3. Classification of elements and the periodic table

Let us assess

1. Question

The table given below lists the contributions and names of scientists who made earlier attempts in the classification of elements. Fill in the blanks.

Contribution/Findings	Name of Scientist
Triads	.....
.....	Newlands
Atomic mass – Atomic volume graph	.....
Telluric helix	.....
.....	John Dalton
Classification of elements into metals and non-metals	.....
Modern Periodic Law	.....

Answer

Contribution/Findings	Name of Scientist
Triads	J.W Dobereiner
Law of octaves	Newlands
Atomic mass – Atomic volume graph	Julius Lothar Meyer
Telluric helix	Chan Courtoise
Atomic theory	John Dalton
Classification of elements into metals and non-metals	Antoine Lavoiser
Modern Periodic Law	Dmitri Mendeleev

1. The German Chemist, J.W Dobereiner was the first to consider the idea of trends among properties of elements.

i. He made group of three elements each which are having similar properties and called them triads.

ii. He showed that the atomic mass of the middle element was approx. equal to the mean of atomic masses of other two elements.

iii. For example:

Triads (having similar properties)	Atomic Mass	Average
Lithium	7	$\frac{7+39}{2}=23$
Sodium	23	
Potassium	39	

2. John Alexander Newlands proposed the law of octaves.

Law of octaves:

i. Law of octaves states that “every eighth element has properties similar to the first element”

ii. In modern periodic table, any element of the same period has similar properties.

iii. For Example-Mg and Ca exhibit similar properties as they both belong to the same group.

3. The German scientist Julius Lothar Meyer plotted a graph of atomic volume against the atomic mass of the elements.

He noticed that:

i. Elements of same properties remained at same positions.

ii. He concluded that atomic mass is the fundamental property of elements.

4. Chan Courtoise put forward the idea of “Telluric helix” to classify elements.

i. He arranged the atoms in spirally ascending order of their atomic masses in a cylindrical way.

ii. He noticed that elements of similar properties will line up vertically.

5. John Dalton discovered an Atomic Theory. He concluded that each element has a fixed mass.

6. Antoine Lavoiser classify the known elements into metals and non-metals. But by that time, he was not able to classify metalloids which show the properties of both metals and non-metals.

7. *Dmitri Mendeleev invented modern periodic law. Modern periodic law states that “the chemical and physical properties of elements are periodic function of their atomic numbers”.*

2. Question

Complete the table

Element	Atomic Number	Electronic Configuration	Group Number	Period Number
Lithium	.....	2,1	1	2
Oxygen	8	.....	.....	.....
Argon	18	.....	.....	.....
Calcium	.....	2,8,8,2	.....	.....

Answer

Element	Atomic Number	Electronic configuration	Group number	Period number
Lithium	3	2,1	1	2
Oxygen	8	2,6	6	2
Argon	18	2,8,8	8	3
Calcium	20	2,8,8,2	2	4

For lithium:

i. Atomic number of lithium = 3

ii. Electronic configuration of lithium = 2,1

iii. Lithium has 1 electron in the outermost shell. Hence, it belongs to first group number.

iv. In lithium (2,1), there are two shells. Hence, it belongs to second period.

For oxygen:

i. Atomic number of oxygen = 8

ii. Electronic configuration of oxygen = 2,6

iii. Oxygen has 6 electrons in the outermost shell. Hence, it belongs to 6^{th} group number.

iv. In oxygen (2,6), there are two shells. Hence, it belongs to second period.

For argon:

i. Atomic number of argon = 18

ii. Electronic configuration of argon = 2,8,8

iii. Argon has 8 electrons in the outermost shell. Hence, it belongs to 8^{th} group number.

iv. In argon (2,8,8), there are three shells. Hence, it belongs to third period.

For calcium:

i. Atomic number of calcium = 20

ii. Electronic configuration of calcium = 2,8,8,2

iii. Calcium has 2 electrons in the outermost shell. Hence, it belongs to 2nd group number.

iv. In calcium (2,8,8,2), there are four shells. Hence, it belongs to fourth period.

3. Question

Symbols of certain elements are given. Write their electronic configuration and find the period and group in which they are included.

(a) 12/6C (b) 24/12Mg (c) 35/17Cl (d) 27/13Al (e) 20/10Ne

Answer

a) For carbon:

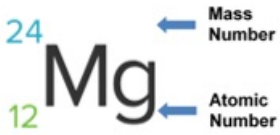
i. The atomic number of carbon = 6

ii. Hence, its electronic configuration will be = 2,4

iii. Carbon has 4 electrons in the outermost shell. Hence, it belongs to 4th group number.

iv. In carbon (2,4), there are two shells. Hence, it belongs to second period.

