CHEMISTRY

BOOKS - VIKRAM PUBLICATION (ANDHRA PUBLICATION)

ATOMIC STRUCTURE

Solved Problems

1. Calculate the number of protons , neutrons and electrons in $._{35}^{80}\mathrm{Br}$

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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 to the species .

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3. 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 transitter . Which part of the electromagnetic spectrum does it belong to ?

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

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5. Calculate: (a) wavenumber and (b) frequency of yellow radiation having wavelength 5000Å

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6. Calculate energy of one mole of photons of radiation whose frequency is 5×10^{14} Hz.

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7. 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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8. When electromagnetic radiations of wave length 300nm falls on the surface of sodium, electrons are emitted with a kinetic energy of $1.68 \times 10^5 J\text{mol}^{-1}$. 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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9. The threshold frequency v_0 for a metal is $7.0 \times 10^{14} s^{-1}$. Calculate the kinetic energy of an electron emitted when radiation of frequency $v = 1.0 \times 10^{15} s^{-1}$ hits the metal .

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

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

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13. 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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14. Calculate the mass of a photon with wavelength 3.6 Å.

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

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16. 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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17. What is the total number of orbitals present in the shell with the principal quantum number, n = 3

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18. Using s, p, d , f notations , describe the orbital with the following quantum numbers .

n = 2 , l = 1

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Important Questions

1. What is the charge , mass and charge to mass ratio of an electron ?

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2. Calculate the charge of one mole of electrons .

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3. Calculate the mass of one mole of electrons?

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4. How many neutrons and electrons are present in the nuclei of

$^{13}_{6}C, ^{16}_{8}O, ^{24}_{12}\mathrm{Mg}, ^{56}_{26}\mathrm{Fe}$ and $^{88}_{38}\mathrm{Sr}$?

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5. What is a black body ?

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6. When an electron is transferred in hydrogen atom from n = 4 orbit to n = 5 orbit to which spectral series does this belong ?

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7. What are the values of principal quantum number (n) and azimuthal quantum number (l) for a 3d electron ?

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8. What is the frequency of radiation of wavelenth 600 nm ?

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9. Explain Pauli's Exclusion principle with an example.

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10. What is Aufbau principle ?

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11. What is Hund's rule ?

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12. Explain Heisenberg's uncertainty principle .

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13. What is the wavelength of an electron moving with a velocity of $2.0 \times 10^{7} \mathrm{ms}^{-1}$?

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14. How many electrons in an atom may have $n = 4$ and $m_s = +\frac{1}{2}$?

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15. Explain the significance of Heisenberg's uncertainty principle .

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16. Show that the circumfernce 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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17. What are the main features of quantum mechanical model of an atom?

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18. What is a nodal plane ? How many nodal plance are possible for 2p and 3d - orbitals ?

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19. How are the quantum numbers n , 1 m_1 for hydrogen atom are obtained ?

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20. Explain the difference between emission and absorpation spectra.

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21. Explain photoelectric effect on the basis of Einstein theory.

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22. Explain Rutherford 's nuclear of an atom . What are its drawbacks ?

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23. What are the postulates of Bohr's model of hydrogen atom ? Discuss the importance of this model to explain various series of line spectra in hydrogen atom.

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24. Explain the success of Bohr's theory for hydrogen atom.

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25. What are the evidence in favour of dual behaviour of electron?

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26. How are the quantum numbers n , 1 m_1 for hydrogen atom are obtained ?

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27. Define atomic orbital . Explain the shapes of s, p and d orbitals with the help of diagrams.

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28. Illustrate the reaasons for the stability of completey filled and half -filled subshells .

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Very Short Answer Questions

1. What is the charge , mass and charge to mass ratio of an electron ?

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2. Calculate the charge of one mole of electrons .

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3. Calculate the mass of one mole of electrons?

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4. Calculate the charge of one mole of protons.

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5. Calculate the charge of one mole of neutrons.

