1. 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 $9 \times 10-31$ kg, $h = 6.6 \times 10-34$ Js

[2023 (06 Apr Shift 1)]

2. If the radius of the first orbit of hydrogen atom is a_0, then de Broglie's wavelength of electron in 3rd orbit is

[2023 (06 Apr Shift 2)]

(1) $\frac{\pi a_0}{6}$

(2) $\frac{\pi a_0}{3}$

(3) $6\pi a_0$

(4) $3\pi a_0$

3. The number of following statement/s which is/are incorrect is _____

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

[2023 (08 Apr Shift 1)]

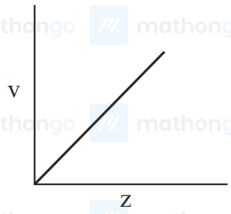
4. Henry Moseley studied characteristic X-ray spectra of elements. The graph which represents his observation correctly is

Given v = Frequency of X-ray emitted

Z = Atomic number

[2023 (08 Apr Shift 2)]

(1)



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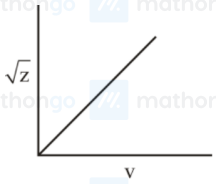

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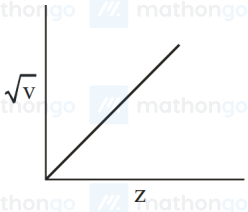

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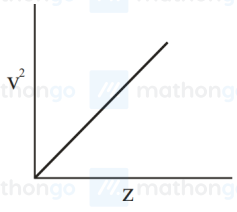
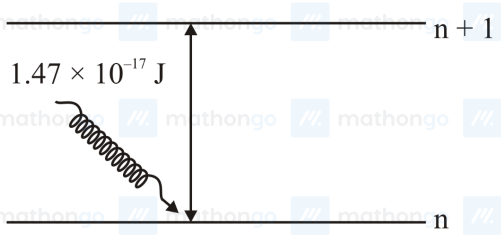


5. The number of atomic orbitals from the following having 5 radial nodes is

7s, 7p, 6s, 8p, 8d

[2023 (08 Apr Shift 2)]

6.



The electron in the n^{th} 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

[2023 (10 Apr Shift 2)]

7. For a metal ion, the calculated magnetic moment is 4.90 BM. This metal ion has _____ number of unpaired electrons

[2023 (10 Apr Shift 2)]

8. 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, the 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 :

[2023 (11 Apr Shift 1)]

(1) Both A and R are correct and R is the correct explanation of A

(2) A is correct but R is not correct

(3) Both A and R are correct but R is NOT the correct explanation of A

(4) A is not correct but R is correct

9. The number of correct statements from the following is .....

A. For 1s orbital, the probability density is maximum at the nucleus

B. For 2s 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

[2023 (11 Apr Shift 2)]

10. Given below are two statement : one is labelled as Assertion A and the other is labelled as Reason R

Assertion A : 5f electron 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

[2023 (12 Apr Shift 1)]

(1) A is false but R is true

(2) Both A and R are true and R is the correct explanation of A

(3) A is true but R is false

(4) Both A and R are true but R is NOT the correct explanation of A

11. Values of work function (W_0) for a few metals are given below

Metal	Li	Na	K	Mg	Cu	Ag
$\frac{W_0}{eV}$	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

[2023 (12 Apr Shift 1)]

12. 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_____.

[2023 (13 Apr Shift 1)]

(1) $\frac{1}{9}$th of the value

(2) $\frac{1}{27}$ of this value

(3) Three times of this value

(4) One third of this value

13. The orbital angular momentum of an electron in 3 s orbital is $\frac{xh}{2\pi}$. The value of x is (nearest integer)

[2023 (13 Apr Shift 2)]

14. Given below are two statements

Statement I : According to Bohr's model of hydrogen atom, the angular momentum of an electron in a given stationary state is quantised.

