CHEMISTRY

BOOKS - PRADEEP CHEMISTRY (HINGLISH)

STRUCTURE OF ATOM

Sample Problem

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

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2. Total number of electrons, protons and neutrons present in the nucleus of $._{92}U^{238}$is

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3. Nuclear radius is of the order of $10^{-13} cm$ while atomic radius is of order$10^{-8} cm$. Assuming the nucleus and the atom to be spherical .What fraction of an atom is occupied by nucleus ?

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4. Complete the following tables:

Particle	Mass No.	Atomic No.	Protons	Neutrons	Electrons
Nitrogen atom	—	—	—	7	7
Calcium ion	—	20	—	20	—
Oxygen atom	16	8	—	—	—
Bromide ion	—	—	—	45	36

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5. The number of electrons, protons and neutrons in a species are equal to 18, 16 and 16 respectively. Assign the proper symbol of the species.

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6. Calculate (a) Wavenumber and (b) frequency of yellow radiation having wavelength $5800A^{\circ}$.

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7. the vividh bharati station of All india Radio, Delhi , broadcasts on a frequency of 1,368 kHz (kilo hertz). Calculate the wavelength of the electromagnetic radiation emitted by transmitter . Which part of the electromagnetic spectrum does it belong to

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8. The wave length range of the visible spectrum extends from violet (400 nm)to red (750 nm). Express these wavelengthsin frequencies (Hz) $(1nm = 10^{-9}m)$.

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9. (a) What are the frequency and wavelength of a photon

emitted during transition from n = 5 state to n = 2 state

in the hydrogen atom ?

(b) In which region of the electromagnetic spectrum will

this radiation lie ?

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10. The wavelength of the first line in the balmer series is $656nm$. Calculate the wavelength of the second line and the limiting line in the Balmer series.

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11. Calculate the wavelength emitted during the transition of an electron in between two level of Li^{2+} ion whose sum is 4 and difference is 2.

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12. Calculate the wavelength of the radiation emitted when an electron in a hydrogen atom undergoes a transition from 4th energy level to the 2nd energy level. In which part of the electromagnetic spectrum does this line lie ?

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13. calculate the energy assoclated with the first orbit of He^+ . What is the radius of this orbit?

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14. Calculate the radius of Bohr's fifth orbit for hydrogen atom. Also calculate the radius of third orbit of He^+ ion

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15. Calculate the velocity of electron in the first Bohr orbit of hydrogen atom. Given that Bohr radius = 0.529Å, Planck's constant, $h = 6.626 \times 10^{-34} J$s, mass of electron $= 9.11 \times 10^{-31} kg$ and $1J = 1kgm^2 s^{-2}$. Also calculate the velocity of electron in third orbit of He^{+} ion

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16. Calculate (i) First excitation energy of the electron in the hydrogen atom. (ii) Ionization energy of the hydrogen atom

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17. The ionization energy of He^{+} is $8.72 \times 10^{-18} J\text{atom}^{-1}$. Calculate the energy of first stationary state of Li^{2+}.

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18. The ionization energy of hydrogen in excited state is $+0.85eV$. What will be the energy of the photon emitted when it returns to the ground state?

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19. To which orbit the electron in H atom will jump on absorbing 12.1 eV energy ?

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20. what is the total number of orbitals associated with the principal quartum number n= 3?

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Problem

1. Calculate the frequency and energy of a photon of radiation having wavelength 6000Å

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2. calculate energy of one mole of photons of radiation whose frequency is $5 \times 10^{14} hz$

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3. A 100 watt bulb emits monochromatic light of wavelength 400 nm. Calculate the number of photons emitted per second by the bulb.

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4. Calculate the kinetic energy of the electron ejected when yellow light of frequency $5.2 \times 10^{14} \sec^{-1}$ falls on the surface of potassium metal.

Threshold frequency of potassium is $5 \times 10^{14} \sec^{-1}$

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5. When electromagnetic radiation of wavelength 300 nm falls on the surface of sodium, electrons are emitted with kinetic energy of $1.68 \times 10^5 J\text{ml}^{-1}$. What is the minimum energy needed to remove an electron from sodium ? What is the maximum wavelength that will cause a photoelectron to be emitted.

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6. The threshold frequency v_0 for a metal is $7 \times 10^{14} s^{-1}$. Calculate the kinetic energy of an electron emitted when radiation of frequency $v = 1.0 \times 10^{15} s^{-1}$ hits the metal .

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7. Calculate the wavelength of a photon in Angstrons having an energy of 1 electron-volt.

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8. Calculate the wavelength associated with an electron (mass $9.1 \times 10^{-31} kg)$ moving with a velocity of $10^3 m \sec^{-1} (h = 6.6 \times 10^{-34} kgm^2 \sec^{-1})$

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

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10. The mass of an electron is $9.1 \times 10^{-31} kg$. If its K.E. is $3.0 \times 10^{-25} J$, calculate its wavelength

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11. Calculate the mass of a photon with wavelength 3.6Å.

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12. Two particles A and B are in motion. If the wavelength associated with particle A is $5 \times 10^{-8} m$, calculate the wavelength associated with particle B if its momentum is half of A.

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13. The kinetic energy of a subatomic particle is $5.85 \times 10^{-25} J$. Calculate the frequency of the particle wave.

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14. Calculate the de Broglie wavelength of an electron that has been accelerated from rest through a potential differecne of 1kV.

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15. When would the be Broglie wavelength of a moving electron become equal to that of a moving proton? Mass of electron $= 9.1095 \times 10^{-31} kg$ and mass of proton = $1.6725 \times 10^{-27} kg$

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

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17. Calculate the uncertainty in the velocity of a wagon of mass 3000kg whose position is known to an accuracy of ± 10 pm (Planck's constant = $6.63 \times 10^{-34} Js$)

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18. Calculate the uncertainty in the position of an electron if the uncertainty in its velocity is $5.7 \times 10^5 m / \sec$ ($h = 6.6 \times 10^{-34} kgm^2 s^{-1}$, mass of the electron $= 9.1 \times 10^{-31} kg$)

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19. A golf ball has a mass of $40g$ and a speed of $45m / s$. If the speed can be measured within accuracy of 2%, calculate the uncertainty in the position.

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20. If an electron is moving with velocity $500ms^{-1}$, which is accurate up to 0.005% then calculate uncertainty in its position. $[h = 6.63 \times 10^{-34} J - s$, mass of electron $= 9.1 \times 10^{-31} kg]$

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21. how fast is an electron moving if it has a wavelength equal to the distance traveled in one second ?

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22. A proton is accelerated to 1/10th of the velocity of light. If its velocity can be measured with a precision of $\pm 0.5\%$, what must be its uncertanity in position?

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23. An electron is in 4f orbital. What possible values for quantum numbers, n,l,m and s can it have ?

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24. Write down the quantum numbers n, l and m for the following orbitals:

(i) $3d_{x^2-y^2}$ (ii) $4d_{z^2}$ (iii) $3d_{xy}$ (iv) $4d_{xz}$ (v) $2p_z$ (vi) $3p_x$

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25. Usings,p,d,f notations, describe the orbital with the following quantum numbers.

(i) $n=2, l=1$

(ii) $n=4, l=0$

9iii) $n=5, l=3$

(iv)$n=3, l=2$

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26. Which of the following sets of quantum numbers are not permitted?

(i) $n = 2, l = 2, m = -1, s = +1/2$ (ii) $n = 2, l = 1, m = -1, 2 = -1/2$

(iii) $n = 2, l = 0, m = 0, s = 0$ (iv) $n = 2, l = 1, m = 2, s = +1/2$

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27. Which of the following orbitals are not possible?

1p, 2s, 3f and 4d

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28. If n = 5, how many electrons can have $m_l = +1$?

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29. Find the number of unpaired electrons present in phosphorus (atomic no.15), chromium (atomic no. 24) and copper (atomic no. 29) after writing their orbital electronic configurations.

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30. Write the electronic configurations of the elements with the following atomic numbers :

3, 8, 14, 17, 21, 38, 57

Also mention the groups of the periodic table to which they belong.

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31. What atoms are indicated by the following eletronic configurations ?

(i) $1s^2 2s^2 2p^1$ (ii) $[Ar]4s^2 3d^1$

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32. A neutral atom of element has 2K, 8K and 5M electrons. Find out the following : (a) Atomic No. of the element (b) Total No. of s electrons (c) Total No. of p- electrons (d) No. of protons in the nucleus and (e) Valency of the element.

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33. Give the electronic configuration of the following ions :

(i) Cu^{2+} (ii) Cr^{3+} (iii) Fe^{2+} and Fe^{3+} (iv) H^{-} (v) S^{2-}

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34. Discuss the possibility of the atom for existing in the following electronic configurations :

(i) $1s^2 2s^2 2p_x^1$ (ii) $1s^2 2s^1 2p_x^1 2p_y^1 2p_z^1$ (iii) $1s^2 2s^1 2p_x^2 2p_y^1$ (iv) $1s^2 2s^2 3s^2$

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35. Consider the electronic configurations : (i) $1^2 2s^1$ (ii) $1s^2 3s^1$

(a) Name the element corresponding to (i)

(b) Does (ii) correspond to the same or different element ?

(c) How can (ii) be obtained from (i) ?

(d) Is it easier to remove one electron from (ii) or (i) ? Explain.

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Curiosity Question

1. What is the basic principle of a television picture tube or fluorescent light tubes ?

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2. A piece of iron is heated in a flame. It first becomes dull red then becomes reddish yellow and finally turns to white hot. The correct explanation for the above observation is possible by using.

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3. What is the range of frequencles used in a microwave oven ?

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4. Give one Important pratical application of photoelectric effect

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5. We do not see a car moving as a wave on the road. Explain.

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6. Iron pieces are attracted towards a magnet but zinc pieces are no. Why ?

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Problem for Practice

1. Neutrons can be found in all atomic nuclei except in one case. Which is this atomic nucleus and what does it consist of?

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2. How many nucleous are present in an atom of Nobelium, $._{102}^{254}No$? How many electrons are present n the atom ? How many nucleons may be considered as neutrons?

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3. Complete the table:

Particle	Atomic No.	Mass No.	No. of electrons	No. of protons	No. of neutrons
Sodium atom	11	—	—	—	12
Aluminium ion	—	27	10	—	—
Chloride ion	—	—	18	—	18
Phosphorus atom	—	31	—	15	—
Cuprous ion	—	—	28	—	35

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4. Complete the table:

Name of the particle	Mass No.	Atomic No.	Protons	No. of Electrons	Neutrons
Oxygen	—	—	8	—	8
Sodium ion	23	—	11	—	—
Bromine	—	—	—	35	45

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5. Find the number of protons, electrons and neutrons in (a) $._{13}^{27}Al^{3+}$ (b) $._{8}^{15}O^{2-}$

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6. The elements P (Atomic weight 39) and Q (Atomic weight 80) contain 20 and 45 neutrons respectively their nucleus. Give their electronic arrangements separately.

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7. Give the name and atomic number of the inert gas atom in which the total number of d-electrons is equal to the difference in number to the p- and $-s$-electrons.

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8. A monoatomic anion of unit charge contains 45 neutrons and 36 electrons. Find the atomic number, mass number of the ion with its identification.

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9. Calculate the frequency of infrared radiations having wavelength, $3 \times 10^6 nm$.

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10. Calculate the range of frequencies of visible light from $3800 - 7600 \text{Å}$

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11. How long would it take a radio wave of frequency $6 \times 10^3 \sec^{-1}$ to travel from mars to the earth, a distance of $8 \times 10^7 km$?

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12. Calculate the wave number of radiations having a frequency of $4 \times 10^{14} Hz$

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13. A particular radiostation broadcasts at a frequency of 1120 Kilo Hertz another radio station broadcasts at a frequency of 98.7 mega Hertz. What are the wave length of radiations from each station?

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14. Which has a higher energy : a photon of red light with a wavelegth of 7500Å or a photon of green light with a wavelength of 5250Å?

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15. In the ultraviolet region of the atomic spectrum of hydrogen, a line is obtained at 1026Å. Calculate the energy of photon of this wavelength ($h = 6.626 \times 10^{-34}$ J-sec)

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16. In the infrared region of the atomic spectrum of hydrogen, a line is obtained at $3802cm^{-1}$. Calculate the energy of this photon $(h = 6.626 \times 10^{-34} J$ sec)`

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17. Light of wavelenght 4000Å falls on the surface of cesium . Calculate the maximum kinetic energy of the photoelectron emiited . The critical wavelenght for photoelectric effect in cesium is 6600Å.

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18. What is the ratio between the energies of two radiations, one with a wavelength of 6000Å and the other with $2000\text{Å}\left[1\text{Å} = 10^{-10}m\right]$?

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19. The threshold energy for photoelectric emission of electrons from a metal is 3.056×10^{-15} joule. If light of 4000Å wavelength is used, will the electrons be efected or not ? ($h = 6.63 \times 10^{-34}$ Joule sec)

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20. Calculate the wavelength of a photon in Angstrons having an energy of 1 electron-volt.

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21. Sodium street lamp gives off a characteristic yellow light of wavelength 588 nm. Calculate the energy mole (in kJ/mol) of these photons.

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22. Calculate the wavelength of the radiations in nanometers emitted when an electron in hydrogen atom jumps from third orbit to the ground state. $\left(R_H = 109677cm^{-1}\right)$

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23. Calculate the wavelength from the Balmer formula when $n_2 = 3$.

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24. Calculate the wavelength of spectral line in Lyman series corresponding to $n_2 = 3$.

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25. If the energy difference between the electronic states is $214.68 kJmol^{-1}$, calculate the frequency of light emited when an electron drop form the height to the lower state. Planck's constant , $h = 39.79 \times 10^{-14} kJsmol^{-1}$

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26. In hydrogen atom, an electron jumps from 3d orbit to the 2nd orbit. Calculate the wavelength of the radiatoin emitted. $(h = 6.63 \times 10^{-34} J \sec)$

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27. Calculate the wave number for the longest wavelength transition in the Balmer series of atomic hydrogen.

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28. Applyig bohr's model when H-atom comes from n=4 to n=2, calcualte its wavelength. In this process, write whether energy is released or aborbed? Also write the range of radiation $R_H = 2.18 \times 10^{-18} J, h = 6.63 \times 10^{-34} J - s$

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29. Calculate the momentum of a particle which has a de Broglie wavelength of 2Å, $\left(h = 6.6 \times 10^{-34} kgm^2 s^{-1}\right)$

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30. Calculate the wavelength of an electron moving at $3.0 \times 10^{10} cm \sec^{-1}$ (mass of the electron $= 9.11 \times 10^{-31} kg, h = 6.6 \times 10^{-34} kgm^2 \sec^{-1}$)

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31. The kinetic energy of an electron is $5 \times 10^5 eV$ (electron volts). Calculate the wavelength of the wave associated with the electron. The mass of the electron may be taken as $10^{-30} kg$

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32. A proton $(mass = 1.66 \times 10^{-27} kg)$ is moving with kinetic energy $5 \times 10^{-27} J$ calculate the de Broglie wavelength associated with it? $(h = 6.6 \times 10^{-34} Js)$

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33. A particle having a wavelength of $6.6 \times 10^{-6} m$ is moving with a velocity of 10^4 m/sec. Find the mass of the particle. Planck's constant is $6.62 \times 10^{-34} kgm^2 \sec^{-1}$

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34. What must be the velocity of a beam of electrons if they are to disply a de Broglie wavelength of 100Å (mass of electron $= 9.1 \times 10^{-31} kg, h = 6.6 \times 10^{-34} Js$)?

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35. What will be the wavelength of oxygen molecule in picometers moving with a velocity of $660 ms^{-1} (h = 6.6 \times 10^{-34} kgm^2 s^{-1})$

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36. A tennis ball of mass $6.0x10^{-2}kg$ is moving with a speed of $62ms^{-1}$. Calculate the wavelength associated with this moving tennis ball. Will the movement of this ball exhibit a wave character?

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37. Calculate de Broglie wavelength of an electron travelling at 1% of the speed of light.

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38. The sodium flame test has a characteristic yellow colour due to the emission of a wavelength of $589nm$. What is the mass equivalent of one photon of this wavelength?

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39. Calculate the wavelength of an electron that has been accelerated in a particle accelerator through a potentiation difference of 100 million volts

$\left[1eV = 1.6 \times 10^{-19} J, m_e = 9.1 \times 10^{-31} kg, h = 6.6 \times 10^{-34} Js, c = 3.0 \times\right.$

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40. Calculate the kinetic energy of an α-particle which has a wavelength of 12pm

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41. A moving electron has 4.55×10^{-25} joules of kinetic energy. Calculate its wavelength (mass $= 9.1 \times 10^{-31} kg$ and $h = 6.6 \times 10^{-34} kgm^2 s^{-1}$)

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42. The energy of an α-particle is $6.8 \times 10^{-18} J$. What will be the wavelength associated with it?

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43. Calculate the ratio between the wavelength of an electron and a proton, if the proton is moving at half the velocity of the electron (mass of the proton $= 1.67 \times 10^{-27} kg$, mass of the electron $= 9.11 \times 10^{-2} m$.