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6. How many neutrons and electrons are present in the nuclei of

$^{13}_{6}C, ^{16}_{8}O, ^{24}_{12}\mathrm{Mg}, ^{56}_{26}\mathrm{Fe}$ and $^{88}_{38}\mathrm{Sr}$?

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7. What is a black body ?

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8. Which part of electromagnetic spectrum does Balmer series belong ?

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9. What is an atomic orbital ?

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10. When an electron is transferred in hydrogen atom from n = 4 orbit to n = 5 orbit to which spectral series does this belong ?

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11. How many P - electrons are present in sulphur atom ?

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12. What are the values of principal quantum number (n) and azimuthal quantum number (l) for a 3d electron ?

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13. What is the complete symbol for the atom with the given atomic number (Z) and atomic mass (A) ?

Z = 4 , A = 9

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14. What is the complete symbol for the atom with the given atomic number (Z) and atomic mass (A) ?

Z = 17 , A = 35

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15. What is the complete symbol for the atom with the given atomic number (Z) and atomic mass (A) ?

Z = 92 , A = 233

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16. Draw the shape of d_{z^2} orbital .

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17. Draw the shape of $d_{x^2-y^2}$ orbital .

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18. What is the frequency of radiation of wavelenth 600 nm ?

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19. What is Zeeman effect ?

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20. What is Stark effect ?

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21. To which element does the following electronic configuration correspond ?

$1s^2 2s^2 2p^6 3s^2 3p^1$

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22. To which element does the following electronic configuration correspond ?

$1s^2 2s^2 2p^6 3s^2 3p^6$

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23. To which element does the following electronic configuration correspond ?

$1s^2 2s^2 2p^5$

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24. To which element does the following electronic configuration correspond ?

$1s^2 2s^2 2p^2$

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25. Electrons are emitted with zero velocity from a metal surface when it is exposed to radiation of wavelength 4000Å . What is the threshold frequency (v_0) ?

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26. State and explain Pauli's exclusion principle.

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27. What is Aufbau principle ?

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28. What is Hund's rule ?

Watch Video Solution

29. Explain Heisenberg's uncertainty principle .

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30. What is the wavelength of an electron moving with a velocity of $2.0 \times 10^{7} \mathrm{ms}^{-1}$?

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31. An atomic orbital has n = 2 , what are the possible valuse of l and m_l ?

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32. Which of the following orbitals are possible ? (2s,1p,3f,2p)

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33. The static electric charge on the oil drop is $-3.2044 \times 10^{-19} C$. How many electrons are present on it ?

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34. Arrange the following type of radiation in increasing order of frequency :

(a) X- rays (b) visible radiation (c) microwave radiation and (d) radiation from radio waves .

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35. How many electrons in an atom may have $n = 4$ and $m_s = +\frac{1}{2}$?

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36. How many sub-shells are associated with n = 5 ?

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37. Explain the particle nature of electromagnetic radiations .

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38. Explain the significance of Heisenberg's uncertainty principle .

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39. What series of lines are observed in hydrogen spectra ?

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Short Answer Questions

1. What is the wavelength of light emitted when the electron in a hydrogen atom undergoes transition from an energy level with n = 5 to an energy level with n = 3 ?

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2. An atom of an element contains 29 electrons ans 35 neutrons . Deduce (i) the number of protons and (ii) the electromic configuration of the element .

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3. Explain giving reasons , which of the following sets of quantum numbers are not possible .

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

b) $n = 1, l = 0, m_l = 0, m_s = -\frac{1}{2}$

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

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

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

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

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4. Show that the circumfernce 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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5. The longest wavelength doublet absorption transition is observed at 589.0 ans 589.6nm .

Calculate the frequency of each transition and energy difference between two excited states .

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6. What are the main features of quantum mechanical model of an atom?

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7. What is a nodal plane ? How many nodal plance are possible for 2p and 3d - orbitals ?

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8. The Lyman series occurs between 91.2 nm and 121.6 nm , the Balmer series occurs between 364.7 nm and 656.5 nm and the Paschen series occurs between 820.6 nm and 1876 nm, Identify the spectral regions to which these wavelengths correspond .