Statement II : The concept of electron in Bohr's orbit, violates the Heisenberg uncertainty principle. In the light of the above statements, choose the most appropriate answer from the options given below

[2023 (15 Apr Shift 1)]

(1) Statement I is incorrect but Statement II is correct

(2) Both Statement I and Statement II are correct

(3) Both Statement I and Statement II are incorrect

(4) Statement I is correct but Statement II is incorrect

15. The total number of isoelectronic species from the given set is _____.

O^{2-}, F^-, Al, Mg^{2+}, Na^+, O^+, Mg, Al^{3+}, F

[2023 (15 Apr Shift 1)]

ANSWER KEYS

1. (7)	**2.** (3)	**3.** (1)	**4.** (3)	**5.** (3)	**6.** (1)	**7.** (4)	**8.** (2)
9. (3)	**10.** (2)	**11.** (3)	**12.** (3)	**13.** (0)	**14.** (2)	**15.** (5)	

1. (7)

Given:

Kinetic energy(K.E.)=4.55×10^{-29}J

Mass of electron

$\left(\mathrm{m_e}\right) = 9.1 \times 10^{-31}\,\mathrm{kg}$

$\mathrm{h} = 6.6 \times 10^{-34}\mathrm{J} - \mathrm{sec}$

debroglie wavelength $\lambda_{\mathrm{d}} = \frac{\mathrm{h}}{\mathrm{mv}} = \frac{\mathrm{h}}{\sqrt{2\,\mathrm{mKE}}}$

Here λ is the de Broglie wavelength, h is Planck's constant, m is the mass of the particle, v is its velocity, and p is the momentum of the particle, which is equal to mv.

$\lambda = \frac{\mathrm{h}}{\sqrt{2\,\mathrm{mKE}}}$

$= \frac{6.6\times10^{-34}}{\sqrt{2\times9\times10^{-31}\times4.5\times10^{-29}}} = \frac{6.6\times10^{-34}}{9\times10^{-30}} = \frac{6.6}{9} \times 10^{-4}$

$= \frac{66}{9} \times 10^{-5}$

$= 7.33 \times 10^{-5}$

2. (3)

According to Bohr's angular momentum equation,

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

The angular momentum equation for third orbit is

$mvr = \frac{3h}{2\pi}$

$\frac{2\pi r}{3} = \frac{h}{mv}$

According de Broglie's equation

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

$\therefore \lambda = \frac{2\pi 9a_0}{3} = 6\pi a_0$

3. (1)

The emission spectrum of a element is the spectrum of frequencies of electromagnetic radiation emitted due to an atom or molecule making a transition from a high energy state to a lower energy state. The energy of the emitted photon is equal to the energy difference between the two states. There are many possible electron transitions for each atom, and each transition has a specific energy difference. This collection of different transitions, leading to different radiated wavelengths, make up an emission spectrum. Each element's emission spectrum is unique.

The emission spectra of atoms in the gaseous phase do not show a continuous spread of wavelength from red to violet, rather they emit light only at specific wavelengths with dark spaces between them.

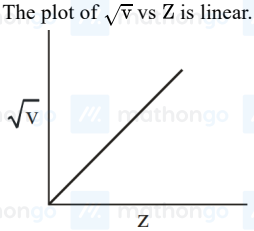
An absorption spectrum is like the photographic negative of an emission spectrum. The element helium was discovered in the sun by spectroscopic method.

4. (3)

Moseley's observation on characteristic X-ray spectra of elements relates frequency (v) of X-rays emitted to the atomic number by the following relation:

$\sqrt{\mathrm{v}} = \mathrm{a}\left(\mathrm{Z} - \mathrm{b}\right)$

The plot of $\sqrt{\mathrm{v}}$ vs Z is linear.



Based on this observation, the periodic law defined as the physical and chemical properties of the elements are periodic functions of their atomic numbers.

5. (3)

The number of radial nodes for an orbital with principal quantum number n and azimuthal quantum number l is given by the expression:

Number of radial nodes $= \ n \ - \ l \ - \ 1$

Using this expression, we can determine the number of radial nodes for each of the given atomic orbitals:

$7s : n = 7, l = 0 \ \ 7 - 0 - 1 = 6$

$7p : n = 7, l = 1 \ \ 7 - 1 - 1 = 5$

$6s : n = 6, l = 0 \ \ 6 - 0 - 1 = 5$

$8p : n = 8, l = 1 \ \ 8 - 1 - 1 = 6$

$8d : n = 8, l = 2 \ \ 8 - 2 - 1 = 5$

Therefore, the atomic orbitals with 5 radial nodes are $7p, \ 6s, \ \text{and} \ 8d$.

6. (1)

The difference energy between two energy levels is

$\Delta E = 2.18 \times 10^{-18} \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] J$

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

$0.749 = \frac{1}{n^2} - \frac{1}{(n+1)^2}$

$n \ = \ 1$

Hence, the transition is taking place between $1 \rightarrow 2$, and it comes under Lymann series.

