CHEMISTRY

BOOKS - CENGAGE CHEMISTRY

ATOMIC STRUCTURE

Mandatory Exercise Exercise Set I

1. The particles present in the nucleus of an atom are

A. the proton and the electron

B. the electron and the neutron

C. neutrons and positrons

D. the proton and the neutron

Answer: D

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2. When the atoms of the gold foil are bombarded by a beam of a particles, only a few α-particles get deflected, whereas most of them go straight, undeflected. This is because

A. the force of attraction on a particles by the oppositely charged electron is not sufficient.

B. the positively charged nucleus occupies much smaller volume as compared with the volume of the atom which deffects only a few α-particles.

C. the force of repulsion on fast moving α-particles is very small.

D. the neutrons in the nucleus do not have any effect on α-particles.

Answer: B

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Mandatory Exercise Exercise Set Ii

1. Write the names of particles represented by the following symbols:

$_{-1}^{0}e$

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2. Give the names and symbols of the following elements:

An element with atomic number 6

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3. Give the names and symbols of the following elements:

An element with 18 protons in the nuclei of its atoms

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4. Give the names and symbols of the following elements:

An element with 23 electrons in its atoms.

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5. Give the number of the fundamental particles in the following atoms:

$^{13}_{15}P$

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6. Give the number of the fundamental particles in the following atoms:

$^{64}_{30}Zn$

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7. Give the number of the fundamental particles in the following atoms:

$^{9}_{4}Be$

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8. Give the number of the fundamental particles in the following atoms:

$^{206}_{82}Pb$

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9. A neutral atom of an element contains 17 electrons. Its nucleus has 20 neutrons. Its mass number is

A. 17

B. 20

C. 37

D. 3

Answer: C

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10. The size of the nucleus is approximately

A. 1/100th of the atom

B. 1/1000th of the atom

C. 1/10,000th of the atom

D. 1/1,00,000th of the atom

Answer: D

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11. e/m ratio is highest for

A. electron

B. Proton

C. neutron

D. He^{2+}

Answer: A

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12. Increasing order for the value of charge/mass is

A. e, p, n, α

B. n, p, e, α

C. n, p, α, e

D. n, α, p, e

Answer: D

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13. Which one of the following pair represents isobars?

A. ${}_2He^3$ and ${}_2He^4$

B. ${}_{12}Mg^{24}$ and ${}_{12}K^{25}$

C. ${}_{19}K^{40}$ and ${}_{19}K^{39}$

D. ${}_{19}K^{40}$ and ${}_{18}Ar^{40}$

Answer: D

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14. An isotone of $^{76}_{32}Ge$ is -

A. $^{77}_{32}Ge$

B. $^{87}_{33}As$

C. $^{77}_{34}Se$

D. $^{78}_{34}Se$

Answer: D

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15. Which of the following are isoelectronic?

A. Na^+ and Ne

B. K^+ and O

C. Ne and O

D. Na^+ and K^+

Answer: A

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16. Consider the following pairs of ions:

(1) Sc^{3+} and Ti^{4+}

(2) Mn^{2+} and Fe^{2+}

(3) Fe^{2+} and Co^{3+}

(4) Cu^{+} and Zn^{2+}

Among these pairs of ions, isoelectronic pairs would include:

A. 2, 3 and 4

B. 1, 3 and 4

C. 1, 2 and 4

D. 1, 2 and 3

Answer: B

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17. Which of the following salt has isoelectronic cation and anion?

A. KF

B. NaCl

C. $SrCl_2$

D. MgF_2

Answer: D

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18. How many unpaired electrons are present in Ni^{2+}?

A. 0

B. 2

C. 4

D. 8

Answer: B

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19. Which of the following has minimum number of unpaired d-electrons?

A. Fe^{3+}

B. Mn^{2+}

C. Co^{2+}

D. Co^{3+}

Answer: C

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20. Hund's rule is applicable for:

A. $3p_x, 3p_y, 3p_z$

B. 3s, 3p, 3d

C. 6s, 5p, 4d

D. All of the above

Answer: A

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21. Which quantum number determines the shape of the orbital?

