Structure of Atom

Question1

Which of the following electronic configuration would be associated with the highest magnetic moment?

[27-Jan-2024 Shift 1]

Options:

A.

$[Ar]3d^7$

B.

$[Ar]3d^8$

C.

$[Ar]3d^3$

D.

$[Ar]3d^6$

Answer: D

Solution:

	$3d^7$	$3d^8$	$3d^3$	$3d^6$
No.of. unpaired e^-	3	2	3	4
Spin only Magnetic moment	$\sqrt{15}$ BM	$\sqrt{8}$ BM	$\sqrt{15}$ BM	$\sqrt{24}$ BM

Question2

Consider the following complex ions

$P = [FeF_6]^{3-}$

$Q = [V(H_2O)_6]^{2+}$

$R = [Fe(H_2O)_6]^{2+}$

The correct order of the complex ions, according to their spin only magnetic moment values (in B.M.) is :

[27-Jan-2024 Shift 1]

Options:

A.

R < Q < P

B.

R < P < Q

C.

Q < R < P

D.

Q < P < R

Answer: C

Solution:

$[FeF_6]^{3-}$: Fe^{+3} : $[Ar]3d^5$

1	1	1	1	1

F : Weak field Ligand

No. of unpaired electron's $= 5$

$\mu = \sqrt{5(5+2)}$

$\mu = \sqrt{35}$ BM

$[V(H_2O)_6]^{+2}$: V^{+2} : $3d^3$

1	1	1		

No. of unpaired electron's $= 3$

$\mu = \sqrt{3(3+2)}$

$\mu = \sqrt{15}$ BM

$[Fe(H_2O)_6]^{+2} : Fe^{+2} : 3d^6$

↑↓	↑	↑	↑	↑

H_2O : Weak field Ligand

No. of unpaired electron's $= 4$

No. of unpaired electron's $= 4$

$\mu = \sqrt{4(4+2)}$

$\mu = \sqrt{24}$ BM

Question3

The electronic configuration for Neodymium is: [Atomic Number for Neodymium 60]

[27-Jan-2024 Shift 1]

Options:

A.

$[Xe]4f^4 6s^2$

B.

$[Xe]5f^4 7s^2$

C.

$[Xe]4f^6 6s^2$

D.

$[Xe]4f^1 5d^1 6s^2$

Answer: A

Solution:

Electronic configuration of Nd(Z = 60) is;

$[Xe]4f^4 6s^2$

Question4

The number of electrons present in all the completely filled subshells having n = 4 and s = + 1/2 is____

(Where n = principal quantum number and s= spin quantum number)

[27-Jan-2024 Shift 1]

Answer: 16

Solution:

n = 4 can have,

	4s	4p	4d	4f
Total e^-	2	6	10	14
Total e^- with $S = +\frac{1}{2}$	1	3	5	7

So, Ans. 16

Question5

Total number of ions from the following with noble gas configuration is_____

$Sr^{2+}(Z = 38)$, $Cs^{+}(Z = 55)$, $La^{2+}(Z = 57)$ Pb^{2+} $(Z = 82)$, $Yb^{2+}(Z = 70)$ and $Fe^{2+}(Z = 26)$

[27-Jan-2024 Shift 2]

Answer: 2

Solution:

Noble gas configuration $= ns^2np^6$

$[Sr^{2+}] = [Kr]$

$[Cs^{+}] = [Xe]$

$[Yb^{2+}] = [Xe]4f^{14}$

$[La^{2+}] = [Xe]5d^{1}$

$[Pb^{2+}] = [Xe]4f^{14}5d^{10}6s^{2}$

$[Fe^{2+}] = [Ar]3d^{6}$

Question6

The correct set of four quantum numbers for the valence electron of rubidium atom (Z = 37) is:

[29-Jan-2024 Shift 1]

Options:

A.

5, 0, 0, + 1/2

B.

5, 0, 1, + 1/2

C.

5, 1, 0, + 1/2

D.

5, 1, 1, + 1/2

Answer: A

Solution:

$Rb = [Kr]5s^1$

$n = 5$

$l = 0$

$m = 0$

$s = +1/2$ or $-1/2$

Question7

Choose the correct answer from the options given below :-

	List I (Spectral Series for Hydrogen)		**List II** (Spectral Region Higher
A.	Lyman	I.	Infrared region
B.	Balmer	II.	UV region
C.	Paschen	III.	Infrared region
D.	Pfund	IV.	Visible region

[29-Jan-2024 Shift 2]

Options:

A.

A-II, B-III, C-I, D-IV

B.

A-I, B-III, C-II, D-IV

C.

A-II, B-IV, C-III, D-I

D.

A-I, B-II, C-III, D-IV

Answer: C

Solution:

A - II, B - IV, C - III, D - I

Fact based.

Question8

Given below are two statements:

Statement-I: The orbitals having same energy are called as degenerate orbitals.
Statement-II: In hydrogen atom, 3p and 3d orbitals are not degenerate orbitals.

In the light of the above statements, choose the most appropriate answer from the options given

[30-Jan-2024 Shift 1]

Options:

A.

Statement-I is true but Statement-II is false

B.

Both Statement-I and Statement-II are true.

C.

Both Statement-I and Statement-II are false

D.

Statement-I is false but Statement-II is true

Answer: A

Solution:

For single electron species the energy depends upon principal quantum number ' n ' only. So, statement II is false.

Statement I is correct definition of degenerate orbitals.

Question9

Number of spectral lines obtained in He+spectra, when an electron makes transition from fifth excited state to first excited state will be___

[30-Jan-2024 Shift 2]

Answer: 10

Solution:

5^{th} excited state $\Rightarrow n_1 = 6$

1^{st} excited state $\Rightarrow n_2 = 2$

$\Delta n = n_1 - n_2 = 6 - 2 = 4$

Maximum number of spectral lines

$$= \frac{\Delta n(\Delta n + 1)}{2} = \frac{4(4+1)}{2} = 10$$

Question10

The ionization energy of sodium in $kJmol^{-1}$. If electromagnetic radiation of wavelength 242 nm is just sufficient to ionize sodium atom is___

[31-Jan-2024 Shift 1]

Answer: 494

Solution:

$$E = \frac{1240}{\lambda(nm)} eV$$

$$= \frac{1240}{242} eV$$

$$= 5.12 \, eV$$

$$= 5.12 \times 1.6 \times 10^{-19}$$

$$= 8.198 \times 10^{-19} J/ \text{ atom}$$

$$= 494 \, kJ/mol$$

Question11

The four quantum numbers for the electron in the outer most orbital of potassium (atomic no. 19) are

[31-Jan-2024 Shift 2]

Options:

A.

n = 4, l = 2, m = −1, s = + 1/2

B.

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

C.

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

D.

n = 2, l = 0, m = 0, s = + 1/2

Answer: B

Solution:

$_{19}K \;\; 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1.$

Outermost orbital of potassium is $4s$ orbital

$n = 4, 1 = 0, m_1 = 0, \; s = \pm \frac{1}{2}.$

Question12

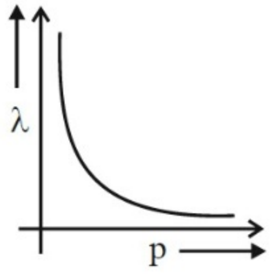
According to the wave-particle duality of matter by de-Broglie, which of

the following graph plot presents most appropriate relationship between wavelength of electron (λ) and momentum of electron (p) ?

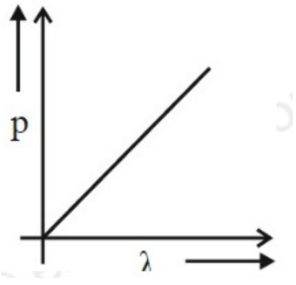
[1-Feb-2024 Shift 1]

Options:

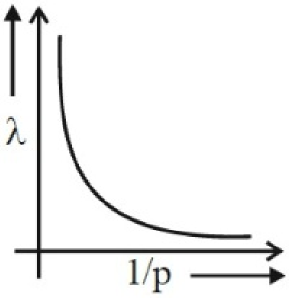
A.



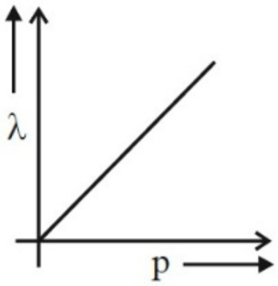
B.



C.



D.



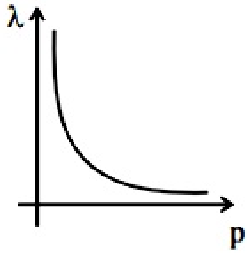
Answer: A

Solution:

$\lambda = \frac{h}{p}\left[\lambda \propto \frac{1}{p}\right]$

$\Rightarrow \lambda p = h(\text{ constant })$

So, the plot is a rectangular hyperbola



Question13

The number of radial node/s for 3p orbital is:

[1-Feb-2024 Shift 2]

Options:

A.

1

B.

4

C.

2

D.

3

Answer: A

Solution:

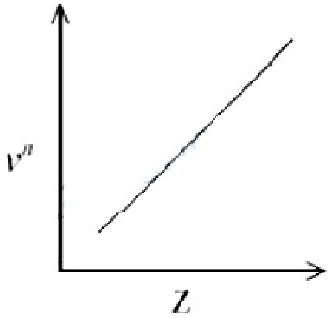
For $3p : n = 3, \ell = 1$

Number of radial node $= n - \ell - 1$

$= 3 - 1 - 1 = 1$

Question14

It is observed that characteristic X-ray spectra of elements show regularity. When frequency to the power 'n' i.e. v^n of X-rays emitted is plotted against atomic number ' Z ', following graph is obtained.



The value of ' n ' is
[24-Jan-2023 Shift 1]

Options:

A. 1

B. 2

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

D. 3

Answer: C

Solution:

According to Henry Moseley $\sqrt{\mathrm{v}} \alpha \mathrm{z} - \mathrm{b}$
So $\mathrm{n} = \frac{1}{2}$

Question15

If wavelength of the first line of the Paschen series of hydrogen atom is 720 nm, then the wavelength of the second line of this series is _____nm (Nearest integer)
[24-Jan-2023 Shift 1]

Answer: 492

Solution:

$$\frac{1}{(\lambda_1)_P} = R_H Z^2 \left(\frac{1}{9} - \frac{1}{16} \right)$$
$$\frac{1}{(\lambda_2)_P} = R_H Z^2 \left(\frac{1}{9} - \frac{1}{25} \right)$$
$$\frac{(\lambda_2)_P}{(\lambda_1)_P} = \frac{\frac{7}{16 \times 9}}{\frac{16}{25 \times 9}} = \frac{25 \times 7}{16 \times 16}$$

$(\lambda_2)_P = \frac{25 \times 7}{16 \times 16} \times 720$
$(\lambda_2)_P = 492\,nm$

Question16

The number of s-electrons present in an ion with 55 protons in its unipositive state is [24-Jan-2023 Shift 2]

Options:

A. 8

B. 9

C. 12

D. 10

Answer: D

Solution:

Solution:
$Z = 55[Cs] \Rightarrow [Xe]6\,s^1$
$[Cs^+] \Rightarrow [Xe]$ i.e. upto 5 s count e^- of s-subshell
i.e. 1 s, 2 s, 3 s, 4 s, 5 s ⇒ 10 electrons

Question17

The radius of the 2^{nd} orbit of Li^{2+} is x. The expected radius of the 3^{rd} orbit of Be^{3+} is [25-Jan-2023 Shift 1]

Options:

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

B. $\frac{4}{9}x$

C. $\frac{27}{16}x$

D. $\frac{16}{27}x$

Answer: C

Solution:

Li^{2+}

$r_2 = x = k \times \frac{2^2}{3} = \frac{4k}{2}$

$\frac{y}{x} = \frac{9}{4} \times \frac{3}{4} = \frac{27}{16}$

$y = \frac{27}{16}x$

Be^{3+}

$r_3 = y = k \times \frac{3^2}{4}$

Question18

How many of the following metal ions have similar value of spin only magnetic moment in gaseous state?________
(Given: Atomic number: V, 23; Cr, 24; Fe, 26; Ni, 28)
$V^{3+} \cdot Cr^{3+}, Fe^{2+}, Ni^{3+}$
[25-Jan-2023 Shift 1]

Answer: 2

Solution:

$\mu_s = \sqrt{n(n+2)}BM$ (n = no. of unpaired electrons)
V^{3+} : $[Ar]3d^2 4s^0$ 2
Cr^{3+} : $[Ar]3d^3 4s^0$ 3
Fe^{2+} : $[Ar]3d^6 4s^0$ 4
Ni^{3+} : $[Ar]3d^7 4s^0$ 3
Cr^{3+} & Ni^{3+} have same value of μ_s

Question19

The shortest wavelength of hydrogen atom in Lyman series is λ. The longest wavelength in Balmer series of He^+ is
[29-Jan-2023 Shift 1]

Options:

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

B. $\frac{9\lambda}{5}$

C. $\frac{36\lambda}{5}$

D. $\frac{5\lambda}{9}$

Answer: B

Solution:

For H : $\frac{1}{\lambda} = R_H \times 1^2 \left(\frac{1}{1^2} - \frac{1}{\infty^2} \right)$ . . . (1)

$\frac{1}{\lambda_{He^+}} = R_H \times 2^2 \times \left(\frac{1}{4} - \frac{1}{9} \right)$ . . . (2)

From (1) & (2) $\frac{\lambda_{He^+}}{\lambda} = \frac{9}{5}$

$\lambda_{He^+} = \lambda \times \frac{9}{5}$

$\lambda_{He^+} = \frac{9\lambda}{5}$

Question20

Assume that the radius of the first Bohr orbit of hydrogen atom is 0.6Å. The radius of the third Bohr orbit of He^+ is ______ picometer. (Nearest Integer)
[29-Jan-2023 Shift 2]

Answer: 270

Solution:

$r \propto \frac{n^2}{Z}$

$r_{He^+} = r_H \times \frac{n^2}{Z}$

$r_{He^+} = 0.6 \times \frac{(3)^2}{2}$

$= 2.7Å$

$r_{He^+} = 270\,pm$

Question21

The energy of one mole of photons of radiation of frequency 2×10^{12} Hz in $Jmol^{-1}$ is _______.
(Nearest integer)
(Given: $h = 6.626 \times 10^{-34}$ Js
$N_A = 6.022 \times 10^{23} mol^{-1}$)
[30-Jan-2023 Shift 1]

Answer: 798

Solution:

For one photon $E = h\nu$
For one mole photon,
$E = 6.023 \times 10^{23} \times 6.626 \times 10^{-34} \times 2 \times 10^{12}$
$= 798.16 J$
$\approx 798 J$

Question22

Maximum number of electrons that can be accommodated in shell with n = 4 are:
[30-Jan-2023 Shift 2]

Options:

A. 16

B. 32

C. 50

D. 72

Answer: B

Solution:

Solution:
The number of electrons in the orbitals of sub-shell of $n = 4$ are

4s	2
4p	6
4d	10
4f	14
(Total)	32

Question23

The wave function (Ψ) of 2 s is given by

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

At $r = r_0$, radial node is formed. Thus, r_0 in terms of a_0
[30-Jan-2023 Shift 2]

Options:

A. $r_0 = a_0$

B. $r_0 = 4a_0$

C. $r_0 = \frac{a_0}{2}$

D. $r_0 = 2a_0$

Answer: D

Solution:

At node $\Psi_{2s} = 0$

$\therefore 2 - \frac{r_0}{a_0} = 0$

$\therefore r_0 = 2a_0$

Question24

Which transition in the hydrogen spectrum would have the same wavelength as the Balmer type transition from n = 4 to n = 2 of He^+spectrum [31-Jan-2023 Shift 1]

Options:

A. n = 2 to n = 1

B. n = 1 to n = 3

C. n = 1 to n = 2

D. n = 3 to n = 4

Answer: A

Solution:

He^+ion:

$$\frac{1}{\lambda(H)} = R(1)^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda(He^+)} = R(2)^2\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

Given $\lambda(H) = \lambda(He^+)$

$$R(1)^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = R(4)\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

$$\frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{1}{1^2} - \frac{1}{2^2}$$

On comparing $n_1 = 1 \& n_2 = 2$

Ans. 1

Question25

Arrange the following orbitals in decreasing order of energy ?
(A) n = 3, 1 = 0, m = 0
(B) n = 4, 1 = 0, m = 0
(C) n = 3, 1 = 1, m = 0
(D) n = 3, l = 2, m = 1
The correct option for the order is :
[31-Jan-2023 Shift 2]

Options:

A. B > D > C > A

B. D > B > C > A

C. A > C > B > D

D. D > B > A > C

Answer: B

Solution:

Solution:
(A) $n = 3; l = 0; m = 0;$ 3 s orbital
(B) $n = 4; 1 = 0; m = 0;$ 4 s orbital
(C) $n = 3; 1 = 1; m = 0;$ 3p orbital
(D) $n = 3; 1 = 2; m = 0;$ 3d orbital
As per Hund's rule energy is given by $(n + l)$ value.
If value of $(n + l)$ remains same then energy is given by n only.

Question26

Electrons in a cathode ray tube have been emitted with a velocity of $1000 ms^{-1}$. The number of following statements which is/are true about the emitted radiation is ______.
Given : $h = 6 \times 10^{-34}$ Js, $m_e = 9 \times 10^{-31}$ kg.
(A) The deBroglie wavelength of the electron emitted is 666.67 nm.
(B) The characteristic of electrons emitted depend upon the material of the electrodes of the cathode ray tube.
(C) The cathode rays start from cathode and move towards anode.
(D) The nature of the emitted electrons depends on the nature of the gas present in cathode ray tube.
[1-Feb-2023 Shift 1]

Answer: 2

Solution:

(A) $V_e = 1000 m/s$; $h = 6 \times 10^{-34}$ Js;
$m_e = 9 \times 10^{-31}$ kg
$$\lambda = \frac{h}{mv} = \frac{6 \times 10^{-34}}{9 \times 10^{-31} \times 1000} = 666.67 \times 10^{-9} m$$
$= 666.67$ nm
(B) The characteristic of electrons emitted is independent of the material of the electrodes of the cathode ray tube.
(C) The cathode rays start from cathode and move towards anode.
(D) The nature of the emitted electrons is independent on the nature of the gas present in cathode ray tube.

