Self Practice Paper (SPP)

1. A 5g orbital has
(1) Zero angular node and zero radial node
(2) Zero radial node and two angular nodes
(3) 4 radial nodes and 4 angular nodes
(4) Zero radial node and 4 angular nodes

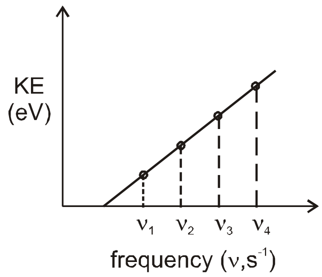
2. The threshold wavelength (λ_0) of sodium metal is 6500Å. If UV light of wavelength 360Å is used, what will be kinetic energy of the photoelectron in ergs?
(1) 55.175×10^{-12}
(2) 3.056×10^{-12}
(3) 52.119×10^{-12}
(4) 48.66×10^{-10}

3. An electron beam can undergo diffraction by crystals. Through what potential should a beam of electrons be accelerated so that its wavelength becomes equal to 1.54 Å?
(1) 54.3 volt
(2) 63.3 volt
(3) 66.2 volt
(4) None of these

4. Radiation corresponding to the transition n = 4 to n = 2 in hydrogen atoms falls on a certain metal (work function = 2.5 eV). The maximum kinetic energy of the photo-electrons will be :
(1) 0.55 eV
(2) 2.55 eV
(3) 4.45 eV
(4) None of these

5. Calculate the number of photons emitted by a 100 W yellow lamp in 1.0 s. Take the wavelength of yellow light as 560 nm and assume 100 percent efficiency.
(1) 6.8×10^{20}
(2) 4×10^{12}
(3) 4×10^{20}
(4) 2.8×10^{20}

6. In a photoelectric experiment, kinetic energy of photoelectrons was plotted against the frequency of incident radiation (ν), as shown in figure. Which of the following statements is correct?



(1) The threshold frequency is ν_1.
(2) The slope of this line is equal to Plank's constant.
(3) As the frequency of incident wavelength increases beyond threshold frequency, kinetic energy of photoelectrons decreases.
(4) It is impossible to obtain such a graph.

7. Which of the following process not lead to formation of isobars ?
(1) 1 α particle and 2β particles are emitted
(2) Positron emission
(3) β particle ($_{-1}e^0$) emission
(4) K-electron capture

8. A sample of hydrogen (in the form of atoms), is made to absorb white light. 52% of the hydrogen atoms got ionised. In order to calculate the ionisation energy of hydrogen from its absorption spectrum (assuming the electrons that got ejected have KE = 0), it is possible by measuring the frequency of the
(1) line of shortest wavelength
(2) line of longest wavelength
(3) line of greatest intensity
(4) line of smallest intensity

9. In what region of the electromagnetic spectrum would you look for the spectral line resulting from the electronic transition from the tenth to the fifth electronic level in the hydrogen atoms? ($R_H = 1.10 \times 10^5$ cm^{-1})

(1) Microwave (2) Infrared (3) Visible (4) Ultraviolet

10. Consider Xenon (Z = 54). The maximum number of electrons in this atom that can have the values for their quantum numbers as n = 4, ℓ = 3 and s = $\frac{1}{2}$ in its ground state is :

(1) Zero (2) 7 (3) 9 (4) 14

11. The increasing order for the values of e/m (charge/mass) is :

(1) e, p, n, α (2) n, p, e, α (3) e, α, e (4) n, α , p, e

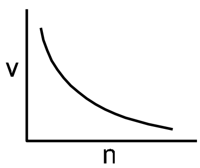
12. An electron in an atom jumps in such a way that its kinetic energy changes from x to $\frac{x}{4}$. The change in potential energy will be :

(1) $+\frac{3}{2}x$ (2) $-\frac{3}{8}x$ (3) $+\frac{3}{4}x$ (4) $-\frac{3}{4}x$

13. What atomic number of an element "X" would have to become so that the 4th orbit around X would fit inside the 1st Bohr orbit of Hydrogen ?