A. Principal

B. Azimuthal

C. Magnetic

D. Spin

Answer: B

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22. Magnetic quantum number specifies:

A. Size of orbitals

B. Shape of orbitals

C. Orientation of orbitals

D. Nuclear stability

Answer: C

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23. The correct set of n, l, m, quantum numbers for the unpaired electron of chlorine atom is:

A. 2,1,0

B. 2,1,1

C. 3,1, 1

D. 3,0,0

Answer: C

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24. In a quantum level the energies of the orbitals will be in the order:

A. $s = p > d > f$

B. $s > p > d > f$

C. $s < p < d < f$

D. None of these

Answer: C

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25. The set of quantum numbers for the 19th electron in chromium is:

A.

$$n = 4, l = 0, m = 0, s = +1/2 \text{ or } -1/2$$

B.

$$n = 3, l = 2, m = 1, s = +1/2 \text{ or } -1/2$$

C.

$$n = 3, l = 2, m = -1, s = +1/2 \text{ or } -1/2$$

D.

$$n = 4, l = 1, m = 0, s = +1/2 \text{ or } -1/2$$

Answer: A

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26. If elements with principal quantum number $n > 4$ is not allowed in nature, the number of possible elements would be:

A. 60

B. 32

C. 64

D. 50

Answer: A

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27. Number of waves made by a Bohr electron in an orbit of maximum magnetic quantum number +2 is:

A. 3

B. 4

C. 2

D. 1

Answer: A

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28. A given orbital is labelled by the magnetic quantum number m=-1. This could not be

A. s-orbital

B. p-orbital

C. d-orbital

D. f-orbital

Answer: A

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Mandatory Exercise Exercise Set Iii

1. Which quantum number will express the difference in two electrons in K shell?

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2. What is the physical significance of the lines in the following depictions of atomicorbitals -

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3. Of the ions Co^{2+}, Sc^{3+} and Cr^{3+} which ones will give coloured aqueous solutions and how will each of them respond to a magnetic field and why?

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4. On the basis of Pauli's exclusion principle show that the maximum number of electrons in the M shell (n = 3) of any individual atom is

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Mandatory Exercise Exercise Set Iv

1. Give the atomic number of the elements with the following electronic configuration in their outermost shell.

$3s^2 3p^6$

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2. Give the atomic number of the elements with the following electronic configuration in their outermost shell.

$3d^5 4s^2$

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3. Write the electronic configuration of neutral atoms of ${}^{27}_{13}X$.

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4. Write the electronic configuration of neutral atoms of ${}^{35}_{17}Y$.

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5. The maximum number of electrons which a shell (designated by n) can accommodate is

A. $2n + 1$

B. 2n

C. $2n^2$

D. n^2

Answer: C

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6. How many 3d electrons can have a spin of $-\frac{1}{2}$?

A. 10

B. 5

C. 15

D. 30

Answer: B

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7. The core charge on oxygen is equal to:

A. $+2e$

B. $-2e$

C. $-6e$

D. $+8e$

Answer: D

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8. An electron will have the highest energy in the set:

A. $3, 2, 1, 1/2$

B. $4, 2, -1, 1/2$

C. $4, 1, 0, -1/2$

D. $5, 0, 0, 1/2$

Answer: B

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9. Which orbital is represented by the complete wave function Ψ_{320}.

A. 3d

B. 4d

C. 4p

D. 4s

Answer: A

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10. The principal quantum number of an atom is related to the:

A. Size of orbital

B. Spin angular momentum

C. Orbital angular momentum

D. Orientation of the orbital in space

Answer: A

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11. In which $(n + l)$ rules not applicable:

A. Cu, Cr

B. Cu, Zn

C. Ag, Zn

D. All of these

Answer: A

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12. The total number of shell, subshell and orbitals are used in Fe^{2+}:

A. 4, 7, 14

B. 3, 6, 14

C. 4, 6, 14

D. 3, 7, 4

Answer: B

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13. If the value of $(n + l)$ is more than 3 and less than 6, what will be the possible number of orbitals:

A. 9

B. 10

C. 6

D. 13

Answer: C

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14. Explain the meaning of the symbol $4d^6$.

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15. How many protons, electrons and neutrons are present m 0.18 g $^{30}_{15}$P ?

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16. In a multi-electron atom, which of the following orbitals describe by the three quantum members will have the same energy in the absence of magnetic and electric fields

(a) $n = 1, l = 0, m = 0$

(b) $n = 2, l = 0, m = 0$

(c) $n = 2, l = 1, m = 1$

(d) $n = 3, l = 2, m = 1$

(e) $n = 3, l = 2, m = 0$

A. c and d

B. d and e

C. a and b

D. b and c

Answer: B

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17. Consider the ground state of Cr atom (Z = 24). The numbers of electrons with the azimuthal quantum numbers, $l = 1$ and 2 are, respectively:

A. 12 and 4

B. 12 and 5

C. 16 and 4

D. 16 and 5

Answer: B

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18. Quantum number 'm' of a free gaseous atom is associated with

A. The effective volume of the orbital

B. The shape of the orbital

C. The spatial orientation of the orbital

D. The energy of the orbital in the absence of a magnetic field.

Answer: C

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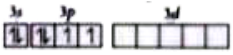
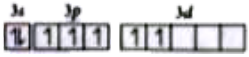
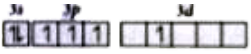
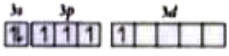
19. Which of the following has maximum energy?