Question27

Which one of the following sets of ions represents a collection of isoelectronic species?
(Given : Atomic Number: F : 9, Cl : 17, Na = 11, Mg = 12, Al = 13, K = 19, Ca = 20, Sc = 21)
[1-Feb-2023 Shift 2]

Options:

A. (Li^+, Na^+, Mg^{2+}, Ca^{2+}.

B. Ba^{2+}, Sr^{2+}, K+, Ca^{2+}

C. CN^{3-}, O^{2-}, F^-, S^{2-}

D. (K^+, Cl^-, Ca^{2+}, Sc^{3+}.

Answer: D

Solution:

Solution:
K^+ Cl^1 Ca^{2+} Sc^{3+}
18 18 18 18

Question28

The wavelength of an electron of kinetic energy 4.50×10^{-29}J is ...... $\times 10^{-5}$m. (Nearest integer)
Given : mass of electron is 9×10^{-31} kg, h = 6.6$\times 10^{-34}$J s
[6-Apr-2023 shift 1]

Answer: 7

Solution:

$$\lambda_d = \frac{h}{mv} = \frac{h}{\sqrt{2 mKE}} = \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 9 \times 10^{-31} \times 4.5 \times 10^{-29}}}$$
$$= \frac{6.6 \times 10^{-34}}{\sqrt{9^2 \times 10^{-60}}}$$
$$= \frac{6.6 \times 10^{-34}}{9 \times 10^{-30}} = \frac{6.6}{9} \times 10^{-4}$$
$= 7.3 \times 10^{-5}$m
Therefore Ans = 7

Question29

If the radius of the first orbit of hydrogen atom a_0, then de Broglie's wavelength of electron in 3^{rd} orbit is [6-Apr-2023 shift 2]

Options:

A. $\frac{\pi a_0}{6}$

B. $\frac{\pi a_0}{3}$

C. $6\pi a_0$

D. $3\pi a_0$

Answer: C

Solution:

Solution:

$$(r_3)_H = \frac{a_0 n^2}{Z} = a_0 \times 3^2 = 9a_0$$
$2\pi r = n\lambda$
$\Rightarrow 2\pi \times 9a_0 = 3\lambda$
$\Rightarrow \lambda = 6\pi a_0$

Question30

The number of following statements which is/are incorrect is ________ [8-Apr-2023 shift 1]

Options:

A. Line emission spectra are used to study the electronic structure

B. The emission spectra of atoms in the gas phase show a continuous spread of wavelength from red to violet

C. An absorption spectrum is like the photographic negative of an emission spectrum

D. The element helium was discovered in the sun by spectroscopic method

Answer: A

Solution:

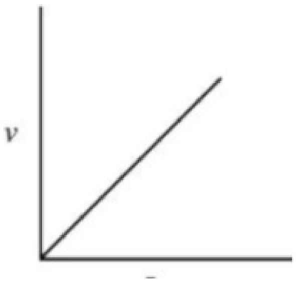
Solution:
Fact

Question31

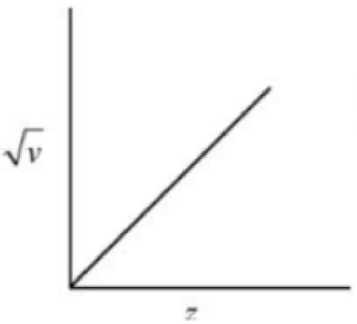
Henry Moseley studied characteristic X-ray spectra of elements. The graph which represents his observation correctly is
Given v = frequency of X-ray emitted
Z = atomic number
[8-Apr-2023 shift 2]

Options:

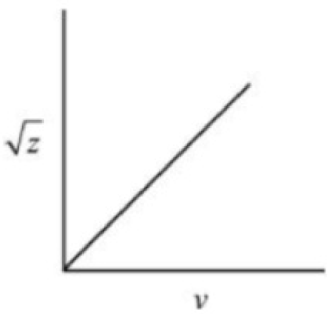
A.



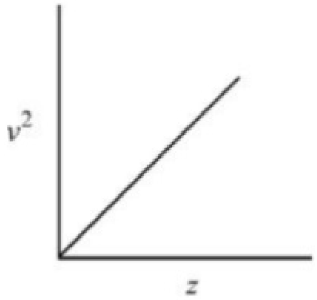
B.



C.



D.



Answer: B

Solution:

Solution:
$\sqrt{v} \alpha Z$

Question32

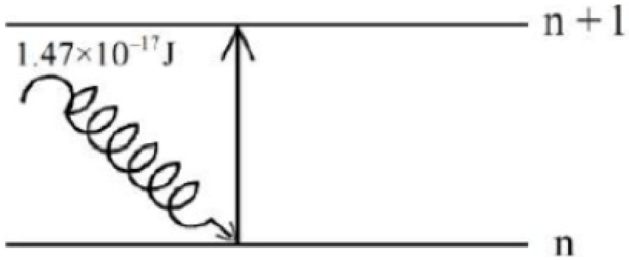
The number of atomic orbitals from the following having 5 radial nodes is _______ 7 s, 7p, 6 s, 8p, 8d
[8-Apr-2023 shift 2]

Answer: 3

Solution:

Solution:
No. of radial node
$= n - \ell - 1$
For $6S \rightarrow 6 - 0 - 1 = 5$
$7P \rightarrow 7 - 1 - 1 = 5$
$8d \rightarrow 8 - 2 - 1 = 5$

Question33



The electron in the nth orbit of Li^{2+} is excited to (n + 1) orbit using the radiation of energy 1.47×10^{-17}J(as shown in the diagram). The value of n is ________
Given: $R_H = 2.18 \times 10^{-18}$J
[10-Apr-2023 shift 2]

Answer: 1

Solution:

Solution:

$$\Delta E = R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

$$1.47 \times 10^{-17} = 2.18 \times 10^{-18} \times 9 \left(\frac{1}{n^2} - \frac{1}{(n+1)^2} \right)$$

$$\frac{1.47}{1.96} = \frac{3}{4} = \frac{1}{n^2} - \frac{1}{(n+1)^2}$$

So, $n = 1$

Question34

For a metal ion, the calculated magnetic moment is 4.90 BM. This metal ion has ________ number of unpaired electrons.
[10-Apr-2023 shift 2]

Answer: 4

Solution:

Solution:

$\mu = 4.90\,\text{BM}.$

$\mu = \sqrt{n(n+2)}$

So, $n = 4$

Question35

Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R:
Assertion A : In the photoelectric effect electrons are ejected from the metal surface as soon as the beam of light of frequency greater than threshold frequency strikes the surface.
Reason R: When the photon of any energy strikes an electron in the atom transfer of energy from the photon to the electron takes place.
In the light of the above statements, choose the most appropriate answer from the options given below:
[11-Apr-2023 shift 1]

Options:

A. A is correct but R is not correct

B. A is not correct but R is correct

C. Both A and R correct and R is the correct explanation of A

D. Both A and R are correct but R is NOT the correct explanation of A

Answer: A

Solution:

Assertion A is correct but Reason is not correct.

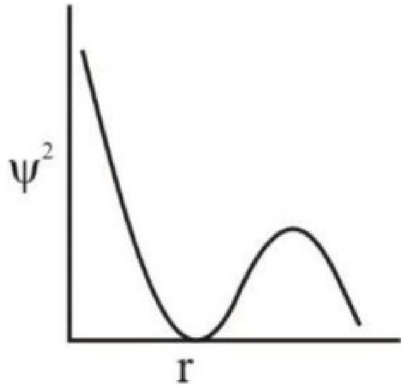
Question36

The number of correct statements from the following is
A. For 1 s orbital, the probability density is maximum at the nucleus
B. For 2 s orbital, the probability density first increases to maximum and then decreases sharply to zero.
C. Boundary surface diagrams of the orbitals encloses a region of 100% probability of finding the electron.
D. p and d-orbitals have 1 and 2 angular nodes respectively
E. probability density of p-orbital is zero at the nucleus
[11-Apr-2023 shift 2]

Answer: 3

Solution:

A, D and E statements are correct.



For 2 s orbital, the probability density first decreases and then increases.
At any distance from nucleus the probability density of finding electron is never zero and it always have some finite value.

Question37

Given below are two statement: one is labelled as Assertion A and the other is labelled as Reason R
Assertion A: 5f electrons can participate in bonding to a far greater extent than 4f electrons
Reason R: 5f orbitals are not as buried as 4f orbitals In the light of the above statements,
choose the correct answer from the options given below
[12-Apr-2023 shift 1]

Options:

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. A is false but R is true

Answer: A

Solution:

Solution:
Due to this reason actinoids participate in more bonding.

Question38

Values of work function (W_0) for a few metals are gives below

Metal	Li	Na	K	Mg	Cu	Ag
W_0/eV	2.42	2.3	2.25	3.7	4.8	4.3

The number of metals which will show photoelectric effect when light of wavelength 400 nm falls on it is
Given: $h = 6.6 \times 10^{-34}$ J s
$c = 3 \times 10^{8} ms^{-1}$
$e = 1.6 \times 10^{-19} C$
[12-Apr-2023 shift 1]

Answer: 3

Solution:

$E(ev) = \frac{1240}{400} = 3.1\,ev$

Mg, Cu, Ag

Question39

The energy of an electron in the first Bohr orbit of hydrogen atom is -2.18×10^{-18}J. Its energy in the third Bohr orbit is ______.
[13-Apr-2023 shift 1]

Options:

A. $\frac{1}{27}$ of this value

B. $\frac{1}{9}$ th of this value

C. One third of this value

D. Three times of this value

Answer: B

Solution:

$E_{1,1} = -2.18 \times 10^{-18}J$

$E_{3,1} = E_{1,1} \times \frac{1^2}{3^2}$

$E_{3,1} = \frac{1}{9} \times E_{1,1}$

Question40

The orbital angular momentum of an electron in 3 s orbital is $\frac{xh}{2\pi}$. The value of x is ______ (nearest integer)
[13-Apr-2023 shift 2]

Answer: 0

Solution:

Orbital angular momentum $= \sqrt{1(1+1)}\,\frac{h}{2\pi}$

Value of 1 for s = 0

Question41

The total number of isoelectronic species from the given set is ________.
O^{2-}, F^{-}, Al, Mg^{2+}, Na^{+}, O^{+}, Mg, Al^{3+}, F
[15-Apr-2023 shift 1]

Answer: 5

Solution:

Solution:

O^{-2},	F^{-}	mg^{+2}	Na^{+1}	Al^{+3}	
$10e^{-}$	$10e^{-}$	$10e^{-}$	$10e^{-}$	$10e^{-}$	Isoelectronic species

----

Question42

Consider the following pairs of electrons
(A)
(a) $n = 3, l = 1, m_1 = 1, m_s = +\frac{1}{2}$
(b) $n = 3, l = 2, m_1 = 1, m_s = +\frac{1}{2}$
(B)
(a) $n = 3, l = 2, m_1 = -2, m_s = -\frac{1}{2}$
(b) $n = 3, l = 2, m_1 = -1, m_s = -\frac{1}{2}$
(C)
(a) $n = 4, l = 2, m_1 = 2, m_s = +\frac{1}{2}$
(b) $n = 3, l = 2, m_1 = 2, m_s = +\frac{1}{2}$
The pairs of electrons present in degenerate orbitals is/are :
[24-Jun-2022-Shift-1]

Options:

A. Only (A)

B. Only (B)

C. Only (C)

D. (B) and (C)

Answer: B

Solution:

For degenerate orbitals, only the value of m must be different.
The value of $(n + 1)$ must be the same.Hence, the pair of electrons with quantum numbers given in (B) are degenerate.

Question43

The energy of one mole of photons of radiation of wavelength 300nm is (Given : $h = 6.63 \times 10^{-34}$ J s, $N_A = 6.02 \times 10^{23} mol^{-1}$, $c = 3 \times 10^8 ms^{-1}$) [24-Jun-2022-Shift-2]

Options:

A. $235 kJ\ mol^{-1}$

B. $325 kJ\ mol^{-1}$

C. $399 kJ\ mol^{-1}$

D. $435 kJ\ mol^{-1}$

Answer: C

Solution:

Energy of one photon

$E = \frac{1240}{\lambda(nm)} eV$

$= \frac{1240}{300}$

$= 4.1333\, eV$

$\therefore$ Energy of one mole of photon

$= 4.1333 \times 6.02 \times 10^{23}\, eV$

$= 4.1333 \times 6.02 \times 10^{23} \times 1.6 \times 10^{-19} J$

$= \frac{4.1333 \times 6.02 \times 10^{23} \times 1.6 \times 10^{-19}}{1000} kJ$

$= 399\, kJ / mol$

Question44

The pair, in which ions are isoelectronic with Al^{3+} is : [25-Jun-2022-Shift-1]

Options:

A. Br^{-} and Be^{2+}

B. Cl^{-} and Li^{+}

C. S^{2-} and K^{+}

D. O^{2-} and Mg^{2+}

Answer: D

Solution:

O^{2-}, Mg^{2+} and Al^{3+} are isoelectronic. All have 10 electrons.

Question45

The longest wavelength of light that can be used for the ionisation of lithium atom (Li) in its ground state is $x \times 10^{-8}$m. The value of x is___ (Nearest Integer).
(Given : Energy of the electron in the first shell of the hydrogen atom is -2.2×10^{-18}J; h = 6.63×10^{-34}Js and c = $3 \times 10^{8}ms^{-1}$)
[25-Jun-2022-Shift-1]

Answer: 4

Solution:

Solution:
Bohr model is not valid for lithium atom (Li) as Bohr model is valid for only single electronic species, so it would be valid for Li^{+2} but not Li atom.

Question46

The minimum energy that must be possessed by photons in order to produce the photoelectric effect with platinum metal is :
[Given: The threshold frequency of platinum is $1.3 \times 10^{15}s^{-1}$ and h = 6.6×10^{-34}Js.]
[25-Jun-2022-Shift-2]

Options:

A. 3.21×10^{-14}J

B. 6.24×10^{-16}J

C. 8.58×10^{-19}J

D. 9.76×10^{-20}J

Answer: C

Solution:

The minimum energy possessed by photons will be equal to the work function of the metal.
$\therefore E_{min} = h\nu_0 J$
$= 6.6 \times 10^{-34} \times 1.3 \times 10^{15}$
$= 8.58 \times 10^{-19} J$

Question47

If the radius of the 3^{rd} Bohr's orbit of hydrogen atom is r_3 and the radius of 4^{th} Bohr's orbit is r_4. Then :
[26-Jun-2022-Shift-1]

Options:

A. $r_4 = \frac{9}{16} r_3$

B. $r_4 = \frac{16}{9} r_3$

C. $r_4 = \frac{3}{4} r_3$

D. $r_4 = \frac{4}{3} r_3$

Answer: B

Solution:

We know,
$r = r_0 \times \frac{n^2}{z}$
For hydrogen atom,
$\therefore r_3 = r_0 \times \frac{3^2}{1}$
$\Rightarrow r_0 \times \frac{r_3}{9}$
and $r_4 = r_0 \times \frac{4^2}{1}$
$= \frac{r_3}{9} \times 16$
$= \frac{16}{9} r_3$

Question48

The number of radial and angular nodes in 4d orbital are, respectively
[26-Jun-2022-Shift-2]

Options:

A. 1 and 2

B. 3 and 2

C. 1 and 0

D. 2 and 1

Answer: A

Solution:

We know,
Radial nodes $= n - l - 1$
and Angular nodes $= 1$
For 4d orbital,
$n = 4$
$I = 2$
$\therefore$ Radial nodes $= 4 - 2 - 1 = 1$
Angular nodes $= 2$

Question49

If the uncertainty in velocity and position of a minute particle in space are, $2.4 \times 10^{-26} (ms^{-1})$ and $10^{-7}(m)$ respectively. The mass of the particle in g is____ (Nearest integer)
(Given : $h = 6.626 \times 10^{-34}$ Js)
[27-Jun-2022-Shift-1]

Answer: 22

Solution:

Solution:
We know from hisenberg uncertainty principle
$\Delta x \cdot \Delta p = \frac{h}{4\pi}$
$\Rightarrow \Delta x \cdot m \Delta v = \frac{h}{4\pi}$
Given,
$\Delta x = 10^{-7} m$
$\Delta x = 2.4 \times 10^{-26} m/s$
$h = 6.626 \times 10^{-34} Js$
$\therefore 10^{-7} \times m \times 2.4 \times 10^{-26} = \frac{6.626 \times 10^{-34}}{4\pi}$
$\Rightarrow 2.4m = \frac{6.626}{4\pi \times 10}$
$\Rightarrow m = 0.022\,kg$
$\Rightarrow m = 22\,gm$

Question50

Consider the following set of quantum numbers.

	n	1	m_l
A.	3	3	3
B.	3	2	2
C.	2	1	+1
D.	2	2	+2

The number of correct sets of quantum numbers is ________.
[27-Jun-2022-Shift-2]

Answer: 2

Solution:

Solution:
For A,
Given $n = 3$ and $l = 3$
but we know maximum value of $I = n - 1$.
∴ I can't be equal to n.
So, Set A of quantum numbers is not possible.
For B,
Given $n = 3, l = 2, m = -2$
Here, $l = 2$ which follow the rule $l = n - 1$.
And we know possible value of m is $-I$ to $+I$.
here possible value of $m = -2$ to $+2$
∴ This Set B is valid set of quantum numbers.
For C,
Given $n = 2, I = 1, m = +1$
Here $I = 1$ which follows the rule $I = n - 1$.
For $I = 1$ possible value of $m = -1$ to $+1$
Here $m = +1$. So value of m is valid.
∴ Set C is valid set of quantum numbers.
For D,
Given $n = 2, I = 2, m = +2$
$I = 2$ does not follow the rule $I = n - 1$ rule.
∴ Set D is not valid set of quantum numbers.