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9. How are the quantum numbers n , 1 m_1 for hydrogen atom are obtained ?

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10. A line in Lyman series of hydrogen atom has a wavelength of $1.03 \times 10^{-7} m$. What is the initial energy level of the electron ?

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11. If the position of the electon is meaured within an accuracy of ± 0.002 nm , calculate the uncertainty in the momentum of the electron .

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12. If the velocity of the electron is $1.6 \times 10^6 \mathrm{ms}^{-1}$, calculate the de-Broglie wavelength associated with this electron .

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13. Explain the difference between emission and absorpation spectra.

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14. The quantum numbers of electrons are given below. Arrange them in order of increasing energies . Do any of these combinations have same energy ?

a) $n = 4, l = 2, m_l = -2, m_s = +1/2$

b) $n = 3, l = 2, m_l = -1, m_s = -1/2$

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

d) $n = 3, l = 1, m_l = -1, m_s = -1/2$

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15. The quantum numbers of electrons are given below. Arrange them in order of increasing energies . Do any of these combinations have same energy ?

a) $n = 4, l = 2, m_l = -2, m_s = +1/2$

b) $n = 3, l = 2, m_l = -1, m_s = -1/2$

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

d) $n = 3, l = 1, m_l = -1, m_s = -1/2$

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16. The quantum numbers of electrons are given below. Arrange them in order of increasing energies . Do any of these combinations have same energy ?

a) $n = 4, l = 2, m_l = -2, m_s = +1/2$

b) $n = 3, l = 2, m_l = -1, m_s = -1/2$

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

d) $n = 3, l = 1, m_l = -1, m_s = -1/2$

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17. The quantum numbers of six electrons are given below. Arrange them in order of increasing energies. Do any of these combination have same energy.

1. $n = 4 \quad l = 2 \quad m_l = -2 \quad m_s = -1/2$
2. $n = 3 \quad l = 2 \quad m_l = 1 \quad m_s = +1/2$
3. $n = 4 \quad l = 1 \quad m_l = 0 \quad m_s = +1/2$
4. $n = 3 \quad l = 2 \quad m_l = -2 \quad m_s = -1/2$
5. $n = 3 \quad l = 1 \quad m_l = -1 \quad m_s = +1/2$
6. $n = 4 \quad l = 1 \quad m_l = 0 \quad m_s = +1/2$

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18. The work function for Cesium atom is 1.9 eV . Calculate the threshold frequency of the radiation . If the Cesium element is irradiated with a wavelength of 500 nm , calculate the kinetic energy of the ejected photoelectron .

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

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20. What is the difference between an orbit and orbital ?

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21. Explain photoelectric effect on the basis of Einstein theory.

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Long Answer Questions

1. Explain Rutherford 's nuclear of an atom . What are its drawbacks ?

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2. Write Planck's equation .

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3. What are the postulates of Bohr's model of hydrogen atom ? Discuss the importance of this model to explain various series of line spectra in hydrogen atom.

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4. Explain the success of Bohr's theory for hydrogen atom.

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5. What are the consequences that lead to the development of quantum mechanical model of an atom?

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6. What are the main features of quantum mechanical model of an atom?

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7. What are the limitation of Bohr's model of an atom?

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8. What are the evidence in favour of dual behaviour of electron?

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9. How are the quantum numbers n , 1 m_1 for hydrogen atom are obtained ?

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10. Explain the dual behaviour of matter. Discuss its significance to microscopic particles like electrons.

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11. What are characteristics of electromagnetic waves ?

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12. Define atomic orbital . Explain the shapes of s, p and d orbitals with the help of diagrams.

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13. Explain diagrammatically the boundary surfaces for three 2p orbitals and five 3d orbitals.

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14. Illustrate the reaasons for the stability of completey filled and half -filled subshells .

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15. Explain emission and absorption spectra. Discuss the general description of line spectra in hydrogen atom .

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