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44. The approximate mass of an electron is $10^{-27} g$. Calculate the uncertainty in its velocity if the uncertainty in its position were of the order of $10^{-11} m \left(h = 6.6 \times 10^{-34} kgm^2 \sec^{-1}\right)$

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45. Calculate the product of uncertainty in position and velocity for an electron of mass $9.1 \times 10^{-31} kg$ according to Heisenberg uncertainty principle

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46. Calculate the uncertainty in the velocity of a cricket hall (mass $= 0.15 kg$) uncertainty in position is of the order of 1Å

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47. Calculate the minimum uncertainty in velocity of a particle of mass $1.1 \times 10^{-27} kg$ if uncertainty in its position is $3 \times 10^{-10} cm$. $(h = 6.62 \times 10^{-34} kg. m^2 s^{-1})$

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48. The uncertainties in the position and velocity of a particle are $10^{-10}m$ and $5.27 \times 10^{-24} ms^{-1}$ respectively. Calculate the mass of the particle $\left(h = 6.625 \times 10^{-24} J.\, s\right)$

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49. The mass of electron is 9.11×10^{-31}kg. Calculate the uncertainty in its velocity if the uncertainty in position is the uncertainty in position is of the order of ± 10pm. $\left(h = 6.6 \times 10^{-34} \text{kg} m^2 s^{-1}\right)$.

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50. An electron has a speed of 500m s^{-1} with uncertainty of 0.02% . What is the uncertainty in locating its position ?

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51. A proton is accelerated to one tenth of velocity of light. If the velocity can be measured with a precision of $\pm 0.5\%$, what must be the uncertainty in its position ? $(m_p = 1.675 \times 10^{-27} kg)$.

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52. Calculate the uncertainty in the position of a dust particle with mass equal to 1 mg if the uncertainty in its velocity is $5.5 \times 10^{-20} ms^{-1}$

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53. The uncertainty in the momentum of a particle is $2.2 \times 10^{-4} gcms^{-1}$. With what accuracy can its position be deterimed ? $(h = 6.626 \times 10^{-27} \text{ ergs})$

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54. Calculate the uncertainty in the velocity in the velocity of an electron if the uncertainty in its position is 1Å or 100 pm $\left(10^{-10}m\right)$

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55. What is the minimum uncertainty in theh position of a bullet of mass 5g that is known to have a speed somewhere between 550,00000 and 550,00001 ms^{-1}?

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56. If n is equal to 3, what are the values of quantum number l and m ?

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57. How many orbitals are present in the subshells with (a) $n = 3, l = 2$ (b) n = 4, l = 2 (c) n = 5, l = 2?

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58. What are the value of n, l and m for 2p-orbitals ?

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59. Write the correct orbital notations for each of the following sets of quantum numbers:

(i) n = 2, l = 1, (ii) n = 3, l = 0 (iii) n = 5, l = 3 and (iv) n = 4, l = 2 ?

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60. What designation is given to an orbital having

n = 2, l = 1, (ii) n = 3, l = 0, (iii) n = 5, l = 3 (iv) n = 4, l = 2?

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61. Give the value of the quantum numbers for the electron with the highest energy in sodium atom

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62. Which of the following orbitals are not possible? 7s, 2d, 3f and 1p

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63. What of the following sets of quantum numbers are not possible?

(i) n = 3, l = 2, m = 0, s = $-1/2$ (ii) n = 3, l = 2, $m = -2, s = -1/2$

(iii) $n = 3, l = 3, m = -3, s = +1/2$ (iv) $n = 3, l = 1, m = 0, s + 1/2$

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64. Give the electronic configurations of :

(i_ Scandium (Z = 21)

(ii) Chromium (Z = 24)

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65. Write the electronic configurations and the names of the elements having the atomic numbers 5, 9, 10, 19 and 20.

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66. Give the electronic configurations of the elements : $\cdot_{19} K, \cdot_{25} Mn, \cdot_{20} Ca$

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67. Write the electronic configurations of the elements : Chlorine and Phosphorus.

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68. Given the electronic configurations of the ions : (i) H^{-1} (ii) Na^{+} (iii) N^{-1} (iv) N^{2+}

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69. Write down the electronic configuration of an element with atomic number 14. Which group in the periodic table does this element belong to ?

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70. Name the elements that correspond to the given electronic configurations. Write down their atomic number also. (i) $1s^2 2s^2 2p^2$ (ii) $1s^2 2s^2 2p^6 3s^2 3p^1$ (iii) $1s^2 2s^2 2p^6 3s^2 3p^6$

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71. Correct the following electronic configurations of the elements in the ground state :

(i) $1s^2 2s^1 2p_x^2 2p_y^2 2p_z^2 3s^2 3p_x^1$ (ii) $1s^2 2s^1 2p_y^2 2p_y^2 2p_z^1$

(iii) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

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

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72. The atomic mass of an element is double its atomic number. If there are four electrons in the 2p-orbital, the draw the model of the atom showing the arrangement of protons, neutrons and electrons. Give its valence and name the element.

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73. Write the electronic configuration of the elements

$(i).^{19}_{9}F$, (ii) $.^{36}_{18}Ar$, (iii) $.^{32}_{16}S$

Point out the element with (a) Maximum nuclear charge ,(b) Minimum number of neutrons , (c) Maximum mass number. , (d) Maximum number of unpaired electrons.

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74. What are thhe atomic numbers of elements whose outermost electrons are represented by

(i) $3s^1$ (ii) $2p^3$ and (iii) $3d^6$?

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75. What atoms are indicated by the following configuration ?

$[He]2s^1$

$[Ne]3s^2 3p^3$

$[Ar]4s^2 3d^1$

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76. Which of the following configurations represent the elemnet in the ground and which in the excited state ? Name the element in each case :

(i) $1s^2 2s^1 2p^1$ (ii) $1s^2 2s^2 2p^1 2p^1$ (ii) $1s^2 2s^2 2p^1$ (iii) $1s^2 2s^1 2p_x^1 2p_y^1 2p_z^1$ (iv) $1s^2 2s^2 2p^6 3s^2 3p_x^1 3p_y^1 3p_z^1 3d^1$

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77. A p-sub-shell which consists of px, py and pz orbitals contains only one electron. In which one of these three orbitals should the electron be located ?

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78. Which of the following quantum numbers for orbitals in hydrogen atom has a greater energy for electrons ?

(i) $n=3, l=2$ and $m=+1$ (ii) $n=3, l=2$ and $m=-1$

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Advanced Problems For Competitions

1. A hydrogen like atom (atomic number z) is in a higher excited state of quantum number n. This excited atom can make a transition to the first excited state by successively emitting two photons of energies $10.2eV$ and $17.0eV$ respectively. Alternatively the atom from the same excited state can make a transition to the second excited state by successively emitting 2 photons of energy $4.25eV$ and$5.95eV$ respectively. Determine the value of $(n+z)$

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2. An iodine molecule dissociates into atom after absorbing light of wavelength $4500 Å$. If quantum of radiation is absorbed by each molecule calculate the kinetic energy of iodine (Bond energy of I_2 is $240 kJ mol^{-1}$)

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3. Calculate the angular frequency of an electron occuppying the second Bohr orbit of He^{+} ion.

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4. A leaser emits monochromatic radiation of wavelength 663 nm. If it emits 10^5 quanta per second per square metre, calculate the power output of the laser in joule per square metre per second.

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5. Find the quantum number n corresponding to the excited state of He^{+} ion, if on transition to the ground state that ion emits two photons in succession with wave lengths 108.5 and $30.4nm$.

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6. 1.8 g hydrogen atoms are excited to raditions . They study of spectra indicates that 27% of the atoms are

in 3rd energy level and 15% of atom in 2nd energy level and the rest in ground state .If .I.P.of H is

21.7×10^{-8}erg . Calcute-

(i) No. the atoms present in III & II energy level .

(ii) Total energy evolved when all the atoms when all the atoms return to ground state.

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7. The velocity of electron in a certain Bohr's orbit of H-atom bears the ratio $1:275$ to the velocity of light. What is the number of orbit ?

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8. In hydrogen atom, energy of first excited state is $-3.4eV$. Then, KE of the same orbit of hydrogen atom is.

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9. Photoelectric emission is observed from a surface for frequencies $v_1 \text{and} v_2$ of the incident radiation $(v_1 > v_2)$. If maximum kinetic energies of the photo electrons in the two cases are in the ratio $1:K$, then the threshold frequency is given by:

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10. A photon with initial frquency 10^{11}Hz scatters off an electron at rest. Its final frequency is $0.9 \times 10^{11} Hz$. The speed of scattered electron is close to :

$(h = 6.63 \times 10^{-34} Js, m_e = 9.1 \times 10^{-31} kg)$

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11. When a hydrogen atoms emits a photon of energy $12.1 eV$, its orbital angular momentum changes by (where h os Planck's constant)

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12. The angular momentum of electron in a Bohr's orbit of H atom is $4.2178 \times 10^{-34} kgm^2 s^{-1}$. Calculate the wavelength of the spectral line when the electrton falls from this level to the next lower level.

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13. The radial wave equation for hydrogen of radial nodes from nucleus are:

$$\Psi_{1s} = \frac{1}{16\sqrt{4}}\left(\frac{1}{a_0}\right)^{3/2}\left[(\mathrm{x}-1)\left(\mathrm{x}^2-8\mathrm{x}+12\right)\right]e^{-x/2}$$

where, $x = 2r/a_0$, a_0 = radius of first Bohr orbit

The minimum and maximum position of radial nodes from nucleus are:

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14. Calculate the momentum of electron moving with $1/3$ 3rd velocity of light .

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15. An electron beam can undergo defraction by crystals. Through what potential should a beam of electrons be accelerated so that its wavelength becomes 1.54 Å?

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16. If He^+ ions are known to have the wavelength difference of the first lines of Balmer series and first line of Lyman series equal to $\Delta\lambda = 132nm$ then the value of Rydberg constant (R) is

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17. An electron in H-atom in its ground state absorbs 1.5 times as much energy as the minimum required for its escape (i. e., 13 . 6 eV) from the atom . Calculate the wavelength of emitted electron.

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18. The wavelength of H_α line of Balmer series is 6500Å. What is the wavelength of H_β line of Balmer series?

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Test Your Grip (Multiple Choice Questions)

1. Deuterium nucleus contains :

A. $1p + 1n$

B. $2p + 0n$

C. $1p + 1e^{-}$

D. $2p + 2n$

Answer: A

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2. Which one of the following pairs constitutes isotones?

A. $._{6}C^{13}$ and $._{6}C^{14}$

B. $._{6}C^{13}$ and $._{7}N^{14}$

C. $._{7}N^{14}$ and $._{9}F^{19}$

D. $._{7}N^{14}$ and $._{7}N^{15}$

Answer: B

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3. Among the following groupings which represents the collection of isoelectronic species?

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

B. N_2, C_2^{-2}, CO, NO

C. $CO, NO^{+}, CN^{-}, C_2^2$

D. NO, CN^{-}, N_2, O_2^{-}

Answer: C

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4. $1 mol$ of photons each of frequency $250 s^{-1}$ would have approximately a total enegry of

A. 1 erg

B. 1 joule

C. 1 eV

D. 1 MeV

Answer: A

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5. In photoelectric effect, the kinetic energy of photoelectrons increases linearly with the

A. wavelength of incident light

B. frequency of incident light

C. velocity of incident light

D. atomic mass of the element

Answer: B

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6. visible line of hydrogen spectrum will be

A. Lyman

B. Balmer

C. Paschen

D. Brackett

Answer: B

Watch Video Solution

7. For which of the following species, Bohr theory is not applicable ?

A. Be^{3+}

B. Li^{2+}

C. He^{2+}

D. H.

Answer: C

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8. In a hydorgen atom, enegry of the first excited state is $-3.4eV$. Find out the kinetic enegry of the same orbit of H atom.

A. $+3.4eV$

B. $+6.8eV$

C. $-13.6eV$

D. $+13.6eV$

Answer: A

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9. Which of the following transitions have minimum wavelength

A. $n_4 \rightarrow n_1$

B. $n_2 \rightarrow n_1$

C. $n_4 \rightarrow n_2$

D. $n_3 \rightarrow n_1$

Answer: A

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10. Planck's constant has the dimension (unit) of

A. work

B. energy

C. angular momentum

D. linear momentum

Answer: C

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11. According to Boohr's theory the angular momentum of an electron in 5th orbit is :

A. $10h / \pi$

B. $2.5h / \pi$

C. $25h / \pi$

D. $1.0h / \pi$

Answer: B

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12. The radius of the forst Bohr orbit of hydrogen atom is 0.59Å. The radius of the third orbit of He^{+} will be

A. 8.46Å

B. 0.705Å

C. 1.59Å

D. 2.38Å

Answer: D

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13. The line spectrum of He^{+} ion will resemble that of :

A. Hydrogen atom

B. Li^{+} ion

C. Helium atom

D. Lithium atom

Answer: A

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14. In the Sommerfeld's modification of Bohr's theory, the trajectory of an electron in a hydrogen atom is

A. a perfect ellipse

B. a closed ellipse like curve, narrower at the perihelion position and flatter at the aphelion position

C. a closed loop on the spherical surface

D. a rosette

Answer: d

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15. When the electron of a hydrogen atom jumps from the n=4 to the n=1 state , the number of all pos - sible spectral lines emitted is :-

A. 15

B. 9

C. 6

D. 3

Answer: C

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16. Which of the following has the largest de Brogile wavelength provided all have equal velocity?

A. Carbon dioxide molecule

B. Electron

C. Ammonia molecule

D. Proton

Answer: B

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17. Which of the following relates to photons both as wave motion and as a stream of particles?

A. Interference

B. $E = mc^2$

C. Diffraction

D. $E = hv$

Answer: D

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18. The de Broglie wavelength of a ball of mass 10g moving with a velocity of $10ms^{-1}$ is $\left(h = 6.626 \times 10^{-34} Js\right)$

A. $6.626 \times 10^{-33} m$

B. $6.626 \times 10^{-29} m$

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

D. $6.626 \times 10^{-36} m$

Answer: A

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19. The position of both , an electron and a helium atom is known within 1.0 nm. Further the momentum of the electron is known within $5.0 \times 10^{-26} kgms^{-1}$ The minimum uncertainty in the measurement of the momentum of the helium atom is

A. $50 kgms^{-1}$

B. $5.0 \times 10^{-26} kgms^{-1}$

C. $80 kgms^{-1}$

D. $80 \times 10^{-26} kms^{-1}$

Answer: B

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20. Given: The mass of electron is 9.11×10^{-31}Kg Planck constant is 6.626×10^{-34}Js, the uncertainty involved in the measurement of velocity within a distance of 0.1Å is:-

A. $5.79 \times 10^{8} ms^{-1}$

B. $5.79 \times 10^{5}) ms^{-1}$

C. $5.79 \times 10^{6} ms^{-1}$

D. $5.79 \times 10^{7} ms^{-1}$

Answer: C

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21. The number of nodal planes '5d' orbital has, is

A. zero

B. one

C. two

D. three.

Answer: C

Watch Video Solution

22. Principal azimuthal , and magnetic quantum numbers are respetively related to

A. Size, orientation and shape

B. Size, shape and orientation

C. Shape, size and orientation

D. None of these

Answer: B

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23. The number of $2p$ electrons having spin quantum number $s = -1/2$ are

A. 6

B. 0

C. 2

D. 3

Answer: D

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24. The angular momentum of an electron is zero. In which orbital may it be present?

A. 2s

B. 2p

C. 3d

D. 4f

Answer: A

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25. Which of the following expression respresents the electron probability function (D)?

A. $4\pi r dr Pshi^2$

B. $4\pi r^2 dr \Psi$

C. $4\pi r^2 dr \Psi^2$

D. $4\pi r dr \Psi$

Answer: C

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26. The number of radial nodes in $3s$ and $2p$, respectively, are

A. 2 and 0

B. 1 and 2

C. 0 and 2

D. 2 and 1

Answer: A

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27. The five d-orbitals are designated as $d_{xy}, d_{yz}, d_{xz}, d_{x^2-y^2}$ and d_{z^2} .

Choose the correct statement.

A. The shapes of the first three orbitals are similar but that of the fourth and fifth orbitals are difference

B. The shapes of all the five d-orbitals are similar

C. The shapes of the first four orbitals are similar but that of the fifth orbital is different

D. The shapes of all the five d-orbitals are different

Answer: C

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28. The orbital diagram in which the Aufbau principle is violated is

A. 

B. 

C. 

D. 

Answer: B

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29. The outer shell configuration of the most electronegative element is

A. ns^2np^3

B. ns^2np^4

C. ns^2np^5

D. ns^2np^6

Answer: C

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30. The electronic configuration, $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$, represents a

A. Metal atom

B. Non-metal atom

C. Non-metallic anion

D. Metallic cation

Answer: D

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Test Your Grip (Fill in the Blanks)

1. Cathode rays are produced in the discharge tube when a voltage of about .... volts is applied and the pressure of the gas inside is of the order of....atm

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2. When cathode rays strike the surface of hard metals like tungsten, molybdenum etc. .....are produced.

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3. The charge and mass of the electron are....coulombs and kg respectively

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4. Proton was discovered by

Watch Video Solution

5. Rutherford's scattering experiment led to the discovery of

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6. Isotone differ in terms of ....and .....but have identical.....

Watch Video Solution

7. Out of cosumic rays, λ-rays, X-rays and radiowaves,....have minimum wavelength and .....have maximum wavelength

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8. The minimum energy required to ejected an electron from the surface of a metal is called............ .

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9. The energy possessed by one mole of photons is called........

