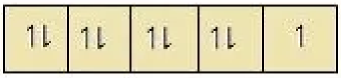
Structure of Atom

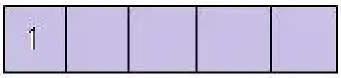
Question 1.
Which of the following pair of ions have same paramagnetic moment?
(a) Cu^{+2}, Ti^{+3}
(b) Mn^{+2}, Cu^{+2}
(c) Ti^{+4}, Cu^{+2}
(d) Ti^{+3}, Ni^{+2}

▼ Answer

Answer: (a) Cu^{+2}, Ti^{+3}
Explanation:
$_{29}Cu$ = [Ar] $3d^{10}$ $4s_1$
Cu^{2+} = [Ar] $3d^9$ (n = 1)



$_{22}Ti$ = [Ar] $3d^2$ $4s^2$
Ti^{3+} = [Ar] $3d^2$ (n = 1)



Both of these ions have one unpaired electron, hence these have same paramagnetic moment.

Question 2.
The charge to mass ratio of α – particles is approximately …… the charge to mass ratio of protons
(a) Twice
(b) Half
(c) Four times
(d) Six times

▼ Answer

Answer: (b) Half
Explanation:
Let charge of proton be +e, then charge of alpha particle will be + 2e. Similarly let mass of proton be m, then mass of alpha particle will be 4m.
Now, specific charge = (charge) / (mass of the substance.)
For proton, specific charge = (e/m)
For alpha particle, specific charge = (2e)/ (4m)
Therefore there ratio is: (e/m) × (4m)/ (2e) = 2 : 1

Question 3.
The frequency of a wave of light is $12 \times 10^{14} s^{-1}$. The wave number associated with this light
(a) $5 \times 10^{-7} m$
(b) $4 \times 10^{-8} cm^{-1}$
(c) $2 \times 10^{-7} m^{-1}$
(d) $4 \times 10^{4} cm^{-1}$

▼ Answer

Answer: (d) 4×10^{4} cm^{-1}
Explanation:

Frequency $v = 12 \times 10^{14} s^{-1}$ and
velocity of light $c = 3 \times 10^{10}$ cms^{-1}.
We know that the wave number $v^{-} = (v/c)$
$= (12 \times 10^{14})/(3 \times 10^{10})$
$= 4 \times 10^{4}$ cm^{-1}

Question 4.
In a multi – electron atom, which of the following orbitals described by the three quantum numbers will have the same energy in the absence of magnetic acid and electric fields? (a) n = 1, l = 0, m = 0 (b) n = 2, l = 0, m = 0 (c) n = 2, l = 1, m = 1 (d) n = 3, l = 2, m = 1 (e) n = 3, l = 2, m = 0
(a) (a) and (b)
(b) (b) and (c)
(c) (c) and (d)
(d) (d) and (e)

▼ Answer

Answer: (d) (d) and (e)
Explanation:
In the absence of magnetic and electric fields, the orbitals defined by magnetic quantum number are degenerate (of same energy). So, energy of the orbital, in the absence of magnetic and electric fields depends on the (n + l) value.
Higher the (n + l) value, larger the energy of the orbital.
Orbitals with same n and n + 1 values are degenerate and have same energy.
In the given combinations, d and e have same n and n + l value and so, have same energy in the absence of magnetic and electric fields.

Question 5.
The electronic transitions from n = 2 to n = 1 will produce shortest wavelength in (where n = principal quantum state)
(a) Li^{2+}
(b) He^{+}
(c) H
(d) H^{+}

▼ Answer

Answer: (a) Li^{2+}
Explanation:
$(1/\lambda) = Z^2R_H [(1/n_1^2) - (1/n_2^2)]$, $n_1 = 1$, $n_2 = 2$
Therefore, $(1/ \lambda) = Z^2R_H [(1/1) - (1/4)]$
$= (3/4) Z^2R_H$
$\lambda \propto (1/Z)^2$
Therefore, Li^{2+} will produce shortest wave length.