For magnesium:



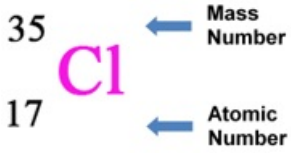
i. The atomic number of magnesium = 12

ii. Hence, its electronic configuration will be = 2,8,2

iii. Magnesium has 4 electrons in the outermost shell. Hence, it belongs to 4th group number.

iv. In magnesium (2,8,2), there are three shells. Hence, it belongs to third period.

For chlorine:



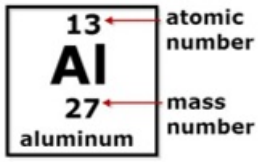
i. The atomic number of chlorine = 17

ii. Hence, its electronic configuration will be = 2,8,7

iii. Chlorine has 7 electrons in the outermost shell. Hence, it belongs to 7th group number.

iv. In chlorine (2,8,7), there are three shells. Hence, it belongs to third period.

For aluminium:



i. The atomic number of aluminium = 13

ii. Hence, its electronic configuration will be = 2,8,3

iii. Aluminium has 3 electrons in the outermost shell. Hence, it belongs to 3rd group number.

iv. In aluminium (2,8,3), there are three shells. Hence, it belongs to third period.

For neon:

i. The atomic number of neon = 10

ii. Hence, its electronic configuration will be = 2,8

iii. Neon has 8 electrons in the outermost shell. Hence, it belongs to 8th group number.

iv. In neon (2,8), there are two shells. Hence, it belongs to second period.

4 A. Question

There are three shells in the atom of element ‘X’, 6 electrons are present in its outmost shell.

Write the electronic configuration of the element.

Answer

Given: Number of shells present in “X” = 3

Number of electrons present in the outermost shell = 6

Electronic configuration = 2,8,6

It is given that there are three shells present.

Six electrons are present in the outermost shell. This means the first two shells have complete octet, i.e., 2,8

Thus, electronic configuration of the element X is 2,8,6

4 B. Question

There are three shells in the atom of element ‘X’, 6 electrons are present in its outmost shell.

What is its atomic number?

Answer

Atomic number = 16

The electronic configuration of the element X is

2,8,6. Add all the electrons.

2+8+6 = 16

Thus, the element has atomic number 16

4 C. Question

There are three shells in the atom of element ‘X’, 6 electrons are present in its outmost shell.

In which period does this element belong?

Answer

Period number = 3

It is given that number of shells present in the element X is 3. Hence, X element belongs to third period

To remember:

Number of shells present = Period number

4 D. Question

There are three shells in the atom of element ‘X’, 6 electrons are present in its outmost shell.

In which group is this element included?

Answer

Group number = 6

It is given that there are six electrons present in the outermost shell. Hence, X element belongs to sixth period

To remember:

Number of electrons present in the outermost shell = Period number

4 E. Question

There are three shells in the atom of element ‘X’, 6 electrons are present in its outmost shell.

Write the name and symbol of this element.

Answer

The element name is “Sulphur” and its symbol is $32^{16}S$

The atomic number of Sulphur is 16.

The mass number of Sulphur is 32. Hence, its symbol is:

4 F. Question

There are three shells in the atom of element ‘X’, 6 electrons are present in its outmost shell.

To which family of element does is this element belong to?

Answer

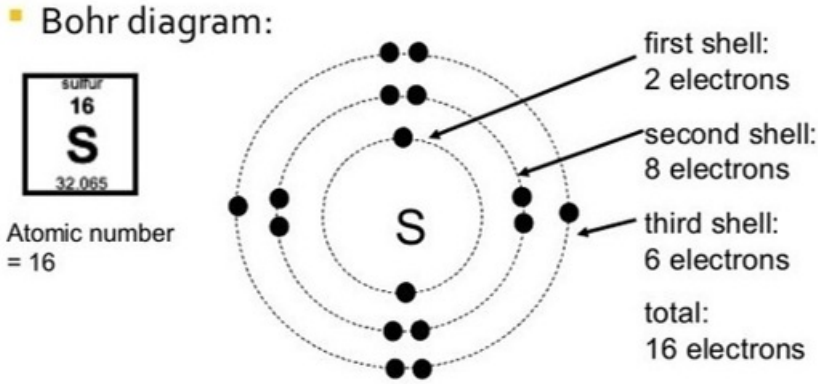
Sulphur belongs to the chalcogen or oxygen family. It is a non-metal. All the members of oxygen family are non-metals.