Watch Video Solution

10. Balmer series of the hydrogen spectrum lies in the ....region

Watch Video Solution

11. The limiting line of any spectral series in the hydrogen spectrum is the line when n_2 in the Rydberg's formula is ....

Watch Video Solution

12. The different orbits or energy levels of an atom according to Bohr model are called.......

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13. If Bohr radius is represented by a_0, the radius of the second orbit of helium ion (He^+) will be......

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14. If v_0 is the velocity of electron in the first orbit of hydrogen atom, then the velocity of electron in the first orbit of Li^{2+} ion will be.....

A. v_0

B. $2v_0$

C. $3v_0$

D. $5v_0$

Answer: C

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15. Humphrey series in the hydrogen spectrum is obtainned as a result of the jump of electrons from $n_2 \geq \dots.$ to $n_1 =$ ......

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16. If an electron is accelerated by a potential of V volts, the wavelength acquired by the electron will be......

Watch Video Solution

17. According to Heisenberg's uncertainty principle, the product of uncertainty in position and uncertainty in momenutm should be $\geq$ ......

Watch Video Solution

18. On solving Schrodinger wave equation for hydrogen atom, the values of the enery obtained are called......and the corresponding values of the wavefunction (Ψ) are called.......

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19. The quantum number which tells about the angular momenta of the different electrons present in an atom is called........

Watch Video Solution

20. The quantum number which tells about the orientation of different orbitals of an atom is called........

Watch Video Solution

21. The number of spherical nodes and planar nodes present in $4d_{x^2-y^2}$ and ......and ....respectively.

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22. The expression for radial probability is........

Watch Video Solution

23. The stability of exactly half-filled and completely filled configuration is due to.........and ....

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24. The IUPAC name of the element with atomic number 104 is..........

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Conceptual Questions

1. Give two examples from everyday life where cathode ray tubes are used

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2. What is the difference in the origin of cathode rays and anode rays ?

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3. When different gases are taken in the discharge tube, how do the e/m values of cathode rays and canal rays vary ?

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4. When α-rays hit a thin foil of gold, very few $\alpha-$ particles are deflected back. What does it prove ?

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5. What is the difference between mass number and atomic mass?

Watch Video Solution

6. Calculate the approximate charge in coulombs and approximate mass in kilograms of the nucleus of lithium-7 isotope

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7. Give one example of each of the following:

(i) Isotope of $._{17}^{35}Cl$ (ii) Isobar of $._{18}^{40}Ar$ (iii) Isotone of $._{6}^{14}C$

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8. What is the main difference between electromagnetic wave theory and Planck's quantum theory ?

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9. What is difference between a quantum and a photon?

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10. What do you understand by ground state and excited state of an atom?

Watch Video Solution

11. What do you mean by saying that energy of the electron is quantized ?

Watch Video Solution

12. What is the number of spectral line in a hydrogen spectrum ?

Watch Video Solution

13. How much energy must be supplied to hydrogen atom, to free (remove) the electron in the ground state?

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14. Which transition between Bohr orbits corresponds to third line in the Balmer series of the hydrogen spectrum

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15. What are dimensions of Planck's constant. What other physical quantity has the same dimensions ?

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16. Which of the following relate to wave nature of light or particle nature or both ?

(a) Interference (b) Diffraction (c) Photoelectric effect (d) Black body radiation

(e) Planck's equation, E = hv (f) Einstein equation, $E = mc^2$

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17. What will become to the wavelength a moving particle if its velocity is doubled ?

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18. Two particles A and B are moving with the same velocity but wavelength of A is found to be double than that of B. What do you conclude ?

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19. What is the main difference between wave emitted by a bulb or heater and that associated with a particle ?

Watch Video Solution

20. Why the ball hit with a hockey by a player does not make a wave ?

Watch Video Solution

21. An electron beam after hitting a nicket crystal produces a diffraction pattern. What do you conclude ?

Watch Video Solution

22. An electron beam on hitting a ZnS screen produces a scintillation on it. What do you conclude ?

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23. The effect of uncertainty principle is significant only for motion of microscopic particles and is negligible for the macroscopic particles. Justify the statement with the help of a suitable example.

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24. Can we apply Heisenberg's uncertainty principle to a stationary state ?

Watch Video Solution

25. Name the quantum number which does not follow from the solution of Schrodinger wave equation ?

Watch Video Solution

26. What is the difference between the notations l and L ?

Watch Video Solution

27. Which of the four quantum number (n, l, m_l, m_s) determine (a) the energy of an electron in a hydrogen atom and in a many electron atom (b) the size of an orbital (c) the shape of an orbital (d) the orientation of an orbital in space ?

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28. Why Pauli exlusion principle is called exlusion principle ?

Watch Video Solution

29. At what distance is the radial probability maximum for 1s orbital ? What is this distance called ?

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30. Do atomic orbitals have sharp boundaries ? Explain why or why not ? or Why don't we draw a boundary surface diagram within which the probability of finding the electron is 100% ?

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31. Draw the shapes (boundary surfaces) of the following orbitals:

(a) $2p_y$ (b) $3d_{z^2}$ (c) $3d_{x^2-y^2}$ (Show coordinate axes in your sketches)

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32. Discuss the similarities and differences between a 1s and 2s orbital.

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33. How many radial/spherical nodes will be present in the 5f orbital ?

Watch Video Solution

34. (i) What is common between $d_9xy)$ and $d_{x^2-y^2}$ orbitals ? (ii) What is the difference between them ? (iii) What is the angle between the lobes of the above two orbitals ?

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35. For each of the following pair of hydrogen orbitals, indicate which is higher in erergy :

$(i)1s, 2s$ $(ii)2p, 3p$

$(iii)3d_{xy}, 3d_{yz}$ $(iv)3s, 3d$

$(v)4f, 5s.$

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36. Which orbital in each of the following pairs is lower in energy in a many electron atom?

$(i) 2s, 2p$ $(ii) 3p, 3d$

$(iii) 3s, 4s$ $(iv) 4d, 5f$

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37. Why Hund's rule is called rule of maximum multiplicity ?

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38. How many electrons in sulphur (Z = 16) can have $n + l = 3$?

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39. The 4f subshell of an atom contains 10 electrons. What is the maximum number of electrons having spin in the same direction ?

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40. Which out of Cu^{2+}, Fe^{2+} and Cr^{3+} has highest paramagnetism and why ?

Watch Video Solution

41. What is the maximum number of electrons that can be present in an atom in which the highest principal quantum number is 4 ?

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42. One unpaired electron in an atom distributes a magnetic moment of 1.1 B.M. Calculate the magnetic moment of chromium (Cr=24)

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43. The ground-state electronic configurations listed here are incorrect. Explain what mistake have been made in each and write the correct electronic configurations

Al : $1s^2 2s^2 2p^4 3s^2 3p^3$ $B : 1s^2 2s^2 2p^5$ $F : 1s^2 2s^2 2p^6$

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44. What is the deviation from Aufbau Principle in case of electronic configuration of La (Z=57)?

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NCERT Questions And Exercises with Answers

1. (i) Calculate the number of electrons which will together with one gram

.

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

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2. (i) Calculate the total number of electrons present in one mole of methane

(ii) Find (a) the total number and (b) the total mass of neutrons in 7 mg of $.^{14}C$ (Assume that the mass of neutron $= 1.675 \times 10^{-27} kg$)

(iii) Find (a) the total number and (b) the total mass of protons in 34 mg of NH_3 at S.T.P. (Assume the mass of proton $= 1.6726 \times 10^{-27} kg$)

Will the answer change if temperature and pressure are changed ?

View Text Solution

3. how many neutrons and protons are there in the following nuclei ?

$._6^{13}C, _8^{16}O, _{12}^{24}Mg, _{26}^{56}Fe, _{38}^{88}Sr$

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

a. $Z = 17, A = 35,$

b. $Z = 92, A = 233,$

c. $Z = 4, A = 9$

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5. Yellow light emitted from a sodium lamp has a wavelength (λ) of 580nm. Calculate the frequency (v) and the wave number $(\bar{v})$ of the yellow light

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6. Find energy of each of the photons which

a. correspond to light of frequency $3 \times 10^{15} Hz$.

b. have wavelength of 0.50Å.

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7. Calculate the wavelength, frequency, and wave number of a light wave whose period is $2.0 \times 10^{-10} s$.

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

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9. A photon of wavelength $4 \times 10^{-7} m$ strikes on metal surface , the work function fo the metal being $2.13 eV$ Calculate :

(i) the energy of the photon (ev)

(ii) the kinetic energy fo the emission and

the velocity fo the photoelectron $(1eV = 1, 6020 \times 10^{-19} J)$,

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

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11. A 25 watt bulb emits monochromatic yellow light of wavelength of 0.57μ m. Calculate the rate of emission of quanta per second .

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12. Electrons are emitted with zero velocity from a metal surface when it is exposed to radiation of wavelength 6800 Å . Calculate threshold frequency (v_0) and work function (W_0) of the metal.

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13. What is the wavelength of light emitted when the electron of a hydrogen atom undergoes a transition from an energy level with $n = 4$ to an energy level with $n = 2$? What is the colour corresponding to this wavelength?

Watch Video Solution

14. How much energy is required to ionise a H - atom if the electron occupie $n = 5$ orbit ? Compare your answer with the ionization energy of H-atom (energy required to remove the electron from nth orbit).

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15. What is the maximum numaber of emission lines obtained when the excited electron of a H atom in $n = 6$ drops to the ground state ?

Watch Video Solution

16. (i) The energy associated with the first orbit in the hydrogen atom is $-2.18 \times 10^{-18}\ \text{J atom}^{-1}$. What is the energy associated with the fifth orbit ?

(ii) Calculate the radius of Bohr's fifth orbit for hydrogen atom.

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17. Calculate the wave number for the longest wavelength transition in the Balmer series of atomic hydrogen.

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

Watch Video Solution

19. The electron energy in hydrogen atom is given by $E_n = (-2.18 \times 10^{-18}) / n^2 J$. Calculate the energy required to remove an electron completely from the $n = 2$ orbit. What is the longest wavelength of light in cm that can be used to cause this transition?

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20. Calculate the wavelength of an electron moving with a velocity fo $2.05 \times 10^7 ms^{-1}$.

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21. The mass of an electron is $9.1 \times 10^{-31} kg$. If its K.E. is $3.0 \times 10^{-25} J$, calculate its wavelength

Watch Video Solution

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

$Na^{\oplus}, K^{\oplus}, Mg^{2+}, Ca^{2+}, S^{2-}, Ar$

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23. (i) write the electronic configurations of the following ions : (a) H^{+} (b) Na^{+} (c) O^{2-} (d) F^{-} ltbr. (ii) What are the atomic number of elements whose outermost electrons are represented by (a) $3s^{1}$ (b) $2p^{3}$ and (c) $3d^{6}$?

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

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

Watch Video Solution

26. An atom of an element contains 29 electrons and 35 neutrons. Deduce

a. The number of protons and

b. The elctonic configuration of the element.

Watch Video Solution

27. Give the number of electrons in the species $H_2^{\ +}$, H_2 and $O_2^{\oplus}$

Watch Video Solution

28. a. An atomic orbital has $n = 3$. What are the possible values of l and m?

b. List the quantum numbers $(m \text{ and } l)$ of electrons for $3d$ orbital.

c. Which of the following orbitals are possible" $1p, 2s, 2p,$ and $3f$?

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29. Using s, p, d notations, descibe the orbital with the following quantum numbers.

a. $n = 1, l = 0,$ b. $n = 3, l = 1$

c. $n = 4, l = 2,$ d. $n = 4, l = 3$

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30. Explain , giving reason , which of the following sets of quantum number are not possible

$$\begin{array}{llllll} a & n=0 & l=0 & m_1=0 & m_s= & +1/2 \\ b & n=1 & l=0 & m_1=0 & m_s= & -1/2 \\ c & n=1 & l=1 & m_1=0 & m_s= & +1/2 \\ d & n=2 & l=1 & m_1=0 & m_s= & -1/2 \\ e & n=3 & l=3 & m_1= & -3 \; m_s= & +1/2 \\ f & n=3 & l=1 & m_1=0 & m_s= & +1/2 \end{array}$$

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31. How many electrons in an atom have the following auantum numbers ?

(i) $n = 4, m_s = -\frac{1}{2}$ (ii) $n = 3, l = 0.$

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32. Show that the circumference of the Bohr orbit for the hydrogen atom is an integral multiple of the de Broglie wavelength associated with the electron revolving around the orbit.

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

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34. Calcultte the enrgy required for the process ,

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

The ionization energy for the H-atom in the grounds state is $2.18 \times 10^{-18} J\text{atom}^{-1}$.

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

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36. 2×10^{8} atoms of carbon are arranged side by side. Calculate the radius of carbon atom if the length of this arrangement is 3.0 cm

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

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

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

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40. In Rutherford's experiment, generally the thin foil of heavy atoms, such as gold, platinum, etc. have been used to be bombarded by the α-particles. If the thin foil of light atoms such as aluminium atc. Is used, what difference would be observed form the above results?

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41. Symbols $._{35}^{79}Br$ and $.^{79}Br$ can be written whereas symbols $._{79}^{35}Br$ and $._{35}Br$ are not accepted. Answer in brief.

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

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

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44. An ion with mass number 56 contains 3 units of positive charge and $30.4\,\%$ more neutrons then electrons. Assign the symbol to this ion.

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45. Arrange the following type of radiations in increasing order of frequency: (a) radiation from microwave oven (b) amber light from traffic signal (c). radiation from FM radio (d) cosmic rays from outer space and (e) X-rays

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46. Nitrogen laser produces a radiation at a wavelength of $337.1nm$. If the number of photons emitted is 5.6×10^{24}. Calculate the energy of this laser

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47. Neon gas is generally used in the sign boards. If it emits strongly at $616nm$, calculate

a. The frequency of emission,

b. The distance travelled by this radiation in $30s$

c. The energy of quantum and

d. The number of quanta present if it produces $2J$ of energy.

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48. In astronomical observations, signals observed from the distant stars are generally weak. If the photon detector receives a total of

$3.15 \times 10^{-18} J$ from the radiations of $600 nm$, calculate the number of photons received by the detector.

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49. Lifetimes of the molecules in the excited states are often measured by using pulsed radiation source of duration nearly in the nano second range. If the radiation source has the duration of 2 ns and the number of photons emitted during the pulse is 2.5×10^{15}, calculate the energy of the source.

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

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51. The work function for caesium atom is $1.9eV$. Calculate (a) the threshold wavelength and (b) the threshold frequency of the radiation. If the caesium element is irradiated with a wavelength $500nm$, calculate the kinetic energy and the velocity of the ejected photoelectron.

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

$\lambda(nm)$	500	450	400
$v \times 10^{-5}(cms^{-1})$	2.55	4.35	5.20

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

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54. If the photon of the wavelength $150 pm$ strikes an atom and one of its inner bound electrons is ejected out with a velocity of $1.5 \times 10^7 ms^{-1}$, calculate the energy with which it is bound to the nucleus.

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55. Emission transitions in the Paschen series end at orbit $n = 3$ and start from orbit n and can be represented as $v = 3.29 \times 10^{15} (Hz) [1/3^2 - 1/n^2]$. Calculate the value of n if the transition is observed at 1285 nm. Find the region of the spectrum.

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

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57. Dual behaviour of matter proposed by de Broglie led to the discovery of electron microscope often used for the highly magnified images of biological molecules and other type of material. If the velocity of the electron in this microcope is $1.6 \times 10^6 ms^{-1}$. Calculate de Broglie wavelength associated with this electron.

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

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59. If the velocity of the electron in Bohr's first orbit is $2.19 \times 10^6 ms^{-1}$, calculate the de Broglie wavelength associated with it.

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60. The velocity associated with a proton moving in a potential difference of $1000V$ is $4.37 \times 10^5 ms^{-1}$. If the hockey ball of mass $0.1kg$ is moving with this velocity, calculate the wavelength associated with this velocity.

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61. If the position of the electron is measured within an accuracy of $\pm 0.02nm$, calculate the uncertainty in the momentum of the electron. If suppose the momentum of the electron is

$$\frac{h}{4\pi \times 0.05nm}$$

is there any problem in defining this value?

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62. The quantum numbers of six electrons are given below. Arrange them in order of increasing energies. If any of these combination(s) has/have the same energy lists:

1. $n = 4, l = 2, m_i = -2, m_s = -1/2$

2. $n = 3, l = 2, m_l = 1, m_s = +1/2$

3.$n = 4, l = 2, m_l = -2, m_s = -1/2$

4. $n = 3, l = 2, m_i = -1, m_s = +1/2$

5. $n = 3, l = 1, m_l = -1, m_s = +1/2$

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

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

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64. Among the following pairs of orbital which orbital will experience the larger effective nuclear charge?

a. $2s$ and $3s$, b. $4d$ and $4f$, c. $3d$ and $3p$

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

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66. Indicate the number of unpaired electrons is

$(i)P(ii)Si(iii)Cr(iv)Fe(v)Kr.$

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

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NCERT Exemplar Problems With Answers, Hints and Solution (I. Multiple Choice Questions)

1. Which of the following conclusions couldnot be derived from Rutehrford's α-particle scattering experiment?

A. Most of the space in the atom is empty

B. The radius of the atom is about 10^{-10} m while that of nucleus is $10^{-15}m$

C. Electrons move in a circular path of fixed energy called orbits

D. Electrons and the nucleus are held together by electrostatic forces of attraction

Answer: C

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2. Which of the following options does not represent ground state electronic configuration of an atom?