Question51

If the work function of a metal is 6.63×10^{-19}J, the maximum wavelength of the photon required to remove a photoelectron from the metal is___ nm. (Nearest integer)
[Given : $h = 6.63 \times 10^{-34}$Js, and $c = 3 \times 10^{8}ms^{-1}$]
[28-Jun-2022-Shift-1]

Answer: 300

Solution:

Solution:
Given,
Work function $= 6.63 \times 10^{-19} J$
$= \frac{6.63 \times 10^{-19}}{1.6 \times 10^{-19}}$
$= 4.14 \, eV$
We know,
$E = \frac{1240}{\lambda(nm)}$
$\Rightarrow 4.14 = \frac{1240}{\lambda}$
$\lambda = 300 \, nm$

Question52

Consider the following statements :
(A) The principal quantum number ' n ' is a positive integer with values of ' n ' = 1, 2, 3, ...
(B) The azimuthal quantum number 'I' for a given 'n' (principal quantum number) can have values as 'I' = 0, 1, 2,..... n
(C) Magnetic orbital quantum number 'm' for a particular 'l' (azimuthal quantum number) has (2l + 1) values.
(D) ±1 / 2 are the two possible orientations of electron spin.
(E) For I = 5, there will be a total of 9 orbital
Which of the above statements are correct?
[28-Jun-2022-Shift-2]

Options:

A. (A), (B) and (C)

B. (A), (C), (D) and (E)

C. (A), (C) and (D)

D. (A), (B), (C) and (D)

Answer: C

Solution:

Solution:
(A) Principle quantum number n is a positive integer and it's possible values are $n = 1, 2, 3 \ldots\ldots$.
$\therefore A$ is correct.
(B) Azimuthal quantum number 'l' for a given ' n ' can have values as $I = 0, 1, 2 \ldots\ldots (n-1)$
∴ Statement B is wrong.
(C) Magnetic orbital quantum number m_l for particular l has values from $-I$ to $+1$ including zero means $2l + 1$ values.
∴ Statement C is correct.
(D) $\pm \frac{1}{2}$ are the two possible orientation of electron spin.
∴ Statement D is correct.
(E) For $I = 5$, there will be a total of 11 orbitals.
$l = 0 \Rightarrow 5$ subshell
$l = 1 \Rightarrow p$ subshell
$l = 2 \Rightarrow d$ subshell

$l = 3 \Rightarrow f$ subshell
$l = 4 \Rightarrow g$ subshell
$l = 5 \Rightarrow h$ subshell
We know,
Number of orbital in any subshell $= 2l + 1$.
∴ For h subshell, number of orbitals $= 2 \times 5 + 1 = 11$

Question53

Which of the following statements are correct?
(A) The electronic configuration of Cr is $[Ar]3d^5 4s^1$.
(B) The magnetic quantum number may have a negative value.
(C) In the ground state of an atom, the orbitals are filled in order of their increasing energies.
(D) The total number of nodes are given by $n - 2$.
Choose the most appropriate answer from the options given below : [29-Jun-2022-Shift-1]

Options:

A. (A), (C) and (D) only

B. (A) and (B) only

C. (A) and (C) only

D. (A), (B) and (C) only

Answer: D

Solution:

Solution:
(A) $Cr(24) = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$
$= [Ar]3d^5 4s^1$
(B) Magnetic quantum number (m) values ranging from $-I$ to $+|$ including zero.
∴ It can have negative value.
(C) According to Aufbau rule, electrons are filled first in these orbitals which have low energy.
∴ Statement C is correct.
(D) We know,
Number of Radial nodes $= n - I - 1$
and number of Angular nodes $= 1$
∴ Total nodes $= n - I - 1 + 1 = n - 1$

Question54

The electronic configuration of Pt (atomic number 78) is: [29-Jun-2022-Shift-1]

Options:

A. $[Xe]4f^{14}5d^9 6s^1$

B. $[Kr]4f^{14}5d^{10}$

C. [Xe]$4f^{14}5d^{10}$

D. [Xe]$4f^{14}5d^{8}6s^{2}$

Answer: A

Solution:

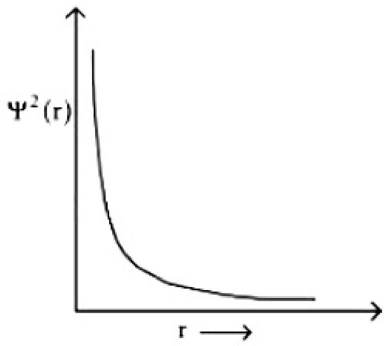
Solution:
Atomic number of Pt is 78
Electronic configuration is $-{}_{78}Pt \rightarrow [Xe]4f^{14}5d^{9}6s^{1}$ (Exceptional electronic configuration)

Question55

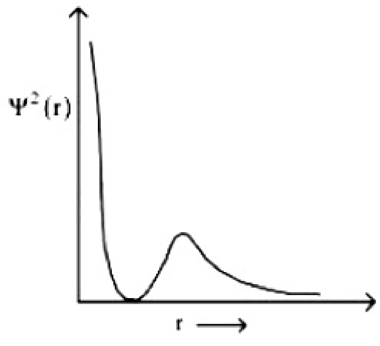
Which of the following is the correct plot for the probability density $\psi^2(r)$ as a function of distance ' r ' of the electron from the nucleus for 2s orbital?
[29-Jun-2022-Shift-2]

Options:

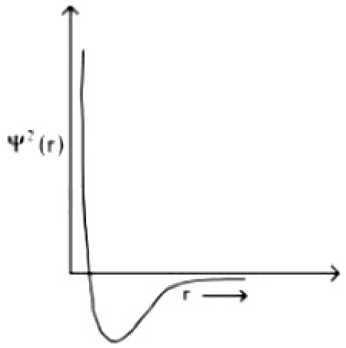
A.



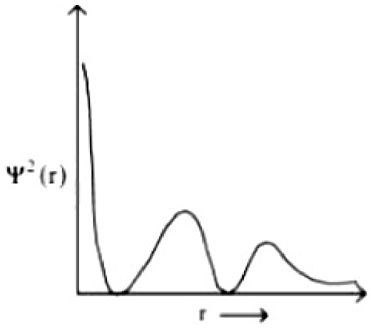
B.



C.



D.



Answer: B

Solution:

Solution:
Formula for number of radial nodes in n^{th} orbital $= n - l - 1$
For $2s$, number of radial nodes $= 2 - 0 - 1 = 1$ and value of ψ^2 is always positive.

Question56

Which of the following sets of quantum numbers is not allowed? [25-Jul-2022-Shift-1]

Options:

A. $n = 3, 1 = 2, m_l = 0, s = +\frac{1}{2}$

B. $n = 3, l = 2, m_l = -2, s = +\frac{1}{2}$

C. $n = 3, l = 3, m_l = -3, s = -\frac{1}{2}$

D. $n = 3, l = 0, m_1 = 0, s = -\frac{1}{2}$

Answer: C

Solution:

Solution:
If $n = 3$, then possible values of $l = 0, 1, 2$
But in option (C), the value of 1 is given ' 3 ', this is not possible.

Question57

When the excited electron of a H atom from n = 5 drops to the ground state, the maximum number of emission lines observed are______ [25-Jul-2022-Shift-2]

Answer: 10

Solution:

Solution:
Maximum number of emission lines
$= \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$
$n_2 = 5$
$n_1 = 1$
$\Rightarrow \frac{(5-1)(5-1+1)}{2} = 10$
Hence maximum number of emission lines observed are 10 .

Question58

The wavelength of an electron and a neutron will become equal when the velocity of the electron is x times the velocity of neutron. The value of x is ________.(Nearest Integer)
(Mass of electron is 9.1×10^{-31} kg and mass of neutron is 1.6×10^{-27} kg)
[26-Jul-2022-Shift-1]

Answer: 1758

Solution:

$\lambda_e = \frac{h}{m_e \times V_e}, \quad \lambda_N = \frac{h}{m_N \times V_N}$
$\lambda_e = \lambda_N$ When $V_e = xV_N$
$\frac{1}{m_e V_e} = \frac{1}{m_N \times V_N}$
$\frac{m_N}{m_e} = \frac{V_e}{V_N} = x$
$x = \frac{1.6 \times 10^{-27}}{9.1 \times 10^{-31}}$
$= 0.17582 \times 10^4$

$\simeq 1758$

Question59

Consider an imaginary ion $_{22}^{48}X^{3-}$. The nucleus contains ' a ' % more neutrons than the number of electrons in the ion. The value of ' a ' is ________ . [nearest integer]
[26-Jul-2022-Shift-2]

Answer: 4

Solution:

Solution:
Number of electrons in $_{22}^{48}X^{3-}$ is 25 .
Number of neutrons $= 48 - 22 = 26$.
% increase in the number of neutrons over electrons
$= \left(\frac{26-25}{25}\right)100 = 4\%$
$\therefore a = 4$

Question60

Given below are two statements. One is labelled as Assertion A and the other is labelled as Reason R.
Assertion A: Energy of 2s orbital of hydrogen atom is greater than that of 2s orbital of lithium.
Reason R: Energies of the orbitals in the same subshell decrease with increase in the atomic number.
In the light of the above statements, choose the correct answer from the options given below.
[27-Jul-2022-Shift-1]

Options:

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. A is false but R is true.

Answer: A

Solution:

As the atomic number increases then the potential energy of electrons present in same shell becomes more and more negative. And therefore total energy also becomes more negative.

$E_{total} = -13.6 \frac{Z^2}{n^2} eV$

∴ Energies of the orbitals in the same subshell decreases with increase in atomic number.

Question61

The correct decreasing order of energy for the orbitals having, following set of quantum numbers :
(A) n = 3, I = 0, m = 0
(B) n = 4, I = 0, m = 0
(C) n = 3, I = 1, m = 0
(D) n = 3, l = 2, m = 1
is :
[27-Jul-2022-Shift-2]

Options:

A. (D) >(B) > (C) > (A)

B. (B) >(D) > (C) > (A)

C. (C) > (B) > (D) > (A)

D. (B) > (C) > (D) > (A)

Answer: A

Solution:

Solution:

(A) $n + \ell = 3 + 0 = 3$

(B) $n + \ell = 4 + 0 = 4$

(C) $n + \ell = 3 + 1 = 4$

(D) $n + \ell = 3 + 2 = 5$

Higher $n + \ell$ value, higher the energy \& if same $n + \ell$ value, then higher n value, higher the energy. Thus :

D > B > C > A.

Question62

Identify the incorrect statement from the following.
[28-Jul-2022-Shift-1]

Options:

A. A circular path around the nucleus in which an electron moves is proposed as Bohr's orbit.

B. An orbital is the one electron wave function (ψ) in an atom.

C. The existence of Bohr's orbits is supported by hydrogen spectrum.

D. Atomic orbital is characterised by the quantum numbers n and l only.

Answer: D

Solution:

Solution:
Atomic orbital is characterised by the quantum numbers n, l and m.
Hence option D is incorrect.

Question63

If the wavelength for an electron emitted from H-atom is 3.3×10^{-10}m, then energy absorbed by the electron in its ground state compared to minimum energy required for its escape from the atom, is times. (Nearest integer)
[Given : $h = 6.626 \times 10^{-34}$J s]
Mass of electron $= 9.1 \times 10^{-31}$ kg
[28-Jul-2022-Shift-2]

Answer: 2

Solution:

Solution:
$\lambda = \frac{h}{mv}$

$\Rightarrow mv = \frac{h}{\lambda} = \frac{6.626 \times 10^{-34} \text{kg} \frac{m^2}{\sec^2} \times \sec}{3.3 \times 10^{-10} m}$

$mv = \frac{6.626 \times 10^{-24}}{3.3} = 2 \times 10^{-24} \text{kg m sec}^{-1}$

Kinetic energy $= \frac{1}{2} mv^2$

$= \frac{(mv)^2}{2m}$

$= \frac{(2 \times 10^{-24})^2}{2 \times 9.1 \times 10^{-31} \text{kg}}$

$= 2.18 \times 10^{-18}$J

$= 21.8 \times 10^{-19}$J

Total energy absorbed = Ionization energy + Kinetic energy
$= (21.76 + 21.8) \times 10^{-19}$
$= 43.56 \times 10^{-19}$J
$\approx$2 times of 21.76×10^{-19}J

Question64

The minimum uncertainty in the speed of an electron in an one dimensional region of length $2a_o$ (Where $a_o =$ Bohr radius 52.9 pm) is

________ $km\,s^{-1}$
(Given : Mass of electron = 9.1×10^{-31} kg, Planck's constant h = 6.63×10^{-34} Js)
[29-Jul-2022-Shift-1]

Answer: 548

Solution:

Solution:
Heisenberg's uncertainty principle
$\Delta x \times \Delta P_x \geq \frac{h}{4\pi}$
$\Rightarrow 2a_0 \times m\, \Delta v_x = \frac{h}{4\pi}$(minimum)
$\Rightarrow \Delta v_x = \frac{h}{4\pi} \times \frac{1}{2a_0} \times \frac{1}{m}$
$= 6.63 \times 10^{-34}$
$4 \times 3.14 \times 2 \times 52.9 \times 10^{-12} \times 9.1 \times 10^{-31}$
$= 548273 ms^{-1}$
$= 548.273 kms^{-1}$
$= 548 kms^{-1}$

Question65

Given below are the quantum numbers for 4 electrons.
A. n = 3, 1 = 2, m_1 = 1, m_s = +1 / 2
B. n = 4, 1 = 1, m_1 = 0, m_s = +1 / 2
C. n = 4, 1 = 2, m_1 = −2, m_s = −1 / 2
D. n = 3, 1 = 1, m_1 = −1, m_s = +1 / 2
The correct order of increasing energy is
[29-Jul-2022-Shift-2]

Options:

A. D < B < A < C

B. D < A < B < C

C. B < D < A < C

D. B < D < C < A

Answer: B

Solution:

Solution:
Energy of the sub-shell is given by, $(n + l)$ rule.
$A \Rightarrow 3d \Rightarrow n + 1 = 5$

B ⇒ 4p ⇒ n + λ = 5
C ⇒ 4d ⇒ n + ℓ ⇒ 6
D ⇒ 3 s ⇒ (n + ℓ) = 4
D < A < B < C

Question66

Electromagnetic radiation of wavelength 663nm is just sufficient to ionise the atom of metal A. The ionisation energy of metal A in kJ mol^{-1} is ....(Rounded off to the nearest integer)
[$h = 6.63 \times 10^{-34} J - s$, $c = 3.00 \times 10^{8} ms^{-1}$,
$N_A = 6.02 \times 10^{23} mol^{-1}$]
[25 Feb 2021 Shift 2]

Answer: 180

Solution:

Solution:
Energy of EMR = IE of the metal (A)

$= h\nu = \frac{hc}{\lambda} atom^{-1} = -\frac{hc}{\lambda} \times N_A mol^{-1}$

$= \frac{(6.63 \times 10^{-34}) \times (3 \times 10^{8}) \times (6.02 \times 10^{23})}{(663 \times 10^{-9})} J\ mol^{-1}$

$[\because \lambda = 663nm = 663 \times 10^{-9} m]$

$= 180600 J\ mol^{-1} = 180.6 kJ\ mol^{-1} \sim eq 180 kJ\ mol^{-1}$

Question67

According to Bohr's atomic theory,
I. kinetic energy of electron is $\propto \frac{Z^2}{n^2}$
II. the product of velocity (v) of electron and principal quantum number (n), ′vn′ $\propto Z^2$.
III. frequency of revolution of electron in an orbit is $\propto \frac{Z^3}{n^3}$
IV. coulombic force of attraction on the electron is $\propto \frac{Z^3}{n^4}$
Choose the most appropriate answer from the options given below.
[24 Feb 2021 Shift 2]

Options:

A. Only III

B. Only I

C. I, III and IV

D. I and IV

Answer: D

Solution:

Solution:
According to Bohr's theory,

I. $KE \propto \frac{Z^2}{n^2}$ or $13.6 \propto \frac{Z^2}{n^2} \frac{(eV)}{(atom)}$ (∴ Correct)

II. Speed of electron $\propto \frac{Z}{n}$

(Here, Z = atomic number, n = number of shells)

$\therefore\ v \times n \propto Z$ (∴ Incorrect)

III. Frequency of revolution of electron $= \frac{v}{2\pi r}$

Frequency $\propto \frac{Z^2}{n^3} \left(\because v \propto \frac{z}{n}, r \propto \frac{n^2}{z}\right)$ (∴ Incorrect)

IV. $F = \frac{kq_1q_2}{r^2} = \frac{kZe^2}{r^2}$

$F = \frac{Z}{\left(\frac{n^2}{Z}\right)^2}$

$F \propto \frac{Z^3}{n^4}$ (∴ Correct)

Hence, only I, and IV are correct.

