l(l+1)} \cdot \frac{h}{2\pi}$

While spin angular momentum is given as $\sqrt{s(s+1)} \cdot \left(\frac{h}{2\pi}\right)$ where $s = \frac{1}{2}$

The electrons having the same value of n, l and m_l are said to belong to the same orbital. According to Pauli's exclusion principle, an orbital can have maximum of two electrons and these two must have opposite spin.

The maximum number of electrons having $n + l = 5$ in an atom is

A. 32

B. 18

C. 10

D. 8

Answer: B

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8. The position and energy of an electron is specified with the help of four quantum numbers namely, principal quantum number (n), azimuthal quantum number (l), magnetic quantum number (m_l) and spin quantum number (m_s) . The permissible values of these are :

$n = 1, 2.... .$

$l = 0, 1, ... (n - 1)$

$m_l = -l, ...0, ... + l$

$m_s = +\frac{1}{2}$ and $-\frac{1}{2}$ for each value of m_l.

The angular momentum of electron is given as $\sqrt{l(l+1)} \cdot \frac{h}{2\pi}$

While spin angular momentum is given as $\sqrt{s(s+1)} \cdot \left(\frac{h}{2\pi}\right)$ where $s = \frac{1}{2}$

The electrons having the same value of n, l and m_l are said to belong to

the same orbital. According to Pauli's exclusion principle, an orbital can have maximum of two electrons and these two must have opposite spin. Which of the following statements is not correct ?

A. For sodium, the outermost electron has $n = 3, l = 0, m_l = 0, s = +1/2$

B. The orbitals having $n = 3, l = 2, m_l = -2$ have same energies

C. For 4f electron, $n = 4, l = 3, m_l = 0, s = +1/2$ is not possible.

D. The orbital 2d, 3f and 4g are not possible.

Answer: C

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9. The hydrogen -like species Li^{2+} is in a spherically symmetric state S_1 with one 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 is to the ground state energy of the hydrogen atom.

The sate S_1 is

A. $1s$

B. $2s$

C. $2p$

D. $3s$

Answer: B

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10. The hydrogen -like species Li^{2+} is in a spherically symmetric state S_1 with one 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 is to the ground state energy of the hydrogen atom.

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

A. 075

B. 1.50

C. 2.25

D. 4.50

Answer: C

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11. The hydrogen -like species Li^{2+} is in a spherically symmetric state S_1 whth one radisal node . Upon absorbing light the ion undergoes transitoj ot a state S_2 has one radial node and its enrgy is equal to the groun sate energy of hhe hydrogen atom.

The orbital angular momentum quantum number of the state s_2 is :

A. 0

B. 1

C. 2

D. 3

Answer: B

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12. The wave function, Ψ_{n,l,m_l} is a mathematical function whose value depends upon spherical polar coordinates (r, θ, ϕ) of the electron and characterized by the quantum numbers n, l and m_l. Here r is distance from nucleus , θ is colatitude and ϕ is azimuth. In the mathemetical functions given in the table, Z is atomic number of a_0 is Bohr radius.

Using this information which is available in three columns of the table, answer the following questions :

For He^+ ion, the only incorrect combination is

A. $(I)(i)(R)$

B. $(II)(ii)(Q)$

C. $(I)(i)(S)$

D. $(I)(iii)(R)$

Answer: D

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13. The wave function, Ψ_{n,l,m_l} is a mathematical function whose value depends upon spherical polar coordinates (r, θ, ϕ) of the electron and characterized by the quantum numbers n, l and m_l. Here r is distance from nucleus , θ is colatitude and ϕ is azimuth. In the mathemetical functions given in the table, Z is atomic number of a_0 is Bohr radius.

Using this information which is available in three columns of the table, answer the following questions :

For the given orbital in Column 1, the only correct combination for any hydrogen like species is

A. $(I)(ii)(S)$

B. $(IV)(iv)(R)$

C. $(III)(iii)(P)$

D. $(II)(ii)(P)$

Answer: D

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14. The wave function, Ψ_{n,l,m_l} is a mathematical function whose value depends upon spherical polar coordinates (r, θ, ϕ) of the electron and characterized by the quantum numbers n, l and m_l. Here r is distance from nucleus , θ is colatitude and ϕ is azimuth. In the mathemetical functions given in the table, Z is atomic number of a_0 is Bohr radius.