A. $1s^2 2s^2 2p^2 3s^2 2p^6 3d^8 4s^2$

B. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9 4s^2$

C. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$

D. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$

Answer: B

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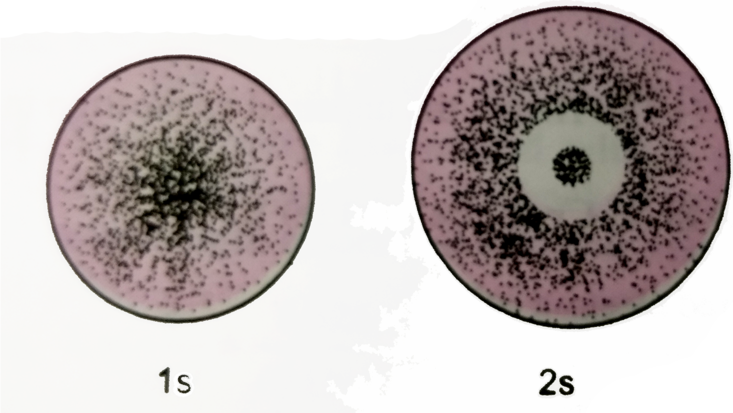
3. The probability density plots of 1s and 2s orbitals are given in Fig:



The density of dots in a region represents the probability density of finding electrons in the regions

on the basis of above diagram which one of the following statements is incorrect ?

A. 1s and 2s orbitals are spherical in shape

B. The probability of finding the electron is maximum near the nucleus

C. The probability of finding the electron at a given distance is equal in all directions

D. The probability density of electrons for 2s orbital decrease uniformly as distance from the nucleus increases.

Answer: D

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4. Which of the following statement is not correct about the characterstics of cathode rays

A. They start from the cathode and move towards the anode

B. They travel in straight line in the absence of an external electrical or magnetic field

C. Characteristics of cathode rays do not depend upon the material of electrodes in cathode ray tube

D. Characteristics of cathode rays depend upon the nature of gas present in the cathode ray tube

Answer: D

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5. Which of the following statements about the electron is incorrect?

A. It is a negatively charged particle

B. The mass of electron is equal to the mass of neutron

C. It is a basic constituent of all atoms

D. It is a constituent of cathode rays

Answer: B

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6. Which of the following properties of atom could be explained correctly by Thomson model of atom?

A. Overall neutrality of atom

B. Spectra of hydrogen atom

C. Position of electrons, protons and neutrons in atom

D. Stability of atom

Answer: A

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7. Two atoms are said to be isobars, if

A. they have same number but different mass number

B. they have same number of electrons but different number of neutrons

C. they have same number of neutrons but different number of electrons

D. sum of the number of protons and neutrons is same but the number of protons is different

Answer: D

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8. The number of radial nodes for 3p orbital is......

A. 3

B. 4

C. 2

D. 1

Answer: D

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9. Number of angular nodes for 4d orbtial is.........

A. 4

B. 3

C. 2

D. 1

Answer: C

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10. Which of the following is responsible to rule out the existence of definite paths or trajectories of electrons?

A. Pauli's exculsion principle

B. Heisenberg's uncertainty principle

C. Hund's rule of maximum multiplicity

D. Aufbau principle

Answer: B

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11. Total number of orbitals associated with thrid shell will be.....

A. 2

B. 4

C. 9

D. 3

Answer: C

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12. Orbital angular momentum depends on ....

A. l

B. n and l

C. n and m

D. m and s

Answer: A

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13. Chlorine exists in two isotopic forms $Cl - 37$ and Cl-35 but its atomic mass is 35.5. this indicates the ratio of Cl-37 and Cl-35 is approximately

A. $1:2$

B. $1:1$

C. $1:3$

D. $3:1$

Answer: C

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14. The pair of ions having same electronic configuration is________.

A. Cr^{3+}, Fe^{3+}

B. Fe^{3+}, Mn^{2+}

C. Fe^{3+}, Co^{3+}

D. Sc^{3+}, Cr^{3+}

Answer: B

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15. For the electrons of oxygen atom, which of the following statemetns correct?

A. Z_{eff} for an electron in a 2s orbital is the same as Z_{eff} for an electron in a 2p orbital

B. An electron in the 2s orbital has the same energy as an electron in the 2p orbital

C. Z_{eff} for electron in 1s orbital is the same Z_{eff} for an electron in a 2s orbital

D. The two electrons present in the 2s orbital have spin quantum number m_s but of opposite sign

Answer: D

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16. It travelling at same speeds, which of the following matter waves have the shortest wavelength?

A. Electron

B. Alpha particle (He^{2+})

C. Neutron

D. Proton

Answer: B

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NCERT Exemplar Problems With Answers, Hints and Solution (II. Multiple Choice Questions)

1. Identify the paris which are not of isotopes?

A. $._{16}^{12}X, ._{6}^{13}Y$

B. $._{17}^{35}X, ._{17}^{37}Y$

C. $._{16}^{14}X, ._{7}^{14}Y$

D. $._{4}^{8}X, ._{5}^{8}Y$

Answer: C::D

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2. Out of the following pairs of electrons, identify the pairs of electrons present in degenerate orbitals :

A. (i) $n = 3, l = 2, m_1 = 2, m_s = -\frac{1}{2}$

(ii) $n = 3, l = 2, m_1 = -1, m_s = -\frac{1}{2}$

B. (i) $n = 3, l = 1, m_1 = , m_s = +\frac{1}{2}$

(ii) $n = 3, l = 2, m_1, m_s = +\frac{1}{2}$

C. (i) $n = 4, l = 1, m_1 = 1, m_s = +\frac{1}{2}$

(ii) $n = 3, l = 2, m_1 = 1, m_s = +\frac{1}{2}$

D. (i) $n = 3, l = 2, m_1 = +2, m_s = -\frac{1}{2}$

(ii) $n = 3, l = 1, m_1 = +2, m_s = +\frac{1}{2}$

Answer: A

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3. Which of the following sets of quantum numbers are correct ?

A. $\begin{matrix} n & l & m_1 \\ 1 & 1 & +2 \end{matrix}$

B. $\begin{matrix} n & l & m_1 \\ 2 & 1 & +1 \end{matrix}$

C. $\begin{matrix} n & l & m_1 \\ 3 & 2 & -2 \end{matrix}$

D. $\begin{matrix} n & l & m_1 \\ 3 & 4 & -2 \end{matrix}$

Answer: B::C

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4. In which of the following pairs the ions are isoelectronic?

A. $Na^{+}, Mg \wedge (2+)$

B. Al^{3+}, O^{-}

C. Na^{+}, O^{2-}

D. N^{3}, Cl^{-}

Answer: A::C

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5. Which of the following statements concerning the quantum numbers are correct?

A. Angular quantum number determines the three dimensional shape of the orbital

B. The pincipal quantum number determines the orientation and energy of the orbital

C. Magnetic quantum number determines the size of the orbital

D. Spin quantum number of an electron determine the orientation of the spin of electron relative to the chosen axis

Answer: A::D

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NCERT Exemplar Problems With Answers, Hints and Solution (Short Answer questions)

1. Arrange s,p and d subshells of a shell in the increasing order of effective nuclear charge (Z_{eff}) experienced by the electron present in them.

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2. Show the distribution of electrons in oxygen atom (atomic number 8) using orbital diagram.

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3. Nickel atom can lose two electrons to form Ni^{2+} ion. The atomic number of nickel is 28. From which orbital will nickel lose two electrons?

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4. Which of the following orbitals are degernate?

$3d_{xy}$, $4d_{xy}$, $3d_{z^2}$, $3d_{yz}$, $4d_{yz}$, $4d_{z^2}$

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5. Calculate the total number of angular nodes and radial nodes present in 3p- orbital.

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6. The arrangement of orbitals on the basis of energy is based upon their (n+l) value. Lower the value of (n+l), lower is the energy . For orbitals having same values of (n+l). The orbital with lower value of n will have lower energy.

I. Based upon the baove information arrange the following orbitals in the increasing order of energy.

(a) 1s,2s,3s,2p (b) 4s,3s,3p,4d

(c) 25p,4d,5d,4f,6s (d) 5f,6d,7s,7p

II. Based upon the above information Solve the question. give below.

(a) hich of the following orbitals has the lowest energy

$4d, 4f, 5s, 5p$

(b) which of the following orbitals has the higher energy?

$5p, 5d, 5f, 6s, 6p$

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7. Which of the following will not show deflection from the path on passing through an electric field?

Proton,cathode rays, electron,neutron.

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8. An atom having mass number 13 has 7 neutrons. What is the atomic number of the atom.

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9. Wavelengths of different radiations are given below:

(A) 300nm (B) $300\mu m$ (C) 3nm $(30A^{\circ}$

Arrange these radiations in the increasing order of their energies.

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10. The electronic configuration of valence shell of Cu is $3d^{10}4s^1$ and not $3d^9 4s^2$. How is this configuration explained?

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11. The Balmer series in the hydrogen spectrum corresponds to the transition from $n_1 = 2$ to $n_2 = 3, 4........$ This series lies in the visible region. Calculate the wave number of line associated with the transition in Balmer series when the electron moves to n=4 orbit.

$\left(R_H = 109677cm^{-1}\right)$

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12. According to de-Brogile, matter should exhibit dual behaviour, that is both particle and wave like properties. However, a cricket ball of mass 100 g does not move like a wave when it is thrown by a b owler at a speed of 100km/h. calculate the wavelength of the ball and explain why it does not show wave nature.

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13. What is the experimental evidence in support of the diea that electronic energies in an atom are quantized?

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14. Out of electron and proton which one will have, a higher velocity to produce matter waves of the same wavelength ? Explain it.

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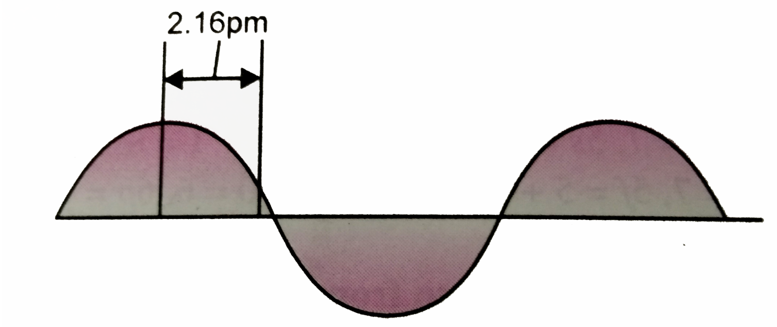
15. A hypothetical electromagnetic wave is shown in Fig. Find out the wavelength of the radiation



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16. Chlorophyll present in green leaves of plants absorbs light at $4.620 \times 10^{14} Hz$. Calculate the wavelength of radiation in nanometer. Which part of the electromagnetic spectrum does it belong to?

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17. What is the difference between the terms orbit and orbital ?

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18. Table-tennis ball has mass 10g and s peed of 90m/s. if speed can be meausred within an accuracy of 4%. What will be the uncertainly in speed and position?

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19. The effect of uncertainty principle is significant only for motion of microscopic particles and is negligible for the macroscopic particles. Justify the statement with the help of a suitable example.

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20. Hydrogen atom has only one electron, So, mutual repulsion between electrons is absent. However, in multielectron atoms mutual repulsion between the electrons is significant. How does this affect the energy of an electron in the orbitals of the same prinicipal quantum number in multielectron atoms?

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NCERT Exemplar Problems With Answers, Hints and Solution (Matching type Questions)

1. Match the following species with their corresponding ground state electronic configuration.

	Atom/lon		Electronic configuration
(a)	Cu	(i)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$
(b)	cu^{2+}	(ii)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
(c)	Zn^{2+}	(iii)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$
(d)	cr^{3+}	(iv)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$
		(v)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$

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2. Match the quantum numbers with the information provided by these

	Quantum number		Information provided
(i)	Principal quantum number	(a)	orientation of the orbital
(ii)	Azimuthal quantum number	(b)	energy and size of orbital
(iii)	Magnetic quantum number	(c)	spin of electron
(iv)	Spin quantum number	(d)	shape of the orbital

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3. Match the following rules with their statements.

Rules		Statements	
A.	Hund's Rule	1.	No two electrons in an atom can have the same set of four quantum numbers.
B.	Aufbau Principle	2.	Half-filled and completely filled orbitals have extra stability.
C.	Pauli Exclusion Principle	3.	Pairing of electrons in the orbitals belonging to the same subshell does not take place until each orbital is singly occupied.
D.	Heisenberg's Uncertainty Principle	4.	It is impossible to determine the exact position and exact momentum of a subatomic particle simultaneously.
		5.	In the ground state of atoms, orbitals are filled in the order of their increasing energies.

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4. Match the following :

(a)	X-rays	(i)	$v = 10^0 - 10^4 Hz$
(b)	UV	(ii)	$v = 10^{10} Hz$
(c)	Long radio waves	(iii)	$v = 10^{16} Hz$
(d)	Microwave	(iv)	$v = 10^{18} Hz$

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5. Match the following :

(a)	Photon	(i)	value is 4 for N-shell
(b)	Electron	(ii)	Probability density
(c)	ψ^2	(iii)	Always positive value
(d)	Principal quantum number n	(iv)	Exhibits both momentum and

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6. Match species given in Column I with the electronic configuration given in Column II.

	Column I		Column II
(a)	cr	(i)	$[Ar]3d^8 4s^0$
(b)	Fe^{2+}	(ii)	$[Ar]3d^{10} 4s^1$
(c)	Ni^{2+}	(iii)	$[Ar]3d^6 4s^0$
(d)	Cu	(iv)	$[Ar]3d^5 4s^1$
		(v)	$[Ar]3d^6 4s^2$

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NCERT Exemplar Problems With Answers, Hints and Solution (Assertion And Reason Type Questions)

1. Assertion(A): All isotopes of a given element show the same type of chemical behaviour.

Reason(R) The chemical properties of an atom are controlled by the numb er of electron s in the atom.

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. Both A and R are false

Answer: A

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2. Assertion(A) Black body is an ideal body that emits and absorbs radiations of all frequencies.

Reason(R) The frequency of radiation emitted by a body goes from a lower frequency to higher frequency with an increase in temperature.

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. Both A and R are false

Answer: B

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3. Assertion (A) It is impossible to determine the exact position and exact momentum of an electron simultaneously.

Reason (R) The path of an electron in an atom is clearly defiened.

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. Both A and R are false

Answer: C

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NCERT Exemplar Problems With Answers, Hints and Solution (Long Answer Questions)

1. What is photoelectric effect ? State the result of photoelectric effect experiment that could not be explained on the basis of laws of classical physics. Explain this effect on the basis of quantum theory of electromagnetic radiations.

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2. Thershold frequency, v_0 is the minimum frequency which a photon must possess to eject an electron from a metal. It is different for different metals. When a photon of frequency $1.0 \times 10^{15} s^{-1}$ was allowed to hit a metal surface, an electron having $1.988x10^{-19} J$ of kinetic energy was emitted. Calculated the threshold frequency of this metal.

equal to 600nm hits the metal surface.

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3. When an electric discharge is passed through hydrogen gas, the hydrogen molecules dissociate to produce excited to produce excited hydrogen atoms. These excited atoms emit electromagnetic radiation of discrete frequencies which can be given by the general formula

$$\vec{v} = 109677\left[\frac{1}{n_i^2} - \frac{1}{n_f^2}\right]$$

What points of Bohr's model of an atom can be used to arrive at this formula? Based on these points derive the above formula giving description of each step and each term.

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4. Calculate the energy and frequency of the radiation emitted when an electron jumps from n=3 to n=2 ina hydrogen atom.

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5. Why was a change in the Bohr Model of atom required? Due to which important development concept of movement of an electron in an orbit was replaced by the concept of probabiltiy of finding electron in an orbital?what is the name given to the changed model of atom?

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Additional Questions (Very Short Answer Questions)

1. What is an electron? Give the values of charge and mass of an electron.

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2. Why electrons present around the nucleus. The force of attractive is balanced by the centrifugal force.

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3. Determine the number of protons and neutrons in ${}_{92}U^{238}$ and ${}_{90}Th^{234}$.

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4. An atom which does not have any neutron is

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5. How many electrons are present in the ion $.{}_{26}^{56}Fe^{2+}$?

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6. Name three ions which are isoelectronic with F^{-} ion

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7. Name the different isotopes of hydrogen. Represent them along with their atomic numbers and mass numbers.

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8. What is Ritz combination principle ?

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9. How are frequency and wavelength related to each other ?

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10. Arrange X-rays, cosmic rays and radiowaves according to frequency.

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11. What is the value of Planck's constant?

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12. What do you observe in the spectrum of NaCl ?

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13. Which one of the series of hydrogen spectrum is in the visible region ?

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14. Write the expression which gives the energy of electron in the nth shell of hydrogen like particles

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15. Give the equation which gives the relationship between wavelength (λ) and momentum (p) of the particle.

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16. What is the most important application of de Broglie concept ?

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17. What happens when an electron hits a zinc sulphide screen and what does it prove ?

Watch Video Solution

18. State de-Broglie hypothesis.

Watch Video Solution

19. Name two experiments which show the dual nature of electrons.

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20. How does the change in velocity of a moving particle alter the wavelength related to the particle ?