(1) 3 (2) 4 (3) 16 (4) 25

14. Select the incorrect graph for velocity of e^- in an orbit VS. Z, $\frac{1}{n}$ and n :

(1)


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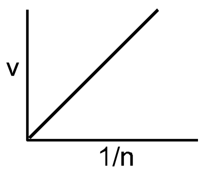

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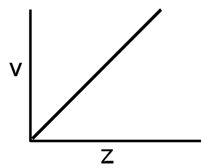

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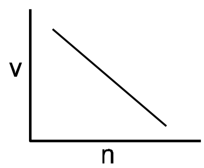


15 Which of the following is discreted in Bohr's theory ?

(1) Potential energy (2) Kinetic energy
(3) Velocity (4) Angular momentum

16 The mass of a proton is 1836 times more than the mass of an electron. It a sub-atomic particle of mass (m') 207 times the mass of electron is captured by the nucleus, then the first ionization potential of H :

(1) decreases (2) increases (3) remains same (4) may be decrease or increase

17. In any subshell, the maximum number of electrons having same value of spin quantum number is :

(1) $\sqrt{\ell(\ell+1)}$ (2) $\ell + 2$ (3) $2\ell + 1$ (4) $4\ell + 2$

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

(1) Principal quantum number (n) (2) Angular momentum quantum number
(3) Magnetic quantum number (m_ℓ) (4) Spin quantum number (m_s)

19. For similar orbitals having different values of n :

(1) the most probable distance increases with increase in n
(2) the most probable distance decreases with increase in n
(3) the most probable distance remains constant with increase in n
(4) none of these

20. Maximum number of total nodes is present in :

(1) 5s (2) 5p
(3) 5d (4) All have same number of nodes

21. The possible set of quantum no. for the unpaired electron of chlorine is :

	n	ℓ	m		n	ℓ	m
(1)	2	1	0	(2)	2	1	1
(3)	3	1	1	(4)	3	0	0

22. Which of the following has the maximum number of unpaired electrons ?

(1) Mn (2) Ti (3) V (4) Al

23. The angular velocity of an electron occupying the seocond Bohr orbit of He^+ ion is (in sec^-):

(1) 2.067×10^{16} (2) 3.067×10^{16} (3) 1.067×10^{18} (4) 2.067×10^{17}

24. An exited state of H-atom emits a photon of wavelength λ and returns in the ground state, the principal quantum number of excited state is given by :

(1) $\sqrt{\lambda R(\lambda R - 1)}$ (2) $\sqrt{\frac{\lambda R}{(\lambda R - 1)}}$ (3) $\sqrt{\lambda R(\lambda R - 1)}$ (4) $\sqrt{\frac{(\lambda R - 1)}{\lambda R}}$

25. Light of wavelength λ strikes a metal surface with intensity X and the metal emits Y electrons per second of average energy Z. What willl happen to Y and Z if X is havled?

(1) Y will be halved (2) Y will double
(3) Y will be remain same (4) Z will be halved

26. Neutron scattering experiments have shown that the radius of the nucleus of an atom is directly proporitonal to the cube root of the number of nucleons in the nucleus. From ${}^{7}_{3}Li$ to ${}^{189}_{76}Os$, the radius is

(1) Halved (2) the same (3) Doubled (4) Tripled

27. The nucleus of an atom is located at x = y = z = 0. If the probability of finding an electron in $d_{x^2-y^2}$ orbital in a tiny volume around x=a , y =0 , z = 0 is 1×10^{-5}, what is the probablility of finding the electron in the same size volume around x = 0 ,y = a, z = 0 ?

(1) 1×10^{-5} (2) $1 \times 10^{-5} \times a$ (3) $-1 \times 10^{-5} \times a$ (4) zero

28. The energy of a I, II and III energy levels of a certain atom are E, $\frac{4E}{3}$ and 2E respectively. A photon of wavelength λ is emitted during a transition from III to I. What will be the wavelength of emission for transition II to I ?