Question68

A ball weighing 10g is moving with a velocity of $90ms^{-1}$. If the uncertainty in its velocity is 5%, then the uncertainty in its position is .... $\times 10^{-33}$m (Rounded off to the nearest integer). [Given, $h = 6.63 \times 10^{-34} J - s$] [26 Feb 2021 Shift 2]

Answer: 1

Solution:

Solution:
According to Heisenberg's uncertainty equation,

$\Delta x \times m \Delta v \geq \frac{h}{4\pi}$ ($\therefore m = 10g = 10 \times 10^{-3}kg, v = 90ms^{-1}$)

Uncertainty in position,

$$\Delta x = \frac{h}{4\pi} \times \frac{1}{m \times \Delta v(\text{ with uncertainty })}$$

$$= \frac{6.63 \times 10^{-34}}{4 \times 3.14} \times \frac{1}{(10 \times 10^{-3}) \times \left(90 \times \frac{5}{100}\right)} m$$

$= 1.17 \times 10^{-33}m$

$= 1 \times 10^{-33}m$

Question69

Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) In TlI_3, isomorphous to CsI_3, the metal is present in +1 oxidation state.
Reason (R) Tl metal has fourteen f -electrons in the electronic configuration.
In the light of the above statements, choose the most appropriate answer from the options given below.
[26 Feb 2021 Shift 2]

Options:

A. A is correct but R is not correct.

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

C. A is not correct but R is correct

D. Both A and R are correct but R is not correct explanation of A.

Answer: B

Solution:

Solution:
Assertion (A) is correct. TlI_3 and CsI_3 are the triiodide, I_3^- (polyhalide) compounds of $Tl^+$and Cs^+ions. Due to inert pair effect of group −13 elements, $Tl^+$is more stable than TH^{3+}. Cs and Tl belong to the same period (6th).
Sizes of $Cs^+$and $Tl^+$are nearly same.
So, geometrical network and lattice pattern of both CsI_3 and TlI_3 are same (bcc lattice). Csl_3 and TlI_3 are also able to form mixed crystals when crystallisation is carried out from a mixture of saturated solutions of CsI_3 and TlI_3. These properties enable TlI_3 and Csl_3 to be isomorphous crystals.
Reason (R) is also correct. Electronic configuration of Cs ($Z = 55$) and TI ($Z = 81$) as follows
$_{55}Cs : [_{54}Xe]6s^1$
$_{81}Tl : [_{54}Xe]4f^{14}{}_{5d}{}^{10}6s^2 6p^1$
So, Tl has fourteen f -electrons in the anti-penultimate (4th) shell. A and R are individually correct and R is the correct explanation of A.

Question70

The orbital having two radial as well as two angular nodes is
[26 Feb 2021 Shift 1]

Options:

A. 3p

B. 4f

C. 4d

D. 5d

Answer: D

Solution:

Solution:
Number of radial nodes $= (n - I - 1)$
[$n =$ principal quantum number, $I =$ az imuthal quantum number] Number of angular nodes $= 1$
(a) $3p (n = 3, I = 1) \Rightarrow 1 \ \ 1$
(b) $4f (n = 4, I = 3) \Rightarrow 0 \ \ 3$
(c) $4d (n = 4, I = 2) \Rightarrow 1 \ \ 2$
(d) $5d (n = 5, I = 2) \Rightarrow 2 \ \ 2$
So, $5d$ -orbital has two radial as well as two angular nodes (option-d). Note $I = 0$ for s-orbital, $I = 1$ for p-orbital, $I = 2$ for d -orbital and $I = 3$ for $f -$orbital.

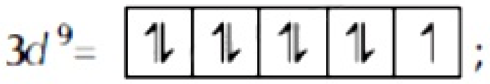
Question71

The spin only magnetic moment of a divaler ion in aqueous solution (atomic number = 29) is .... BM.
[25 Feb 2021 Shift 2]

Answer: 2

Solution:

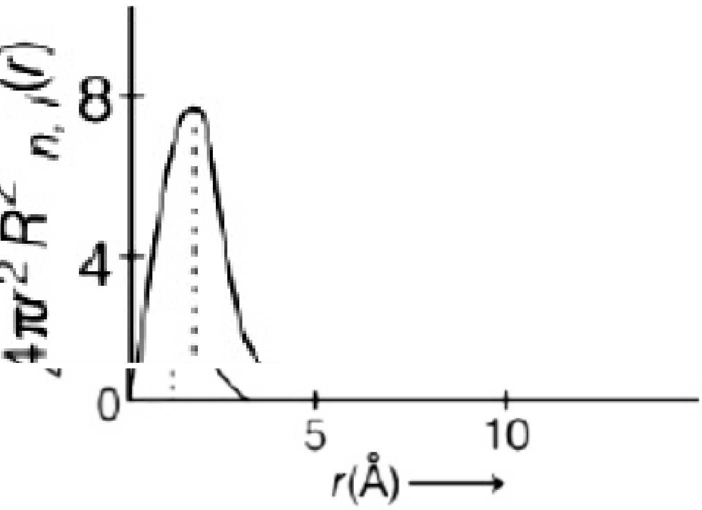
$Z = 29[Cu] \xrightarrow{-2e^-} Cu^{2+} = [Ar]3d^9$

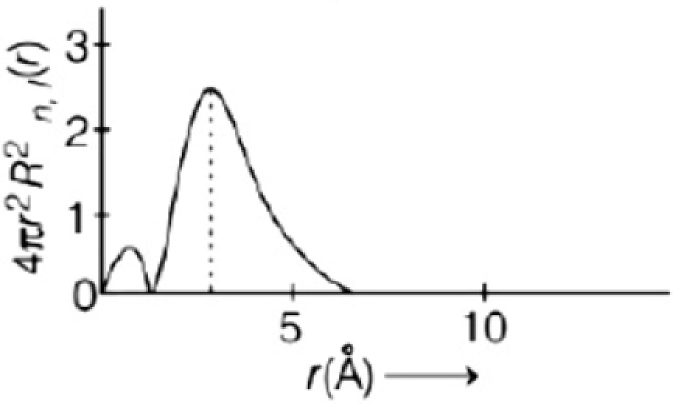


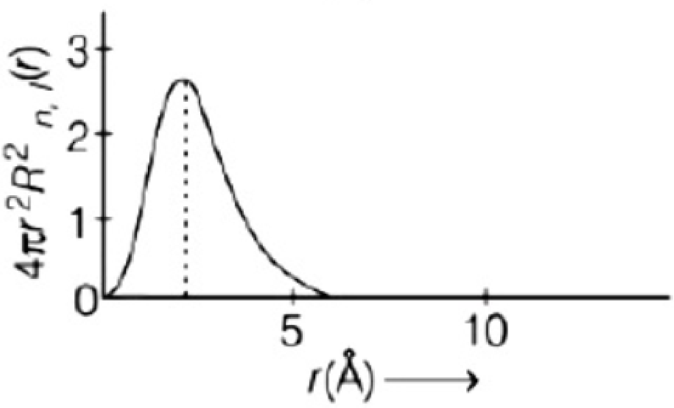
Number of unpaired electron, $n = 1$
∴ Spin only magnetic moment,
$\mu = \sqrt{n(n+2)}BM = \sqrt{1(1+2)}BM = \sqrt{3}BM$
$= 1.73BM = 2BM$

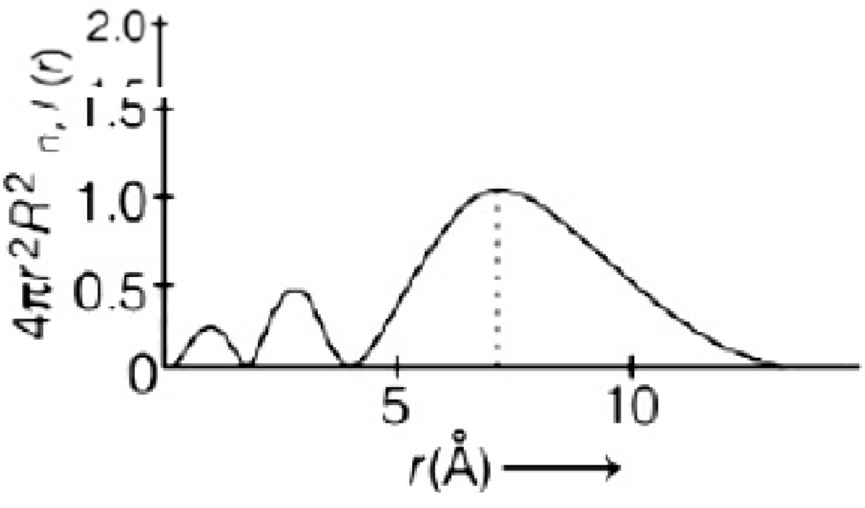
Question72

The plots of radial distribution functions for various orbitals of hydrogen atom against ' r ' are given below.


$4\pi r^2 R^2_{n,l}(r)$
8
4
0
5
10
r(Å) ⟶


$4\pi r^2 R^2_{n,l}(r)$
3
2
1
0
5
10
r(Å) ⟶


$4\pi r^2 R^2_{n,l}(r)$
3
2
1
0
5
10
r(Å) ⟶


$4\pi r^2 R^2_{n,l}(r)$
2.0
1.5
1.0
0.5
0
5
10
r(Å) ⟶

The correct plot for 3s-orbital is
[25 Feb 2021 Shift 1]

Options:

A. (A)

B. (B)

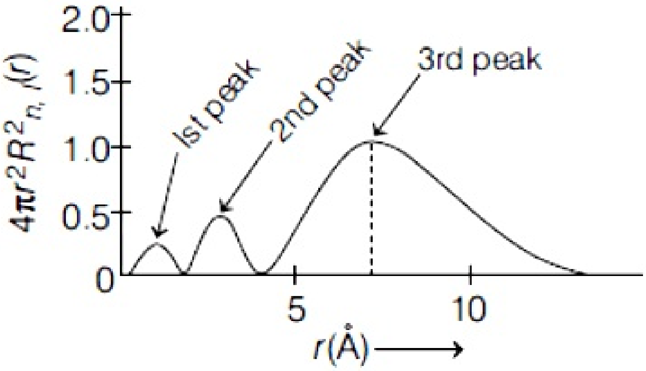
C. (C)

D. (D)

Answer: D

Solution:

The correct plot for 3s-orbital is



For 3s,
value of I = 0
value of n = 3
Number of peak = n − I = 3 − 0 = 3
In graph D, three peaks are present, so this is the correct plot for 3s-orbital.

Question73

A proton and a Li^{3+} nucleus are accelerated by the same potential. If λ_{Li} and λ_P denote the de Broglie wavelengths of Li^{3+} and proton respectively, then the value of $\frac{\lambda_{Li}}{\lambda_P}$ is $x \times 10^{-1}$. The value of x is _____(Rounded off to the nearest integer) (Mass of Li^{3+} = 8.3 mass of proton)
[24feb2021shift1]

Answer: 2

Solution:

$$\lambda = \frac{h}{\sqrt{2mqV}}$$

$$\frac{\lambda_{Li}}{\lambda_P} = \sqrt{\frac{m_P(e)V}{m_{Li}(3e)(V)}} \quad m_{Li} = 8.3m_P$$

$$\frac{\lambda_{Li}}{\lambda_P} = \sqrt{\frac{1}{8.3 \times 3}} = \frac{1}{5} = 0.2 = 2 \times 10^{-1}$$

Question74

Given below are two statements.
Statement I Bohr's theory accounts for the stability and line spectrum of Li^+ ion.
Statement II Bohr's theory was unable to explain the splitting of spectral lines in the presence of a magnetic field.
In the light of the above statements, choose the most appropriate answer from the options given below:
[18 Mar 2021 Shift 2]

Options:

A. Both statements I and II are true.

B. Statement I is false but statement II is true.

C. Both statements I and II are false.

D. Statement I is true but statement II is false.

Answer: B

Solution:

Solution:
Statement I is false, because Bohr's theory accounts for the stability and spectrum of single electronic species (e.g. He^+, Li^{2+} etc.) but Li^+ has two electrons.
Bohr's theory fails to explain splitting of spectral lines in presence of magnetic field i.e. Zeeman effect.
∴ Statement II is true.

Question75

When light of wavelength 248nm falls on a metal of threshold energy 3.0eV , the de-Broglie wavelength of emitted electrons is ...... Å.
[Round off to the nearest integer]
[Use: $\sqrt{3} = 1.73$, $h = 6.63 \times 10^{-34}$J s
$m_e = 9.1 \times 10^{-31}$kg, $c = 3.0 \times 10^8 ms^{-1}$
1eV $= 1.6 \times 10^{-19}$J]
[16 Mar 2021 Shift 1]

Answer: 9

Solution:

Solution:
Given wavelength, if incident light $(\lambda) = 248nm = 2480Å$
Threshold energy $= 3.0eV$
We know, for electron de-Broglie wavelength is given by
$\lambda = \frac{h}{mv}$
$\lambda = \frac{h}{\sqrt{2m(KE)}}$
$KE = q \times V$ (where, q = charge of particle)
V = voltage applied
$\lambda = \frac{h}{\sqrt{2m(qV)}}$
Putting mass of electron, $m_e = 9.1 \times 10^{-31}kg$
Charge of electron, $q = 1.6 \times 10^{-19}C$
$\lambda = \sqrt{\frac{150}{V}}$Å....(i)
We know, $E_{applied} = \varphi + K_{max}$....(ii)
where, $\varphi =$ threshold energy
$\varphi = 3eV$
$E_{applied} = \frac{12400}{\lambda_Å} = \frac{12400}{2480} = 5eV$
Putting value in Eq. (ii),
$5 = 3 + K_{max}$
$\Rightarrow KE_{max} = 2eV$
Voltage $= 2$
$\lambda_e = \sqrt{\frac{150}{2}} = 8.6Å$ [Eq. (i)]
Nearest integer $= 9$

Question76

A certain orbital has no angular nodes and two radial nodes. The orbital is
[18 Mar 2021 Shift 1]

Options:

A. 2s

B. 3s

C. 3p

D. 2p

Answer: B

Solution:

Solution:
As, we know,
For 2s orbital, $n = 2$, $I = 0$
Angular node $(l) = 0$
Radial nodes $= n - 1 - 1 \Rightarrow 2 - 0 - 1 = 1$
For 2p orbital, $n = 2$ and $I = 1$
Angular node $(l) = 1$
Therefore, number of radial nodes $= 2 - 1 - 1 = 0$
It has one angular and zero radial node.

For 3p orbital, $n = 3$, $I = 1$
Angular node $(l) = 1$
It has one angular and one radial node.
For 3s orbital, $n = 3$, $I = 0$
No. of angular node $(l) = 0$
No. of radial node $\Rightarrow n - I - 1$
$= 3 - 0 - 1 = 2 = 2$
Hence, for 3 s-orbital has no angular node and 2 radial nodes.

Question77

A certain orbital has n = 4 and $m_l = -3$. The number of radial nodes in this orbital is (Round off to the nearest integer). [17 Mar 2021 Shift 1]

Answer: 0

Solution:

Solution:
Given, $n = 4$, $m_l = -3$, so $l = 3$
Possible value of $I = 0, 1, 2, 3$
As $m = -3$ is possible only for $I = 3$
For $l = 3$, $m_l = -3, -2, -1, 0, 1, 2, 3$
So, this is 4f-orbital.
Number of radial nodes $= n - l - 1$
$= 4 - 3 - 1$
$= 0$
So, there is no radial node in 4f orbital.

Question78

The number of orbitals with n = 5, m_1 = +2 is (Round off to the nearest integer).
[16 Mar 2021 Shift 2]

Answer: 3

Solution:

Given, $n = 5$, $m_l = +2$
For $n = 5$, possible value of $I = 0, 1, 2, 3, 4$
For $l = 0$, $m_1 = 0$
$l = 1$, $m_l = -1, 0, 1$
$l = 2$, $m_l = -2, -1, 0, 1, 2$
$l = 3$, $m_1 = -3, -2, -1, 0, 1, 2, 3$
$l = 4$, $m_l = -4, -3, -2, -1, 0, 1, 2, 3, 4$
Possible value of m_l for a given value of l
$= 0, \pm1, \pm2, \pm3 \ldots \pm 1$
So, number of orbitals having $n = 5$ and $m_l = \pm2$ are 3 .

Question79

If the Thompson model of the atom was correct, then the result of Rutherford's gold foil experiment would have been:
[27 Jul 2021 Shift 2]

Options:

A. All of the α-particles pass through the gold foil without decrease in speed.

B. α-Particles are deflected over a wide range of angles.

C. All α-particles get bounced back by 180°

D. α-Particles pass through the gold foil deflected by small angles and with reduced speed.

Answer: D

Solution:

Solution:
As in Thomson model, protons are diffused (charge is not centred) α - particles deviate by small angles and due to repulsion from protons, their speed decreases.

Question80

Given below are two statements :
Statement I : Rutherford's gold foil experiment cannot explain the line

spectrum of hydrogen atom.
Statement II : Bohr's model of hydrogen atom contradicts Heisenberg's uncertainty principle.
In the light of the above statements, choose the most appropriate answer from the options given below :
[27 Jul 2021 Shift 1]

Options:

A. Statement I is false but statement II is true.

B. Statement I is true but statement II is false.

C. Both statement I and statement II are false.

D. Both statement I and statement II are true.

Answer: D

Solution:

Solution:
Rutherford's gold foil experiment only proved that electrons are held towards nucleus by electrostatic forces of attraction and move in circular orbits with very high speeds.
Bohr's model gave exact formula for simultaneous calculation of speed & distance of electron from the nucleus, something which was deemed impossible according to Heisenberg.

