NCERT
National Council Of Educational Research And Training

NCERT Solutions for 11th Class Chemistry: Chapter 2-Structure of Atom

IndCareer Schools

indCareer indCareer indCareer

NCERT Solutions for 11th Class Chemistry: Chapter 2-Structure of Atom

Class 11: Chemistry Chapter 2 solutions. Complete Class 11 Chemistry Chapter 2 Notes.

NCERT Solutions for 11th Class Chemistry: Chapter 2-Structure of Atom

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

Page No: 65

Exercises

https://www.indcareer.com/schools/ncert-solutions-for-11th-class-chemistry-chapter-2-structureof-atom/

2.1. (i) Calculate the number of electrons which will together weigh one gram.

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

Answer

(i) Mass of one electron = 9.11×10^{-31}kg

∴ 1g = 10^{-3} kg = $(1/9.11\times10^{-31})\times10^{-3}$ electrons = $1.09^{8}\times10^{27}$

(ii) Mass of one electron = 9.11×10^{-31}kg

∴ Mass of 1 mole of electrons = $(9.11\times10^{-31})\times(6.022\times10^{23})$= 5.48×10^{-7} kg

Charge on one electron = 1.602×10^{-19} coulomb

∴ Charge on 1 mole of electrons = $(1.602\times10^{-19})\times(6.022\times10^{23})$ = 9.65×10^{4} coulombs.

2.2. (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 7 mg of ^{14}C. (Assume that mass of a neutron = 1.675×10^{-27}kg).

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

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

Answer

(i) Electrons present in 1 molecule of methane (CH_4) = 6+4 = 10

∴ Electrons in mol i.e. 6.022×10^{23} molecules = 6.022×10^{24}

(ii) (a) Number of atoms in ^{14}C in 1 mole= 6.022×10^{23} atoms

1 atom of ^{14}C contains = 14-6 = 8 neutrons.

∴ The number of neutrons in 14 g of ^{14}C = $6.022\times10^{23}\times8$ neutrons

Number of neutrons in 7 mg = $(6.022\times10^{23}\times8\times7)/14000$ = 2.4088×10^{21} neutrons

(b) Mass of one neutron = 1.674×10^{-27}kg

Mass of total neutrons in 7 g of ^{14}C = (2.4088×10^{21}) $(1.675\times10^{-27}$ kg) = 4.035×10^{-6} kg

(iii) (a) 1 mol of NH_3 = 17gNH_3 =6.022×10^{23} molecules of NH_3

1 atom of NH_3 contains = 7+3 = 10 protons

∴ The number of protons in 1 mol of NH_3 =6.022×10^{24} protons.

Number of protons in 34 mg of NH_3 = $(6.022\times10^{24}\times34)/17\times1000 = 1.2044\times10^{22}$ protons.

(b) Mass of one proton = 1.6726×10^{-27}kg

∴ Mass of 1.2044×10^{22} protons = $(1.6726\times10^{-27})\times(1.2044\times10^{22})$ kg = 2.0145×10^{-5} kg.

No, there will be no effect of temperature and pressure.

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

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

$^{13}C_6$, $^{16}O_8$, $^{24}Mg_{12}$, $^{56}Fe_{26}$, $^{88}CSr_{38}$

Answer

Nucleus	Z	A	Protons(Z)	Neutrons(A-Z)
$^{13}C_6$	6	13	6	13-6=7
$^{16}O_8$	8	16	8	16-8=8
$^{24}Mg_{12}$	12	24	12	24-12=12
$^{56}Fe_{26}$	26	56	26	56-26=30
$^{88}CSr_{38}$	38	88	38	88-38=50

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

(i) Z = 17 , A = 35.

(ii) Z = 92 , A = 233.

(iii) Z = 4 , A = 9.

Answer

(i) $^{35}Cl_{17}$

(ii) $^{233}U_{92}$

(iii) $^{9}Be_{4}$

2.5. Yellow light emitted from a sodium lamp has a wavelength (λ) of 580 nm. Calculate the frequency (v) and wave number (ṽ) of the yellow light.

Answer

$\lambda = 580\ nm = 580\times10^{-9}\ m$

frequency (v) $= c/\lambda = 3.0\times10^{8}\ ms^{-1}/580\times10^{-9}\ m = 5.17\times10^{14}\ s^{-1}$

wave number $(\tilde{v}) = 1/\lambda = 1/580\times10^{-9}\ m = 1.72\times10^{6}\ m^{-1}$

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

2.6. Find energy of each of the photons which

(i) correspond to light of frequency 3×10^{15} Hz.

(ii) have wavelength of 0.50 Å.

Answer

(i) $v = 3\times10^{15}\ Hz$

$E = hv = (6.626\times10^{-34}\ Js)\times(3\times10^{15}\ s^{-1}) = 1.988\times10^{-18}\ J$

(ii) $\lambda = 0.50\times10^{-10}\ m$

$E = hv = hc/\lambda = (6.626\times10^{-34}\ Js)\times(3\times10^{15}\ s^{-1})/0.50\times10^{-10}\ m = 3.98\times10^{-15}\ J$

2.7. Calculate the wavelength, frequency and wave number of a light wave whose period is

2.0×10^{-10} s.

Answer

Frequency (v) = 1/Period = $1/2.0\times10^{-10}$ s = 5×10^{9} s^{-1}.

