2. Periodic Classification of Elements

Question 1:

Rearrange the columns 2 and 3 so as to match with the column 1.

Column 1	Column 2	Column 3
i. Triad ii. Octave iii. Atomic number iv. Period v. Nucleus vi. Electron	a. Lightest and negatively charged particle in all the atoms b. Concentrated mass and positive charge c. Average of the first and the third atomic mass d. Properties of the eighth element similar to the first e. Positive charge on the nucleus f. Sequential change in molecular formulae	1.Mendeleev 2. Thomson 3. Newlands 4. Rutherford 5. Dobereiner 6. Moseley

Answer

Rearrange the columns 2 and 3 so as to match with the column 1.

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1. Triad 2. Octave 3. Atomic number 4. Period 5. Nucleus 6. Electron	1. Average of the first and the third atomic mass 2. Properties of the eighth element similar to the first 3. Positive charge on the nucleus 4. Sequential change in molecular formulae 5. Concentrated mass and positive charge 6. Lightest and negatively charged particle in all the atoms	1. Dobereiner 2. Newlands 3. Mendeleev 4. Moseley 5. Rutherford 6. Thomson

Question 2:

Choose the correct option and rewrite the statement.

a. The number of electrons in the outermost shell of alkali metals is .....

(i) 1 (ii) 2 (iii) 3 (iv) 7

Answer

a. The number of electrons in the outermost shell of alkali metals is **1.**

b. Alkaline earth metals have valency 2. This means that their position in the modern periodic table is in ....
(i) Group 2 (ii) Group 16 (iii) Period 2 (iv) d-block

Answer

b. Alkaline earth metals have valency 2. This means that their position in the modern periodic table is in **group2**.

c. Molecular formula of the chloride of an element X is XCl. This compound is a solid having high melting point. Which of the following elements be present in the same group as X.
(i) Na (ii) Mg (iii) Al (iv) Si

Answer

c. Molecular formula of the chloride of an element X is XCl. This compound is a solid having high melting point. An element to be present in the same group as X is **Na**.

d. In which block of the modern periodic table are the nonmetals found?
(i) s-block (ii) p-block (iii) d-block (iv) f-block

Answer

d. In **p-block** of the modern periodic table are the nonmetals found.

Question 3:

An element has its electron configuration as 2, 8, 2. Now answer the following question.
a. What is the atomic number of this element?
b. What is the group of this element?
c. To which period does this element belong?
d. With which of the following elements would this element resemble? (Atomic numbers are given in the brackets)
N(7), Be(4), Ar(18), Cl(17)

Answer

An element has its electron configuration as 2, 8, 2.
a. The atomic number of this element is 12.
b. The group number of this element is second.
c. This element belongs to third period.
d. This element resembles with Be(2).

Question 4:

Write down the electronic configuration of the following elements from the given atomic numbers. Answer the following question with explanation.

a. $_{3}$Li, $_{14}$He, $_{11}$Na, $_{15}$P Which of these elements belong to be period 3?

Answer

a. $_{3}$Li, $_{14}$He, $_{11}$Na, $_{15}$P

Electronic configuration of the following elements is:

$_{3}$Li = 2,1

$_{14}$He =2,8,4

$_{11}$Na = 2,8,1

$_{15}$P = 2,8,5

$_{14}$He, $_{11}$Na, $_{15}$P belong to the third period because according to their electronic configuration, each element contains three shell i.e. K,L,M.

b. $_{1}$H, $_{7}$N, $_{20}$Ca, $_{16}$S, $_{4}$Be, $_{18}$Ar Which of these elements belong tot he second group?

Answer

b. $_{1}$H, $_{7}$N, $_{20}$Ca, $_{16}$S, $_{4}$Be, $_{18}$Ar

Electronic configuration of the following elements is:

$_{1}$H = 1

$_{7}$N = 2,5

$_{20}$Ca = 2,8,8,2

$_{16}$S = 2,8,6

$_{4}$Be = 2,2

$_{18}$Ar = 2,8,8

$_{20}$Ca, $_{4}$Be belong to second group because these elements have 2 electrons in its outermost shell.

c. $_{7}N$, $_{6}C$, $_{8}O$, $_{5}B$, $_{13}Al$ Which is the most electronegative element among these?