Question81

An accelerated electron has a speed of $5 \times 10^{6} ms^{-1}$ with an uncertainty of 0.02%. The uncertainty in finding its location while in motion is $x \times 10^{-9}$m.
The value of x is __________ . (Nearest integer)
[Use mass of electron $= 9.1 \times 10^{-31}$kg, $h = 6.63 \times 10^{-34}$J s, $\pi = 3.14$]
[25 Jul 2021 Shift 2]

Answer: 58

Solution:

$$\Delta v = \frac{0.02}{100} \times 5 \times 10^{6} = 10^{3} m/s$$

$$\Delta x \cdot \Delta v = \frac{h}{4\pi m}$$

$$x \times 10^{-9} \times 10^{3} = \frac{6.63 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31}} x \times 10^{-9} \times 10^{3} = 0.058 \times 10^{-3}$$

$$x = \frac{0.058 \times 10^{-6}}{10^{-9}} = 58$$

Question82

A source of monochromatic radiation of wavelength 400nm provides 1000J of energy in 10 seconds. When this radiation falls on the surface of sodium, $x \times 10^{20}$ electrons are ejected per second. Assume that wavelength 400nm is sufficient for ejection of electron from the surface of sodium metal. The value of x is ______.
(Nearest integer)
($h = 6.626 \times 10^{-34}$ J s)
[25 Jul 2021 Shift 1]

Answer: 2

Solution:

Solution:
Total energy provided by
Source per second $= \frac{1000}{10} = 100\text{J}$
Energy required to eject electron $= \frac{hc}{\lambda}$
$= \frac{6.626 \times 10^{-34}}{400 \times 10^{-9}} \times 3 \times 10^{8}$
Number of electrons ejected $= \frac{100}{\frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{400 \times 10^{-9}}}$
$= \frac{400 \times 10^{-7} \times 10^{26}}{6.626 \times 3}$
$= \frac{40 \times 10^{-20}}{6.626 \times 3}$
$= 2.01 \times 10^{20}$

Question83

The wavelength of electrons accelerated from rest through a potential difference of 40kV is $x \times 10^{-12}$m. The value of x is _______ . (Nearest integer)
Given : Mass of electron $= 9.1 \times 10^{-31}$kg
Charge on an electron $= 1.6 \times 10^{-19}$C
Planck's constant $= 6.63 \times 10^{-34}$J S
[20 Jul 2021 Shift 2]

Answer: 6

Solution:

De-broglie-wave length of electron:

$\lambda_e = \frac{h}{\sqrt{2m(KE)}}$ {∵ e^- is accelerated from rest ⇒ $KE = q \times V$

$\lambda = \frac{h}{\sqrt{2mqv}}$

$= \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 1.6 \times 10^{-19} \times 9.1 \times 10^{-31} \times 40 \times 10^{3}}}$

$= 0.614 \times 10^{-11} m$

$= 6.14 \times 10^{-12} m$

Nearest integer = 6

Question84

The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is equal to $\frac{h^2}{xma_0^2}$. The value of 10x is .... (a_0 is radius of Bohr's orbit) (Nearest integer)
[Given, π = 3.14]
[27 Aug 2021 Shift 1]

Answer: 3155

Solution:

Solution:

∵ Angular moment is given as,

$mvr = \frac{nh}{2\pi}$

∴ Kinetic energy $= \frac{n^2h^2}{8\pi^2mr^2} = \frac{4h^2}{8\pi^2m(4a_0)^2}$

$= \left(\frac{4}{8\pi^2 \times 16}\right)\frac{h^2}{ma_0^2} = \frac{h^2}{xma_0^2}$

$x = \frac{4}{8\pi^2 \times 16}$

⇒ x = 315.507

10x = 3155.07

Question85

Given below are two statements.
Statement I According to Bohr's model of an atom, qualitatively the magnitude of velocity of electron increases with decrease in positive charges on the nucleus as there is no strong hold on the electron by the nucleus.
Statement II According to Bohr's model of an atom, qualitatively the magnitude of velocity of electron increases with decrease in principal quantum number.In the light of the above statements, choose the most appropriate answer from the options given below.

[26 Aug 2021 Shift 1]

Options:

A. Both statement I and statement II are false.

B. Both statement I and statement II are true.

C. Statement I is false but statement II is true.

D. Statement I is true but statement II is false.

Answer: C

Solution:

According to Bohr's atom, velocity of electron is given by,
$v \propto \frac{Z}{n}$ ...(i)
where, v = velocity of electron
where, v = velocity of electron
n = principal quantum number
From Eq. (i), velocity of electron is directly proportional to atomicnumber of atom, corresponding to positive charge. So, as Z increases velocity also increases.
Hence, statement I is false. Also, velocity of electron is inversely proportional to n i.e. as 'n' decreases velocity of electron increases.
So, statement II is true.

Question86

The number of photons emitted by a monochromatic (single frequency) infrared range finder of power $1\,\mathrm{mW}$ and wavelength of $1000\,\mathrm{nm}$, in 0.1 second is $x \times 10^{13}$. The value of x is .... (Nearest integer) ($h = 6.63 \times 10^{-34}\,\mathrm{Js}$, $c = 3.00 \times 10^{8}\,\mathrm{ms^{-1}}$) [27 Aug 2021 Shift 2]

Answer: 50

Solution:

Solution:
Power of the source $= 1\,\mathrm{mW} = 10^{-3}\mathrm{W}$
Energy of one photon, $E = hv = \frac{hc}{\lambda}$
where, $h = 6.6 \times 10^{-34}\,\mathrm{Js}$
$c = 3 \times 10^{8}\mathrm{m}$ / s and
λ = 1000 nm
$= 1000 \times 10^{-9}\mathrm{m}\ (1\,\mathrm{nm} = 10^{-9}\mathrm{m})$
$= 10^{-6}\mathrm{m}$
$E = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{10^{-6}} \cong 20 \times 10^{-20}\mathrm{J}$
Power = number of photons emitted in one second × energy of 1 photon.
$10^{-3} = n \times 20 \times 10^{-20}$

$\Rightarrow n = \frac{10^{-3}}{20 \times 10^{-20}} = 0.5 \times 10^{16}$

Number of photons emitted in 1s = 0.5×10^{16}

Number of photons emitted in 0.1s = $0.5 \times 10^{16} \times 0.1 = 50 \times 10^{13}$

$x \times 10^{13} = 50 \times 10^{13}$

x = 50

Question87

A metal surface is exposed to 500 nm radiation. The threshold frequency of the metal for photoelectric current is 4.3×10^{14} Hz. The velocity of ejected electron is .... $\times 10^5 ms^{-1}$. (Nearest integer)
[Use $h = 6.63 \times 10^{-34}$ Js, $m_e = 9.0 \times 10^{-31}$ kg]
[26 Aug 2021 Shift 2]

Answer: 5

Solution:

Solution:

According to photoelectric effect $= \frac{hc}{\lambda} = hv_0 + \frac{1}{2}mv^2$

(where, h = Planck's constant, λ = wavelength

v_0 = threshold frequency, v = velocity of electron

m = mass of electron, c = speed of light)

$\Rightarrow \frac{6.63 \times 10^{-34} \times 310^8}{500 \times 10^{-9}}$

$= 6.63 \times 10^{-34} \times 4.3 \times 10^{14} + \frac{1}{2}mv^2$

$\frac{6.63 \times 30 \times 10^{-19}}{50} = 6.63 \times 4.3 \times 10^{-20} + \frac{1}{2}mv^2$

$11.271 \times 10^{-20} J = \frac{1}{2} \times 9 \times 10^{-31} \times v^2$

$v = 5 \times 10^5 m / s$

∴ x = 5

Question88

The value of magnetic quantum number of the outermost electron of Zn^+ ion is
[31 Aug 2021 Shift 2]

Answer: 0

Solution:

The configuration of $Zn^+ = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$
The outermost electron is in s-orbital.
For s-orbital, azimuthal quantum number (l) = 0
Magnetic quantum number, m = − l to + l
For l = 0, m = 0

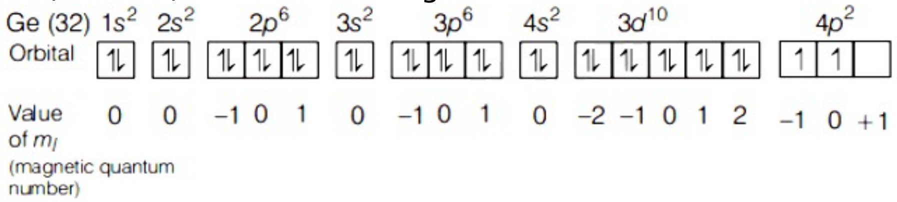
Question89

Ge(Z = 32) in its ground state electronic configuration has x completely filled orbitals with $m_1 = 0$. The value of x is
[31 Aug 2021 Shift 1]

Answer: 7

Solution:

Ge (Z = 32) electronic configuration is



For s-orbitals (1s, 2s, 3s and 4s) $m_l = 0\{2 \times 0\}$
For p-orbitals (2p, 3p)$m_l = 0\{(-1) \times 2 + 0 \times 2 + (+1) \times 2 = 0\}$
For d-orbitals (3d)$m_1 = 0 \left\{ \begin{array}{c} (-2) \times 2 + (-1) \times 2 + 0 \times 2 \\ (+1) \times 2 + (+2) \times 2 = 0 \end{array} \right\}$
∴ Completely filled orbitals with m_l = 0 are seven (7).

Question90

A 50 watt bulb emits monochromatic red light of wavelength of 795 nm. The number of photons emitted per second by the bulb is $x \times 10^{20}$. The value of x is ......
[Given, $h = 6.63 \times 10^{-34}$ Js and $c = 3.0 \times 10^8 ms^{-1}$]
[1 Sep 2021 Shift 2]

Answer: 2

Solution:

Energy of photon is given as

$E = \frac{nhc}{\lambda}$ ...(i)
where, E = energy of photon (50 W),
n = number of photon
$h =$ Planck's constant (6.63×10^{-34} Js)
$c =$ speed of light (3×10^{8} m / s)
$\lambda =$ wavelength of light (795×10^{-9} m)
E = 50 W = 50 J = energy of photon
$50J = \frac{n \times 6.63 \times 10^{-34} Js \times 3 \times 10^{8} m / s}{795 \times 10^{-9} m}$
$\Rightarrow n = \frac{50 \times 795 \times 10^{-9}}{6.63 \times 10^{-34} \times 3 \times 10^{8}} = 1998.49 \times 10^{17} = 1.998 \times 10^{20} = 2 \times 10^{20}$
$\therefore x = 2$
∴ Answer is 2.

Question91

For the Balmer series in the spectrum of H atom, $\bar{v} = R_H \left\{ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right\}$, the correct statements among (I) to (IV) are:
(I) As wavelength decreases, the lines in the scries converge
(II) The integer n_1 is equal to 2
(III) The lines of longest wavelength corresponds to $n_2 = 3$
(IV) The ionization energy of hydrogen can be calculated from wave number of these lines
[Jan. 08,2020 (I)]

Options:

A. (I), (III), (IV)

B. (I), (II), (III)

C. (I), (II), (IV)

D. (II), (III), (IV)

Answer: B

Solution:

Solution:
In the Balmer series of H-atom the transition takes place from the higher oribtal to $n = 2$. Therefore the longest wave length corresponds to $n_1 = 2$ and $n_2 = 3$. As the wave length decreases, the lines in the series converges. Hence, statement I, II, III are the correct statements among the given options.

Question92

The radius of the second Bohr orbit, in terms of the Bohr radius, a_0, in Li^{2+} is:
[Jan. 08, 2020 (II)]

Options:

A. $\frac{2a_0}{3}$

B. $\frac{4a_0}{9}$

C. $\frac{4a_0}{3}$

D. $\frac{2a_0}{9}$

Answer: C

Solution:

Solution:

$r = \frac{a_0 n^2}{Z}$

For Li^{2+}, $r = \frac{a_0(2)^2}{3} = \frac{4a_0}{3}$

Question93

The de Broglie wavelength of an electron in the 4 th Bohr orbit is: [Jan. 09, 2020 (I)]

Options:

A. $2\pi a_0$

B. $4\pi a_0$

C. $6\pi a_0$

D. $8\pi a_0$

Answer: D

Solution:

$2\pi r = n\lambda$

$r = \frac{n^2 a_0}{Z}$

$2\pi \times \frac{4^2}{1} a_0 = 4\lambda$

$\lambda = 2\pi \times \frac{4}{1} a_0$

$\lambda = 8\pi a_0$

Question94

The number of orbitals associated with quantum numbers $n = 5, m_s = +\frac{1}{2}$ is:
[NV, Jan. 07,2020(I)]

Options:

A. 11

B. 25

C. 50

D. 15

Answer: B

Solution:

Solution:
The possible number of orbitals in a shell in term of "n ' is n^2
$\therefore n = 5; n^2 = 25$

Question95

The difference between the radii of 3^{rd} and 4^{th} orbits of Li^{2+} is ΔR_1. The difference between the radii of 3^{rd} and 4^{th} orbits of He^+ is ΔR_2. Ratio $\Delta R_1 : \Delta R_2$ is :
[Sep .05,2020 (I)]

Options:

A. 8 : 3

B. 3 : 8

C. 2 : 3

D. 3 : 2

Answer: C

Solution:

$r = 0.529 \frac{n^2}{Z} Å$
For Li^{2+},
$(r_{Li^{2+}})_{n=4} - (r_{Li^{2+}})_{n-3} = \frac{0.529}{3}[4^2 - 3^2] = \Delta R_1$
For He^+,
$(r_{He^+})_{n=4} - (r_{He^+})_{n=3} = \frac{0.529}{2}[4^2 - 3^2] = \Delta R_2$
$\frac{\Delta R_1}{\Delta R_2} = \frac{2}{3}$

Question96

The region in the electromagnetic spectrum where the Balmer series lines appear is:
[Sep. 04, 2020 (I)]

Options:

A. Visible

B. Microwave

C. Infrared

D. Ultraviolet

Answer: A

Solution:

Solution:
In hydrogen spectrum maximum lines of Balmer series lies in visible region.

Question97

The shortest wavelength of H atom in the Lyman series is λ_1. The longest wavelength in the Balmer series is He^+ is:
[Sep. 04, 2020 (II)]

Options:

A. $\frac{36\lambda_1}{5}$

B. $\frac{5\lambda_1}{9}$

C. $\frac{9\lambda_1}{5}$

D. $\frac{27\lambda_1}{5}$

Answer: C

Solution:

Solution:
Shortest wavelength → Max. energy (∞ → 1)
For Lyman series of H atom,

$$\frac{1}{\lambda_1} = R_H (1)^2 \left[\frac{1}{1} - 0 \right]$$

$$\Rightarrow \frac{1}{\lambda_1} = R_H \Rightarrow R_H = \frac{1}{\lambda_1}$$

For Balmer series of He^{+},

$$\frac{1}{\lambda} = R_H (2)^2 \left[\frac{1}{2^2} - \frac{1}{3^2} \right] \Rightarrow \frac{1}{\lambda} = R_H (4) \left(\frac{9-4}{36} \right)$$

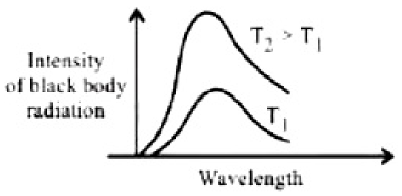
$$\Rightarrow \frac{1}{\lambda} = \frac{5R_H}{9} \Rightarrow \lambda = \frac{9}{5R_H} = \frac{9\lambda_1}{5}$$

Question98

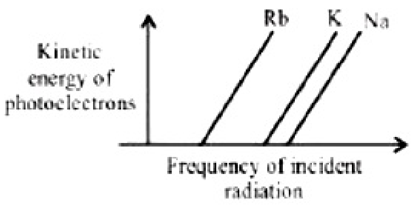
The figure that is not a direct manifestation of the quantum nature of atoms is :
[Sep. 02, 2020 (I)]

Options:

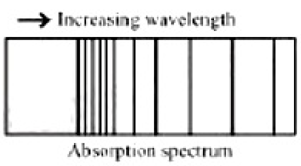
A.



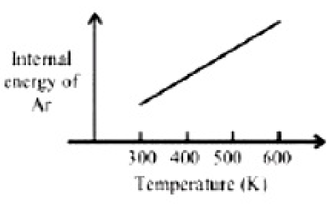
B.



C.



D.



Answer: D

Solution:

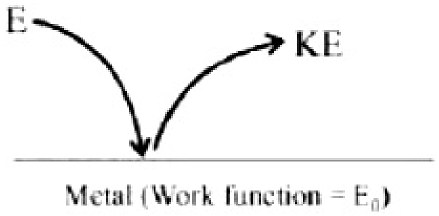
Solution:
(d) (a), (b) and (c) are according to quantum theory but (d) is statement of kinetic theory of gases.

Question99

The work function of sodium metal is 4.41×10^{-19}J . If photons of wavelength 300nm are incident on the metal, the kinetic energy of the ejected clectrons will be
$(h = 6.63 \times 10^{-34}$J s; $c = 3 \times 10^{8}$m / s) $\times 10^{-21}$J
[NV, Sep. 02, 2020(II)]

Answer: 222

Solution:



$E = E_0 + (KE)_{max}$

$\frac{hc}{\lambda} = 4.41 \times 10^{-19} + KE$

$\frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{300 \times 10^{-9}} = 4.41 \times 10^{-19} + KE$

So, $(KE)_{max} = 6.63 \times 10^{-19} - 4.41 \times 10^{-19}$

$= 2.22 \times 10^{-19}J = 222 \times 10^{-21}J$

Question100

In the sixth period, the orbitals that are filled are:
[Sep. 05,2020 (I)]

Options:

A. 6s, 4f , 5d , 6p

B. 6s, 5d , 5f , 6p

C. 6s, 5f , 6d , 6p

D. 6s, 6p, 6d , 6f

Answer: A

Solution:

Solution:

	6s	4f	5d	6p
$n+1$	$6+0$	$4+3$	$5+2$	$6+1$
	⇩	⇩	⇩	⇩
	6	7	7	7

Thus, order of orbitals filled are
6s < 4f < 5d < 6p

Question101

The correct statement about probability density (except at infinite distance from nucleus) is:
[Sep. 05, 2020 (II)]

Options:

A. It can be zero for 1s orbital

B. It can be negative for 2p orbital

C. It can be zero for 3p orbital

D. It can never be zero for 2s orbital

Answer: C

Solution:

Solution:
Radial node $= n - l - 1$
$\therefore 1s \Rightarrow 0(\psi^2 \neq 0)$
$2s \Rightarrow 1(\psi^2 = 0)$
$2p \Rightarrow 0(\psi^2 \neq 0)$
$3p \Rightarrow 1(\psi^2 = 0)$
Probability density (ψ^2) can be zero for 3p orbital other than infinite distance. It has one radial node.
Thus, statement (c) is correct.

Question102

Consider the hypothetical situation where the azimuthal quantum number, l, takes values 0, 1, 2, ... n + 1, where n is the principal quantum number. Then, the element with atomic number:
[Sep. 03, 2020 (II)]

Options:

A. 9 is the first alkali metal

B. 13 has a half-filled valence subshell

C. 8 is the first noble gas

D. 6 has a 2p -valence subshell

Answer: B

Solution:

Solution:
Under the given situation for $n = 1, l = 0, 1, 2$
$n = 2, l = 0, 1, 2, 3$
$n = 3, l = 0, 1, 2, 3, 4$
According to $(n + l)$ rule of order of filling of subshells will be:
1s1p1d 2s2p3s2d 3f
Atomic number $1s^2 1p^4$
Atomic number $1s^2 1p^6 1d^1$
Atomic number $1s^2 1p^6$
Atomic number $1s^2 1p^6 1d^5$
Therefore option (b) is correct. Atomic number of first noble gas will be $18(1s^2 1p^6 1d^{10})$.