Wavelength (λ) = c/v = 3.0×10^{8} ms^{-1}/5×10^{9} s^{-1} = 6.0×10^{2} m

Wave number ($\tilde{v}$) = $1/\lambda$ = $1/6.0\times10^{2}$ m = 16.66 m^{-1}

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

Answer

λ = 4000 pm = 4000×10^{-12} m = 4×10^{-9} m

E = Nhv = Nhc/λ

$\therefore$ N = E×λ/h×c = (1J×4×10^{-9} m)/(6.626×10^{-34} Js×3.0×10^{8} ms^{-1}) = 2.012×10^{16} photons.

2.9. A photon of wavelength 4×10^{-7} m strikes on metal surface, the work function of the metal being 2.13 eV. Calculate

(i) the energy of the photon (eV),

(ii) the kinetic energy of the emission, and

(iii) the velocity of the photoelectron (1 eV = 1.6020×10^{-19} J).

Answer

(i) Energy of the photon (E) = hv = hc/λ = (6.626×10^{-34} Js×3.0×10^{8} ms^{-1})/4×10^{-7} m = 4.97×10^{-19} J

= $4.97\times10^{-19}/1.602\times10^{-19}$ eV

(ii) Kinetic energy of emission (1/2 mv^2) = hv- hvo = 3.10-2.13 = 0.97 eV

(iii) 1/2 mv^2 = 0.97 eV = 0.97×1.602×10^{-19} J

$\Rightarrow$ 1/2×($9.11\times10^{-31\ kg}$)×v^2 =0.97×1.602×10^{-19} J

$\Rightarrow$ v^2 =0.341×10^{12} = 34.1×10^{10}

$\Rightarrow$ v = 5.84×10^{5} ms^{-1}

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

Answer

$E = Nh\nu = Nhc/\lambda = (6.022\times10^{23}\ mol^{-1})\times(6.626\times10^{-34}\ Js\times3.0\times10^{8}\ ms^{-1})/242\times10^{-9}\ m$

$= 4.945\times10^{5}\ Jmol^{-1} = 494.5\ kJmol^{-1}$

2.11. A 25 watt bulb emits monochromatic yellow light of wavelength of 0.57μm. Calculate the rate of emission of quanta per second.

Answer

Energy emitted by the bulb = 25 watt = 25 Js^{-1}

Energy of one photon (E) = $h\nu = hc/\lambda$

$\lambda = 0.57\mu m = 0.57\times10^{-6}\ m$

$E = (6.626\times10^{-34}\ Js\times3.0\times10^{8}\ ms^{-1})/0.57\times10^{-6}\ m = 3.48\times10^{-19}\ J$

$\therefore$ No. of photons emitted per sec = $25\ Js^{-1}/3.48\times10^{-19}\ J = 7.18\times10^{19}$

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

Answer

$c = \nu\lambda$

$\therefore\ \nu o = c/\lambda o = 3.0\times10^{8}\ ms^{-1}/6800\times10^{-10}\ m = 4.14\times10^{14}\ s^{-1}$

Work function (wo) = $h\nu o = 6.626\times10^{-34}\ Js\times4.14\times10^{14}\ s^{-1} = 2.92\times10^{-19}\ J$

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

Answer

$\tilde{v} = R(1/n1^2 - 1/n2^2) = 109677(1/2^2 - 1/4^2)\ cm^{-1} = 20564.4 cm^{-1}$

$\lambda = 1/v = 1/20564.4 = 486\times10^{-7}\ cm = 486\times10^{-9}\ m = 486\ nm$

Page No: 66

2.14. How much energy is required to ionise a H atom if the electron occupies n = 5 orbit? Compare your answer with the ionization enthalpy of H atom (energy required to remove the electron from n=1 orbit).

Answer

$E_n = -21.8\times10^{-19}/n^2\ Jatom^{-1}$

For ionization from 5th orbit, $n_1 = 5$, $n_2 = \infty$

$\therefore \Delta E = E_2 - E_1 = -21.8\times10^{-19}\times(1/n2^2 - 1/n1^2) = 21.8\times10^{-19}\times(1/n1^2 - 1/n2^2)$

$= 21.8\times10^{-19}\times(1/5^2 - 1/\infty) = 8.72\times10^{-20}\ J$

For ionization from 1st orbit, $n_1 = 1$, $n_2 = \infty$

$\therefore \Delta E' = 21.8\times10^{-19}\times(1/1^2 - 1/\infty) = 21.8\times10^{-19}\ J$

$\Delta E'/\Delta E = 21.8\times10^{-19}/8.72\times10^{-20} = 25$

Hence, 25 times less energy is required to ionize an electron in the 5th orbital of hydrogen atom as compared to that in the ground state.

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

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

Answer

The number of spectral lines produced when an electron in the nthlevel drops down to the ground state is given by n(n-1)/2.

Given, n=6

$\therefore$ Number of spectral lines = 6×5/2 = 15 also given by, ∑(n2 - n1) = ∑(6-1) = ∑5 = 5+4+3+2+1 = 15

2.16. (i) The energy associated with the first orbit in the hydrogen atom is -2.18×10^{-18} J atom^{-1}. What is the energy associated with the fifth orbit? (ii) Calculate the radius of Bohr's fifth orbit for hydrogen atom.