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21. What happens to the position and momentum of an electron if a photon of a short wavelength hits the electron?

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22. Why did Heisenberg's uncertainty principle replace the concept of definite orbit by the concept of probability?

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23. Mention the physical significance of Ψ and Ψ^2

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24. Write Schrodinger wave equation in the briefest possible form

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25. Which quantum number determines the (a) shape (b) orientation and (c) size of the orbital ?

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26. Define an atomic orbital. What does angular momentum quantum number tell about an orbital ?

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27. Which energy levels do not have p-orbital ?

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28. What is the maximum probability for an electron to be present within the atomic orbital ?

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29. Which is the first energy level containing f-orbitals ?

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30. What is the maximum number of electrons that can be accommodated in the d-subshell ?

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

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32. What values of m are permitted for electron having angular quantum number l=2 ?

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33. What value are permitted for the angular momentum quantum number l for an electron with principal quantum number n = 4 ?

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34. What are the values of n, l and m for $2p_x$ and $3p_z$ orbitals ?

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35. Which orbitals is non-directional ?

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36. How many orbitals do you expect to be present in the 5th shell ?

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37. Which d-orbital does not have four lobes and what is its shape called ?

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38. (a) What is radial probability distribution curve ? Draw radial probability distribution curves for 1s and 2s orbitals.

(b) Discuss the similarities and difference between 1s and 2s orbitals.

(c) How many nodes are present in 1s and 2s orbitals ?

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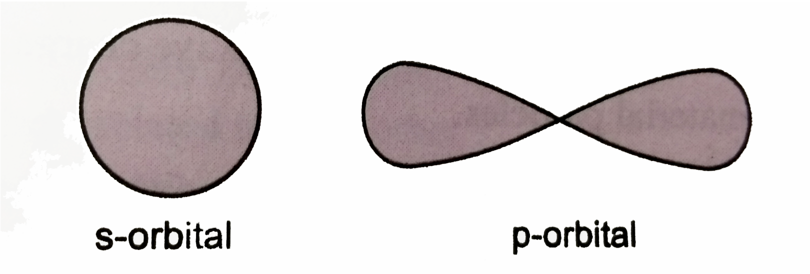
39. What is the physical significance of the lines in the following depictions of atomic orbitals ?



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40. Draw the shapes of various p and d orbitals.

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41. What will be the order of energy levels 3s, 3p and 3d in case of H-atom ?

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42. What are degenerate orbitals ?

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43. Which element has only one electron in the d-orbitals ?

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44. Write the electronic configuartion of Cu^{+} (At. No. of Cu= 29)

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45. Copper (I) is diamagnetic while copper (II) is paramagnetic . Explain.

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46. Why is the electronic configuration $1s^2 2s^2 2p_x^2 2p_y^1 2p_z^0$ not correct for the ground state of nitrogen (atomic number = 7) ?

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47. What are the possible values of principal (n) and azimuthal (l) quantum number for the unpaired electron in the atom of an element whose atomic number is 9 ?

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48. Out of Fe^{2+} and Fe^{3+} which is more paramagnetic and why?

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49. Write the electronic configuration of a divalent ion of a coinage metal.

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50. By what name are the following principles known ?

(i) Electrons with the same spin quantum number cannot be present in the same atomic orbital.

(ii) The wavelength associated with a moving particle is given by $\lambda = h/p$

(iii) Of a pair of conjugate properties, both cannot be measured precisely at the same time

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51. What is the nuclear radius of an atom whose mass number is 125 ?

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Additional Questions (Short Answer question)

1. From which electrode do cathode rays originate?

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2. How can you say that electron is a universal constituent of all atoms ?

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3. Describe in brief the experiments to demonstrate that cathode rays

(i) travel along straight path ,

(ii) are made up of material particles ,

(iii) are negatively charged .

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4. How was proton discovered ?

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5. What is Thomoson's model of atom?

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6. How can you say that nucleus is small in size but heavy in mass ?

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7. Who discovered neutron?

Watch Video Solution

8. Define atomic number and mass number .

Watch Video Solution

9. What are isotopes ? How are they represented ?

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10. Define wave length , frequency and wave number. How is frequency related to wave number ?

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11. Plancks Quantum Theory

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12. Explain the dual character of light radiations.

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13. How is the atomic spectra of hydrogen obtained ? Whar are the different series of lines present in it ? In which regions do they lie ?

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14. Using the Rydberg formula, calculate the wavelength of the first four spectral lines in the Lyman series of the hydrogen spectrum.

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15. What is the difference between Rydberg formula and Balmer formula?

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16. What were the drawbacks of Rutherford's model of an atom?

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17. What do you understand by stationary states ?

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18. What do you mean by quantisation of electronic energy and angular momentum ?

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19. Bohr model cannot explain spectrum of

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20. How does Bohr modeal explain the simultaneous appearance of a large number of lines in the hydrogen spectrum ?

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21. Outline the weaknesses of Bohr's model of atom

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22. What is meant by dual nature of particles in motion ?

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23. State de Broglie relationship. For what purpose is it used ?

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24. Derive de Broglie equation for microscopic particles.

Watch Video Solution

25. State de Broglie equation. How would the wavelength of a moving object vary with mass ?

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26. Derive a relationship between wavelength (λ) associated with particle of mass (m) moving with a velocity (v) . Give the importance of this relation.

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27. State Heisenberg's uncertainty principle. Give mathematical expression for the same

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28. Explain why it is impossible to measure simultaneously the position and velocity of a fast moving small body like an electron

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29. State Heisenberg's uncertainty principle. Why motion of electron around the nucleus cannot be described in terms of orbits ?

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30. In what ways Heisenberg's uncertainty principle contradicts the concept of stationary orbit for electron as suggested by Bohr ? or Give the physical significance of uncertainty principle.

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31. What happened to Bohr's model of atom in the light of uncertainty principle ? Explain the concept of 'probability'. Define 'atomic orbtial'.

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32. What is the significane of wave function Ψ in the Schrodinger wave equation ? What is an atomic orbital ? What Ψ is called orbital wave function ?

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33. How are the quantum numbers related to each other ?

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34. Define Pauli exclusion principle. Why is it called exclusion principle ?

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35. In an atom, the first shell may contain upto 2 electrons, the second shell upto 8, the third upto 18 and then fourth shell upto 32 electrons. Explain this arrangement in terms of quantum number.

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36. How do 1s, 2s and 3s-orbitals differ from each other ?

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37. Draw probability distribution curves for 1s and 2s electrons. What observations are made from the graph ?

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38. Draw and discuss the shapes of d-orbitals.

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39. Name five d-orbitals. Give their shapes

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40. the current statement on the Aufbau principle is that

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41. State Hund's rule and its importance in filling the orbitals in various energy levels, take atomic number 17 as an example.

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42. State Hund's rule of maximum multiplicity. How is it used for the distribution of electrons in nitrogen (At No.7) and fluorine (At. No. 9) atoms ?

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43. Why is the electronic configuartion of oxygen written as $1s^2 2s^2 2p_x^2 2p_y^1 2p_z^1$ and not as $1s^2 2s^2 2p_x^2 2p_y^2$? Name and state the rule governing this type of distribution

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44. Write the sequence in which electrons fill the various energy sub-shells in an unexcited atom.

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45. Why do some atoms posses exceptional electronic configuation ? Explain with suitable examples.

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46. Explain why atoms with half filled and completely filled orbitals have extra stability ?

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47. Write electronic configurations of atoms of Cr (at. no 24) and Cu (at. no. 29). Show the orientations of electron spins by arrow heads.

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Additional Questions (Long Answer Questions)

1. Electron was discovered by

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2. How are cathode rays produced ? Briefly explain their important properties

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3. What are Anode Rays ? How do they originate ? List their important properties.

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4. Rutherford's scattering experiment led to the discovery of

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5. How was the nuclear model of atom discovered ?

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6. How was the neutrons discovered ? Mention the characteristics of neutrons.

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7. (a) Define the terms Atomic Number and Mass Number

(b) How does mass number differ from atomic mass ? How do atomic number (Z) and mass number (A) help to calculate the number of electrons, protons and neutrons in an atom ?

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8. What were the main points of Electromagnetic wave theory ? What were its limitations ? How have these been overcome by Planck's quantum theory ?

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9. Write short notes on the following :

(i) Solar spectrum or continuous spectrum.

(ii) Atomic spectra or line spectra.

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10. State and explain de Broglie's relation

Watch Video Solution

11. State and explain Heisenberg's uncertainty principle.

Watch Video Solution

12. List the main points of difference between orbit and orbital.

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13. The basis of quantum mechanical model of an atom is

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14. Define Quantum numbers and brief them.

Watch Video Solution

15. Define atomic orbital. Give the shapes of s and p orbitals.

Watch Video Solution

16. State and explain the following:

(i) Aufbau principle

(ii) Pauli exclusion principle

(iii) Hund's rule of maximum multiplicity.

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Analytical Questions And Problems with Answers/solutions (Questions)

1. Why cathode rays are produced only when the pressure of the gas inside the discharge tube is very low ?

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2. Name the element in each of the following cases:

(i) A bivalent anion of the element having 10 electrons

(ii) A trivalent cation of the element having 10 electrons.

What is the relationship between the two ions called ?

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3. Why are Bohr orbits called stationary states ?

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4. Why electronic energy is negative ? Comment on the spacing between the energy levels.

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5. A molecule of O_2 and that of SO_2 travel with the same velocity. What is the ratio of their wavelengths ?

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6. Why can't we overcome the uncertainty predicted by Heisenberg principle by building more precise devices to reduce the error in measurement below the $h / 4\pi$ limit ?

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7. What shell would be the first to have a g-subshell ? How many orbitals will be possible in a g-subshell ?

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8. How many electrons are present in all subshells (fully - filled) with $n + l = 5$?

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9. What is the angular momentum of an electron in (i) 2 s orbital (ii) 4f orbital ?

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10. What is the difference between angular momentum of an electron present in 3p orbital from that of an electron present in 4p orbital ?

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11. Why does that splitting of spectral lines occur when the source of the spectrum is placed in a magnetic field ?

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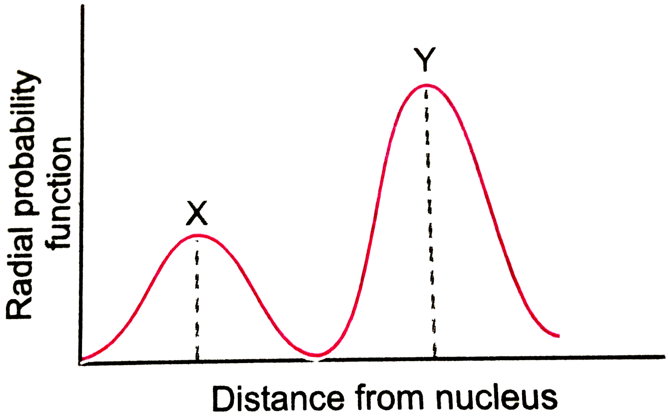
12. The plot of radial probability function versus distance from nucleus for 2s orbital is given below :



Calculate the distance between the peaks X and Y

View Text Solution

13. Which of the two is paramagnetic : V (IV) or V (V) and why ?

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14. For a hydrogen -like particle, derive the expression : $v_n = \left(\frac{Ze^2}{mr_n}\right)^{1/2}$

where v_n is the velocity of the electron at distance r_n from the nucleus, Z is the atomic number of the H-like particles, m and e are the charge and mass of the electron.

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15. If the uncertainty in the position of a moving electron is equal to its de Broglie wavelength, then its velocity will be completely uncertain. Explain.

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16. What do you understand by rest mass of the electron ? What is its value on the unified scale ? How is the mass of the electron related to its velocity ? What will be the mass of the electron if it travels with velocity equal to the velocity of light ?

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17. In H-atoms, the energy of electron in the nth orbit is given as $E_n = -\frac{13.6}{n^2} eV$

Show that $E_{(n+1)} - E_n = \frac{13.6 \times 2}{n^3} eV$ for large value of n.

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18. The wave function of $2s$ electron is given by

$$\psi_{2s} = \frac{1}{4\sqrt{2\pi}}\left(\frac{1}{a_0}\right)^{3/2}\left(2 - \frac{r}{a_0}\right)e^{-\frac{r}{a_0}}$$

It has a node at $r = r_p$. Find the relation between r_p and a.

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19. How many nodes are present in 3p-orbital, Represent diagrammatically

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20. If the energy of an electron in 3rd Bohr orbit is $-E$, what is the energy of the electron in (i) 1st Bohr orbit (ii) 2nd Bohr orbit ?

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21. Show that ground state energy of an electron in H-atom is equal to the first excited state energy of electron in He^{+} ion (assuming their Rydberg's constants to be equal).

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22. The two electrons in the 1s orbital of helium have antiparallel spin. Why do not they have parallel spin ?

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23. On the basis of uncertainty principle show that an electron cannot exist with in atomic nucleus. (Given : Nuclear radius = 10^{-15} m)

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24. In each of the following pairs of salts, which one is more stable and why ?

(i) Ferrous and ferric salts (ii) Cuprous and cupric salts.

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25. Heisenberg uncertainty principle has no significance in our every day life. Explain.

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Analytical Questions And Problems with Answers/solutions (Problems)

1. If the kinetic energy of a particle is doubled, by what factor the de Broglie wavelength of the particle increase or decrease ?

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2. Calculate the accelerating potential that must be imported to a proton beam to give it an effective wavelength of 0.05 nm

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3. With what velocity must an electron travel so that its momentum is equal to that of a photon of wavelength 560 nm ?

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4. If the uncertainties in the measurement of position and momentum of an electron are equal calculate the uncertainty in measuring the velocity

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5. When a certain metal was irradiated with a light of frequency 3.2×10^{16} Hz, the photoelectrons had twice the kinetic energy as emitted when the same was irradiated with light of frequency $2.0 \times 10^{16} Hz$. Calculate the threshold frequency (v_0) of the metal.

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6. Which state of the triply ionized Be^{+++} has the same orbital radius as that of the ground state of hydrogen? Compare the energies of two states.

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7. Find out the number of waves made by a Bohr's electron in one complete revolution in its $3rd$ orbit.

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8. A bulb emits light of wavelength 4500 Å .The bulb is rated as 150 W and $8\,\%$ of the energy is emmitted as light. How many photons are emitted by the bulb per second?

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9. What is the distance of separation between second and third orbits of H-atom is given as :

$r_n = 0.529 \times n^2 \text{Å}$

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10. To which orbit the electron in the hydrogen atom will jump after absorbing $1.94 \times 10^{-18} J$ of energy ?

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11. The wavelength of a photon is 1.4Å. It collides with an electron. Its wavelength after collision is 2.0Å. Calculate the energy of the scattered electron.

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12. If the binding energy of electrons in a metal is 250 kJ mol^{-1} , what is the threshold frequency of the striking photons ?

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13. A base ball of mass $200g$ is moving with velocity of $3 \times 10^3 cms^{-1}$. If we can locate the base ball with an error equal to the magnitude of the wavelength of the light used (5000Å). How will the uncertainty in momentum be used with the total momentum of the base ball?

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14. Find the velocity (in ms^{-1}) of electron in first Bohr orbit of radius a_0. Also find the de Broglie wavelength (in m). Find the orbital angular momentum of 2p orbital of hydrogen atom in units of $h/2\pi$.

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15. The frequency of one of the lines in Paschen series of hydrogen atom is $2.340 \times 10^{11} Hz$. The quantum number n_2 Which produces this transition is.

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16. The longest wavelength of He^{+} in paschen series is "m", then shortest wavelenght of Be^{+3} in Pacchen series is(in terms of m):

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17. Calculate the de Broglie wavelength of the electron in third orbit of hydrogen atom

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18. What is the ratio of time periods (T_1 / T_2) in second orbit of hydrogen atom to third orbit of He^+ ion?

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Competition Focus (JEE (Main and Advanced)/Medical Entrance (I. Multiple Choice Question) With one correct Answer

1. A strong argument in favour of the particle nature of cathode rays is that they

A. produce fluorescence

B. travel through vacuum

C. can rotate a light paddle wheel placed in their path

D. cast shadow of the objects lying in their path

Answer: C

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2. Which of the following feature of an atom is not a direct result of Rutherford's experiment

A. extraordinary hollow nature of atom

B. existence of circular electronic of atom

C. small size of the nucleus

D. exceptionally high density of the nucleus

Answer: B

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3. A metallic ion M^{2+} has an electronic configuration of 2, 8, 14 and the ionic weight is 56 amu. The number of neutrons in its nucleus is

A. 30

B. 32

C. 34

D. 42

Answer: A

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4. Which one is a set of isolectronic species ?