Question 6.
In a hydrogen atom, if energy of an electron in ground state is 13.6 eV, then that in the 2nd excited state is
(a) 1.51 eV
(b) 3.4 eV
(c) 6.04 eV
(d) 13.6 eV

▼ Answer

Answer: (a) 1.51 eV
Explanation:
$E_n = (13.6)/(n^2)$ eV
or E = (13.6)/(9)eV
= 1.51 eV

Question 7.
The credit of discovering neutron goes to
(a) Rutherford
(b) Thomson
(c) Goldstein
(d) Chadwick

▼ Answer

Answer: (d) Chadwick
Explanation:
The essential nature of the atomic nucleus was established with the discovery of the neutron by James Chadwick in 1932 and the determination that it was a new elementary particle, distinct from the proton.

Question 8.
The maximum number of electrons that can be accommodated in fifth energy level is
(a) 10
(b) 25
(c) 50
(d) 32

▼ Answer

Answer: (c) 50
Explanation:
The maximum number of electrons that can occupy a given energy level n is given by
max. no. of electrons = $2n^2$
So the number of orbitals that are present in an energy level n is given by
of orbitals = n^2
Also a given orbital can hold a maximum of 2 electrons, which is why the maximum number of electrons that can be added to a given energy level n is twice the number of orbitals present on said energy level.
According to given,
n = 5, it refers to the fifth energy level, holds
of orbitals = 5^2
of orbitals = 25
This means that the maximum number of electrons that can be added to the fifth energy level is
max no. of electrons = 2 × 25
= 50 electrons

Question 9.
According to Aufbaus principle, which of the three 4d, 5p and 5s will be filled with electrons first
(a) 4d
(b) 5p
(c) 5s
(d) 4d and 5s will be filled simultaneously

▼ Answer

Answer: (c) 5s
Explanation:
According to the Aufbaus principle, electron will be first enters in those orbital which have least energy. So decreasing order of energy is 5p > 4d > 5s.

Question 10.
A hydrogen atom in its ground state absorbs 10.2 eV of energy. The orbital angular momentum is increased by (Given Planck constant h = 6.6×10^{-34} Jsec)
(a) 1.05×10^{-34} Jsec
(b) 3.16×10^{-34} Jsec
(c) 2.11×10^{-34} Jsec
(d) 4.22×10^{-34} Jsec

▼ Answer

Answer: (a) 1.05×10^{-34} Jsec
Explanation:
Electron after absorbing 10.2 eV energy goes to its first excited state (n = 2) from ground state (n = 1).
Therefore, Increase in momentum = (h)/(2π)
= $(6.6 \times 10^{-34})/ (6.28)$
= 1.05×10^{-34} Js.

Question 11.
The ionization enthalpy of hydrogen atom is 1.312×10^{6} J mol^{-1}. The energy required to excite the electron in the atom from n = 1 to n = 2 is
(a) 8.51×10^{5} $Jmol^{-1}$
(b) 6.56×10^{5} $Jmol^{-1}$
(c) 7.56×10^{5} $Jmol^{-1}$
(d) 9.84×10^{5} $Jmol^{-1/sup>}$

▼ Answer

Answer: (d) 9.84×10^{5}J mol^{-1}
Explanation:
Energy required when an electron makes transition from n = 1 to n = 2
$E_2 = -(1.312 \times 10^{6} \times (1)^2)/(2^2)$
$= -3.28 \times 10^{5}$J mol^{-1}
$E_1 = -1.312 \times 10^{6}$J mol^{-1}
$\Delta E = E_2 - E_1$
$= -3.28 \times 10^{5} - (-13.2 \times 10^{6})$
$\Delta E = 9.84 \times 10^{5}$J mol^{-1}

Question 12.
For principal quantum number n = 4, the total number of orbitals having l = 3 is
(a) 3
(b) 7
(c) 5
(d) 9

▼ Answer

Answer: (b) 7
Explanation:
For n = 4 and l = 3, the orbital is 4f.
Number of values of m= no. of orbitals= (2l + 1) = 7.

Question 13.
Maximum number of electrons in a subshell with l = 3 and n = 4 is
(a) 10
(b) 12
(c) 14
(d) 16

▼ Answer

Answer: (c) 14
Explanation:
n = 4, so 4th shell and l = 3 so it is f subshell.
Thus n = 4, l = 3 indicates 4f orbitals.
In f subshell there are 7 orbitals and each orbital can accommodate a maximum of 2 electrons. So, maximum no. of electrons in 4f subshell = 7 × 2 = 14.