Answer

(i) $E_n = -21.8\times10^{-19}/n^2$ J

∴ $E_5 = -21.8\times10^{-18}/5^2$ J = 8.72×10^{-20} J

(ii) For H atom, $r_n = 0.529\times n^2$ Å

∴ $r_5 = 0.529\times5^2 = 13.225$Å = 1.3225 nm

2.17. Calculate the wavenumber for the longest wavelength transition in the Balmer series of atomic hydrogen.

Answer

For the Balmer series, n1 = 2. Hence, $\tilde{v} = R(1/2^2 - 1/n2^2)$

$\tilde{v} = 1/\lambda$ (inversely proportional)

For λ to be maximum, ṽ should be minimum. This can be happened when n2 is minimum i.e. n2 = 3. Hence, $\tilde{v} = (1.097\times10^7 \text{ m}^{-1})(1/2^2 - 1/3^2) = 1.097\times10^7\times5/36 \text{ m}^{-1} = 1.523\times10^6 \text{ m}^{-1}$

2.18. What is the energy in joules, required to shift the electron of the hydrogen atom from the first Bohr orbit to the fifth Bohr orbit and what is the wavelength of the light emitted when the electron returns to the ground state? The ground state electron energy is -2.18×10^{-11} ergs.

Answer

1erg = 10^{-7} J

As ground state electronic energy is -2.18×10^{-11} ergs, this means that $E_n = -21.8\times10^{-11}/n^2$ ergs.

$\Delta E = E_5 - E_1 = 2.18\times10^{-11}(1/1^2 - 1/5^2) = 2.18\times10^{-11}(24/25) = 2.09\times10^{-11}$ ergs $= 2.09\times10^{-18}$ J

When electron returns to ground state (n=1), energy emitted = 2.09×10^{-11} ergs.

As, $E = h\nu = hc/\lambda$

$\Rightarrow \lambda = hc/E = (6.626\times10^{-27}$ erg sec$) (3.0\times10^{10}$ cm $s^{-1})/2.09\times10^{-11}$ ergs

$= 9.51\times10^{-6}$ cm $= 951\times10^{-8}$ cm $= 951$ Å

2.19. The electron energy in hydrogen atom is given by E n = $(-2.18\times10^{-18})/n^2$ 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?

Answer

$\Delta E = E_\infty - E_2 = 0 - (-2.18\times10^{-18}$ J $atom^{-1}/2^2) = 5.45\times10^{-19}$ J $atom^{-1}$

$\Delta E = h\nu = hc/\lambda$

$\Rightarrow \lambda = hc/\Delta E = (6.626\times10^{-34}$ Js$)\times(3.0\times10^{8}$ $ms^{-1})/5.45\times10^{-19}$ J $= 3.674\times10^{-7}$ m $= 3.674\times10^{-5}$ cm

2.20. Calculate the wavelength of an electron moving with a velocity of 2.05×10^{7} ms^{-1}.

Answer

By de Broglie equation,

$\lambda = h/mv = 6.626\times10^{-34}$ Js$/(9.11\times10^{-31}$ kg$) (2.05\times10^{7}$ $ms^{-1}) = 3.55\times10^{-11}$ m

2.21. The mass of an electron is 9.11×10^{-31} kg. If its K.E. is 3.0×10^{-25} J, calculate its wavelength.

Answer

K.E. $= 1/2\ mv^2$

$$= \sqrt{\frac{2\times 3.0\times 10^{-25}\ \text{J}}{9.11\times 10^{-31}\ \text{kg}}}$$

$\therefore v = \sqrt{2}$ K.E./m

$= 812$ ms^{-1}

By de Broglie equation, $\lambda = h/mv = 6.626\times10^{-34}$ Js$/(9.11\times10^{-31}$ kg$) (812$ $ms^{-1}) = 8.967\times10^{-7}$ m

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

Na^+ , K^+ , Mg^{2+} , Ca^{2+} , S^{2-} , Ar.

Answer

Notes:

Isoelectronic are the species having same number of electrons.

A positive charge means the shortage of an electron.

A negative charge means gain of electron.

Number of electrons in Na^+ = 11-1 = 10

Number of electrons in K^+ = 19-1 = 18

Number of electrons in Mg^{2+} = 12-2 = 10

Number of electrons in Ca^{2+} = 20-2 = 18

Number of electrons in S^{2-} = 16+2 = 18

Number of electrons in Ar = 18

Hence, the following are isoelectronic species:

1) Na^+ andMg^{2+} (10 electrons each)

2) K^+, Ca^{2+}, S^{2-} and Ar (18 electrons each)

2.23. (i) Write the electronic configurations of the following ions: (a) H^- (b) Na^+ (c) O^{2-} (d) F^-

(ii) What are the atomic numbers of elements whose outermost electrons are represented by (a) $3s^1$ (b) $2p^3$ and (c) $3p^5$?

(iii) Which atoms are indicated by the following configurations ? (a) [He]$2s^1$ (b) [Ne]$3s^2$ $3p^3$ (c) [Ar] $4s^2$ $3d^1$.

Answer

(i) (a) $_1H = 1s^1$. A negative charge means gain of electron.

∴ electronic configuration of $H^- = 1s^2$

(b) $_{11}Na = 1s^2 2s^2 2p^6 3s^1$. A positive charge means the shortage of an electron.