If we take $0.749 \simeq 0.75 = \frac{3}{4}$

7. (4)

The magnetic moment of the metal ion can be calculated using

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

n =number of unpaired electrons.

$\mu = 4.90 \ BM$

$4.90 BM = \sqrt{(n)(n+2)} \ BM$

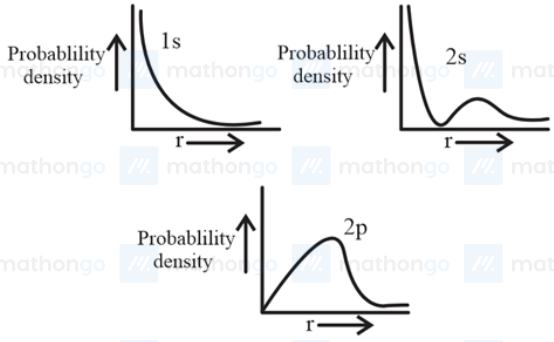
$24 \ = \ (n) \ (n \ + \ 2)$

$n \ = \ 4$

8. (2) The threshold frequency is the minimum frequency required for emission of electrons from the outermost shell. The light with frequencies lower than threshold would not eject photoelectrons from the shell of an atom. As for the emission kinetic energy of an electron should be greater than or equal to zero. Hence, the photoelectric emission will take place only when the energy of a photon is greater than the energy possessed by the electron. Atoms are ionised resulting in transfer of energy when photons of sufficient energy strike the metal surface.

9. (3)

Probability density curves for 1s, 2s and 2p orbitals are given below.



For 1s orbital, the probability density is maximum at the nucleus. For 2s 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. The number of angular nodes are equal to azimuthal quantum number. For p−orbital it is equal to 1 and for d−orbital it is equal to 2. Probability density of p-orbital is zero at the nucleus

10. (2)

The distance between the nucleus and 5f orbital is more than the distance between the nucleus and 4f orbital. Hence the hold of nucleus on valence electron decrease in 5f orbital. 5f orbital not buried as 4f oribitals so electron present in 5f orbital experience less nuclear attraction than electron present in 4f orbital. Hence electrons of 5f orbital can take part in bonding to far great extent.

11. (3)

The minimum amount of energy necessary to start the emission of electrons from a metal's surface is known as its work function. The work function is the minimum amount of energy required to remove an electron from a metal's surface to infinity.

Energy of incident photon $= \frac{hc}{\lambda}$

$= \frac{6.6\times10^{-34}\times3\times10^{8}}{400\times10^{-9}}$ J

$= \frac{6.6\times10^{-34}\times3\times10^{8}}{400\times10^{-9}\times1.6\times10^{-9}}$ eV

$= 3.1$ eV

If radiation energy is greater than work function of metal, then metal show photo electric effect.

$\therefore$ Li, Na and K will show photoelectric effect.

12. (3)

The energy of an electron in the n^{th} Bohr orbit of a hydrogen atom can be calculated using the formula:

$E_n = \frac{-2.18\times10^{-18}Z^2}{n^2}$

Where n is the principal quantum number of the Bohr orbit.

$E_n \alpha \frac{1}{n^2}$

$E_n \alpha \frac{1}{9}$

Therefore, the energy of the electron in the third Bohr orbit of a hydrogen atom is Three times of this value.

13. (0) The orbital angular momentum

$= \frac{h}{2\pi}\sqrt{l(l+1)}$

For 3s-electron, $l = 0$.

$\therefore$ The orbital angular momentum

$= \frac{h}{2\pi}\sqrt{0(0+1)}$

$= 0$ (zero)

14. (2) According to Bohr's postulates the angular momentum in stationary orbit is quantised and is equal to $nh/2\pi$, where n is the principal quantum number of the orbit. Bohr's model of the atom assumes fixed orbits and trajectories for the electron. Simultaneously known orbits and trajectories violate the Heisenberg Uncertainty Principle.

15. (5)

Isoelectronic are those which have the same number of electrons. Let us write the number of electrons from the given species.

Species	No. of electrons
O^{-2}	10
F^{-}	10
Al	13
Mg^{2+}	10
Na^{+}	10
O^{+}	7
Mg	12
Al^{3+}	10
F	9

Hence five species among the given are isoelectronic species.