Answer

c. $_{7}N$, $_{6}C$, $_{8}O$, $_{5}B$, $_{13}Al$

Electronic configuration of the following elements is:

$_{7}N$ =2,5

$_{6}C$ = 2,4

$_{8}O$ = 2,6

$_{5}B$ = 2,3

$_{13}Al$ = 2,8,3

$_{8}O$ is the most electronegative element among these because electronegativity increases as we move from left to right in a period of the periodic table.

d. $_{4}Be$, $_{6}C$, $_{8}O$, $_{5}B$, $_{13}Al$ Which is the most electropositive element among these?

Answer

d. $_{4}Be$, $_{6}C$, $_{8}O$, $_{5}B$, $_{13}Al$

Electronic configuration of the following elements is:

$_{4}Be$ = 2,2

$_{6}C$ = 2,4

$_{8}O$ = 2,6

$_{5}B$ = 2,3

$_{13}Al$ = 2,8,3

$_{13}Al$ is the most electropositive element among these because $_{4}Be$, $_{6}C$, $_{8}O$, $_{5}B$ belong to same period, but $_{13}Al$ belong to next period. According to the trend, electropositive character of an elements increases as we move from top to bottom in a group of the periodic table. This happens as the tendency of an atom to lose electrons increases due to decrease in nuclear charge and increase in numbers of shell.

e. $_{11}Na$, $_{15}P$, $_{17}Cl$, $_{14}Si$, $_{12}Mg$ Which of these has largest atoms?

Answer

e. $_{11}Na$, $_{15}P$, $_{17}Cl$, $_{14}Si$, $_{12}Mg$

Electronic configuration of the following elements is:

$_{11}Na$ = 2,8,1

$_{15}P$ = 2,8,5

$_{17}Cl$ = 2,8,7

$_{14}Si$ = 2,8,4

$_{12}Mg$ = 2,8,2

$_{11}Na$ has largest size among these because according to the trend, atomic radius decreases as we move from left to right in a period of the periodic table. The atomic number of elements increases which means the number of protons and electrons in the atoms increases. Due to large positive charge on the nucleus, the electrons are pulled closer to the nucleus and the size of atom decreases.

f. $_{19}K$, $_{3}Li$, $_{11}Na$, $_{4}Be$ Which of these atoms has smallest atomic radius?

Answer

f. $_{19}K$, $_{3}Li$, $_{11}Na$, $_{4}Be$

Electronic configuration of the following elements is:

$_{19}K$ = 2,8,8,1

$_{3}Li$ = 2,1

$_{11}Na$ = 2,8,1

$_{4}Be$ = 2,2

$_{4}Be$ has smallest atomic radius because $_{19}K$, $_{3}Li$, $_{11}Na$ are present in same group 1 but Be is present in group 2. According to the trend, as we move from left to right atomic size of an atoms decreases. Due to large positive charge on the nucleus, the electrons are pulled closer to the nucleus and the size of atom decreases.

g. $_{13}Al$, $_{14}Si$,$_{11}Na$, $_{12}Mg$, $_{16}S$ Which of the above elements has the highest metallic character?

Answer

g. $_{13}Al$, $_{14}Si$, $_{11}Na$, $_{12}Mg$, $_{16}S$

Electronic configuration of the following elements is:

3Al = 2,8,3

$_{14}Si$ = 2,8,4

$_{11}Na$ = 2,8,1

$_{12}Mg$ = 2,8,2

$_{16}S$ = 2,8,6

$_{11}Na$ has the highest metallic character because metallic character of an elements decreases as we move from left to right in a modern periodic table. This happens as the tendency of an atom to lose electrons decreases due to gradual increase in the number of protons and nuclear charge.

h. $_{6}C$, $_{3}Li$, $_{9}F$, $_{7}N$, $_{8}O$ Which of the above elements has the highest nonmetallic character?