∴ electronic configuration of $Na^+ = 1s^2 2s^2 2p^6$

(c) $_8O = 1s^2 2s^2 2p^4$

∴ electronic configuration of $O^{2-} = 1s^2 2s^2 2p^6$

(d) $_9F = 1s^2 2s^2 2p^5$

∴ electronic configuration of $F^- = 1s^2 2s^2 2p^6$

(ii) (a) $3s^1$

Completing the electron configuration of the element as $1s^2 2s^2 2p^6 3s^1$

∴ Number of electrons present in the atom of the element = 2+2+6+1 = 11

∴ Atomic number of the element = 11

(b) $2p^3$

Completing the electron configuration of the element as $1s^2 2s^2 2p^3$

∴ Number of electrons present in the atom of the element = 2+2+3 = 7

∴ Atomic number of the element = 7

(c) $3p^5$

Completing the electron configuration of the element as $1s^2 2s^2 2p^6 3s^2 3p^5$

∴ Number of electrons present in the atom of the element = 2+2+6+2+5 = 17

∴ Atomic number of the element = 9

(iii) (a) $[He]2s^1$

electronic configuration = $1s^2 2s^1$

∴ Atomic number of the element = 2+1 = 3

Hence, the element with the electronic configuration $[He]2s^1$ is lithium (Li).

(b) $[Ne]3s^23p^3$

electronic configuration = $1s^22s^22p^63s^23p^3$

∴ Atomic number of the element = 2+2+6+2+3 = 15

Hence, the element with the electronic configuration $[Ne]3s^23p^3$ is phosphorus (P).

(c) $[Ar]\ 4s^23d^1$

electronic configuration = $1s^22s^22p^63s^23p^64s^23d^1$

∴ Atomic number of the element = 2+2+6+2+6+2+1 = 21

Hence, the element with the electronic configuration $[Ar]\ 4s^23d^1$ is scandium (Sc).

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

Answer

For g-orbitals, l = 4.

For any value 'n' of principal quantum number, the Azimuthal quantum number (l) can have a value from zero to (n - 1).

∴ For l = 4, minimum value of n = 5

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

Answer

For the 3d orbital:

Principal quantum number (n) = 3

Azimuthal quantum number (l) = 2

Magnetic quantum number (m_l) = -2,-1,0,1,2

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

Answer

(i) For neutral atom, number of protons = number of electrons.

∴ Number of protons in the atom of the given element = 29 = Atomic number

(ii) The electronic configuration of the atom with Z=29 is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$

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

Answer

H_2^+ = 2-1 = 1 electron

$H_{2} = {}_1H + {}_1H$ = 2 electrons

O_2^+ = 16-1 = 15 electrons

2.28. (i) An atomic orbital has n = 3. What are the possible values of *l* and m_l ?

(ii) List the quantum numbers (m_l and *l*) of electrons for 3d orbital.

(iii) Which of the following orbitals are possible?

1p, 2s, 2p and 3f

Answer

(i) For a given value of n, *l* can have values from 0 to (n-1).

∴ For n = 3 , l = 0, 1, 2

For a given value of *l*, m_l can have (2*l*+1) values.

When *l* = 0, m = 0

l = 1, m = - 1, 0, 1

l = 2, m = - 2, - 1, 0, 1, 2

l = 3, m = -3, -2, -1, 0, 1, 2, 3

(ii) For 3d orbital,n = 3, l = 2.

∴ For l = 2

m_2 = -2, -1, 0, 1, 2

(iii) 1p is not possible because when n = 1, l = 0. (for p, l = 1)

2s is possible because when n=2, l = 0,1 (for s, l=0)

2p is possible because when n=2, l = 0,1 (for p, l=1)

3f is not possible because when n=3, l = 0, 1 , 2 (for f, l=3)

2.29. Using s, p, d notations, describe 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.

Answer

(a) 1s

(b) 3p

(c) 4d

(d) 4f

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

(a) n = 0, l = 0, m_l = 0, m_s = +½

(b) n = 1, l = 0, m_l = 0, m_s = –½

(c) n = 1, l = 1, m_l = 0, m_s = +½

(d) n = 2, l = 1, m_l = 0, m_s = –½

(e) n = 3, l = 3, m_l = –3, m_s = +½

(f) n = 3, l = 1, m_l = 0, m_s = +½

Answer

(a) Not possible because n≠0

(b) Possible

(c) not possible because when n=1, *l*≠1

(d) Possible

(e) Not possible because when n=3, *l*≠3

(f) Possible

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

Page No: 67

2.31. How many electrons in an atom may have the following quantum numbers?

(a) n = 4, m_s = –½ (b) n = 3, *l* = 0

Answer

(i) The total number of electrons in n is given by $2n^2$

n=4, Number of electrons = $2 \times 4^2 = 32$

Half of 32 electrons will have spin quantum number m_s = –½ i.e. 16 electrons

(ii) n=3 and *l*=0 means it is 3s orbital which can have only 2 electrons.