Question103

The number of subshells associated with n = 4 and m = −2 quantum numbers is:
[Sep. 02,2020 (II)]

Options:

A. 8

B. 2

C. 16

D. 4

Answer: B

Solution:

Solution:
For $n = 4$ possible values of $l = 0, 1, 2, 3$; only $l = 2$ and $l = 3$ can have $m = -2$. So possible subshells are 2.

Question104

What is the work function of the metal if the light of wavelength 4000Å generates photoelectrons of velocity $6 \times 10^5 ms^{-1}$ from it ?
(Mass of electron $= 9 \times 10^{-31}$kg
Velocity of light $= 3 \times 10^8 ms^{-1}$
Planck's constant $= 6.626 \times 10^{-34}$J s
Charge of electron $= 1.6 \times 10^{-19}$J eV $^{-1}$)
[Jan. 12, 2019 (I)]

Options:

A. 0.9eV

B. 3.1eV

C. 2.1eV

D. 4.0eV

Answer: C

Solution:

Solution:

$E = hv = \frac{hc}{\lambda}$

$E = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{4000 \times 10^{-10}} = 4.97 \times 10^{-19} J$

$= \frac{4.97 \times 10^{-19} J}{1.6 \times 10^{-10} J\, eV^{-1}} = 3.1 eV$

$KE = \frac{1}{2} mv^2 = \frac{1}{2} \times 9 \times 10^{-31} kg \times (6 \times 10^5 ms^{-1})^2$

$= 1.62 \times 10^{-19} J\ [1J = kg \cdot m^2 s^{-2}]$

$= 1cV$

According to photoelectric effect,

$K.E. = hv - hv_0$

$hv_0 = hv - K.E$

Work function $(W_0) = E - K.E$

$= 3.1 - 1 = 2.1 eV$

Question105

Heat treatment of muscular pain involves radiation of wavelength of about 900nm. Which spectral line of H atom is suitable for this purpose?

$[R_H = 1 \times 10^5 cm^{-1} \cdot h = 6.6 \times 10^{-34} J\, s, c = 3 \times 10^8 ms^{-1}]$

[Jan. 11, 2019 (I)]

Options:

A. Paschen, $\infty \rightarrow 3$

B. Paschen, $5 \rightarrow 3$

C. Balmer, $\infty \rightarrow 2$

D. Lyman, $\infty \rightarrow 1$

Answer: A

Solution:

Solution:

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

$n_1 = 3, n_2 = \infty$

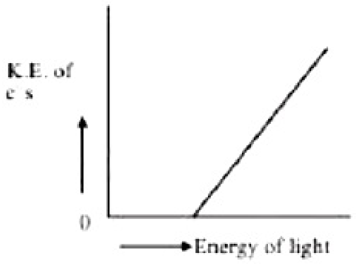
$$\frac{1}{\lambda} = R\left(\frac{1}{9}\right) \Rightarrow \lambda = \frac{9}{R} = \frac{9}{10^5} = 9 \times 10^{-5}\text{cm} = 900\text{nm}$$

Question106

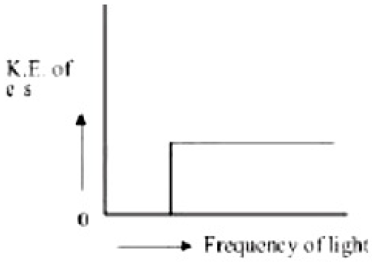
Which of the graphs shown below does not represent the relationship between incident light and the electron cjected from metal surface? [Jan. 10, 2019 (I)]

Options:

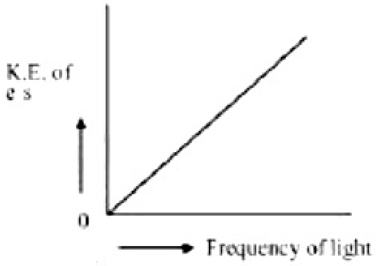
A.



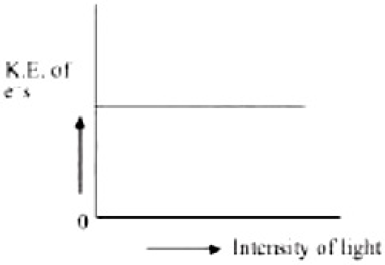
B.



C.



D.



Answer: C

Solution:

$K.E. = hv - hv_0$
where, $v =$ Frequency of incident radiation
$v_0 =$ Threshold frequency
KE is independent of intensity but it depends on frequency of light. Intensity is directly proportional to the no. of electrons emitted.

Question107

The ground state energy of hydrogen atom is $-13.6eV$. The energy of second excited state of He^+ ion in eV is:
[Jan. 10, 2019 (II)]

Options:

A. -54.4

B. -3.4

C. -6.04

D. -27.2

Answer: C

Solution:

Solution:
According to Bohr's model energy in n^{th} state
$= -13.6 \times \frac{Z^2}{n^2} eV$
For second excited state, of He^+, $n = 3$
$\therefore E_3(He^+) = -13.6 \times \frac{2^2}{3^2} eV = -6.04 eV$

Question108

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)
[Jan. 9,2019 (I)]

Options:

A. Linear with intercept $-R_H$

B. Non linear

C. Linear with slope R_H

D. Linear with slope $-R_H$

Answer: D

Solution:

Solution:
As we know,
$\bar{v} = -R_H \left(\frac{1}{n_2^2} - \frac{1}{n_1^2} \right) Z^2$ (where, $Z = 1$)
After putting the values, we get
$\bar{v} = -R_H \left(\frac{1}{n^2} - \frac{1}{8^2} \right) \Rightarrow \bar{v} = \frac{R_H}{64} - \frac{R_H}{n^2}$
Comparing to $y = mx + c$, we get
$x = \frac{1}{n^2}$ and $m = -R_H$ (slope)

Question109

If the de Broglie wavelength of the electron in n^{th} Bohr orbit in a hydrogenic atom is equal to $1.5\pi a_0$(a_0 is Bohr radius), then the value of n / z is:
[Jan. 12, 2019 (II)]

Options:

A. 0.40

B. 1.50

C. 1.0

D. 0.75

Answer: D

Solution:

Solution:
Given $\lambda = 1.5\pi a_0$
$n\lambda = 2\pi r$ . . . (i)
Radii of stationary states (r) is expressed as:
$r = a_0 \frac{n^2}{z}$ . . . (ii)
From eqn (i) and (ii)
$n\lambda = \frac{2\pi a_0 n^2}{z}; \lambda = \frac{2\pi a_0 n}{z}$
$1.5\pi a_0 = 2\pi a_0 \frac{n}{z}$
$\frac{n}{z} = \frac{1.5}{2} = 0.75$

Question110

The de Broglie wavelength (λ) associated with a photoelectron varies

with the frequency (v) of the incident radiation as, [v_0 is threshold frequency]:
[Jan. 11, 2019 (II)]

Options:

A. $\lambda \propto \frac{1}{(v - v_0)}$

B. $\lambda \propto \frac{1}{(v - v_0)^{\frac{1}{4}}}$

C. $\lambda \propto \frac{1}{(v - v_0)^{\frac{3}{2}}}$

D. $\lambda \propto \frac{1}{(v - v_0)^{\frac{1}{2}}}$

Answer: D

Solution:

Solution:
According to de-Broglie wavelength equation,
$\lambda = \frac{h}{mv} \Rightarrow \lambda \propto \frac{1}{v}$
According to photoelectric effect,
$hv - hv_0 = \frac{1}{2}mv^2; v - v_0 = \frac{1}{2} = \frac{mv^2}{h}$
$v - v_0 \propto v^2$
$v \propto (v - v_0)^{1/2}$
$\therefore \lambda \propto \frac{1}{(v - v_0)^{1/2}}$

Question111

Which of the following combination of statements is true regarding the interpretation of the atomic orbitals?
[Jan. 9,2019 (II)|]

Options:

A. An electron in an orbital of high angular momentum stays away from the nucleus than an electron in the orbital of lower angular momentum.

B. For a given value of the principal quantum number, the size of the orbit is inversely proportional to the azimuthal quantum number.

C. According to wave mechanics, the ground state an- gular momentum is equal to $\frac{h}{2\pi}$

D. The plot of ψ vs r for various azimuthal quantum numbers, shows peak shifting towards higher r value.
(a) (a), (d) (b) (a), (b) (c) (a), (c) (d) (b), (c)

Answer: A

Solution:

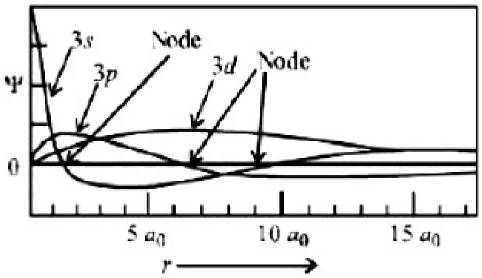
(a) Angular momentum (L) = $\frac{nh}{2\pi}$

Therefore, as n increases, L also increases.

(b) $r \propto \frac{n^2}{z}$

(c) For $n = 1$, $L = \frac{h}{2\pi}$

(d) As l increases, the peak of ψ vs r shifts towards higher ' r ' value.



Question112

Among the following, the energy or 2s or orbital is lowest in [April 12, 2019 (II)]

Options:

A. K

B. H

C. Li

D. Na

Answer: A

Solution:

Solution:
As the value of Z (atomic number) increases, energy of orbitals decreases (becomes more-ve value)
∴ Order of energy of 2s orbital is $H > Li > Na > K$

Question113

The ratio of the shortest wavelength of two spectral series of hydrogen spectrum is found to be about 9. The spectral series are : [April 10, 2019 (II)]

Options:

A. Lyman and Paschen

B. Balmer and Brackett

C. Brackett and Pfund

D. Paschen and Pfund

Answer: A

Solution:

For determined shortest wavelength, $n_2 = \infty$

Lyman series $\bar{v}_L = \frac{1}{\lambda_L} = R\left[\frac{1}{(1)^2} - \frac{1}{\infty^2}\right]$

Paschen series $\bar{v}_P = \frac{1}{\lambda_P} = R\left[\frac{1}{(3)^2} - \frac{1}{\infty^2}\right]$

$\frac{\bar{v}_L}{\bar{v}_P} = \frac{\lambda_p}{\lambda_L} = 9$

Question114

For any given series of spectral lines of atomic hydrogen, let $\Delta\bar{v} = \bar{v}_{max} - \bar{v}_{min}$ be the difference in maximum and minimum frequencies in cm^{-1}. The ratio $\Delta\bar{v}_{Lyman} / \Delta\bar{v}_{Balmer\ i\ is}$:
[April 9, 2019 (I)]

Options:

A. 4 : 1

B. 9 : 4

C. 5 : 4

D. 27 : 5

Answer: B

Solution:

$\bar{v} \propto \Delta E$
For H-atom
$\bar{v} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$
For Lyman series,
$\bar{v}(max) = 13.6\left(1 - \frac{1}{\infty}\right)$

$\bar{v}(min) = 13.6\left(1 - \frac{1}{4}\right)$

$\therefore \bar{v}_{max} - \bar{v}_{min} = 13.6\left(\frac{1}{4}\right)$
For Balmer series,
$\bar{v}(max) = 13.6\left(\frac{1}{4} - \frac{1}{\infty}\right)$

$\bar{v}(min) = 13.6\left(\frac{1}{4} - \frac{1}{9}\right)$

$\therefore\ \bar{v}_{max} - \bar{v}_{min} = 13.6\left(\frac{1}{9}\right)$

So, $\frac{\Delta\bar{v}_{Lyman}}{\Delta\bar{v}_{Balmer}} = \frac{9}{4}$

Question115

Which one of the following about an electron occupying the 1s orbital in a hydrogen atom is incorrect? (The Bohr radius is represented by a_0). [April 9, 2019 (II)]

Options:

A. The probability density of finding the electron is maximum at the nucleus.

B. The electron can be found at a distance $2a_0$ from the nucleus.

C. The magnitude of the potential energy is double that of its kinetic energy on an average.

D. The total energy of the electron is maximum when it is at a distance a_0 from the nucleus.

Answer: D

Solution:

Solution:
The total energy of the electron is minimum at a distance of a_0 from the nucleus for 1s orbital.

Question116

If p is the momentum of the fastest electron ejected from a metal surface after the irradiation of light having wavelength m, then for 1.5p momentum of the photoelectron, the wavelength of the light should be: (Assume kinetic energy of cjected photoelectron to be very high in comparison to work function): [April 8, 2019 (II)]

Options:

A. $\frac{3}{4}\lambda$

B. $\frac{1}{2}\lambda$

C. $\frac{2}{3}\lambda$

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

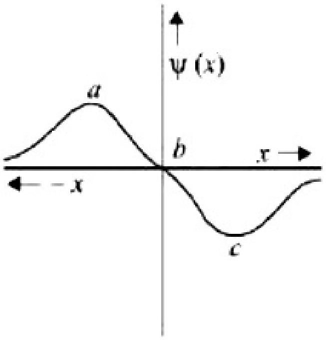
Answer: D

Solution:

In photoelectric effect,
$\frac{hc}{\lambda} = w + KE$ of electron
Given that KE of ejected photoelectron is very high in comparison to work function w.
$\frac{hc}{\lambda} = KE$
$\frac{hc}{\lambda} = \frac{1}{2}mv^2\left(\frac{m}{m}\right)$
$\frac{hc}{\lambda} = \frac{1}{2} \cdot \frac{m^2v^2}{m}$
$\frac{hc}{\lambda} = \frac{P^2}{2m}$
New wavelength
$\frac{hc}{\lambda_1} = \frac{(1.5P)^2}{2m} \Rightarrow \lambda_1 = \frac{4}{9}\lambda$

Question117

The electrons are more likely to be found:



[April 12, 2019 (I)]

Options:

A. in the region a and c

B. in the region a and b

C. only in the region a

D. only in the region 0

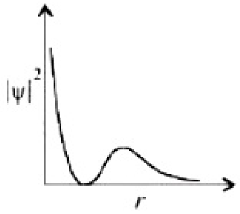
Answer: A

Solution:

Solution:
Probability of finding an electron will have maximum value at both 'a' and 'c'. There is zero probability of finding an electron at 'b'.

Question118

The graph between $|\psi|^2$ and r (radial distance) is shown below. This represents :



[April 10, 2019 (I)]

Options:

A. 3s orbital

B. 2s orbital

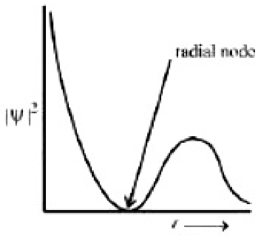
C. 1s orbital

D. 2p orbital

Answer: B

Solution:

Solution:
The given probability density curve is for 2s orbital due to the presence of only one radial node. 1s and 2p orbital do not have any radial node and 3s orbital has two radial nodes. Hence, option (b) is correct.



Question119

The isoelectronic set of ions is [April 10, 2019 (I)]

Options:

A. N^{3-}, O^{2-}, F^{-} and Na^{+}

B. N^{3-}, Li^{+}, Mg^{2+} and O^{2-}

C. F^{-}, Li^{+}, Na^{+} and Mg^{2+}

D. Li^{+}, Na^{+}, O^{2-} and F^{-}

Answer: A

Solution:

Solution:
Atomic numbers of N, O, F and Na are 7, 8, 9 and 11 respectively. Therefore, total number of electrons in each of N^{3-}, O^{2}, F^{-}, and Na^{+} are 10 and hence they are isoelectronic.

Question120

The quantum number of four electrons are given below:
I. $n = 4, l = 2, m_l = -2, m_s = -1/2$
II. $n = 3, l = 2, m_l = 1, m_s = +1/2$
III. $n = 4, l = 1, m_l = 0, m_s = +1/2$
IV. $n = 3, l = 1, m_l = 1, m_s = -1/2$
The correct order of their increasing energies will be:
[April 8, 2019(I)]

Options:

A. IV < III < II < I

B. I < II < III < IV

C. IV < II < III < I

D. I < III < II < IV

Answer: C

Solution:

Solution:

				$n+l$
(I)	$n=4$	$l+2$	$4d$	6
(II)	$n=3$	$l+2$	$3d$	5
(III)	$n=4$	$l+1$	$4p$	5
(IV)	$n=3$	$l+1$	$3p$	4

The energy of an atomic orbital increases with increasing $n + \ell$. For identical values of $n + \ell$, energy increases with increasing value of n. Therefore the correct order of energy is:

Question121

The size of the iso-electronic species Cl^-, Ar and Ca^{2+} is affected by:
[April 8, 2019 (I)]

Options:

A. azimuthal quantum number of valence shell

B. electron-electron interaction in the outer orbitals

C. principal quantum number of valence shell

D. nuclear charge

Answer: D

Solution:

Solution:
Iso-electronic species differ in size due to different effective nuclear charge.

Question122

Which of the following statements is false?
[Online April 16, 2018]

Options:

A. Splitting of spectral lines in electrical field is called Stark effect

B. Frequency of emitted radiation from a black body goes from a lower wavelength to higher wavelength as the temperature increases

C. Photon has momentum as well as wavelength

D. Rydberg constant has unit of energy

Answer: B

Solution:

Solution:
When temperature is increased, black body emits high energy radiation from higher wavelength to lower wavelength.