Question 14.
Which hydrogen-like species will have same radius as that of Bohr orbit of hydrogen atom?
(a) n = 2, Li^{2+}
(b) n = 2, Be^{3+}
(c) n = 2, He^{+}
(d) n = 3, Li^{2+}

▼ Answer

Answer: (b) n = 2, Be^{3+}
Explanation:
$r = (r_0) \times (n^2/Z)$ Å
whereas,
r_0 = radius of 1st Bohrs orbit of hydrogen atom = 0.529 Å
For $r = r_0^-$
$(n^2/Z) = 1$
$n^2 = Z$ (1)
Because for n = 2 , Be^{+3}
Z = 4, which satisfies equation (1).
Hence, n = 2,Be^{+3} will have the same radius of 1 st Bohrs orbit of a hydrogen atom.

Question 15.
The magnetic quantum number specifies
(a) Size of orbitals
(b) Shape of orbitals
(c) Orientation of orbitals
(d) Nuclear Stability

▼ Answer

Answer: (c) Orientation of orbitals
Explanation:
The magnetic quantum number specifies orientation of orbitals.

Question 16.
In Bohr series of lines of hydrogen spectrum, the third line from the red end corresponds to which one of the following inner-orbit jumps of the electron for Bohr orbits in an atom of hydrogen?
(a) $3 \rightarrow 2$
(b) $5 \rightarrow 2$
(c) $4 \rightarrow 1$
(d) $2 \rightarrow 5$

▼ Answer

Answer: (b) $5 \rightarrow 2$
Explanation:
Since the line in hydrogen spectrum lies within visible region that is at red end, therefore it is corresponds to the Balmer series.
The line at the red end suggests that
The first line of Balmer series is n = 3 to n =2
The second line of Balmer series is n = 4 to n = 2
The third line of Balmer series is n = 5 to n = 2

Question 17.
In chromium atom, in ground state, the number of occupied orbitals is
(a) 14
(b) 15
(c) 7
(d) 12

▼ Answer

Answer: (b) 15
Explanation:
The configuration of
$_{24}Cr$ is $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$
Therefore, total s-orbitals = 4
total p-orbitals = 6
total d-orbitals = 5 and thus
Thus, total orbitals = 4 + 6 + 5 = 15.

Question 18.
A sub-shell with n = 6 , l = 2 can accommodate a maximum of
(a) 12 electrons
(b) 36 electrons
(c) 10 electrons
(d) 72 electrons

▼ Answer

Answer: (c) 10 electrons
Explanation:
n = 6, ℓ = 2 means 6d $\rightarrow$ will have 5 orbitals.
Therefore max 10 electrons can be accommodated as each orbital can have maximum of 2 electrons.

Question 19.
Which of the following sets of quantum numbers represents the highest energy of an atom?
(a) n = 3, l = 0, m = 0, s = +1/2
(b) n = 3, l = 1, m = 1, s = +1/2

(c) n = 3, l = 2, m = 1, s = +1/2
(d) n = 4, l = 0, m = 0, s = +1/2

▼ Answer

Answer: (c) n = 3, l = 2, m = 1, s = + 1/2
Explanation:
n = 3, l = 0 represents 3s orbital n = 3, l = 1 represents 3p orbital n = 3, l = 2 represents 3d orbital n = 4, l = 0 represents 4s orbital The order of increasing energy of the orbitals is 3s < 3p < 4s < 3d.

Question 20.
The value of Plancks constant is 6.63×10^{-34}Js. The velocity of light is $3.0 \times 10^{8}ms^{-1}$. Which value is closest to the wavelength in nanometres of a quantum of light with frequency of $8 \times 10^{15}s^{-1}$
(a) 3×10^{7}
(b) 2×10^{-25}
(c) 5×10^{-18}
(d) 4×10^{1}

▼ Answer

Answer: (d) 4×10^{1}
Explanation:
$\lambda = (c/v) = (3 \times 10^{8})/(8 \times 10^{15})$
$= 3.75 \times 10^{-8}$
$= 3.75 \times 10^{-8} \times 10^{9}$ nm
$= 4 \times 10^{1}$ nm.