2.32. 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 or**

mvr = nh/2π ⇒ 2πr = nh/mv ...(i)

Accor2πr = nλ

Thus, circumference of the Bohr orbit for the hydrogen atom is an integral multiple of de Broglie's wavelength ass

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

Answer

For H-like particles, $\tilde{v} = (2\pi^2 mZ^2e^4/ch^3)\times(1/n1^2 - 1/n2^2) = RZ^2(1/n1^2 - 1/n2^2)$

∴ For He^+ spectrum, Balmer transition, n=4 to n=2

$\tilde{v} = 1/\lambda = RZ^2(1/2^2 - 1/4^2) = R\times4\times3/16 = 3R/4$

For hydrogen spectrum ,

$\tilde{v} = 1/\lambda = R(1/n1^2 - 1/n2^2) = 3R/4 \Rightarrow (1/n1^2 - 1/n2^2) = 3/4$

which can be true only for n1=1 and n2=2 i.e. transition from n=2 to n=1.

2.34. Calculate the energy required for the process

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

The ionization energy for the H atom in the ground state is 2.18×10^{-18} J $atom^{-1.}$

Answer

For H-like particles, $E_n = -(2\pi^2 mZ^2e^4/n^2h^2)$

For H-atom, I.E. = $E - E_1 = 0 - (-2\pi^2 m\times2^2\times e^4/1^2\times h^2)$

$= (4\times2\pi^2 me^4/h^2) = 4\times2.18\times10^{-18}$ J $= 8.72\times10^{-18}$ J

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

Answer

Diameter of a carbon atom = 0.15 nm = 0.15×10^{-9} m = 1.5×10^{-10} m

Length along which atoms are to be placed = 20 cm = 2×10^{-1} m

∴ No. of C-atoms which can be placed along the line = 2×10^{-1} m/1.5×10^{-10} m = 1.33×10^9

2.36. 2×10^8 atoms of carbon are arranged side by side. Calculate the radius of carbon atom if the length of this arrangement is 2.4 cm.

Answer

Total length = 2.4 cm

Total number of atoms along the length = 2×10^8

∴ Diameter of each atom = 2.4 cm/2×10^8 = 1.2×10^{-8} cm

∴ Radius of the atom = Diameter/2 = 1.2×10^{-8} cm/2 = 0.6×10^{-8} cm

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

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

Answer

(a) Radius of zinc atom = 2.6Å/2 = 1.3Å = 1.3×10^{-10} m = 130×10^{-12} pm

(b) Given length = 1.6 cm = 1.6×10^{-2} m

Diameter of one atom = 2.6 Å = 2.6×10^{-10} m

∴ No. of atoms present along the length = $1.6\times10^{-2}/2.6\times10^{-10}$ = 6.154×10^{7}

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

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

Answer

Charge on one electron = 1.602×10^{-19} C

∴ Number of electrons carrying 2.5×10^{-16} C charge = $2.5\times10^{-16}/1.602\times10^{-19}$ =1560

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

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

Answer

As in the above question,

Number of electrons present in oil drop = $–1.282×10^{-18}/1.602×10^{-19}$ = 8

2.40. In Rutherford's experiment, generally the thin foil of heavy atoms, like gold, platinum etc. have been used to be bombarded by the α-particles. If the thin foil of light atoms like aluminium etc. is used, what difference would be observed from the above results ?

Answer

Heavy atoms have nucleus carrying large amount of positive charge. Therefor, some α-particles will easily deflected back. Also a number of α-particles are deflected through small angles because of large positive charge.

If light atoms are used, their nuclei will have small positive charge, hence the number of α-particles getting deflected even through small angles will be negligible.

2.41. Symbols $^{79}Br_{35}$ and ^{79}Br can be written, whereas symbols $^{35}Br_{79}$ and $_{35}Br$ are not acceptable. Answer briefly.

Answer

$^{35}Br_{79}$ is not acceptable because atomic number should be written as subscript, while mass number should be written as superscript. $_{35}Br$ is not acceptable because atomic number of an element is fixed. However, mass number is not fixed as it depends upon the isotopes taken. Hence, it is essential to indicate mass number.

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

Answer

Mass number = protons+neutrons = p+n = 81 (given)

Let p be x, then neutrons = x + (31.7/100)x = 1.317 x

∴ x + 1.317 x = 81

⇒ 2.317 x = 81

⇒ x = 81/2.317 = 35

Thus, protons = 35 = atomic number.

The symbol of the element is $^{81}Br_{35}$ or $^{81}_{35}Br$

2.43. An ion with mass number 37 possesses one unit of negative charge. If the ion contains 11.1% more neutrons than the electrons, find the symbol of the ion.

Answer

Let the number of electrons in the ion = x

Then, number of neutrons = x+(11.1 x/ 100) = 1.111 x

Number of electrons in the neutral atom = x-1 (ion possesses one unit of negative charge)

∴ Number of protons = x-1

Mass number = No. of protons + No. of neutrons

∴ 1.111 x + x - 1 = 37

⇒ 2.111x = 38

⇒ x = 18

∴ No. of protons = Atomic no. = x-1 = 18-1 = 17

The symbol of the ion is $^{37}_{17}Cl^{-1}$

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

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

Answer

Let the number of electrons in the ion = x

Then, number of neutrons = x+(30.4 x/ 100) = 1.304 x

Number of electrons in the neutral atom = x+3 (ion possesses 3 units of positive charge)

∴ Number of protons = x+3

Mass number = No. of protons + No. of neutrons

∴ 1.304 x + x +3 = 56

⇒ 2.304x = 53

⇒ x = 23

∴ No. of protons = Atomic no. = x+3 = 23+3 = 26

The symbol of the ion is ${}^{56}_{26}Fe^{+3}$

2.45. 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.