Question123

Ejection of the photoelectron from metal in the photoelectric effect experiment can be stopped by applying 0.5V when the radiation of 250nm is used. The work function of the metal is:
[Online April 15, 2018 (I)]

Options:

A. 4eV

B. 5.5eV

C. 4.5eV

D. 5eV

Answer: C

Solution:

$\lambda = 250nm$

$E = \frac{hc}{\lambda} = \frac{1240eV . nm}{250nm} = 4.96eV$

$KE =$ stopping potential $= 0.5eV$

$E = W_0 + K.E$

$4.96 = W_0 + 0.5$

$W_0 = 4.46 \approx 4.5eV$

Question124

The de-Broglie's wavelength of electron present in first Bohr orbit of 'H' atom is:
[Online April 15, 2018 (II)]

Options:

A. $4 \times 0.529Å$

B. $2\pi \times 0.529Å$

C. $\frac{0.529}{2\pi}Å$

D. 0.529A

Answer: B

Solution:

Solution:

First Bohr orbit of H atom has radius $r = 0.529Å$ Also, the angular momentum is quantised.

$mvr = \frac{h}{2\pi}$

$2\pi r = \frac{h}{mV} = \lambda$

$\therefore \lambda = 2\pi \times 0.529Å$

Question125

The radius of the second Bohr orbit for hydrogen atom is: (Plank's const. $h = 6.6262 \times 10^{-34}J s$; mass of electron $= 9.1091 \times 10^{-31}kg$; charge of electron $e = 1.60210 \times 10^{-19}C$; permittivity of vaccum $E_0 = 8.854185 \times 10^{-12}kg^{-1}m^{-3}A^2$)
[2017]

Options:

A. 1.65Å

B. 4.76Å

C. 0.529Å

D. 2.12Å

Answer: D

Solution:

Solution:
Radius of n^{th} Bohr orbit in H-atom $= 0.53n^2 Å$
Radius of II Bohr orbit $= 0.53 \times (2)^2 = 2.12 Å$

Question126

If the shortest wavelength in Lyman series of hydrogen atom is A, then the longest wavelength in Paschen series of He^+ is : [Online April 8,2017]

Options:

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

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

C. $\frac{36A}{5}$

D. $\frac{36A}{7}$

Answer: D

Solution:

For Lyman series (shortest wavelength)
$n_1 = 1, n_2 = \infty$

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\Rightarrow \frac{1}{A} = 1^2R\left(\frac{1}{1} - \frac{1}{\infty}\right) \Rightarrow \frac{1}{A} = R$$

Longest wavelength $= 1^{st}$ line
$n_1 = 3, n_2 = 4$

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{3^2} - \frac{1}{4^2}\right) \Rightarrow \frac{1}{\lambda} = \frac{R7}{36}$$

$$R = \frac{1}{A}$$

$$\frac{1}{\lambda} = \frac{\frac{1}{A} \times 7}{36} \Rightarrow \frac{1}{\lambda} = \frac{7}{36A} \Rightarrow \lambda = \frac{36A}{7}$$

Question127

The electron in the hydrogen atom undergoes transition from higher orbitals to orbital of radius 211.6pm. This transition is associated with : [Online April 9, 2017]

Options:

A. Lyman series

B. Balmer series

C. Paschen series

D. Brackett serics

Answer: B

Solution:

Solution:

$r = 0.529 \times \frac{n^2}{Z} Å$

$r = 211.6 pm = 2.11 Å$

$\Rightarrow 0.529 \times \frac{n^2}{Z} = 2.11 Å$

n = 2 (Balmer series)

Question128

A stream of electrons from a heated filaments was passed two charged plates kept at a potential difference V esu. If 'e' and m are charge and mass of an electron, respectively, then the value of h / λ (where λ is wavelength associated with electron wave) is given by: [2016]

Options:

A. $\sqrt{meV}$

B. $\sqrt{2meV}$

C. meV

D. 2meV

Answer: B

Solution:

Solution:

As electron of charge 'e' is passed through 'V' volt, kinetic energy of electron will be eV

Wavelength of electron wave (λ) = $\frac{h}{\sqrt{2m \cdot K.E}}$

$\lambda = \frac{h}{\sqrt{2meV}} \quad \therefore \frac{h}{\lambda} = \sqrt{2meV}$

Question129

The total number of orbitals associated with the principal quantum

number 5 is:
[Online April 9,2016]

Options:

A. 20

B. 25

C. 10

D. 5

Answer: B

Solution:

Solution:
Number of orbitals in a shell $= n^2 = (5)^2 = 25$.

Question130

Which of the following is the energy of a possible excited state of hydrogen?
[2015]

Options:

A. -3.4eV

B. $+6.8\text{eV}$

C. $+13.6\text{eV}$

D. -6.8eV

Answer: A

Solution:

Solution:
Total energy $= -\frac{13.6}{n^2}Z^2\text{eV}$
where $n = 2, 3, 4....$
Putting $n = 2$
$E_T = -\frac{13.6}{4} = -3.4\text{eV}$

Question131

At temperature T, the average kinetic energy of any particle is $\frac{3}{2}kT$. The de Broglie wavelength follows the order :
[Online April 11, 2015]

Options:

A. Visible photon > Thermal neutron > Thermal electron

B. Thermal proton > Thermal electron > Visible photon

C. Thermal proton > Visible photon > Thermal electron

D. Visible photon > Thermal electron > Thermal neutron

Answer: D

Solution:

Solution:
Kinetic energy of any particle $= \frac{3}{2}kT$

Also $K.E. = \frac{1}{2}mv^2$

$\frac{1}{2}mv^2 = \frac{3}{2}kT \Rightarrow v^2 = \frac{3kT}{m}$

$v = \sqrt{\frac{3kT}{m}}$

de-broglie wavelength $= \lambda = \frac{h}{mv} = \frac{h}{m\sqrt{\frac{3kT}{m}}}$

$\lambda = \frac{h}{\sqrt{3kT\,m}}; \lambda \propto \frac{1}{\sqrt{m}}$

Mass of electron < mass of neutron λ (electron) >λ (neutron)

Question132

If the principal quantum number n = 6, the correct sequence of filling of electrons will be:
[Online April 10,2015]

Options:

A. $ns \rightarrow (n-2)f \rightarrow np \rightarrow (n-1)d$

B. $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$

C. $ns \rightarrow np \rightarrow (n-1)d \rightarrow (n-2)f$

D. $ns \rightarrow (n-1)d \rightarrow (n-2)f \rightarrow np$

Answer: B

Solution:

Solution:
According to Aufbau principle, the sequence of filling electrons in sixth period is
$6s - 4f - 5d - 6p$ i.e., $(ns) \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$

Question133

If λ_0 and λ be threshold wavelength and wavelength of incident light, the velocity of photoelectron ejected from the metal surface is:
[Online April 11,2014]

Options:

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

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

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

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

Answer: C

Solution:

Solution:
The kinetic energy of the ejected electron is given by the equation

$$h\nu = h\nu_0 + \frac{1}{2}mv^2 \quad \because \nu = \frac{c}{\lambda}$$

or $\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + \frac{1}{2}mv^2$

$$\frac{1}{2}mv^2 = \frac{hc}{\lambda} - \frac{hc}{\lambda_0} = hc\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)$$

$$\therefore v^2 = \frac{2hc}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)$$

or $v = \sqrt{\frac{2hc}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)}$

Question134

The energy of an electron in first Bohr orbit of H-atom is 13.6eV. The energy value of electron in the excited state of Li^{2+} is:
[Online April 9, 2014]

Options:

A. -27.2eV

B. 30.6eV

C. -30.6eV

D. 27.2eV

Answer: C

Solution:

Solution:
For Li^{2+} ion

$$E = -13.6 \times \frac{Z^2}{n^2} eV = -13.6 \times \frac{(3)^2}{(2)^2}$$
$$= \frac{-13.6 \times 9}{4} = -30.6 eV$$

Question135

Based on the equation:

[Online April 11,2014] $\Delta E = -2.0 \times 10^{-18} J \left(\frac{1}{n_2^2} - \frac{1}{n_1^2} \right)$ the wavelength of the light that must be absorbed to excite hydrogen electron from level n = 1 to level n = 2 will be: ($h = 6.625 \times 10^{-34} J\ s$, $C = 3 \times 10^8 ms^{-1}$) [Online April 11, 2014]

Options:

A. $1.325 \times 10^{-7} m$

B. $1.325 \times 10^{-10} m$

C. $2.650 \times 10^{-7} m$

D. $5.300 \times 10^{-10} m$

Answer: A

Solution:

Solution:

$$\Delta E = -2.0 \times 10^{-18} \times \left(\frac{1}{2^2} - \frac{1}{1^2} \right)$$
$$= -2.0 \times 10^{-18} \times \frac{-3}{4}$$
$$= 1.5 \times 10^{-18} J$$
$$\Delta E = \frac{hc}{\lambda}$$
$$\lambda = \frac{hc}{\Delta E} = \frac{6.625 \times 10^{-34} js \times 3 \times 10^8 ms^{-1}}{1.5 \times 10^{-18} J}$$
$$= 1.325 \times 10^{-7} m$$

Question136

If m and e are the mass and charge of the revolving electron in the orbit of radius r for hydrogen atom, the total energy of the revolving electron will be: [Online April 12,2014]

Options:

A. $\frac{1}{2}\frac{e^2}{r}$

B. $-\frac{e^2}{r}$

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

D. $-\frac{1}{2}\frac{e^2}{r}$

Answer: D

Solution:

Solution:
Total energy of a revolving electron is the sum of its kinetic and potential energy.
Total energy $= K.E. + P.E$
$= \frac{e^2}{2r} + \left(-\frac{e^2}{r}\right); \; = -\frac{e^2}{2r}$

Question137

Excited hydrogen atom emits light in the ultraviolet region at $2.47 \times 10^{15} Hz$. With this frequency, the energy of a single photon is: ($h = 6.63 \times 10^{-34} J\,s$)
[Online April 12, 2014]

Options:

A. $8.041 \times 10^{-40} J$

B. $2.680 \times 10^{-19} J$

C. $1.640 \times 10^{-18} J$

D. $6.111 \times 10^{-17} J$

Answer: C

Solution:

Solution:
$E = hv$
$= 6.63 \times 10^{-34} \times 2.47 \times 10^{15}$
$= 1.640 \times 10^{-18} J$

Question138

Ionization cnergy of gaseous Na atoms is $495.5 kJ\,mol^{-1}$. The lowest possible frequency of light that ionizes a sodium atom is ($h = 6.626 \times 10^{-34} J\,s$, $N_A = 6.022 \times 10^{23} mol^{-1}$)

[Online April 19,2014]

Options:

A. $7.50 \times 10^{4} s^{-1}$

B. $4.76 \times 10^{14} s^{-1}$

C. $3.15 \times 10^{15} s^{-1}$

D. $1.24 \times 10^{15} s^{-1}$

Answer: D

Solution:

Solution:
Energy $= N_A hv$
$495.5 = 6.023 \times 10^{23} \times 6.6 \times 10^{-34} \times v$
$v = \frac{495.5 \times 10^{3} J}{6.023 \times 10^{23} \times 6.6 \times 10^{-34}} = 12.4 \times 10^{14}$
$= 1.24 \times 10^{15} s^{-1}$

Question139

The de-Broglie wavelength of a particle of mass 6.63g moving with a velocity of $100ms^{-1}$ is:
[Online April 12, 2014]

Options:

A. $10^{-33} m$

B. $10^{-35} m$

C. $10^{-31} m$

D. $10^{-25} m$

Answer: A

Solution:

Solution:
de $(\lambda) = \frac{h}{mv}$
$= \frac{6.63 \times 10^{-34} J\ s}{6.63 \times 10^{-3} kg \times 100 m / s} = 10^{-33} m$

Question140

The correct set of four quantum numbers for the valence electrons of rubidium atom (Z = 37) is:

[2014]

Options:

A. 5, 0, 0, + $\frac{1}{2}$

B. 5, 1, 0, + $\frac{1}{2}$

C. 5, 1, 1, + $\frac{1}{2}$

D. 5, 0, 1, + $\frac{1}{2}$

Answer: A

Solution:

Solution:
The electronic configuration of Rubidium (Rb = 37) is
$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^1$
Since last electron enters in 5s orbital
Hence $n = 5, l = 0, m = 0, s = \pm \frac{1}{2}$

Question141

Energy of an electron is given by $E = -2.178 \times 10^{-18} J \left(\frac{Z^2}{n^2} \right)$ Wavelength of light required to excite an electron in an hydrogen atom from level n = 1 to n = 2 will be:
$(h = 6.62 \times 10^{-34} J\ s$ and $c = 3.0 \times 10^8 ms^{-1})$
[2013]

Options:

A. $1.214 \times 10^{-7} m$

B. $2.816 \times 10^{-7} m$

C. $6.500 \times 10^{-7} m$

D. $8.500 \times 10^{-7} m$

Answer: A

Solution:

Solution:
$\Delta E = 2.178 \times 10^{-18} \left(\frac{1}{1^2} - \frac{1}{2^2} \right) = \frac{hc}{\lambda}$
$\Rightarrow 2.178 \times 10^{-18} \times \frac{3}{4} = \frac{hc}{\lambda}$
$= \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{\lambda}$

$$\lambda = \frac{6.62 \times 10^{-34} \times 3 \times 10^{8} \times 4}{2.178 \times 10^{-18} \times 3}$$
$$= 1.214 \times 10^{-7} m$$

Question142

The wave number of the first emission line in the Balmer series of H-Spectrum is:
(R = Rydberg constant):
[Online April 22, 2013]

Options:

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

B. $\frac{9}{400}R$

C. $\frac{7}{6}R$

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

Answer: A

Solution:

Solution:

$$\bar{v} = RZ^{2}\left(\frac{1}{2^{2}} - \frac{1}{3^{2}}\right)$$
$$= R\left(\frac{1}{4} - \frac{1}{9}\right) = \frac{5R}{36}$$

Question143

The de Broglie wavelength of a car of mass 1000kg and velocity 36 km/hr is :
[Online April 23, 2013]

Options:

A. $6.626 \times 10^{-34} m$

B. $6.626 \times 10^{-38} m$

C. $6.626 \times 10^{-31} m$

D. $6.626 \times 10^{-30} m$

Answer: B

Solution:

$\lambda = \frac{h}{mv}$

$h = 6, 6 \times 10^{-34} J\ s$

$m = 1000 kg$

$v = 36 km / hr = \frac{36 \times 10^3}{60 \times 60} m / sec = 10 m / sec$

$\therefore\ \lambda = \frac{6.6 \times 10^{-34}}{10^3 \times 10} = 6.6 \times 10^{-38} m$

Question144

In an atom how many orbital(s) will have the quantum numbers; $n = 3, l = 2$ and $m_l = +2$?
[Online April 9, 2013]

Options:

A. 5

B. 3

C. 1

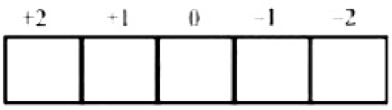
D. 7

Answer: C

Solution:

Solution:

$n = 3, l = 2$ means 3d orbital



i.e. in an atom only one orbital can have the value $m_l = +2$

Question145

Given
(A) $n = 5, m = +1$
(B) $n = 2, \ell = 1, m_f = -1, m_s = -1 / 2$
The maximum number of electron(s) in an atom that can have the quantum numbers as given in (A) and (B) are respectively:
[Online April 25, 2013]

Options:

A. 25 and 1

B. 8 and 1

C. 2 and 4

D. 4 and 1

Answer: B

Solution:

Solution:
(i) $n = 5$ means $l = 0, 1, 2, 3, 4$
since $m = +1$
hence total no. of electrons will be
$= 0(\text{ from s}) + 2(\text{ from p}) + 2(\text{ from d}) + 2(\text{ from f}) + 2(\text{ from g})$
$= 0 + 2 + 2 + 2 + 2 = 8$
(ii) $n = 2, l = 1, m_l = -1, m_s = -1/2$ represent 2p orbital with one electron.

Question146

The limiting line in Balmer series will have a frequency of (Rydberg constant, $R_\infty = 3.29 \times 10^{15}$ cycles/s) [Online May 7,2012]

Options:

A. $8.22 \times 10^{14} s^{-1}$

B. $3.29 \times 10^{15} s^{-1}$

C. $3.65 \times 10^{14} s^{-1}$

D. $5.26 \times 10^{13} s^{-1}$

Answer: A

Solution:

$$v = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) Hz$$

$$v = 3.29 \times 10^{15}\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right)$$

$$= 8.22 \times 10^{14} s^{-1}$$

Question147

If the radius of first orbit of H atom is a_0, the de-Broglie wavelength of an electron in the third orbit is [Online May 12, 2012]

Options:

A. $4\pi a_0$

B. $8\pi a_0$

C. $6\pi a_0$

D. $2\pi a_0$

Answer: C

Solution:

Solution:

$r_n = a_0 n^2$

$r = a_0 \times (3)^2 = 9a_0$

$mvr = \frac{nh}{2\pi}$; $mv = \frac{nh}{2\pi r} = \frac{3h}{2\pi \times 9a_0} = \frac{h}{6\pi a_0}$

$\lambda = \frac{h}{mv} = \frac{n}{h} \times 6\pi a_0 = 6\pi a_0$

Question148

If the kinetic energy of an electron is increased four times, the wavelength of the de-Broglie wave associated with it would become [Online May 19, 2012]

Options:

A. one fourth

B. half

C. four times

D. two times

Answer: B

Solution:

Solution:

de − Broglie wavelength is given by:

$\lambda = \frac{h}{mv} \ldots$ (i)

$K.E. = \frac{1}{2}mv^2$

$v^2 = \frac{2K \cdot E}{m}$

$v = \sqrt{\frac{2K \cdot E}{m}}$

Substituting this in equation (i)

$\lambda = \frac{h}{m}\sqrt{\frac{m}{2K \cdot E}}$

$\lambda = h\sqrt{\frac{1}{2m(K \cdot E)}}$

i.e. $\lambda \propto \frac{1}{\sqrt{K \cdot E}}$

$\therefore$ when KE become 4 times wavelength become $1/2$.