4 G. Question

There are three shells in the atom of element ‘X’, 6 electrons are present in its outmost shell.

Draw and illustrate the Bohr atom model of this element.

Answer



In a sulphur atom, the valence shell has 6 electrons

Note: Valence shell means the outermost shell. The electrons present in the outermost shell are called valence electrons.

5 A. Question

Electronic configurations of elements P, Q, R and S are given below. (These are not actual symbols).

P — 2, 2

Q — 2, 8, 2

R — 2, 8, 5

S — 2, 8

Which among these elements are included in the same period?

Answer

Elements Q and R are included in the same period.

Element P and S are included in the same period.

In Q (2,8,2) and R (2,8,5), there are three shells

present. Hence, they both belong to third period.

In P (2,2) and S (2,8), there are two shells present. Hence they both belong to second period.

5 B. Question

Electronic configurations of elements P, Q, R and S are given below. (These are not actual symbols).

P — 2, 2

Q — 2, 8, 2

R — 2, 8, 5

S — 2, 8

Which are those included in the same group?

Answer

Elements P and Q are included in the same group.

In P (2,2) and Q (2, 8, 2), there are two electrons in the outermost shell. Hence, they both belong to second period.

5 C. Question

Electronic configurations of elements P, Q, R and S are given below. (These are not actual symbols).

P — 2, 2

Q — 2, 8, 2

R — 2, 8, 5

S — 2, 8

Which among them is a noble gas?

Answer

Among the given elements, “S” is a noble gas.

S (2,8) has a complete noble gas configuration. It has maximum number of electrons in the outermost shell. Hence it is a noble gas.

5 D. Question

Electronic configurations of elements P, Q, R and S are given below. (These are not actual symbols).

P — 2, 2

Q — 2, 8, 2

R — 2, 8, 5

S — 2, 8

To which group and period does the element R belong?

Answer

R belongs to group 5 and period 3

For group:

i. To find out the group number, first we need to find out the number of electrons in the outermost shell of R.

ii. In R, five electrons are present in the outermost shell.

iii. Hence, R belongs to group 5.

For period:

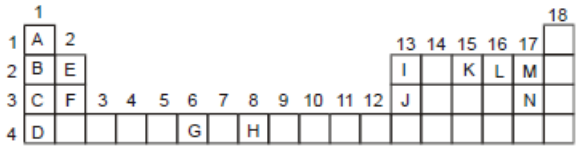
i. To find out the period number, first we need to find out the number of shell present in R.

ii. In R (2,8,5), three shells are present.

iii. Hence, R belongs to period 3.

6 A. Question

An incomplete form of the periodic table is given below. Write answers to the questions connecting the position of elements in it.



Which is the element with the biggest atom in group 1?

Answer

Element D

Atomic size goes on increasing down a group because:

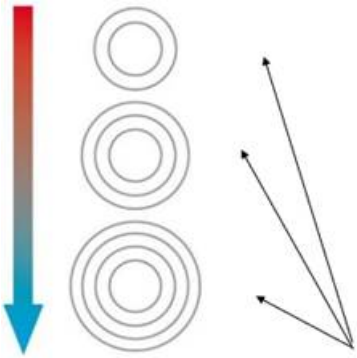
i. Down a group, the atomic number increases one by one.

ii. The outer electrons are adding in a new valence shell.

iii. Therefore, the distance between the outermost electron (valence electron) and the nucleus is also

increasing.

iv. Therefore, the size of the atom increases with increase in atomic number.

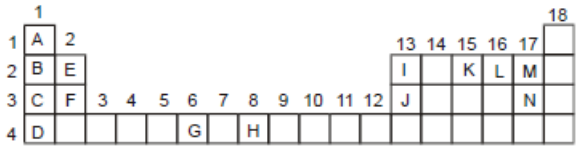


Number of shells are increasing down a group

Thus, D has the biggest atom in group 1.

6 B. Question

An incomplete form of the periodic table is given below. Write answers to the questions connecting the position of elements in it.



Which is the element having very lowest ionization energy in group 1?

Answer

Element A

Ionization energy is the energy required to remove an electron.

It goes on decreasing as we move from top to bottom because:

i. The outer electrons are adding in a new outermost shell.

ii. Therefore, the distance between the outermost electron (valence electron) and the nucleus is also increasing.

iii. It becomes easy to remove electrons.

iv. Thus, ionization energy decreases.