(1) $\frac{\lambda}{2}$ (2) λ (3) 2λ (4) 3λ

29. A compound of vanadium has a magnetic moment of 1.73 BM. What will be the electronic configurations:

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

30. Calculate the minimum and maximum number of electrons which may have magnetic quantum number, m = +1 and spin quantum number, s = $-\frac{1}{2}$ in chromium (Cr) :

(1) 0, 1 (2) 1, 2 (3) 4, 6 (4) 2, 3

31. Which of the following pairs are isobars ?

(1) ${}^{235}_{92}U, {}^{239}_{94}Pu$ (2) ${}^{83}_{36}Kr, {}^{84}_{36}Kr$ (3) ${}^{19}_{10}Ne, {}^{19}_{9}F$ (4) ${}^{139}_{58}Ce, {}^{140}_{58}Ce$

32. The ratio of the velocity of the electron in the third and fifth shell for He^+ would be :

(1) 5 : 3 (2) 1 : 2 (3) 3 : 5 (4) 3 : 4

33. The light radiations with discrete quantities of energy are called :

(1) Photoelectric effect (2) photons (3) Photo emission (4) Photo-absorbtion

34. **S_1:** The designation of an orbital, n = 4 and l = 0 is 4s.

S_2: All the orbitals in a subshell are first occupied singly with parallel spins before pairing starts. This is Hund's rule.

S_3: The energies of various subshells in the same shell are in the order of s > p > d > f

(1) TTF (2) FFT (3) TTT (4) FFF

35. Bohr's theory is not applicable to :

(1) H (2) He^+ (3) Li^{2+} (4) H^+

36. Difference in ${}_{17}Cl^{35}$ and ${}_{17}Cl^{37}$ is of :

(1) atomic number (2) number of neutron (3) number of electron (4) number of proton

37. Which of the following is known as alpha particle?

(1) Electron (2) Charged helium atom
(3) Proton (4) Positron

38. Which of the following do not travel with the speed of light?

(1) de-Broglie waves (2) X-rays (3) Gamma rays (4) All of the above

39. The ratio of area covered by second orbital to the first orbital is :

(1) 1 : 1 (2) 1 : 16 (3) 8 : 1 (4) 16 : 1

40. The probability of finding of three unpaired electron in nitrogen atom is defined by :

(1) Aufbau's principle (2) Uncertainty principle (3) Pauli's principle (4) Hund's rule

41. Electron occupy the available sub level which has lower (n + l) value. This is called :

(1) Aufbau rule (2) Paulli exclusion principle
(3) Hund's rule (4) Heisenberg uncertainty principle

42. For n = 3 the value of l and m respectively are :

(1) 3, 9 (2) 3, 6 (3) 9,3 (4) 6, 3

43. The minimum real charge on any particle which can exist is :

(1) 4.8×10^{-10} coulomb (2) 1.6×10^{-19} coulomb (3) 1.6×10^{-10} coulomb (4) zero

44. In d-subshell electron is :

(1) less than p (2) equal to p (3) more than s (4) more than f

45. The mass of neutron is of the order of :

(1) 10^{-27} kg (2) 10^{-26} kg (3) 10^{-24} kg (4) 10^{-23} kg

SPP Answers

1.	(4)	**2.**	(3)	**3.**	(2)	**4.**	(4)	**5.**	(4)	**6.**	(2)	**7.**	(1)
8.	(1)	**9.**	(2)	**10.**	(1)	**11.**	(4)	**12.**	(1)	**13.**	(3)	**14.**	(4)
15	(4)	**16**	(2)	**17.**	(3)	**18.**	(3)	**19.**	(1)	**20.**	(4)	**21.**	(3)
22.	(1)	**23.**	(1)	**24.**	(2)	**25.**	(1)	**26.**	(4)	**27.**	(1)	**28.**	(4)
29.	(1)	**30.**	(4)	**31.**	(3)	**32.**	(1)	**33.**	(2)	**34.**	(1)	**35.**	(4)
36.	(2)	**37.**	(2)	**38.**	(1)	**39.**	(4)	**40.**	(4)	**41.**	(1)	**42.**	(1)
43.	(2)	**44.**	(3)	**45.**	(1)								

SPP Solutions

1. Total number of nodes = n – 1 = 5 – 1 = 4

Angular node = ℓ = 4.