A. 

B. 

C. 

D. 

Answer: B

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20. Quantum number $n = 3, l = 2, m = +2$ shows how many orbitals

A. 1

B. 2

C. 3

D. 4

Answer: A

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21. Which of the following are isoelectronic species

$I - CH_3^+, II - NH_2^-, III - NH_4^+, IV - NH_3$

A. I, II, III

B. II, III, IV

C. I, II, IV

D. I and II

Answer: B

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22. Which of the following has highest unpaired d-electrons?

A. Zn^+

B. Fe^{2+}

C. Ni^{3+}

D. Cu^+

Answer: B

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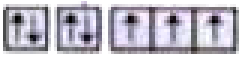
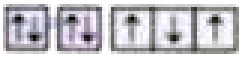
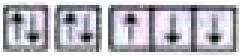
23. Ground state electronic configuration of nitrogen atom can be represented by

A. 

B. 

C. 

D. None of these

Answer: A

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24. Which of the following explain the sequence of filling the electrons in different orbitals:

A. Hunds' rulent

B. Octet rule

C. Aufbau principle

D. All of these

Answer: A

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Consolidated Exercise Comprehension

1. Quantum Numbers

The whereabouts and characteristics of an electron in an atom can be known by a set of four quantum numbers, which describe the electron's distance from nucleus, shape of the orbital, its orientation, and spin.

Principal quantum number (n): The principal quantum number (n) is a positive integer (n = 1, 2, 3, 4, ...) on which the size and energy level of the orbital primarily depends. Its value gives us the 'shell in which the electron is present. It also gives us an idea of the average energy possessed by an electron and the average distance from the

nucleus where it is likely to be found.

Azimuthal quantum number (l): The azimuthal quantum number defines the three-dimensional shape of the orbital (subshell) in which the electron is present. Its value ranges from 0 to n-1 for a given value of n, for example, if n = 2, possible values of l are 0 and 1. The azimuthal quantum number is also known as the angular momentum quantum number, and it gives an idea about the absolute value of energy possessed by the electron.

For example, an orbital with n= 3 and l= 2 in the 3d orbital, n = 3 represents the 3rd shell and l = 2 represents the d subshell (if l = 0, 1, 2, and 3, the

orbital is s, p, d, and f, respectively).

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For example, if $l = 0$, then m= 0.

If $l = 1$, then m = -1, 0, or +1.

If $l = 2$, then $m = -2, -1, 0, +1, \text{ or } +2.$

If $l = 3,$ then

$m = -3, -2, -1, 0, +1, +2, \text{ or } +3 \ldots$

and so forth.

Spin quantum number(s): The spin quantum number exemplifies the spin of an electron around its imaginary axis. For each value of magnetic quantum number, only two values of the spin quantum number are permitted, that is, $+\frac{1}{2}$ or $-\frac{1}{2}, s = +\frac{1}{2}$ denotes a clockwise spin and $-\frac{1}{2}$ denotes anticlockwise spin. A maximum of only 2 electrons can be accommodated in each of the spatial orientations represented by m.

Based on the provided information, answer the following questions:

If the principal quantum number is 3, what

possible values can azimuthal quantum number have?

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of only 2 electrons can be accommodated in each of the spatial orientations represented by m.

Based on the provided information, answer the following questions:

Which of the following sets of quantum numbers are not permitted? Why?

A. $n = 4, l = 0, m = 0, s = 0$

B. $n = 4, l = 4, m = 1, s = -\frac{1}{2}$

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

D. $n = 4, l = 2, m = 3, s = +\frac{1}{2}$

Answer:

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Based on the provided information, answer the

following questions:

Write down the values of n and l for an electron having the highest energy in a sodium atom.

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and $-\frac{1}{2}$ denotes anticlockwise spin. A maximum of only 2 electrons can be accommodated in each of the spatial orientations represented by m.

Based on the provided information, answer the following questions:

If $l = 2$, what are the permitted values for m?