Answer

The increasing order of frequency is as follows:

Radiation from FM radio < amber light < radiation from microwave oven < X- rays < cosmic rays

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

Answer

$E = Nh\nu = Nhc/\lambda = (5.6\times10^{24})\times(6.626\times10^{-34}\ Js\times3.0\times10^{8}\ ms^{-1})/337.1\times10^{-9}\ m = 3.3\times10^{6}\ J$

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

2.47. Neon gas is generally used in the sign boards. If it emits strongly at 616 nm, calculate (a) the frequency of emission, (b) distance traveled by this radiation in 30 s (c) energy of quantum and (d) number of quanta present if it produces 2 J of energy.

Answer

$\lambda = 616$ nm $= 616\times10^{-9}$ m

(a) Frequency, $v = c/\lambda = 3.0\times10^{8}$ $ms^{-1}/616\times10^{-9}$ m $= 4.87\times10^{14}$ s^{-1}

(b) Velocity of the radiation $= 3.0\times10^{8}$ ms^{-1}

∴ Distance travelled in 30 s $= 30\times3\times10^{8}$ m $= 9.0\times10^{9}$ m

(c) $E = hv = hc/\lambda = (6.626\times10^{-34}$ $Js\times3.0\times10^{8}$ $ms^{-1})/616\times10^{-9}$ m $= 32.27\times10^{-20}$ J

(d) No. of quanta in 2J of energy $= 2J/32.27\times10^{-20}$ J $= 6.2\times10^{18}$

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

Answer

Energy of one photon $= hv = hc/\lambda = (6.626\times10^{-34}$ $Js\times3.0\times10^{8}$ $ms^{-1})/600\times10^{-9}$ m $= 3.313\times10^{-19}$ J

Total energy received $= 3.15\times10^{-18}$ J

∴ No. of photons received $= 3.15\times10^{-18}$ $J/3.313\times10^{-19}$ J $= 9.51$ (approx 10)

2.49. 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 source is 2.5×10^{15} , calculate the energy of the source.

Answer

Frequency $= 1/2\times10^{-19}$ s $= 0.5\times10^{9}$ s^{-1}

Energy $= Nhv = (2.5\times10^{15})\times(6.626\times10^{-34}$ $Js)\times(0.5\times10^{9}$ $s^{-1}) = 8.28\times10^{-10}$ J

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

Answer

$\lambda_1 = 589$ nm $= 589\times10^{-9}$ m

$\therefore$ $v_1 = c/\lambda_1 = 3.0\times10^8\ ms^{-1}/589\times10^{-9}\ m = 5.093\times10^{14}\ s^{-1}$

$\lambda_2 = 589.6\ nm = 589.6\times10^{-9}\ m$

$\therefore$ $v_2 = c/\lambda_2 = 3.0\times10^8\ ms^{-1}/589.6\times10^{-9}\ m = 5.088\times10^{14}\ s^{-1}$

$\Delta E = E_2 - E_1 = h(v_2 - v_1) = (6.626\times10^{-34}\ Js)\times(5.093-5.088)\times10^{14}\ s^{-1} = 3.31\times10^{-22}\ J$

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

2.51. The work function for caesium atom is 1.9 eV. 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.

Answer

(a) Work function $(W_0) = hv_0$

$\therefore$ $v_0 = W_0/h = 1.9\times1.602\times10^{-19}\ J/6.626\times10^{-34}\ Js = 4.59\times10^{14}\ s^{-1}$ $(1eV = 1.602\times10^{-19}\ J)$

(b) $\lambda_0 = c/v_0 = 3.0\times10^8\ ms^{-1}/4.59\times10^{14}\ s^{-1} = 6.54\times10^{-7}\ m = 654\times10^{-9}\ m = 654\ nm$

(c) K.E. of ejected electron $= h(v-v_0) = hc\ (1/\lambda - 1/\lambda_0)$

$= (6.626\times10^{-34}\ Js\times3.0\times10^8\ ms^{-1})\times(1/500\times10^{-9}\ m - 1/654\times10^{-9}\ m)$

$= (6.626\times3.0\times10^{-26}/10^{-9})\times(154/500\times654)\ J = 9.36\times10^{-20}\ J$

K.E. $= 1/2\ mv^2 = 9.36\times10^{-20}\ J$

$\therefore$ $1/2\times(9.11\times10^{-31}\ kg)\ v^2 = 9.36\times10^{-20}\ kgm^2s^{-2}$

$\Rightarrow v^2 = 2.055\times10^{11}\ m^2s^{-2} = 20.55\times10^{10}\ m^2s^{-2}$

$\Rightarrow v = 4.53\times10^5\ ms^{-1}$

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

λ (nm)	**500**	**450**	**400**
$v\times10^{-5}(cm\ s^{-1})$	**2.55**	**4.35**	**5.35**

Answer

Let the threshold wavelength to be λ_0 nm = $\lambda_0 \times 10^{-9}$ m .