A. N_2, CO_2, CN^-

B. N, H_2S, CO

C. N_2, CO, CN^-

D. Ca, Mg, Cl

Answer: C

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5. In which one of the following pairs, the two species are both isoelectronic and isotopic ? (At. Numbers : Ca = 20, Ar = 18, K = 19, Mg = 12, Fe = 26, Na = 11)

A. $.^{40} Ca^{2+}$ and $.^{40} Ar$

B. $._{39} K^{+}$ and $.^{40} K^{+}$

C. $.^{24} Mg^{2+}$ and $.^{25} Mg$

D. $.^{23} Na$ and $.^{24} Na^{+}$

Answer: B

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6. The group having isoelectronic species is

A. $O^{2-}, F^{-}, Na, Mg^{2+}$

B. $O^{-}, F^{-}, Na^{+}, Mg^{+}$

C. $O^{2-}, F^{-}, Na^{+}, Mg^{2+}$

D. O^{-}, F^{-}, Na, Mg

Answer: C

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7. A standing wave in a string 35 cm long has a total of six nodes including those at the ends. Hence, wavelength of the standing wave is

A. 5.8 cm

B. 4.6 cm

C. 10.4 cm

D. 14 cm

Answer: D

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8. For hydrogen atom, Rydberg constant (R_H) is xm^{-1}. Then for He^+ ion, the corresponding value of this constant will be

A. xcm^{-1}

B. $400xcm^{-1}$

C. $4xcm^{-1}$

D. $0.04xcm^{-1}$

Answer: D

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9. The energies E_1 and E_2 of two radiations are $25eV$ and $50eV$ respectively. The relation between their wavelengths, i.e., λ_1 and λ_2 will be.

A. $\lambda_1 = \frac{1}{2}\lambda_2$

B. $\lambda_1 = \lambda_2$

C. $\lambda_1 = 2\lambda_2$

D. $\lambda_1 = 4\lambda_2$

Answer: C

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10. The value of planok,s constant is $6.63 \times 10^{-34} Js$ the speed of light is $3 \times 10^{17} nms^{-1}$ which value is closest to the wavelength in nanometer of a quantum of light with frequency of $6 \times 10^{15} S^{-1}$?

A. 10

B. 25

C. 50

D. 75

Answer: C

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11. Calculate the wavelength of light required to break the bond between two chlorine atoms in a chlorine molecule. The Cl- Cl bond energy is 243 kJ $mol^{-1}(h = 6.6 \times 10^{-34} Js, c = 3 \times 10^8 m/s,$ Avogadro's number $= 6.02 \times 10^{23} mol^{-1}$)

A. $8.18 \times 10^{-31} m$

B. $6.26 \times 10^{-21} m$

C. $4.91 \times 10^{-7} m$

D. $4.11 \times 10^{-6} m$

Answer: C

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12. A 600 W mercury lamp emits monochromatic radiation of wave length 313.3 nm. How many photons are emitted from the lamp per second ? ($h = 6.626 \times 10^{-34} Js$, velocity of light $= 3 \times 10^8 ms^{-1}$)

A. 1×10^{19}

B. 1×10^{20}

C. 1×10^{21}

D. 1×10^{23}

Answer: C

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13. When the frequency of light incident an a metallic plate is doubled , the KE of the emitted photoelectrons will be :

A. doubled

B. halved

C. more than doubled

D. increases but less than doubled.

Answer: C

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14. Photoelectric emission is observed from a metallic surface for frequencies v_1 and v_2 of the incident light. If the maximum value of kinetic energies of the photoelectrons emitted in the two cases are in the ratio $n:1$ then the threshold frequency of the metallic surface is

A. $v_1 = v_2$

B. $\dfrac{v_1 - v_2}{h}$

C. $2v_1 - v_2$

D. $2v_2 - v_1$

Answer: D

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15. The wavelength of the radiation emitted , when in a hydrogen atom electron falls from infinity to stationary state 1 , would be :

(Rydberg constant = $1.097 \times 10^7 m^{-1}$)

A. 91 nm

B. 192 nm

C. 406 nm

D. $9.1 \times 10^{-8} nm$

Answer: A

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16. The frequency of light emitted for the transition $n = 4$ to $n = 2$ of He^+ is equal to the transition in H atom corresponding to which of the following ?

A. $n = 3 \text{ to } n = 1$

B. $n = 2 \text{ to } n = 1$

C. $n = 3 \text{ to } n = 2$

D. $n = 4 \text{ to } n = 3$

Answer: B

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17. Based on equation $E = -2.178 \times 10^{-18} J\left(\frac{Z^2}{n^2}\right)$, certain conclusions are written. Which of them is not correct ?

A. The negative sign in equation simply means that the energy of electron bound to the nucleus is lower than it would be if the electrons were at infinite distance from the nucleus.

B. Lower the value of n, the larger is the orbit radius

C. Equation can be used to claculate the change in energy when the electron changes orbit

D. For $n = 1$, the electron has a more negative energy that it does for $n = 6$ which means that the electron is more lossely bound in the smallest allowed orbit.

Answer: D

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18. The shortest wavelength in hydrogen spectrum of Lyman series when $R_H = 109678 cm^{-1}$ is :-

A. $1002.7 Å$

B. $1215.67 Å$

C. $1127.30 Å$

D. $911.7 Å$

Answer: D

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19. The ratio of the frequency corresponding to the third line in the lyman series of hydrogen atomic spectrum to that of the first line in Balmer series of Li^{2+} spectrum is

A. $\frac{4}{5}$

B. $\frac{5}{4}$

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

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

Answer: D

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20. The wave number of the spectral line in the emission spectrum of hydrogen will be equal to $\frac{8}{9}$ times the Rydberg's constant if the electron jumps from ....:-

A. $n = 3 \text{ to } n = 1$

B. $n = 10 \text{ to } n = 1$

C. $n = 9 \text{ to } n = 1$

D. $n = 2 \text{ to } n = 1$

Answer: A

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21. For balmer series in the spectrum of atomic hydrogen the wave number of each line is given by $\overline{V} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ where R_H is a constant and n_1 and n_2 are integers. Which of the following statements (s), is (are correct)

1. As wave length decreases the lines in the series converge

2. The integer n_1 is equal to 2.

3. The ionisation energy of hydrogen can be calculated from the wave numbers of three lines.

4. The line of shortest wavelength corresponds to = 3.

A. 1, 2 and 3

B. 2, 3 and 4

C. 1, 2 and 4

D. 2 and 4 only

Answer: C

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22. According to the Bohr Theory, the third from the red end corresponds to which one of the following transitions in the hydrogen atom will give rise to the least energetic photon ?

A. n = 6 to n = 1

B. n = 5 to n = 4

C. n = 6 to n = 5

D. n = 5 to n = 3

Answer: C

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23. The angular momentum of electron in 'd' orbital is equal to:

A. $2\sqrt{3}h$

B. $0h$

C. $\sqrt{6}h$

D. $\sqrt{2}h$

Answer: C

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24. In 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 ?

A. $5 \rightarrow 2$

B. $4 \rightarrow 1$

C. $2 \rightarrow 5$

D. $3 \rightarrow 2$

Answer: A

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25. The frequency of radiation emiited when the electron falls n =4 to n=1 in a hydrogen atom will be (given ionization energy of $H = 2.18 \times 10^{-18} J\text{atom}^{-1}$ and $h = 6.625 \times 10^{-34} Js)$

A. $1.54 \times 10^{15} s^{-1}$

B. $1.03 \times 10^{15} s^{-1}$

C. $3.08 \times 10^{15} s^{-1}$

D. $2.0 \times 10^{15} s^{-1}$

Answer: C

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26. 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 excited an electron in an hydrogen atom from level $n = 1$ to $n = 2$ will be

$\left(h = 6.62 \times 10^{-34} Js\right.$ and $c = 3.0 \times 10^8 ms^{-1}$).

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

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

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

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

Answer: B

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27. the radius of which of the following orbit is same as that of the first Bohr's orbit of hydrogen atom?

A. $He^{+}(n=2)$

B. $Li^{2+}(n=2)$

C. $Li^{2+}(n=3)$

D. $Be^{3+}(n=2)$

Answer: D

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28. One electron species having ionization enegry of $54.4eV$ is

A. H

B. He^{+}

C. B^{4+}

D. Li^{2+}

Answer: B

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

A. $1:1$

B. $1:16$

C. $8:1$

D. $16:1$

Answer: D

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30. The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is [a_0 is Bohr radius] :

A. $\frac{h^2}{4\pi^2 m a_0^2}$

B. $\frac{h^2}{16\pi^2 m a_0^2}$

C. $\frac{h^2}{32\pi^2 m a_0^2}$

D. $\frac{h^2}{64\pi^2 m a_0^2}$

Answer: C

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31. The most probable radius (in pm) for finding the electron in He^+ is

A. 0.0

B. 52.9

C. 26.5

D. 105.8

Answer: C

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32. If ΔE is the energy emitted in electron volts when an electronic transition occurs from higher energy level to a lower energy level in H-atom, the wavelength of the line produced is approximately equal to

A. $\frac{19800}{\Delta E}\text{Å}$

B. $\frac{12375}{\Delta E}\text{Å}$

C. $\frac{13600}{\Delta E}\text{Å}$

D. $\frac{21800}{\Delta E}\text{Å}$

Answer: B

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33. If R_H represents Rydberg constant, then the energy of the electron in the ground state of hydrogen atom is

A. $-\frac{hc}{R_H}$

B. $-\frac{1}{R_H ch}$

C. $-R_H ch$

D. $-\frac{R_H c}{h}$

Answer: C

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

A. $-2.2 \times 10^{-15} Jatom^{-1}$

B. $8.82 \times 10^{-17} Jatom^{-1}$

C. $4.41 \times 10^{-16} Jatom^{-1}$

D. $-4.41 \times 10^{-17} J atom^{-1}$

Answer: D

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35. If an electron travels with a velocity of 1/100th speed of light in the first in the first Bohr orbit, what is its velocity (relative to the speed of light) in the 5th Bohr orbit ?

A. 0.002

B. 0.1

C. 0.5

D. 0.7

Answer: A

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36. In the hydrogen atom, the electrons are excited to the 5th energy level. The number of lines that may appear in the spectrum will be

A. 4

B. 8

C. 10

D. 12

Answer: C

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37. Which of the following is the energy of a possible excited state of hydrogen?

A. $-3.4eV$

B. $+6.8eV$

C. $+13.6eV$

D. $-6.8eV$

Answer: A

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38. Calculate the energy in joule corresponding to light of wavelength $45nm$:

(Planck' constant $h = 6.63 \times 10^{-34} Js$, speed of light $c = 3 \times 10^{8} ms^{-1}$)

A. 6.67×10^{15}

B. 6.67×10^{11}

C. 4.42×10^{-15}

D. 4.42×10^{-18}

Answer: D

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39. The radius of the second Bohr orbit for hydrogen atom is :

(Planck's constant, $h = 6.6262 \times 10^{-34} Js$, mass of electron = $9.1091 \times 10^{-31} kg$, charge of electron $e = 1.60210 \times 10^{-19} C$, permittivity of vaccum $\in_0 = 8.854185 \times 10^{-12} kg^{-1} m^{-3} A^2$)

A. $0.529 Å$

B. $2.12 Å$

C. $1.65 Å$

D. $4.76 Å$

Answer: B

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40. Schrodinger wave equation for a particle in a one-dimension box is

A. $\frac{\delta^2 \psi}{\delta x^2} + \frac{2m}{h}(E - \infty)\psi = 0$

B. $\frac{\delta^2 \psi}{\delta x^2} + \frac{8\pi^2 m}{h^2}(E - V)\psi = 0$

C. $\frac{\delta^2\psi}{\delta x^2}+\frac{2m}{h}(E-V)\psi=0$

D. $\frac{\delta^2\psi}{\delta x^2}+\frac{2\pi^2 m}{h^2}(E-\infty)=0$

Answer: B

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41. $\Psi^2=0$ represents

A. a node

B. an orbital

C. angular wave function

D. wave function

Answer: A

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42. The wavelength (in nanometer) associated with a proton moving at 1.0×10^{3} m/s is

A. 0.032 nm

B. 0.40 nm

C. 2.5 nm

D. 14.0 nm

Answer: B

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43. If the de-Broglie wavelength of a particle of mass m is 100 times its velocity then its value in terms of its mass (m) and Planck's constant (h) is

A. $\frac{1}{10}\sqrt{\frac{m}{h}}$

B. $10\sqrt{\frac{h}{m}}$

C. $\frac{1}{10}\sqrt{\frac{h}{m}}$

D. $10\sqrt{\frac{m}{h}}$

Answer: B

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44. how fast is an electron moving if it has a wavelength equal to the distance traveled in one second ?

A. $\sqrt{\frac{m}{h}}$

B. $\sqrt{\frac{h}{m}}$

C. $\sqrt{\frac{h}{p}}$

D. $\sqrt{\frac{h}{2(KE)}}$

Answer: B

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45. The radius of first Bohr orbit is x, then de-Broglie wavelength of electron in 3rd orbit is nearly

A. $\frac{x}{3}$

B. 9x

C. $2\pi x$

D. $6\pi x$

Answer: D

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46. The de Broglie wavelength associated with a ball of mass $1kg$ having kinetic enegry $0.5J$ is

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

B. $13.20 \times 10^{-34} m$

C. $10.38 \times 10^{-21} m$

D. 6.626×10^{-34}Å

Answer: A

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47. In an atom , an electron is moving with a speed of 600 m/s with an accuracy of 0.05% . The certainty with which the position of the electron can be located is (h = $6.6 \times 10^{-34} kgm^2 s^{-1}$, mass of electron , $e_m = 9.1 \times 10^{-31}$ kg):

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

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

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

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

Answer: C

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48. A stream of electrons from a heated filament was passed between two charged plates kept at a potential difference V esu. If c and m are charge and mass of an electron repectively, then the value of h/λ (where λ is wavelength associated with electron wave) is given by :

A. meV

B. $2meV$

C. $\sqrt{meV}$

D. $\sqrt{2meV}$

Answer: D

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49. Two electrons occupying the same orbital are distinguished by:

A. azimuthal quantum number

B. spin quantum number

C. principal quantum number

D. magnetic quantum number

Answer: B

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50. The total number of atomic orbitals in fourth energy level of an atom is.

A. 4

B. 8

C. 16

D. 32

Answer: C

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51. Maximum number of electrons in a sub-shell of an atom is determined by the following.

A. $2l+1$

B. $4l-2$

C. $2n^2$

D. $4l+2$

Answer: D

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52. Which set of quantum numbers is not possible ?

A. $\begin{array}{cccc} n & l & m & s \\ 3 & 2 & 0 & +1/2 \end{array}$

B. $\begin{array}{cccc} n & l & m & s \\ 2 & 2 & 1 & +1/2 \end{array}$

C. $\begin{array}{cccc} n & l & m & s \\ 1 & 0 & 0 & -1/2 \end{array}$

D. $\begin{array}{cccc} n & l & m & s \\ 3 & 2 & -2 & +1/2 \end{array}$

Answer: B

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53. For principal quantum number, n = 4, the toal number of orbitals having l = 3 is

A. 3

B. 7

C. 5

D. 9

Answer: B

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54. What is the maximum number of electrons that can be associated with a following set of quantum numbers ?

$(n = 3, l = 1 \text{ and } m = -1)$.

A. 10

B. 6

C. 4

D. 2

Answer: D

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55. How many delectrons can fit in the orbital for which n = 3 and l = 1?

A. 2

B. 6

C. 10

D. 14

Answer: A

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56. The following quantum numbers are possible for how many orbitals $(s)n = 3, l = 2, m = \ +2$?

A. 1

B. 2

C. 3

D. 4

Answer: A

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57. The orbital angular momentum of a p-electron is given as :

A. $\sqrt{\frac{3}{2}\frac{h}{\pi}}$

B. $\sqrt{6}\frac{h}{2\pi}$

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

D. $\sqrt{3}\frac{h}{2\pi}$

Answer: C

Watch Video Solution

58. What is the maximum number of orbitals that can be identified with the following quantum numbers ? $n = 3, l = 1, m_l = 0.$

A. 1

B. 2

C. 3

D. 4

Answer: A

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59. Which of the following orbitals will have zero probability of finding the electron in the yz plane ?

A. p_x

B. p_y

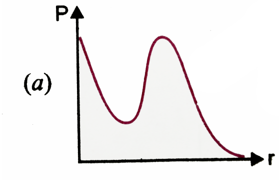
C. p_z

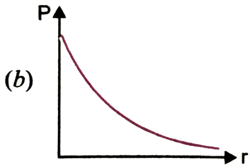
D. d_{yz}

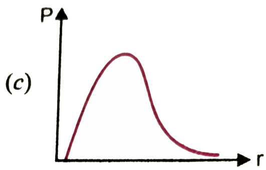
Answer: A

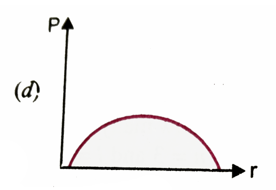
Watch Video Solution

60. P is the probability of finding the Is electron of hydrogen atom in a spherical shell of infitesimal thickness, dr, at a distance r from the nucleus. The volume of this shell is $4\pi r^2 dr$. The qualitative sketch of the dependence of P on r is

A. 

B. 

C. 

D. 

Answer: C

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61. The maximum probability of finding electron in the d_{xy} orbital is -

A. along the x-axis

B. along the y-axis

C. at an angle of 45° from the x-axis and y-axis

D. at an angle of 90° from the x-axis and y-axis

Answer: C

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62. Which of the following has zero electron density in xy plane ?

A. d_{z^2}

B. $d_{x^2-y^2}$

C. p_z

D. d_{xy}

Answer: C

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63. Which of the following pairs of d-orbitals will hare electron density along the axes ?

A. d_{z^2}, d_{xz}

B. d_{xz}, d_{yz}

C. $d_{z^2}, d_{x^2-y^2}$

D. $d_{xy}, d_{x^2-y^2}$

Answer: C

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64. What would be the IUPAC name for the element with atomic number 120 ?