Zero radial node and 4 angular nodes.

2. The threshold frequency (ν_0) corresponding to the wavelength 6500 Å is c/λ_0.

Therefore, the threshold energy = $h\nu_0 = hc/\lambda_0$.

Substituting for h, c and λ_0 we get, threshold energy = 3.056×10^{-12} ergs.

The energy of the incident photons is given by E = hc/λ_0, since incident wavelength λ = 360 Å. Therefore, incident energy = 55.175×10^{-12} ergs.

The kinetic energy of the photoelectrons will be the difference of incident energy and threshold energy,

$\therefore$ KE = $h\nu - h\nu_0 = (55.175 \times 10^{-12}) - (3.056 \times 10^{-12})$ ergs. = 52.119×10^{-12} ergs

3. For an electron $\frac{1}{2}mu^2 = eV$ and $\lambda = \frac{h}{mu}$

Thus, $\frac{1}{2}m = \frac{h^2}{m^2\lambda^2} = eV$

or $V = \frac{1}{2}\frac{h^2}{m\lambda^2 e} = \frac{1\times(6.62\times10^{-34})^2}{2\times9.108\times10^{-31}(1.54\times10^{-10})^2\times1.602\times10^{-19}}$ = 63.3 volt.

4. $E_n = -\frac{13.6}{n^2}$ eV; $E_2 = \frac{13.6}{2^2}$

$E_4 = -\frac{13.6}{4^2}$ eV/atom

$\Delta E = E_4 - E_2 = 2.55$ eV

Absorbed energy = work function of metal + K.E. 2.55 = 2.5 + K.E. ; K.E. = 0.05 eV

5. The number of photon is $N = \frac{E}{h\nu} = \frac{P\Delta t}{h(c/\lambda)} = \frac{\lambda P\Delta t}{hc}$

Substitution of the data gives

$$N = \frac{(5.60\times10^{-7}m)\times(100Js^{-1})\times(1.0s)}{(6.626\times10^{-36}s)\times(3\times10^8ms^{-1})} = 2.8 \times 10^{20}$$

7. $_{X}A^{Z} \rightarrow {}_{X-2}B^{Z-4} + {}_{2}He^{4}$

$_{X-2}B^{Z-4} \rightarrow {}_{X-1}C^{Z-4} + {}_{-1}e^{0}$

$_{X-1}C^{Z-4} \rightarrow {}_{X}D^{Z-4} + {}_{-1}e^{0}$

9. Wave numbers are the reciprocals of wavelengths and are given by the expression $\bar{v} = \frac{1}{\lambda}$.

$\frac{1}{\bar{v}} = 1.1 \times 10^5 \left[\frac{1}{n_1} - \frac{1}{n_2}\right]$

11. Charge/mass for n = 0, for $\alpha = \frac{2}{4}$,

for p $= \frac{1}{1}$, for $e^- = \frac{1}{1/1837}$

12. Change in P.E. $= -\frac{2x}{4} + (2x) \Rightarrow \frac{3}{2}x$

13. $r_1 = 0.529$ Å; $r_{4(X)} = r_1 \times \frac{n^2}{Z}$;

$r_{4(X)} \Rightarrow \frac{0.529 \times (4)^2}{Z}$; Z = 160

16 The ionization potential of an atom of nucleus of proton and the new sub-atomic particle system is determined by replacing the mass of electron by reduced mass m, while

$$m = \frac{m_p m'}{m_p + m'} = \frac{1836m_e \times 207m_e}{1836m_e + 207m_e}$$

$m = 186\ m_e$

I.E. $\propto$ m, So, I.E. increases

17. Maximum number of electrons with same spin is equal to maximum number of orbitals, i.e., $(2\ell + 1)$.

20. Total nodes = n – 1.

21. Cl_{17} : [Ne] $3s^2\ 3p^5$.

Unpaired electron is in 3p orbital. $\therefore$ n = 3, ℓ = 1, m = 1, 0, – 1.