Following equation holds true for photoelectric emission in given case:

K.E. = 1/2 mv^2 =h(v-v_0)

$\Rightarrow$ 1/2 mv^2 = hv-hv_0

$\Rightarrow$ hv_0 =hv - 1/2 mv^2

$\Rightarrow$ hc/λ_0 =hc/λ - 1/2 mv^2

$$\Rightarrow \lambda_0 = \frac{1}{\frac{1}{\lambda} - \frac{1}{2}\frac{m}{hc}v^2} = \frac{1}{\frac{1}{\lambda} - \frac{1}{2}\frac{9.1\times10^{-31}}{6.6\times10^{-34}\times3\times10^{8}}v^2}$$

(a) Substituting the value of λ and v from the above given data, we get three values of λ_0 as,

$\lambda_{0(1)}$ = 541 nm

$\lambda_{0(2)}$ = 546 nm

$\lambda_{0(3)}$ = 542 nm

Threshold frequency = λ_{av} = {$\lambda_{0(1)}$+$\lambda_{0(2)}$+$\lambda_{0(3)}$}/3 = (541+546+542)/3 = 543 (approx 540)

(b) Part of this question can't be solved due to incorrect value of v i.e 5.35.

Students can assume this value as 5.20 if they want to solve this question.

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

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

Answer

Energy of the incident radiation = Work function + Kinetic energy of photoelectron

$E = hc/\lambda = (6.626\times10^{-34}\ Js\times3.0\times10^{8}\ ms^{-1})/(256.7\times10^{-9}\ m) = 7.74\times10^{-19}\ J = 4.83\ eV$

The potential applied gives kinetic energy to the electron.

Hence, kinetic energy of the electron = 0.35 eV

∴ Work Function = 4.83 eV - 0.35 eV = 4.48 eV

2.54. If the photon of the wavelength 150 pm strikes an atom and one of its inner bound electrons is ejected out with a velocity of $1.5\times10^{7}\ ms^{-1}$, calculate the energy with which it is bound to the nucleus.

Answer

Energy of the incident photon= $hc/\lambda = (6.626\times10^{-34}\ Js\times3.0\times10^{8}\ ms^{-1})/(150\times10^{-12}m) = 13.25\times10^{-16}$ J

Energy of the electron ejected = $1/2\ mv^2 = 1/2\times(9.11\times10^{-31}kg)\times(1.5\times10^{7}ms^{-1})^2 = 1.025\times10^{-16}$ J

Energy with which the electron was bound to the nucleus = 13.25×10^{-16} J - 1.025×10^{-16} J

$= 12.225\times10^{-16}\ J = 12.225\times10^{-16}/1.602\times10^{-19}\ eV = 7.63\times10^{3}\ eV$

2.55. Emission transitions in the Paschen series end at orbit n = 3 and start from orbit n and can be represeted as $v = 3.29\times10^{15}(Hz)\ [1/3^2–1/n^2]$ Calculate the value of n if the transition is observed at 1285 nm. Find the region of the spectrum.

Answer

$v = c/\lambda = 3.0\times10^{8}\ ms^{-1}/1285\times10^{-9}\ m = 3.29\times10^{15}\ (1/3^2 - 1/n^2)$

$\Rightarrow 1/n^2 = 1/9 - (3.0\times10^{8}\ ms^{-1}/1285\times10^{-9}\ m)\times(1/3.29\times10^{15}) = 0.111-0.071 = 0.04 = 1/25$

$\Rightarrow n^2 = 25$

$\Rightarrow n = 5$

The radiation corresponding to 1285 nm lies in the infrared region.

2.56. 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.

Answer

Radius of nth orbit of H-like particles = $0.529n^2/Z$ Å = $52.9n^2/Z$ pm

$r_1 = 1.3225$ nm = 1322.5 pm = $52.9n_1^2$

$r_2 = 211.6$ pm = $52.9n_2^2/Z$

∴ $r_1/r_2 = 1322.5$ pm/211.6 pm = n_1^2/n_2^2

⇒ $n_1^2/n_2^2 = 6.25$

⇒ $n_1/n_2 = 2.5$

If $n_2 = 2$, $n_1 = 5$. Thus the transition is from 5th orbit to 2nd orbit. It belongs to Balmer series.

$\tilde{v} = 1.097\times10^7\ m^{-1}\ (1/2^2 - 1/5^2) = 1.097\times10^7\times21/100\ m^{-1}$

$\lambda = 1/\tilde{v} = 100/(1.097\times21\times10^7)\ m = 434\times10^{-9}\ m = 434$ nm

It lies in visible range.

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

2.57. 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 microscope is $1.6\times10^6\ ms^{-1}$, calculate de Broglie wavelength associated with this electron.

Answer

$\lambda = h/mv = 6.626\times10^{-34}\ kgm^2s^{-1}/(9.11\times10^{-31}\ kg)\ (1.6\times10^6\ ms^{-1}) = 4.55\times10^{-10}\ m = 455$ pm

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

Answer

Mass of neutron = 1.675×10^{-27} kg

$\lambda = h/mv$

$\Rightarrow v = h/m\lambda = 6.626\times10^{-34}\ kgm^2s^{-1}/(1.675\times10^{-27}\ kg)\ (800\times10^{-12}\ m) = 4.94\times10^4\ ms^{-1}$

2.59. If the velocity of the electron in Bohr's first orbit is $2.19\times10^6\ ms^{-1}$, calculate the de Broglie wavelength associated with it.