A. Ununbium

B. Unnibium

C. Unnilunium

D. Unbinilium

Answer: D

Watch Video Solution

65. Arrabge in decreasing order, the energy of 2s orbital in the following atoms H, Li, Na, K

A. $E_{2s}(H) > E_{2s}(Li) > E_{2s}(Na) > E_{2s}(K)$

B. $E_{2s}(H) > E_{2s}(Na) > E_{2s}(Li) > E_{2s}(K)$

C. $E_{2s}(H) > E_{2s}(Na) = E_{2s}(K) > E_{2s}(Li)$

D. $E_{2s}(K) > E_{2s}(Na) > E_{2s}(Li) > E_{2s}(H)$

Answer: A

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66. The orbital diagram in which both the pauli's exclusion principal and Hund's rule are violated is :

A. 

B. 

C. 

D. 

Answer: A

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67. Which is the correct order of increasing energy of the listed orbitals in the atom of titanium ?

A. 3s 3p 3d 4s

B. 3s 3p 4s 3d

C. 3s 4s 3p 3d

D. 4s 3s 3p 3d

Answer: B

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68. If $n = 6$, the correct sequence for filling of electrons will be.

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

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

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

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

Answer: B

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69. The number of d-electrons in Fe^{2+} (Z=26) is not equal to the number of electrons in which one of the following ?

A. d-electrons in Fe (Z = 26)

B. p-electrons in Ne (Z = 10)

C. s-electrons in Mg (Z = 12)

D. p-electrons in Cl (Z = 17)

Answer: D

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70. The electronic, identified by quantum numbers n and l, (i) $n=4, l=1$, (ii) $n=4, l=0$, (iii) $n=3, l=2$, (iv) $n=3, l=1$ can be placed in order of increasing energy, from the lowest to highest, as

A. $(1) > (3) > (2) > (4)$

B. $(3) > (4) > (2) > (1)$

C. $(4) > (2) > (3) > (1)$

D. $(2) > (4) > (1) > (3)$

Answer: C

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71. What is the maximum number of electrons which can be accommodated in an atom in which the highest principal quantum number is 4 ?

A. 10

B. 18

C. 36

D. 54

Answer: C

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72. If $n = 3$, $l = 0$, and $m = 0$, then the atomic number is

A. 12, 13

B. 13, 14

C. 10, 11

D. 11, 12

Answer: D

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73. How many electron in an atom with atomic number 105 can have $(n + l) = 8$?

A. 15

B. 17

C. 19

D. 21

Answer: B

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74. According to $(n + l)$ rule after completing 'np' level the electron enters int

A. $(n + 1)p$

B. $(n + 1)s$

C. $(n - 1)d$

D. nd

Answer: B

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

A. 5, 1, 1, $+1/2$

B. 6, 0, 0, $+1/2$

C. 5, 0, 0, $+1/2$

D. 5, 1, 0, $+1/2$

Answer: C

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76. The set of quantum number for the 19^{th} electrons in chromium is -

A. 4, 0, 0, $\frac{1}{2}$

B. 4, 1, -1, $\frac{1}{2}$

C. 3, 2, 2, $\frac{1}{2}$

D. 3, 2, -2, $\frac{1}{2}$

Answer: A

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77. In Cu (At. no. = 29)

A. 13 electrons have spin in one direction and 16 electrons in other direction

B. 14 electrons have spin in one direction and 15 electrons in other direction

C. one electron can have spin only in the clockwise direction

D. none of the above is correct.

Answer: B

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78. In the Bohr's orbit, what is the ratio of total kinetic energy and total energy of the electron

A. -1

B. -2

C. $+1$

D. $+2$

Answer: A

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79. A proton is about 1840 times heavier than an electron. When it is accelerated by a potential difference of $1kV$. Its kinetic energy will be

A. 1840 keV

B. 1/1840 ke V

C. 1 keV

D. 920 keV

Answer: C

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80. Time taken by an electrons to complete one revolution in the Bohr orbit of the H atom is

A. $\dfrac{4\pi^2 mr^2}{nh}$

B. $\dfrac{nh}{4\pi^2 mr}$

C. $\dfrac{2\pi mr}{n^2h^2}$

D. $\dfrac{h}{2\pi mr}$

Answer: A

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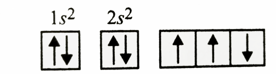
81. Which is a wrong statement ?

A. Total orbital angular momentum of electron in 's' orbital is equal to zero

B. An orbital is designated by three quantum numbers while an electron in an atom is designated by four quantum numbers

C. The electronic configuation of N atom is



D. The value of m for d_{z^2} is zero

Answer: C

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82. Which of the following has maximum spin ?

A. Electron

B. Proton

C. Neutron

D. All have equal spin

Answer: D

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83. A gas absorbs a photon of $355 nm$ and emits at two wavelengths . If one of the emission is at 680 nm , the other is at :

A. 325 nm

B. 743 nm

C. 518 nm

D. 1035 nm

Answer: B

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84. Frequency of the X-rays emitted by an element is $100 s^{-1}$. If constant in the Moseley equation are $a = b = 1$, the element will be

A. Na

B. K

C. Rb

D. Cs

Answer: A

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85. The ratio of specific charge of an electron to that of a hydrogen ion is

A. $1:1$

B. $2:1$

C. $1840:1$

D. $1:1840$

Answer: C

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86. If $E_1, E_2 \text{and} E_3$ represent respectively the kinetic energies of an electron , an alpha particle and a proton each having same de Broglie wavelength then :

A. $E_1 > E_2 > E_3$

B. $E_3 > E_2 > E_1$

C. $E_1 > E_3 > E_2$

D. $E_1 = E_2 = E_3$

Answer: C

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87. As electron moves away from the nucleus, its

A. K.E. decreases and P.E. increases

B. Both K.E. and P.E. decrease

C. Both K.E. and P.E. increase

D. K.E. increases but P.E. decreases.

Answer: A

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88. In Bohr's model of hydrogen atom, the period of revolution of an electron in the 1st orbit to that in the 2nd orbit are in the ratio

A. $1:2$

B. $2:1$

C. $1:4$

D. $1:8$

Answer: D

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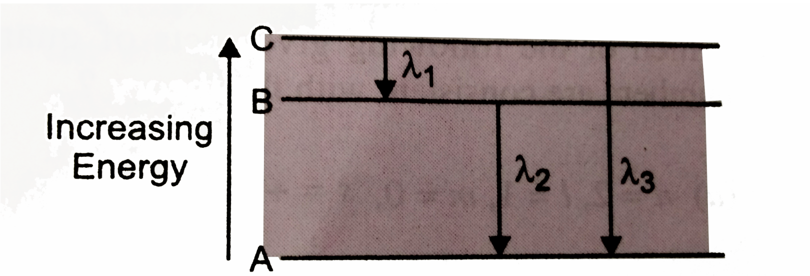
89. Three energy levels and the wavelengths of the lines produced by transitions are shown in the Fig. below



Which one of the following relationship is correct ?

A. $\lambda_3 = \lambda_1 + \lambda_2$

B. $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

C. $\lambda_3 = \dfrac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

D. $\lambda_1 + \lambda_2 + \lambda_3 = 0$

Answer: C

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90. The energy absorbed by each molecule (A_2) of a substance is $4.4 \times 10^{-19} J$ and bond energy per molecule is $4.0 \times 10^{-19} J$. The kinetic energy of the molecule per atom will be.

A. $2.2 \times 10^{-19} J$

B. $2.0 \times 10^{-19} J$

C. $4.0 \times 10^{-20} J$

D. $2.0 \times 10^{-20} J$

Answer: D

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91. The species Ar, K^{+} and Ca^{2+} contain the same number of electrons. In which order do their radii increase ?

A. $Ca^{2+} < K^{+} < Ar$

B. $K^{+} < Ar < Ca^{2+}$

C. $Ar < K^{+} < Ca^{2+}$

D. $Ca^{2+} < Ar < K^{+}$

Answer: A

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92. Which one is the wrong statement ?

A. de-Broglie's wavelength is given by $\lambda = \frac{h}{mv}$ where m is the mass of the particle, $v =$ groups velocity of the particle

B. The uncertainty principle is $\Delta E \times \Delta t \geq \frac{h}{4\pi}$

C. Half-filled and fully-filled orbitals have greater stability due to greater exchange energy, greater symmetry and more balanced arrangement

D. The energy of 2s orbitals is less than the energy of 2p orbital in case of hydrogen like atoms

Answer: D

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Competition Focus (JEE (Main and Advanced)/Medical Entrance (II. Multiple Choice Question)

1. Which of the following statement regarding spectral series is/are correct ?

A. The lines in the Balmer series correspond to the electronic transition from the energy levels higher than n = 1 energy level

B. Paschen series appear in the infrared region

C. The line of Lyman series appear in the visible region

D. Transition from higher energy levels to 5th energy level produces Pfund series which falls in the infrared region

Answer: B::D

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2. The orbitals which have same number of nodes are

A. 2s, 2p

B. 3p, 3d

C. 2s, 3p

D. 3s, 4d

Answer: A::B

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3. Select the pair of atoms having the same number of electrons in their outermost shell

A. Na, Ca

B. Mg, Fe

C. As, Bi

D. Pb, Sb

Answer: B::C

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4. Which of the following set of quantum numbers is not consistent with the theory ?

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

B. $n = 4, l = 3, m = 2, s = -\frac{1}{2}$

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

D. $n = 4, l = 3, m = 3, s = +\frac{1}{2}$

Answer: A::B::D

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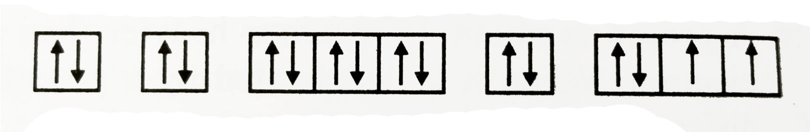
5. The diagram illustrates a possible electronic configuration of which of the following species



A. Cl^{+} ion

B. S atom

C. Ar^{2+} ion

D. P^{3-} ion

Answer: a,b,c

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6. The probability of finding the electron in the orbital is

A. zero at the nucleus

B. Maximum on two opposite sides of the nucleus along X-axis

C. Zero on Z-axis

D. same on all sides around the nucles.

Answer: A::B::C

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7. In the ground state, an element has 13 electrons in its M-shell. The element is

A. Manganese

B. Chromium

C. Nickel

D. Iron

Answer: A::B

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8. Which of the following statement are correct ?

A. The electronic configuration of Cr is $[Ar]3d^5 4s^1$ (Atomic No. of cr = 24)

B. The magnetic quantum number may have a negative value

C. In silver atom, 23 electrons a spin of one type and 24 of the opposite type (Atomic No. of Ag = 47)

D. The oxidation state of nitrogen in HN_3 is -3

Answer: A::B

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9. The energy of an electron in the first Bohr orbit of H atom is $-13.6eV$. The possible energy value (s) of the excited state (s) for electron in Bohr orbits of hydrogen is (are)

A. $-3.4eV$

B. $-4.2eV$

C. $-6.8eV$

D. $-1.5eV$

Answer: A::D

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Competition Focus (JEE (Main and Advanced)/Medical Entrance (III. Multiple Choice Question) (Based on Comprehension)

1. The enregy, radius and velocity of the electron in the hydrogen atom in the ground state are $-13.6eV$, 0.53Å and $2.188 \times 10^8 ms^{-1}$ respectively.

The energy of the electron in the third orbit will be

A. $-4.4eV$

B. $-1.5eV$

C. $-40.8eV$

D. $-22.4eV$

Answer: B

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2. The enregy, radius and velocity of the electron in the hydrogen atom in the ground state are $-13.6eV$, 0.53Å and $2.188 \times 10^8 ms^{-1}$ respectively. The radius of the third orbit of hydrogen atom will be

A. 1.59Å

B. 4.77Å

C. 3.0Å

D. $6.0 \AA$

Answer: B

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3. The enregy, radius and velocity of the electron in the hydrogen atom in the ground state are $-13.6 eV, 0.53 \AA$ and $2.188 \times 10^8 cms^{-1}$ respectively.

The velocity of the electron in the third orbit of hydrogen atom will be

A. $0.729 \times 10^8 cms^{-1}$

B. $6.564 \times 10^8 cms^{-1}$

C. $19.692 \times 10^8 cms^{-1}$

D. $0.243 \times 10^8 cms^{-1}$

Answer: A

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4. The enregy, radius and velocity of the electron in the hydrogen atom in the ground state are $-13.6eV$, 0.53Å and $2.188 \times 10^8 ms^{-1}$ respectively. If the electron absorbs $12.1eV$ of energy, it will jump to the orbit

A. 2nd

B. 3rd

C. 4th

D. 5th

Answer: B

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5. The enregy, radius and velocity of the electron in the hydrogen atom in the ground state are $-13.6eV$, 0.53Å and $2.188 \times 10^8 ms^{-1}$ respectively. In which orbit of He^+ the electron will have same velocity

A. 1st

B. 2nd

C. 4th

D. None

Answer: D

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6. The enregy, radius and velocity of the electron in the hydrogen atom in the ground state are $-13.6eV$, 0.53Å and $2.188 \times 10^8 ms^{-1}$ respectively. In which orbit of He^+ the electron will have same velocity

A. 1st

B. 2nd

C. 4h

D. none

Answer: B

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7. The enregy, radius and velocity of the electron in the hydrogen atom in the ground state are $-13.6eV$, 0.53Å and $2.188 \times 10^8 ms^{-1}$ respectively. Which shell of He^+ ion will have the same energy

A. 1st

B. 2nd

C. 3rd

D. 4th

Answer: B

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8. An electron in the hydrogen atom absorbs energy and jumps to the 4th orbit. It jumps back to the ground state in steps e.g., from 4th to 3rd orbit, then from 3rd to 2nd orbit and finally to the ground state etc.

Total number of lines obtained in the spectrum would be

A. 3

B. 6

C. 9

D. 12

Answer: B

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9. An electron in the hydrogen atom absorbs energy and jumps to the 4th orbit. It jumps back to the ground state in steps e.g., from 4th to 3rd orbit, then from 3rd to 2nd orbit and finally to the ground state etc.

If λ_1 is the wave length of line for jump of the electron from 4th to 3rd orbit and λ_2 that of the line for jump from 3rd to 2nd orbit, then wavelength of the line for jump from 4th orbit to 2nd orbit would be

A. $\lambda_1 + \lambda_2$

B. $\frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

C. $\frac{\lambda_1 \lambda_2}{\lambda_1 - \lambda_2}$

D. $\frac{\lambda_1 + \lambda_2}{\lambda_1 \lambda_2}$

Answer: D

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10. An electron in the hydrogen atom absorbs energy and jumps to the 4th orbit. It jumps back to the ground state in steps e.g., from 4th to 3rd orbit, then from 3rd to 2nd orbit and finally to the ground state etc.

If the ionization of the hydrogen atom in the ground state is $13.6eV$. The longest wavelength of the radiation required to remove the electron from Bohr's first orbit will be approximately

A. 612Å

B. 712Å

C. $812 Å$

D. $912 Å$

Answer: D

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11. An electron in the hydrogen atom absorbs energy and jumps to the 4th orbit. It jumps back to the ground state in steps e.g., from 4th to 3rd orbit, then from 3rd to 2nd orbit and finally to the ground state etc.