Using this information which is available in three columns of the table, answer the following questions :

For hydrogen atom, the only correct combination is

A. $(II)(i)(Q)$

B. $(I)(iv)(R)$

C. $(I)(i)(P)$

D. $(I)(i)(S)$

Answer: D

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15. Consider the Bohr's model of a one-electron atom where the electron moves around the nucleus. In the following, List - I contains some quantities for the nth orbit of the atom and List - II contains options showing how they depends on n.

Which of the following options has the correct combination considering List - I and List - II ?

A. (III), (S)

B. (IV) , (Q)

C. (III),(P)

D. (IV), (U)

Answer: C

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16. Consider the Bohr's model of a one-electron atom where the electron moves around the nucleus. In the following, List - I contains some quantities for the nth orbit of the atom and List - II contains options showing how they depends on n.

Which of the following options has the correct combination considering List-O and List-II ?

A. (II), (R)

B. (II), (Q)

C. (I),(P)

D. (I), (T)

Answer: D

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Competition File Objective Type Questions Interger Type And Numerical Value Type Questions

1. The maximum number of electrons can have principal quantum number $n = 3$ and spin quantum number $m_s = 1/2$ is

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2. How many times is the ionization energy of He^+ ion as compared to that of H-atom?

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3. Total number of orbitals in a f-sub-shell is

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4. Number of unpaired electrons in Fe^{2+} ion is

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5. The maximum number of electrons in an atom with $n = 4$ and $l = 1$ is

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6. The value of angular momentum for an electron in 3d orbital is $\sqrt{x}\frac{h}{2\pi}$. The value of x is

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7. Number of times radius of the 3rd shell of the H-atom as compared to that of radius of first shell is

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8. 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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9. In an atom, the total number of electrons having quantum numbers $n = 4, |m_l| = 1$ and $m_s = -\frac{1}{2}$ is

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10. Not considering the electronic spin, the degeneracy of the second excited state $(n = 3)$ of H atom is 9, while the degeneracy of the second excited state of H^+ is

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Unit Practice Test

1. Maximum number of electrons in a sub-shell of an atom is determined by the following.

A. $2l + 1$

B. $2n^2$

C. $4l + 2$

D. $4l - 2$

Answer: C

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2. The orbital angular momentum of a p-electron is given as :

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

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

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

D. 0

Answer: A

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3. Which of the following d-orbital has electron density in all the three axes

A. $3d_{xy}$

B. $3d_{x^2-y^2}$

C. $3d_{x^2}$

D. $3d_{yz}$

Answer: C

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4. Assertion : 2s orbital is spherically symmetrical .

Reason: s-orbital is sperically dependence.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: A

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5. Assertion : Wavelength associated with a moving particle becomes double if its velocity is doubled.

Reason : Wavelength associated with a moving object is inversely proportional to its velocity.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: D

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6. Which has larger wavelength: an electron or a proton ?

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7. What is the designation of an orbital having $n = 4$ and $l = 2$?

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8. Calculate the wavelength associated with an electron (mass = $9.1 \times 10^{-31} kg$) having kinetic energy $2.275 \times 10^{-25} J$.

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9. Write the electronic configurations and predict the number of unpaired electrons in the following :

(i) $Cr(Z = 24)$

(ii) $Fe(Z = 26)$

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10. What is an orbital ? Compare the shapes of 1s and 2s-orbital.

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11. An electron has a speed of $600ms^{-1}$ with uncertianty of 0.025%. What is the uncertainty in locating its position?

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12. What are Balmer series? Calculate the wave number of the longest and shortest wavelength transition in the Balmer series of atomic spectrum.

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13. (a) What observations in scartterting experiment led Rutherford to make the following conclusions?

(i) The most of the space in an atom is empty.

(ii) The whole of the mass of the atom is present in the centre of the nucleus.

(iii) Nucleus has positive charge.

(b) What is the value of orbital angular momentum for an electron in 2s orbital ?

(c) How many electrons in an atom may have $n = 4$ and $m_s = +1/2$?

(d) What physical meaning is attributed to the square of the absolute value of wave function Ψ^2?

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