Answer

$\lambda = h/mv = 6.626\times10^{-34}\ kgm^2s^{-1}/(9.11\times10^{-31}\ kg)\ (2.19\times10^6\ ms^{-1}) = 3.32\times10^{-10}\ m = 332\ pm$

2.60. The velocity associated with a proton moving in a potential difference of 1000 V is $4.37\times10^5\ ms^{-1}$. If the hockey ball of mass 0.1 kg is moving with this velocity, calcualte the wavelength associated with this velocity.

Answer

$\lambda = h/mv = 6.626\times10^{-34}\ kgm^2s^{-1}/(0.1\ kg)\ (4.37\times10^5\ ms^{-1}) = 1.516\times10^{-28}\ m$

2.61. If the position of the electron is measured within an accuracy of + 0.002 nm, calculate the uncertainty in the momentum of the electron. Suppose the momentum of the electron is

$h/(4\pi\times0.05\ nm)$, is there any problem in defining this value.

Answer

$\Delta x = 0.002\ nm = 2\times10^{-12}\ m$

$\Delta x \times \Delta p = h/4\pi$

$\therefore \Delta p = h/4\pi\Delta x = 6.626\times10^{-34}\ kgm^2s^{-1}/(4\times3.14\times2\times10^{-12}\ m) = 2.638\times10^{-23}\ kgms^{-1}$

Actual momentum $= h/(4\pi\times0.05\ nm) = h/(4\pi\times5\times10^{-11}\ m)$

$= 6.626\times10^{-34}\ kgm^2s^{-1}/(4\times3.14\times5\times10^{-11}\ m) = 1.055\times10^{-24}\ kgms^{-1}$

It cannot be defined because the actual magnitude of the momentum is smaller than the uncertainty.

2.62. 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_l = –2 , m s = –1/2

2. n = 3, l = 2, m_l = 1 , m s = +1/2

3. n = 4, l = 1, m_l = 0 , m s = +1/2

4. n = 3, l = 2, m_l = –2 , m s = –1/2

5. n = 3, l = 1, m_l = –1 , m s = +1/2

6. n = 4, l = 1, m_l = 0 , m s = +1/2

Answer

The orbitals occupied by the electrons are:

(1) 4d

(2) 3d

(3) 4p

(4) 3d

(5) 3p

(6) 4p

Same orbitals will have same energy and higher the value of (n+l) higher is the energy,

Their energies will be in order: (5)<(2)=(4)<(6)=(3)<(1)

NCERT 11th Chemistry Chapter 2, class 11 Chemistry Chapter 2 solutions

2.63. The bromine atom possesses 35 electrons. It contains 6 electrons in 2p orbital, 6 electrons in 3p orbital and 5 electron in 4p orbital. Which of these electron experiences the lowest effective nuclear charge ?

Answer

4p electrons, being farthest from the nucleus experience the lowest effective nuclear charge.

2.64. Among the following pairs of orbitals which orbital will experience the larger effective nuclear charge? (i) 2s and 3s, (ii) 4d and 4f, (iii) 3d and 3p.

Answer

(i) 2s is closer to the nucleus than 3s. Hence, 2s will experience larger effective nuclear charge.

(ii) 4d (Reason being the same as above)

(iii) 3p (Reason being the same as above)

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

Answer

Silicon has greater nuclear charge (+14) than aluminium (+13). Hence, the unpaired 3p electron in case of silicon will experience more effective nuclear charge.

2.66. Indicate the number of unpaired electrons in : (a) P, (b) Si, (c) Cr, (d) Fe and (e) Kr.

Answer

(a) ${}_{15}P = 1s^2\,2s^2\,2p^6\,3s^2\,3\,p_x^1\,p_y^1\,p_z^1$.3 unpaired electrons. (in 3p)

(b) ${}_{14}Si = 1s^2\,2s^2\,2p^6\,3s^2\,3\,p_x^1\,p_y^1$. 2 unpaired electrons.(in 3p)

(c) ${}_{24}Cr = 1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^5\,4s^1$. 6 unpaired electrons. (5 in 3d and 1 in 4s)

(d) ${}_{26}Fe = 1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^6\,4s^2$. 4 unpaired electrons. (in 3d)

(e) ${}_{36}Kr$ = It is a Noble gas. All orbitals are filled. No unpaired electrons.

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

Answer

(a) n=4, *l* = 0, 1, 2, 3. 4 sub-shells are associated with n = 4

(b) No. of orbitals in the shells = $n^2 = 4^2 = 16$

Each orbitals has one electron with $m_s = -1/2$. Hence, there will be 16 electrons with $m_s = -1/2$.

Chapterwise NCERT Solutions for Class 11 Chemistry:

About NCERT

The National Council of Educational Research and Training is an autonomous organization of the Government of India which was established in 1961 as a literary, scientific, and charitable Society under the Societies Registration Act. The major objectives of NCERT and its constituent units are to: undertake, promote and coordinate research in areas related to school education; prepare and publish model textbooks, supplementary material, newsletters, journals and develop educational kits, multimedia digital materials, etc.

Organise pre-service and in-service training of teachers; develop and disseminate innovative educational techniques and practices;collaborate and network with state educational departments, universities, NGOs and other educational institutions; act as a clearing house for ideas and information in matters related to school education; and act as a nodal agency for achieving the goals of Universalisation of Elementary Education.
Its headquarters are located at Sri Aurobindo Marg in New Delhi.
Visit the Official NCERT website to learn more.