Question149

The electrons identified by quantum numbers n and ℓ :
(A) n = 4, l = 1
(B) n = 4, l = 0
(C) n = 3, l = 2
(D) n = 3, l = 1
can be placed in order of increasing energy as:
[2012]

Options:

A. (C) < (D) < (B) < (A)

B. (D) < (B) < (C) < (A)

C. (B) < (D) < (A) < (C)

D. (A) < (C) < (B) < (D)

Answer: B

Solution:

Solution:
(A)4p (B) 4s
(C) 3d (D) 3p Accroding to Bohr Bury's $(n + l)$ rule, increasing order of energy (D) < (B) < (C) < (A).
Note: If the two orbitals have same value of $(n + l)$ then the orbital with lower value of n will be filled first.

Question150

The increasing order of the ionic radii of the given iscelectronic species is :
[2012]

Options:

A. Cl , Ca^{2+}, K^{+}, S^{2}

B. S^{2}, Cl^{-}, Ca^{2+}, K^{+}

C. Ca^{2+}, K^{+}, Cl^{-}, S^{2}

D. K^{+}, S^{2}, Ca^{2+}, Cl^{-}

Answer: C

Solution:

Solution:
Among isoelectronic species ionic radii increases as the negatives charge increases.
Order of ionic radii $Ca^{2+} < K^{+} < Cl^{-} < S^{2-}$
The number of electrons remains the same but nuclear charge increases with increase in the atomic number causing decrease in size.

Question151

The following sets of quantum numbers represent four electrons in an atom.
(i) n = 4, l = 1
(ii) n = 4, l = 0
(iii) n = 3, l = 2
(iv) n = 3, l = 1
The sequence representing increasing order of energy, is
[Online May 26, 2012]

Options:

A. (iii) < (i) < (iv) < (ii)

B. (iv < (ii) < (iii) < (i)

C. (i) < (iii) < (ii) < (iv)

D. (ii) < (iv) < (i) < (iii)

Answer: B

Solution:

Solution:
(i) 4p (ii) 4s
(iii) 3d (iv) 3p
According to Bohr Bury's $(n + l)$ rule, increasing order of energy will be (iv) < (ii) < (iii) < (i).
Note: If the two orbitals have same value of $(n + l)$ then the orbital with lower value of n will be filled first.

Question152

The frequency of light emitted for the transition n = 4 to n = 2 of the He^+ is equal to the transition in H atom corresponding to which of the following ?
[2011RS]

Options:

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

Solution:

For He^+,

$v = RZ^2\left(\frac{1}{2^2} - \frac{1}{4^2}\right) Hz$

For H,

$v = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) Hz$

For same frequency,

$Z^2\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

Since, $Z = 2$

$\therefore \frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{1}{1^2} - \frac{1}{2^2}$

$\therefore n_1 = 1 \; \& \; n_2 = 2$

Question153

The energy required to break one mole of $Cl - Cl$ bonds in Cl_2 is $242 kJ\ mol^{-1}$. The longest wavelength of light capable of breaking a single $Cl - Cl$ bond is

$(c = 3 \times 10^8 ms^{-1}$ and $N_A = 6.02 \times 10^{23} mol^{-1})$
[2010]

Options:

A. 594nm

B. 640nm

C. 700nm

D. 494nm

Answer: D

Solution:

Solution:

Energyrequired to break single $Cl - Cl$ bond

$= \frac{242 \times 10^3}{6.023 \times 10^{23}} = \frac{hc}{\lambda}$

$= \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{\lambda}$

$\therefore \lambda = \frac{6.626 \times 10^{-34} \times 3 \times 10^8 \times 6.023 \times 10^{23}}{242 \times 10^3}$

$= 0.4947 \times 10^{-6} m = 494.7 nm$

Question154

Ionisation energy of He^+ is $19.6 \times 10^{-18} J\ atom^{-1}$. The energy of the first stationary state $(n = 1)$ of Li^{2+} is
[2010]

Options:

A. 4.41×10^{-16}J atom $^{-1}$

B. -4.41×10^{-17}J atom $^{-1}$

C. -2.2×10^{-15}J atom $^{-1}$

D. 8.82×10^{-17}J atom $^{-1}$

Answer: B

Solution:

I. $E = \frac{Z^2}{n^2} \times 13.6\text{eV}$

or $\frac{I_1}{I_2} = \frac{Z_1^{\,2}}{n_1^{\,2}} \times \frac{n_2^{\,2}}{Z_2^{\,2}}$

Given $I_1 = -19.6 \times 10^{-18}$J / atom, $Z_1 = 2$,
$n_1 = 1$, $Z_2 = 3$ and $n_2 = 1$
Substituting these values in equation (ii).

$-\frac{19.6 \times 10^{-18}}{I_2} = \frac{4}{1} \times \frac{1}{9}$

or $I_2 = -19.6 \times 10^{-18} \times \frac{9}{4}$

$= -4.41 \times 10^{-17}$J / atom

Question155

Calculate the wavelength (in nanometer) associated with a proton moving at $1.0 \times 10^3 \text{ms}^{-1}$. (Mass of proton $= 1.67 \times 10^{-27}$kg and $h = 6.63 \times 10^{-34}$J s) [2009]

Options:

A. 0.40nm

B. 2.5nm

C. 14.0nm

D. 0.32nm

Answer: A

Solution:

Solution:

$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{1.67 \times 10^{-27} \times 1 \times 10^3}$

$= 3.97 \times 10^{-10}\text{m} = 0.397\text{nm}.$

Question156

In an atom, an electron is moving with a speed of 600m / s with an accuracy of 0.005%. Certainity with which the position of the electron can be located is ($h = 6.6 \times 10^{-34}$ kgm^2s^{-1}, mass of electron, $e_m = 9.1 \times 10^{-31}kg$):
[2009]

Options:

A. $5.10 \times 10^{-3}m$

B. $1.92 \times 10^{-3}m$

C. $3.84 \times 10^{-3}m$

D. $1.52 \times 10^{-4}m$

Answer: B

Solution:

Solution:
According to Heisenberg uncertainty principle.
$\Delta xm \Delta v = \frac{h}{4\pi}$; $\Delta x = \frac{h}{4\pi m \Delta v}$
Here $\Delta v = \frac{600 \times 0.005}{100} = 0.03m / s$
So,
$\Delta x = \frac{6.6 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31} \times 0.03}$
$= 1.92 \times 10^{-3}m$

Question157

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

Options:

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

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

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

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

Answer: D

Solution:

(ΔE), The energy required to excite an electron in an atom of hydrogen from $n = 1$ to $n = 2$ is ΔE (difference in energy E_2 and E_1)
Values of E_2 and E_1 are,
$E_2 = \frac{-1.312 \times 10^6 \times (1)^2}{(2)^2} = -3.28 \times 10^5 \text{J mol}^{-1}$
ΔE is given by the relation,
$E_1 = -1.312 \times 10^6 \text{J mol}^{-1}$
$\therefore \Delta E = E_2 - E_1 = [-3.28 \times 10^5] - [-1.312 \times 10^6] \text{J mol}^{-1}$
$= (-3.28 \times 10^5 + 1.312 \times 10^6) \text{J mol}^{-1}$
$= 9.84 \times 10^5 \text{J mol}^{-1}$

Question158

Which one of the following constitutes a group of the isoelectronic species?
[2008]

Options:

A. C_2^{2-}, O_2^-, CO, NO

B. NO^+, C_2^{2-}, CN^-, N_2

C. CN^-, N_2, O_2^{2-}, C_2^{2-}

D. N_2, O_2^-, NO^+, CO

Answer: B

Solution:

Solution:
Species having same number of electrons are isoelectronic. On calculating the number of electrons in each species given here, we get.
$CN^-(6 + 7 + 1 = 14)$; $N_2(7 + 7 = 14)$
$O_2^{2-}(8 + 8 + 2 = 18)$; $C_2^{2}(6 + 6 + 2 = 14)$
$O_2^-(8 + 8 + 1 = 17)$; $NO^+(7 + 8 - 1 = 14)$
$CO(6 + 8 = 14)$; $NO(7 + 8 = 15)$
From the above calculation we find that all the species listed in choice (b) have 14 electrons each so it is the correct answer.

Question159

Which of the following sets of quantum numbers represents the highest energy of an atom?
[2007]

Options:

A. $n = 3, l = 0, m = 0, s = +\frac{1}{2}$

B. $n = 3, l = 1, m = 1, s = +\frac{1}{2}$

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

D. $n = 4, l = 0, m = 0, s = +\frac{1}{2}$.

Answer: C

Solution:

Solution:
(a) $n = 3, l = 0$ means $3s$ -orbital and $n + l = 3$
(b) $n = 3, l = 1$ means $3p$ -orbital $n + l = 4$
(c) $n = 3, l = 2$ means $3d$ -orbital $n + l = 5$
(d) $n = 4, l = 0$ means $4s$ -orbital $n + l = 4$
Increasing order of energy among these orbitals is
$3s < 3p < 4s < 3d$
$\therefore 3d$ has highest energy.

Question160

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

Options:

A. $10h / \pi$

B. $2.5h / \pi$

C. $25h / \pi$

D. $1.0h / \pi$

Answer: B

Solution:

Solution:
Angular momentum of an electron in n^{th} orbital is given by, $mvr = \frac{nh}{2\pi}$

For $n = 5$, we have

Angular momentum of electron $= \frac{5h}{2\pi} = \frac{2.5h}{\pi}$

Question161

Uncertainty in the position of an electron (mass $= 9.1 \times 10^{-31}$kg) moving with a velocity $300ms^{-1}$, accurate upto 0.001% will be ($h = 6.63 \times 10^{-34}$J s) [2006]

Options:

A. 1.92×10^{-2}m

B. 3.84×10^{-2}m

C. 19.2×10^{-2}m

D. 5.76×10^{-2}m

Answer: A

Solution:

Solution:
Given $m = 9.1 \times 10^{-31}$kg
$h = 6.6 \times 10^{-34}$J s
$\Delta v = \frac{300 \times .001}{100} = 0.003 ms^{-1}$
From Heisenberg's uncertainity principle
$$\Delta x = \frac{6.62 \times 10^{-34}}{4 \times 3.14 \times 0.003 \times 9.1 \times 10^{-31}}$$
$= 1.92 \times 10^{-2}$m

Question162

Which one of the following sets of ions represents a collection of isoelectronic species?
[2006]

Options:

A. $N^{3-}, O^{2-}, F^{-}, S^{2}$

B. $Li^{+}, Na^{+}, Mg^{2+}, Ca^{2+}$

C. $K^{+}, Cl^{-}, Ca^{2+}, Sc^{3+}$

D. $Ba^{2+}, Sr^{2+}, K^{+}, Ca^{2+}$

Answer: C

Solution:

Solution:
(a) $N^{3-} = 7 + 3 = 10e^{-}, O^{2-} \longrightarrow 8 + 2 = 10c^{-}$
$F^{-} = 9 + 1 = 10c^{-}, S^{2-} \longrightarrow 16 + 2 = 18e^{-}$
(not isoelectronic)
(b) $Li^{+} = 3 - 1 = 2e, Na^{+} = 11 - 1 = 10e^{-}$
$Mg^{2+} = 12 - 2 = 10e^{-}$
$Ca^{2+} = 20 - 2 = 18c^{-}$
(not isoelectronic)
(c) $K^{+} = 19 - 1 = 18e^{-}, Cl^{-} = 17 + 1 = 18e^{-}$
$Ca^{2+} = 20 - 2 = 18e^{-}, Sc^{3+} = 21 - 3 = 18e^{-}$
(isoelectronic)
(d) $Ba^{2+} = 56 - 2 = 54e^{-}, Sr^{2+} = 38 - 2 = 36e^{-}$
$K^{+} = 19 - l = 18e^{-}, Ca^{2+} = 20 - 2 = 18e^{-}$
(not isoelectronic)

Question163

Of the following sets which one does NOT contain isoelectronic species? [2005]

Options:

A. BO_3^{3-}, CO_3^{2-}, NO_3^{-}

B. SO_3^{2-}, CO_3^{2-}, NO_3^{-}

C. CN^{-}, N_2, C_2^{2-}

D. PO_4^{3-}, SO_4^{2-}, ClO_4^{-}

Answer: B

Solution:

Solution:

Question164

In a multi-electron atom, which of the following orbitals described by the three quantum members will have the same energy in the absence of magnetic and electric fields?
(A) n = 1, l = 0, m = 0
(B) n = 2, l = 0, m = 0
(C) n = 2, l = 1, m = 1
(D) n = 3, l = 2, m = 1
(E) n = 3, l = 2, m = 0
[2005]

Options:

A. (D) and (E)

B. (C) and (D)

C. (B) and (C)

D. (A) and (B)

Answer: A

Solution:

Solution:
The energy of an orbital is given by $(n + l)$ rule. $(n + l)$ value for option (E) and (D) is $(3 + 2) = 5$ hence they will have same energy, since their n values are also same.

Question165

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

Options:

A. 406nm

B. 192nm

C. 91nm

D. 9.1×10^{-8}nm

Answer: C

Solution:

Solution:

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

$$\frac{1}{\lambda} = 1.097 \times 10^7\left(\frac{1}{1} - \frac{1}{\infty}\right) = 1.097 \times 10^7$$

$\lambda = 91.15 \times 10^{-9}m \approx 91nm$

Question166

Which of the following sets of quantum numbers is correct for an electron in 4f orbital ? [2004]

Options:

A. $n = 4, l = 3, m = +1, s = +1/2$

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

C. $n = 4, l = 3, m = +4, s = +1/2$

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

Answer: A

Solution:

Solution:
The possible quantum numbers for 4f electron are
$n = 4, l = 3, m = -3, -2 - 1, 0, 1, 2, 3$ and $s = \pm\frac{1}{2}$ Of various possiblities only option (a) is possible.

Question167

Consider the ground state of Cr atom ($X = 24$). The number of electrons with the azimuthal quantum numbers, $l = 1$ and 2 are, respectively [2004]

Options:

A. 16 and 4

B. 12 and 5

C. 12 and 4

D. 16 and 5

Answer: B

Solution:

Electronic configuration of Cr atom ($Z = 24$)
$= 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$
when $l = 1$, p -subshell,
Numbers of electrons $= 12$
when $l = 2$, d -subshell,
Numbers of electrons $= 5$

Question168

Which one of the following sets of ions represents the collection of isoelectronic species?
(Atomic nos. :
$F = 9, Cl = 17, Na = 11, Mg = 12, Al = 13, K = 19, Ca = 20, Sc = 21$)
[2004]

Options:

A. $K^+, Cl^-, Mg^{2+}, Sc^{3+}$

B. $Na^+, Ca^{2+}, Sc^{3+}, F^-$

C. $K^+, Ca^{2+}, Sc^{3+}, Cl$

D. $Na^+, Mg^{2+}, Al^{3+}, Cl$

Answer: C

Solution:

${}_{19}K^+, {}_{20}Ca^{2+}, {}_{21}Sc^{3+}, {}_{17}Cl$
each contains 18 electrons.

Question169

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

Options:

A. zero

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

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

D. $+\frac{1}{2} \cdot \frac{h}{2\pi}$

Answer: A

Solution:

Solution:
For s -electron, $l = 0$
∴ Orbital angular momentum
$= \sqrt{0(0+1)} \frac{h}{2\pi} = 0$

Question170

In Bohr series of lines of hydrogen spectrum, the third line from the red end corresponds to which one of the following inter-orbit jumps of the electron for Bohr orbits in an atom of hydrogen
[2003]

Options:

A. $5 \rightarrow 2$

B. $4 \rightarrow 1$

C. $2 \rightarrow 5$

D. $3 \rightarrow 2$

Answer: A

Solution:

Solution:
The lines falling in the visible region comprise Balmer series. Hence the third line from red would be $n_1 = 2$, $n_2 = 5$ i.e. $5 \rightarrow 2$

Question171

The de Broglie wavelength of a tennis ball of mass 60g moving with a velocity of 10 metres per second is approximately Planck's constant, $h = 6.63 \times 10^{-34}$ J s [2003]

Options:

A. 10^{-31} metres

B. 10^{-16} metres

C. 10^{-25} metres

D. 10^{-33} metres

Answer: D

Solution:

Solution:

$$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{60 \times 10^{-3} \times 10}$$
$$= 1.105 \times 10^{-33} \approx 10^{-33} m$$

Question172

The number of d -electrons retained in Fe^{2+} (At. no. of Fe=26) ion is [2003]

Options:

A. 4

B. 5

C. 6

D. 3

Answer: C

Solution:

Solution:

$Fe^{++}(26 - 2 = 24) = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^0 3d^6$ hence no. of d electrons retained is 6 .
[Two 4s electron are removed]

Question173

Which one of the following groupings represents a collection of isoelectronic species?(At. nos. : Cs : 55, Br : 35)
[2003]

Options:

A. N^{3-}, F^{-}, Na^{+}

B. Be, Al^{3+}, Cl^{-}

C. Ca^{2+}, Cs^{+}, Br

D. Na^{+}, Ca^{2+}, Mg^{2+}

Answer: A

Solution:

Solution:
N^{3-}, F^{-} and Na^{+} contain 10 electrons each.

Question174

In a hydrogen atom, if energy of an electron in ground state is 13.6 . eV , then that in the 2^{nd} excited state is
[2002]

Options:

A. 1.51eV

B. 3.4eV

C. 6.04eV

D. 13.6eV .

Answer: A

Solution:

Solution:
2^{nd} excited state will be the 3^{rd} energy level
$E_n = \frac{13.6}{n^2}eV$
or $E_3 = \frac{13.6}{9}eV = 1.51eV$.

Question175

Uncertainty in position of a minute particle of mass 25g in space is 10^{-5}m. What is the uncertainty in its velocity (in

ms^{-1})?($h = 6.6 \times 10^{-34}$J s)
[2002]

Options:

A. 2.1×10^{-34}

B. 0.5×10^{-34}

C. 2.1×10^{-28}

D. 0.5×10^{-23}.

Answer: C

Solution:

$$\Delta x \cdot \Delta p = \frac{h}{4\pi}; \quad \text{or} \quad \Delta x, m, \Delta v = \frac{h}{4\pi}$$

$$\therefore \Delta v = \frac{6.62 \times 10^{-34}}{4 \times 3.14 \times 0.025 \times 10^{-5}} = 2.1 \times 10^{-28} ms^{-1}$$