Answer

h. $_{6}C$, $_{3}Li$, $_{9}F$, $_{7}N$, $_{8}O$

Electronic configuration of the following elements is:

$_{6}C$ = 2,4

$_{3}Li$ = 2,1

$_{9}F$ = 2,7

$_{7}N$ = 2,5

$_{8}O$ = 2,6

$_{9}F$ has the highest nonmetallic character because non-metallic character of an elements increases as we move from left to right in a period of the periodic table. This happens as the tendency of an atom to gain electrons increases due to increase in nuclear charge, the valence electrons are pulled in strongly by the nucleus and it becomes easier for an atom to gain electrons.

Question 5:

Write the name and symbol of the element from the description.

a. The atom having the smallest size.

b. The atom having the smallest atomic mass.

c. The most electronegative atom.

d. The noble gas with the smallest atomic radius.

e. The most reactive nonmetal.

Answer

a. The atom having the smallest size = Hydrogen (H)

b. The atom having the smallest atomic mass = Hydrogen (H)

c. The most electronegative atom = Fluorine (F)

d. The noble gas with the smallest atomic radius = Helium (He)

e. The most reactive nonmetal = Fluorine (F)

Question 6:

Write short notes.

a. Mendeleev's periodic law.

Answer

When the elements are arranged in the order of their increasing atomic masses, Mendeleev found that the elements with similar physical and chemical properties repeat after a definite interval. On the basis of these finding Mendeleev stated the periodic law.

The physical and chemical properties of elements are a periodic function of their atomic masses.

Merits of Mendeleev's periodic table :

(1) To give the proper place in the periodic table, atomic masses of some elements were revised in accordance with their properties.

(2) Mendeleev had kept some vacant places in the periodic table for elements that were yet to be discovered. Their properties were also predicted. Later on these elements were discovered subsequently and were named as scandium (SC), gallium (Ga) and germanium (Ge) respectively. The properties of these elements matched well with those predicted by Mendeleev. Due to this success all were convinced about the importance of Mendeleev's periodic table.

(3) When noble gases such as helium, neon and argon were discovered, Mendeleev created the 'zero group' without disturbing the original periodic table in which the noble gases were placed very well.

Demerits of Mendeleev's periodic table :

(1) The elements cobalt (Co) and nickel (Ni) have the same whole number atomic mass. As a remit there was an ambiguity regarding their sequence in Mendeleev's periodic table.

(2) Isotopes were discovered long time after Mendeleev put forth the periodic table. A challenge was posed in placing isotopes in Mendeleev's periodic table as isotopes have the same chemical properties but different atomic masses.

(3) The rise in atomic mass does not appear to be uniform when elements are arranged in an increasing order of atomic masses. It was not possible, therefore, to predict how many elements could be discovered between two heavy elements.

(4) Position of hydrogen: Hydrogen shows similarity with halogens (group VII). For example, the molecular formula of hydrogen is H, while the molecular formulae of fluorine and chlorine are F, and Cl,, respectively. In the same way, there is a
similarity in the chemical properties of hydrogen and alkali metals (group I). There is a similarity in the molecular formulae of the compounds of hydrogen alkali metals (Na, K, etc.) formed with chlorine and oxygen. On considering the above properties it is difficult to decide the correct position of hydrogen whether it is in the group of alkali metals (group I) or in the group of halogens (Group VII)

b. Structure of the modern periodic table.

Answer

(1) In. the modern periodic table, the elements are arranged in the order of their increasing atomic numbers. In the modern periodic table there are seven horizontal rows called periods and the eighteen vertical columns (1 to 18) called groups.

The arrangement of the periods and groups results into formation of boxes. Atomic numbers are serially indicated in the upper part of these boxes.

(2) Each box represents the place for one element. Apart from these seven rows, there are two rows of elements placed separately at the bottom of the periodic table. They are lanthanides and actinides series. There are 118 boxes in the periodic table including the two series that means there are 118 places for elements in the modern periodic table.
The formation of a few elements was established experimentally very recently and thereby the modern periodic table is now completely filled with 118.elements.