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Based on the provided information, answer the following questions:

Match the following:

A	B
(1) Orbitals are filled in order of increasing energy	(a) Heisenberg's principle
(2) Degenerate orbitals are first singly occupied	(b) Aufbau principle
(3) An orbital can have maximum two electrons	(c) Hund's rule
(4) Position and momentum of a small particle cannot be measured simultaneously with absolute accuracy	(d) Pauli's exclusion principle

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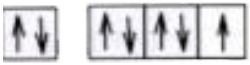
Consolidated Exercise Multiple Choice Questions With More Than One Correct Answer

1. The orbital box diagram/s in which both Pauli's exclusion theory and Hund's rule are violated is

A. 

B. 

C. 

D. 

Answer: A::C::D

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2. Which of the following atoms has two neutrons in its nucleus?

A. Helium

B. Lithium

C. Protium

D. Tritium

Answer: A::D

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3. Which of the following species have three unpaired electrons?

A. Cr^{2+}

B. Cr^{3+}

C. Ar

D. P

Answer: A::D

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4. Which of the following statements are correct?

A. ${}_{7}^{14}N$ and ${}_{6}^{14}C$ are isobars.

B. ${}_{7}^{14}N$ and ${}_{7}^{15}C$ are isobars.

C. ${}_{6}^{12}N$ and ${}_{6}^{13}C$ are isobars.

D. ${}_{7}^{14}N$ and ${}_{6}^{14}C$ are isobars.

Answer: A::B::D

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5. Which of the following electronic configurations are forbidden?

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

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

C. $1s^2 2s^2 2p^6 3s^2 4d^7$

D. $2s^2$

Answer: A::C::D

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Challenging Exercise

1. What is the symbol of the species composed of the following sets of subatomic particles?

25p, 30m, 25e

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2. What is the symbol of the species composed of the following sets of subatomic particles?

20p, 20n, 18e

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3. What is the symbol of the species composed of the following sets of subatomic particles?

34p, 45n, 36e

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Olympiad And Ntse Level Exercises

1. In Rutherford's scattering experiment, which of the following does not happen?

A. Most of the α-rays pass through without deflection.

B. A few α-particles pass through the nucleus.

C. A few α-particles are deflected back.

D. α-particles going near the nucleus are slightly deflected.

Answer: B

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2. When alpha particles are sent through a thin metal foil, most of them go straight through the foil because

A. Alpha particles are much heavier than electron.

B. Alpha particles are positively charged.

C. Alpha particles move with high velocity.

D. Most part of the atom is empty.

Answer: D

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3. The atomic masses of two isotopes of O are 15.9936 and 17.0036. Select the incorrect statement

A. Total number of neutrons in each atom is 17

B. Total number of protons in each atom is 17

C. Total number of electrons in each atom is 16

D. Total mass number in each atom is 33

Answer: B

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4. Which of the following pairs consists of molecules having the same mass number?

A. H_2O and D_2O

B. H_2O and HTO

C. D_2O and HTO

D. D_2O and HCl

Answer: C

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5. If two neutrons are added to an element X, then it will get converted to its

A. Isotope

B. Isotone

C. Isobar

D. None of the above

Answer: A

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6. A diapositive ion has 16 protons. What is the number of electrons in its tetrapositive ion?

A. 16

B. 14

C. 12

D. 10

Answer: C

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7. What is the total numbers of orbitals and electrons for m = 0, if there are 30 protons in an atom?

A. 7 orbitals, 14 electrons

B. 6 orbitals, 12 electrons

C. 5 orbitals, 10 electrons

D. 3 orbitals, 6 electrons

Answer: A

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8. The radial probability is the probability of finding electrons in a small spherical shell around the nucleus at a particular distance (r). Hence, radial probability is

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

B. $(4/3)\pi r^2 dr\Psi^2$

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

D. $4\pi r dr\Psi$

Answer: A

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9. Which of the following is(are) correct for H atom?

(i) $1s < 2s < 2p < 3s < 3p$

(ii) $1s < 2s = 2p < 3s = 3p$

(iii) $1s < 2p < 3d < 4s$

(iv) $1s < 2s < 4s < 3d$

The correct choice is

A. (ii), (iii)

B. (i), (iv)

C. (i), (iii)

D. (ii), (iv)

Answer: B

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10. Which of the d orbitals lies in the xy-plane?

A. d_{xz}

B. d_{xy}

C. $d_{x^2-y^2}$

D. d_{xy} and $d_{x^2-y^2}$

Answer: C

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