If a_0 represents Bohr radius, the de-Broglie wavelength of the electron when it moves in the 3rd orbit after absorbing same definite amount of energy will be

A. $a_0 / 3$

B. $9a_0$

C. $2\pi a_0$

D. $6\pi a_0$

Answer: D

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12. A physicist was performing experiments to study the effect of varying voltage on the velocity and wavelength of the electrons. In one case, the electron was accelerated through a potential difference of 1kV and in the second case, it was accelerated through a potential difference of 2kV

The velocity acquired by the electron will be

A. double in the second case than in the first case

B. four times in the second case than in the first case

C. same in both cases

D. 1.4 times in the second case than in the first case

Answer: D

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13. A physicist was performing experiments to study the effect of varying voltage on the velocity and wavelength of the electrons. In one case, the electron was accelerated through a potential difference of 1kV and in the second case, it was accelerated through a potential difference of 2kV The wavelength associated with the electron will be

A. double in the second case than in the first case

B. double in the first case than in the second case

C. 1.4 times in the second case than in the first case

D. 1.4 times in the first case than in the second case

Answer: D

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14. A physicist was performing experiments to study the effect of varying voltage on the velocity and wavelength of the electrons. In one case, the electron was accelerated through a potential difference of 1kV and in the second case, it was accelerated through a potential difference of 2kV

In order to have half the velocity in the second case than in the first case, the potential applied should be

A. 0.5 kV

B. 2kV

C. 0.25 kV

D. 0.75 kV

Answer: C

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15. The uncertainty in the position of a flying dust particle of mass 0.1 mg is found to be 10^{-4}m. The uncertainty in the position of another flying dust particle of mass 0.5 mg is also found to be same

The uncertainty in the velocity of the lighter dust particle is nearly

A. $5 \times 10^{-24} ms^{-1}$

B. $2.5 \times 10^{-24} ms^{-1}$

C. $1.25 \times 10^{-24} ms^{-1}$

D. $5 \times 10^{-25} ms^{-1}$

Answer: A

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16. The uncertainty in the position of a flying dust particle of mass 0.1 mg is found to be 10^{-4}m. The uncertainty in the position of another flying dust particle of mass 0.5 mg is also found to be same

The uncertainty in the velocity of the heavier dust particle as compared to the lighter dust particle is

A. 5 times

B. $\frac{1}{5} th$

C. same

D. 50 times

Answer: B

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17. The uncertainty in the position of a flying dust particle of mass 0.1 mg is found to be 10^{-4}m. The uncertainty in the position of another flying dust particle of mass 0.5 mg is also found to be same

If a third flying dust particle of mass 1 mg had the same uncertainty in position as in its velocity, the uncertainty in its momentum would be

A. $5.2 \times 10^{-28} kgms^{-1}$

B. $5.2 \times 10^{-34} kgms^{-1}$

C. $7.2 \times 10^{-15} kgms^{-1}$

D. $7.2 \times 10^{-21} kgms^{-1}$

Answer: D

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18. The hydrogen like species Li^{2+} is in a spherically symmetric state S_1 with one radial node. Upon absorbing light, the ion undergoes transition to a state S_2. The state S_2 has one radial node and its energy is equal to the ground state energy of the hydrogen atom

The state S_1 is

A. 1s

B. 2s

C. 2p

D. 3s, 4d

Answer: B

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19. The hydrogen like species Li^{2+} is in a spherically symmetric state S_1 with one radial node. Upon absorbing light, the ion undergoes transition to a state S_2. The state S_2 has one radial node and its energy is equal to the ground state energy of the hydrogen atom

Energy of the state S_1 in units of the hydrogen atom ground state energy is

A. 0.75

B. 1.50

C. 2.25

D. 4.50

Answer: C

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20. The hydrogen like species Li^{2+} is in a spherically symmetric state S_1 with one radial node. Upon absorbing light, the ion undergoes transition to a state S_2. The state S_2 has one radial node and its energy is equal to the ground state energy of the hydrogen atom

The orbital angular momentum quantum number of the state S_2 is

A. 0

B. 1

C. 2

D. 3

Answer: B

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Competition Focus (JEE (Main and Advanced)/Medical Entrance (IV. Matching type Questions)

1. Match the entries in column I with appropriate entries of column II and choose the correct option out of the four options (a), (b), (c), (d) given at the end of each question

	Column I		Column II
(A)	Lymn series	(p)	Visible region
(B)	Paschen series	(q)	Ultraviolet region
(C)	Pfund series	(r)	Far infrared region
(D)	Humphrey series	(s)	Infrared region

A. $A - s, B - r, C - q, D - p$

B. $A - q, B - p, C - s, D - r$

C. $A - p, B - q, C - r, D - s$

D. $A - r, B - s, C - p, D - q$

Answer: B

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2.

Column I		Column II
Light has dual character	(p)	de Broglie
Electrons have dual character	(q)	Einstein
N has electronic configuration $1s^2\, 2s^2\, 2p_x^1\, 2p_y^1\, 2p_z^1$ and not $1s^2\, 2s^2\, 2p_x^2\, 2p_y^2$	(r)	Aufbau
(D) 4s orbital is filled first than 3d	(s)	Hunds
(E) Basis of Quantum mechanics	(t)	Schrodinger

A. $A - q, B - p, C - s, D - r, E - t$

B. $A - p, B - q, C - r, D - s, E - t$

C. $A - t, B - s, C - r, D - q, E - p$

D. $A - r, B - s, C - t, D - p, E - q$

Answer: A

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3.

Column I (orbital)		Column II (Radial nodes)	
(A)	$3p$	(p)	0
(B)	$5d$	(q)	1
(C)	$4f$	(r)	2
(D)	$4s$	(s)	3

(a) A-r, B-q, C-s, D-p
(b) A-p, B-q, C-r, D-s
(c) A-r, B-s, C-p, D-q
(d) A-q, B-r, C-p, D-s

A. $A - r, B - q, C - s, D - p$

B. $A - p, B - q, C - r, D - s$

C. $A - r, B - s, C - p, D - q$

D. $A - q, B - r, C - p, D - s$

Answer: D

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4. According to Bohr's Theory

E_n = total energy, K_n = kinetic energy, V_n= potential energy, r_n = radius of nth orbit

Match that following:

	Column I		Column II
(A)	$V_n/K_n = ?$	(p)	0
(B)	$r_n \propto E_n^x, x = ?$	(q)	-1
(C)	Angular momentum in lowest orbital	(r)	-2
(D)	$\frac{1}{r_n} \propto Z^y, y = ?$	(s)	1

A. $A - p, B - q, C - r, D - s$

B. $A - r, B - q, C - p, D - s$

C. $A - q, B - p, C - s, D - r$

D. $A - s, B - r, C - q, D - p$

Answer: B

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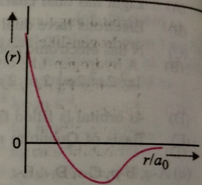
Competition Focus (JEE (Main and Advanced)/Medical Entrance (V. Matching type Questions)

1. The wave function, Ψ_{n,l,m_1} is a mathematical function whose value depends upon spherical polar coordinates (r, θ, ϕ) of the electron and characterized by the quantum numbers n, l, and m_1. Here, r is the distance from the nucleus, θ is colatitude and ϕ is azimuth. In the mathematical functions given in the Table, Z is atomic number and a_0 is Bohr radius

Column 1	Column 2	Column 3
(I) 1s orbital	(i) $\Psi_{n,l,m_l} \propto \left(\frac{Z}{a_0}\right)^{3/2} e^{-\left(\frac{Zr}{a_0}\right)}$	(P) $\Psi_{n,l,m_l}(r)$ 
(II) 2s orbital	(ii) One radial node	(Q) Probability density at nucleus $\propto \frac{1}{a_0^3}$
(III) $2p_z$ orbital	(iii) $\Psi_{n,l,m_l} \propto \left(\frac{Z}{a_0}\right)^{5/2} re^{-\left(\frac{Zr}{2a_0}\right)} \cos\theta$	(R) Probability density is maximum at nucleus
(IV) $3d_z^2$ orbital	(iv) xy-plane is a nodal plane	(S) Energy needed to excite electron from $n = 2$ state to $n = 4$ state is $\frac{27}{32}$ times the energy needed to excite electron from $n = 2$ state to $n = 6$ state

For He^+ ion, the only INCORRECT combination is

A. (I) (i) (S)

B. (II) (ii) (Q)

C. (I) (iii) (R)

D. (I) (i) (R)

Answer: C

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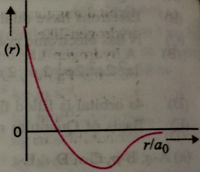
2. The wave function, Ψ_{n,l,m_1} is a mathematical function whose value depends upon spherical polar coordinates (r, θ, ϕ) of the electron and characterized by the quantum numbers n, l, and m_1. Here, r is the distance from the nucleus, θ is colatitude and ϕ is azimuth. In the mathematical functions given in the Table, Z is atomic number and a_0 is Bohr radius

Column 1	Column 2	Column 3
(I) 1s orbital	(i) $\Psi_{n,l,m_l} \propto \left(\frac{Z}{a_0}\right)^{3/2} e^{-\left(\frac{Zr}{a_0}\right)}$	(P) $\Psi_{n,l,m_l}(r)$ 
(II) 2s orbital	(ii) One radial node	(Q) Probability density at nucleus $\propto \frac{1}{a_0^3}$
(III) $2p_z$ orbital	(iii) $\Psi_{n,l,m_l} \propto \left(\frac{Z}{a_0}\right)^{5/2} re^{-\left(\frac{Zr}{2a_0}\right)} \cos\theta$	(R) Probability density is maximum at nucleus
(IV) $3d_z^2$ orbital	(iv) xy-plane is a nodal plane	(S) Energy needed to excite electron from $n = 2$ state to $n = 4$ state is $\frac{27}{32}$ times the energy needed to excite electron from $n = 2$ state to $n = 6$ state

For the given orbital in column 1, the only CORRECT combination for any hydrogen -like species is

A. (II) (ii) (P)

B. (I) (ii) (S)

C. (IV) (iv) (R)

D. (III) (iii) (P)

Answer: A

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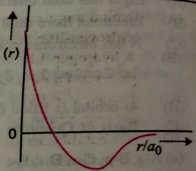
3. The wave function, Ψ_{n,l,m_1} is a mathematical function whose value depends upon spherical polar coordinates (r, θ, ϕ) of the electron and characterized by the quantum numbers n, l, and m_1. Here, r is the distance from the nucleus, θ is colatitude and ϕ is azimuth. In the mathematical functions given in the Table, Z is atomic number and a_0 is Bohr radius

Column 1	Column 2	Column 3
(I) 1s orbital	(i) $\Psi_{n,l,m_l} \propto \left(\frac{Z}{a_0}\right)^{3/2} e^{-\left(\frac{Zr}{a_0}\right)}$	(P) $\Psi_{n,l,m_l}(r)$ 
(II) 2s orbital	(ii) One radial node	(Q) Probability density at nucleus $\propto \frac{1}{a_0^3}$
(III) $2p_z$ orbital	(iii) $\Psi_{n,l,m_l} \propto \left(\frac{Z}{a_0}\right)^{5/2} re^{-\left(\frac{Zr}{2a_0}\right)} \cos\theta$	(R) Probability density is maximum at nucleus
(IV) $3d_z^2$ orbital	(iv) xy-plane is a nodal plane	(S) Energy needed to excite electron from $n = 2$ state to $n = 4$ state is $\frac{27}{32}$ times the energy needed to excite electron from $n = 2$ state to $n = 6$ state

For hydrogen atom, the only CORRECT combination is

A. (I) (i) (P)

B. (I) (iv) (R)

C. (II) (i) (Q)

D. (I) (i) (S)

Answer: D

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Competition Focus (JEE (Main and Advanced)/Medical Entrance (VI. Matrix-Match Type Questions)

1.

	Column I (Electronic configuration)		Column II (Atom/Ion)
(A)	[Ar] $3d^8 4s^2$	(p)	Cu^{2+}
(B)	[Ar] $3d^{10}$	(q)	Zn^{2+}
(C)	[Ar] $3d^1$	(r)	Ti(III)
(D)	[Ar] $3d^9$	(s)	Cu^+
		(t)	Ni

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2. Match the entries in Column I with the correctly related quantum number(s) in Column II. Indicate your answer by darkening the appropriates bubbles of the 4×4 matrix given in the ORS

Column I	Column II
(A) Orbital angular momentum of the electron in a hydrogen-like atomic orbital	(p) Principal quantum number
(B) A hydrogen-like one-electron wave function obeying Pauli principle	(q) Azimuthal quantum number
(C) Shape, size and orientation of hydrogen-like atomic orbitals	(r) Magnetic quantum number
(D) Probability density of electron at the nucleus in hydrogen-like atom	(s) Electron spin quantum number

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Competition Focus (JEE (Main and Advanced)/Medical Entrance (VII. Integer Type Questions)

1. The inner shell to which the electrons jump from the outer shells in the formation of Pfund series in the hydrogen spectrum is

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2. Number of times radius of the 3rd shell of the H-atom as compared to that of radius of first shell is

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3. How many times is the velocity of the electron in the first shell of He^{+} ion as compared to that in the first shell of hydrogen atom ?

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4. Total number of nodes (planar and spherical) present in the 5f-orbital is

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5. How many times is the distance of maximum probability of 2p electron from the nucleus as compared to Bohr radius ?

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6. How many times is the ionization energy of He^{+} ion as compared to that of H-atom?

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7. The work function (ϕ) of some metals is listed below . The number of metals which will show photoelectric effect when light of 300 nm wavelength falls on the metal is :

Metal	Li	Na	K	Mg	Cu	Ag	Fe	Pt	W
ϕ (eV)	2.4	2.3	2.2	3.7	4.8	4.3	4.7	6.3	4.75

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8. The maximum number of electrons that can have principal quantum number, n = 3, and spin quantum number m_s = - 1 /2, is

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9. The atomic masses of He and Ne are 4 and 20 amu respectively . The value of the de Broglie wavelength of He gas at $-73.^\circ C$ is "M" times that of the de Broglie wavelength of Ne at $727.^\circ C.$ M is

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10. In an atom, the total number of electrons having quantum numbers $n = 4, |m_l| = 1$ and $m_s = -\frac{1}{2}$ is

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11. Not considering the electronic spin, the degenracy of the second excited state of H^- is

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Competition Focus (JEE (Main and Advanced)/Medical Entrance (VIII. Numerical Value Type Question)

1. The atomic spectrum of hydrogen is found to contain a series of lines of wavelengths 656.46, 486.27, 434.17 and 410.29 nm. The wavelength (in nm) of the next line in the series will be....

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Competition Focus (JEE (Main and Advanced)/Medical Entrance (IX. Assertion And Reason Type Questions (Type I))

1. Statement-I : 2p orbitals do not have spherical nodes.

Because

Statement-II : The number of spherical nodes in p-orbitals is given by $(n-2)$

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement-1 is True, Statement-2 is True, Statement-2 is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: A

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2. Assertion (A) : Fe^{3+} (g) ion is more stable than $Fe^{2+}(g)$ ion.

Reason (R) : Fe^{3+} ion has more number of unpaired electrons than Fe^{2+} ion.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-2

B. Statement-1 is True, Statement-2 is True, Statement-2 is NOT a correct explanation for Statement-2

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: B

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3. Statement-1. The opposite lobes of a p-orbital have opposite sign whereas opposite lobes of d-orbital have the same sign

Statement-2 The opposite lobes of a p-orbital have opposite charge whereas opposite of lobes of d-orbital have the same charge

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement-1 is True, Statement-2 is True, Statement-2 is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: C

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4. Statement-1. The radii of corresponding orbitals in all H-like particles are equal

Statement-2 All H-like particles contain only one electron.

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

B. Statement-1 is True, Statement-2 is True, Statement-2 is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: D

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5. Statement-1. The number of radial nodes in 3s and 4p orbitals is not equal.

Statement-2 The number of radial nodes in any orbital depends upon the values of 'n' and 'l' which are different for 3s and 4p orbitals

A. Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-5

B. Statement-1 is True, Statement-2 is True, Statement-2 is NOT a correct explanation for Statement-2

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: D

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Competition Focus (JEE (Main and Advanced)/Medical Entrance (IX. Assertion And Reason Type Questions (Type II))

1. Assertion. Cathode rays originate from the cathode and move towards andoe.

Reason. Electrons present in the material of the cathode are continuously emitted on applying high voltage

A. If both assertion and reason are true, and reason is the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: D

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2. Assertion. According to Thomson model of atom, mass of the atom is concentrated in the centre of the atom.

Reason. According to Thomson model, positive charge is concentrated in the centre of the atom

A. If both assertion and reason are true, and reason is the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: D

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3. Assertion(A): All isotopes of a given element show the same type of chemical behaviour.

Reason(R) The chemical properties of an atom are controlled by the numb er of electron s in the atom.

A. If both assertion and reason are true, and reason is the true explanation of the arrertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertional

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: A

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4. Assertion (A) : Hydrogen has only one electron in its 1s orbital but it produces several spectral lines.

Reason (R) : There are many excited energy levels available in H atoms.

A. If both assertion and reason are true, and reason is the true explanation of the arrertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertional

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: A

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5. Assertion. In Lyman series of H-spectra, the maximum wavelength of lines is 121.56 nm

Reason. Wavelength is maximum when the transition is from the very next level

A. If both assertion and reason are true, and reason is the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: A

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6. Assertion. The plots of probability density and radial probability function versus distance r from the nucleus for any particular orbital are not identical

Reason. Probability density is Ψ^2 whereas radial probability function represents probability of finding the electron in a shell of thickness dr.

A. If both assertion and reason are true, and reason is the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: A

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7. Assertion (A) : A spectral line will be seen for $2p_x$-$2p_y$ transition

Reason (R) : Energy is raleased in the form of wave of light when the electron drops from $2p_x$, to $2p_y$ orbital.

A. If both assertion and reason are true, and reason is the true explanation of the arrertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertional

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: D

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8. Assertion : The energy of an electron is mainly determined by principal quantum number.

Reason : The principal quantum number is the measure of the most probable distance of finding the electron around the nucleus.

A. If both assertion and reason are true, and reason is the true explanation of the arrertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertional

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: A

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9. Assertion. Electronic configurations of Cr^{3+} (containing 21 electrons) is same as that of $Sc(Z = 21)$, i.e., isoelectronic species have the same electronic configuration

Reason. Orbitals of atoms as well as ions are filled in order of increasing energy following aufbau principle

A. If both assertion and reason are true, and reason is the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: D

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10. STATEMENT-1 : The 19^{th} electron in potassium atom enters into 4s-orbital than in 3d-orbital.

and

STATEMENT-2 : $(n + 1l)$ rule is followed for determining the orbital of lowest energy state.

A. If both assertion and reason are true, and reason is the true explanation of the arrertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertional

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: A

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11. Assertion. Only principal quantum number determines the energy of an electron in an orbital of Na atom.

Reason. For one electron system, the expression of energy is quite different from that obtained in Bohr's theory.

A. If both assertion and reason are true, and reason is the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: D

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12. The free gaseous Cr atom has six unpaired electrons.

Half-filled s-orbital has greater stability.

A. If both assertion and reason are true, and reason is the true explanation of the arrertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertional

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: C

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