(3) On the basis of the electronic configuration, the elements in the modern periodic table are divided into four blocks, viz. s-block, p-block, d-block and fblock. The s-block constitute the groups 1 and 2, The groups 13 to 18 constitute the p-block. The groups 3 to 12 constitute the d-block, while the lanthanide and actinide series at the bottom form the f-block. The d-block elements are called transition elements. A zig-zag line is shown in the p-block of the periodic table. This zig-zag line shows the three traditional types of elements, i.e. metals, nonmetals and metalloid. The metalloid elements lle along the border of this zig-zag line. All the metals lie on the left side of the zig-zag line while all the nonmetals lie on the right side.

c. Position of isotopes in the Mendeleev's and the modern periodic table.

Answer

Isotopes: Isotopes are the atoms having same atomic number but different atomic masses. Therefore, according to Mendeleev's classification these should be placed at different places depending upon their atomic masses.
For example, hydrogen isotopes with atomic masses 1,2 and 3 should be placed at three places. However, isotopes have not been given separate places in the periodic table because of their similar properties. So this was drawback of Mendeleev's periodic table as he could not explained the position of isotopes.
Modern periodic table is based upon arrangement of the elements on the basis of their atomic number. So that, all the isotopes of hydrogen should be placed at same place depending upon their atomic number.

Question 7:

Write scientific reasons.

a. Atomic radius goes on decreasing while going from left to right in a period.

Answer

Atomic radius goes on decreasing while going from left to right in a period because atomic number of the elements increases which means the number of protons and electrons in the atoms increases(the extra electrons being added to the same shell). Due to large positive charge on the nucleus, the electrons are pulled closer to the nucleus and the size of an atom decreases.

b. Metallic character goes on decreasing while going from left to right in a period.

Answer

Metallic character goes on decreasing while going from left to right in a period because the tendency of atoms of the elements to lose electrons(or gain electrons) changes in a period. As we move from left to right in a period, the nuclear charge increases due to gradual increase in the number of protons. Due to the increase in nuclear charge, the valence electrons are pulled strongly by the nucleus and it becomes difficult for the atoms to lose electrons. Hence, metallic character decreases.

c. Atomic radius goes on increasing down a group.

Answer

Atomic radius increases as we move from top to bottom in a group of the periodic table because a new shell of electrons is added to the atoms at every step. As the number of shells in the atoms increases gradually due to which the size of atoms also increases. As the size of the atoms increases which leads to increase in atomic radius of an atom.

d. Elements belonging to the same group have the same valency.

Answer

Elements belong to the same group have the same valency because the number of valence electrons in a group is same due to which the tendency of an atom to lose or gain electrons in order to attain nearest noble gas configuration is also same.

e. The third period contains only eight elements even through the electron capacity of the third shell is 18 .

Answer

The third period contains only eight elements even through the electron capacity of the third shell is 18 because when the other shells get filled and the resultant no of electrons becomes eighteen, it gets added up and settles in the third electron shell and three shells is acquired by fourth period.

Question 8:

Write the names from the description.

a. The period with electrons in the shells K, L and M.

Answer

a.The period with electrons in the shells K, L and M = 3 period.

b. The group with valency zero.

Answer

b. The group with valency zero = 18 group.

c. The family of nonmetals having valency one.

Answer

c. The family of nonmetals having valency one = Halogens.

d. The family of metals having valency one.

Answer

d. The family of metals having valency one = Alkali metals.

e. The family of metals having valency two.

Answer

e. The family of metals having valency two = Alkaline earth metals.

f. The metalloids in the second and third periods.

Answer

f. The metalloids in the second and third periods = Boron(second period), Silicon (third period)

g. Nonmetals in the third period.

Answer

g. Nonmetals in the third period = Sulphur, Chlorine

h. Two elements having valency 4.

Answer

h. Two elements having valency 4 = Carbon, Silicon