23. Velocity of an electron in He^+ ion in an orbit $= \frac{2\pi Ze^2}{nh}$ .....(i)

Radius of He^+ ion in an orbit $= \frac{n^2h^2}{4\pi^2 me^2 Z}$ ....(ii)

By equations (i) and (ii),

Angular velocity $(\omega) = \frac{u}{r} = \frac{8\pi^3 Z^2 me^4}{n^3h^3}$ ....(iii)

$$= \frac{8 \times (22/7)^3 \times (2)^2 \times (9.108 \times 10^{-28}) \times (4.803 \times 10^{-10})^4}{(2)^3 \times (6.626 \times 10^{-26})^3} = \mathbf{2.067 \times 10^{16}\ sec^{-1}.}$$

24. $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$; $n_1 = 1$, $n_2 = ?$;

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

$\Rightarrow n_2 = \sqrt{\frac{\lambda R}{\lambda R - 1}}$

25. Number of emitted electron $\propto$ Intensity of incident light.

26. $\frac{R_{Os}}{R_{Li}} = \left(\frac{189}{7}\right)^{1/3} = 3$

27. It would be same in x and y axis for $d_{x^2-y^2}$.

28. For II to I transition, $\Delta E = \frac{4E}{3} - E = \frac{hc}{\lambda_{II \to I}}$; $\frac{E}{3} = \frac{hc}{\lambda_{II-I}}$

For III to I transition, $\Delta E = 2E - E = \frac{hc}{\lambda}$ or $E = \frac{hc}{\lambda}$

$\therefore$ $\frac{hc}{3 \times \lambda} = \frac{hc}{\lambda_{II-I}}$ $\lambda_{II-I} = 3\lambda$

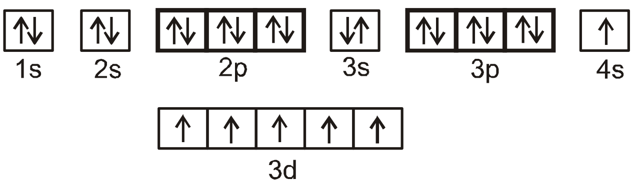
29. Number of unpaired elecron are given by Magnetic moment = $\sqrt{[n(n+2)]}$ where n is number of unpaired electrons or 1.73 = $\sqrt{[n(n+2)]}$ or 1.73 × 1.73 = $n^2 + 2n$

$\therefore$ n = 1.

Now vanadium atom must have one unpaired electron and thus its confiuration is :

$_{23}V^{4+}$: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^1$

30.



Out of 6 electrons in 2p and 3p must have on electron with m = + 1 and s = $\frac{1}{2}$ but in 3d-subshell an orbital having m = + 1 may have spin quantum no. – $\frac{1}{2}$ or + $\frac{1}{2}$. Therefore, minimum and maximum possible values are 2 and 3 respectively.

31. Isobars have same mass number.

32. $V_n = \frac{V_0 Z}{n} \Rightarrow \frac{V_3}{V_5} = \frac{5}{3}$

35. Bohr's theory is applicable only to atoms having one electron. Therefore, it is not applicable to H^+ as it has no electron. According to Bohr.

$$E_n = \frac{-13.6\,Z^2}{n^2} \text{ eV / atom}$$

(Z = atomic number, n = number of the shell)

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

39. $r_n \propto n^2$ $\therefore$ Area covered $(A_n) \propto n^4$ $(\therefore \text{Area} = \pi r^2)$

$$\therefore \frac{A_2}{A_1} = \frac{2^4}{1^4} = \frac{16}{1}$$

40. Hund's rule

41. Electron occupy the available sub level which has lower (n + l) value. This called Aufbau rule.

42. Total value of l = n
Total value of $m = n^2$
n = 3
Total value of l = 3
Total value of m = 9

43. The minimum real charge on any particle which can exist is 1.6×10^{-19} C.

44. In d– subshell electron is more than s
subshell d = 10 electron
subshell s = 2 electron

45. The mass of neutron is of the order of 10^{-27}kg