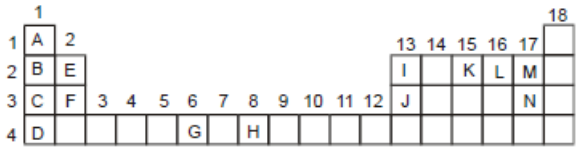
Thus, element A has lowest ionization energy as we go down in group 1.

To remember:

Ionization energy increases with decrease in atomic number and decreases with increase in atomic number.

6 C. Question

An incomplete form of the periodic table is given below. Write answers to the questions connecting the position of elements in it.



Which element has the smallest atom in period 2?

Answer

Element M

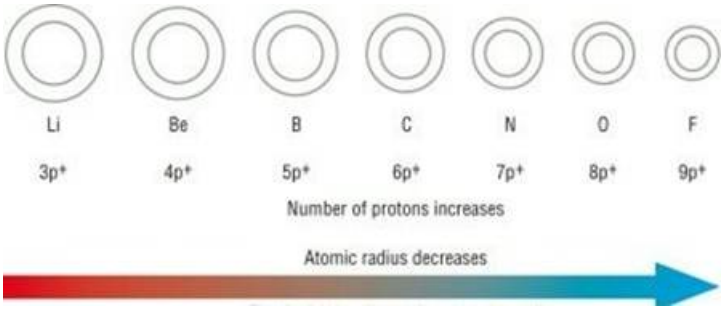
Atomic size goes on decreasing while going from left to right in a period because:

i. Within a period, the atomic number increases one by one as a result nuclear charge increases.

ii. The outer electrons are adding in the same valence shell.

iii. Due to increased nuclear charge, the attraction of electrons by the nucleus increases.

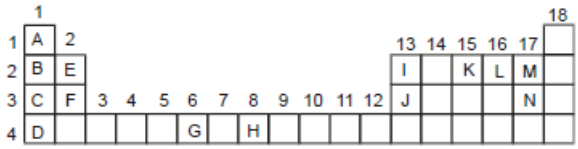
iv. Therefore, the size of the atom decreases with the increase in atomic number (number of protons).



Thus, element M has smallest atom in period 2.

6 D. Question

An incomplete form of the periodic table is given below. Write answers to the questions connecting the position of elements in it.



Which among them are transition elements?

Answer

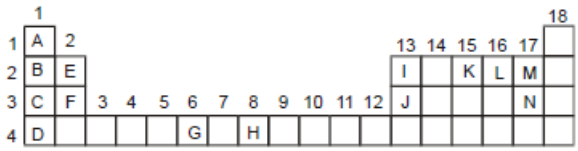
Elements G and H

The elements present in group 3 to 12 in the periodic table are called transition elements.

G belongs sixth group and H belongs to eighth group. Hence, G and H are transition elements.

6 E. Question

An incomplete form of the periodic table is given below. Write answers to the questions connecting the position of elements in it.



Which of the elements L and M has the lowest electronegativity?

Answer

Element L

Both elements L and M belong to the same period.

Electronegativity increases along a period because:

The atomic radius goes on decreasing as we move from left to right due to which the attraction between the outer electrons and nucleus increases.

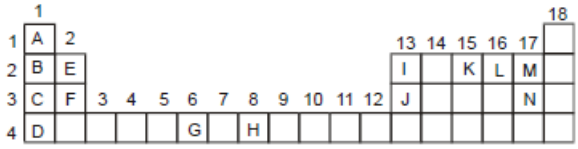
Also, there is increase in electronegativity with increase in ionization energy. Thus, L has lowest electronegativity.

To remember:

Electronegativity increases with decrease in atomic number and decreases with increase in atomic number.

6 F. Question

An incomplete form of the periodic table is given below. Write answers to the questions connecting the position of elements in it.



Among B and I which has higher metallic character?

Answer

B has higher metallic character

Metallic character goes on decreasing across a period because:

i. As we move from left to right, nuclear charge increases with increase in atomic number. This increase the force of attraction of electrons by the nucleus.

ii. As a result, the tendency of losing electrons goes on decreasing.

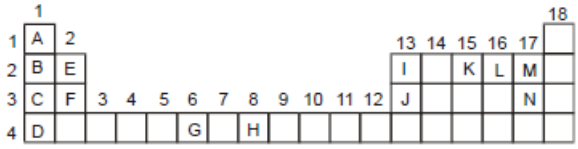
iii. Therefore, metallic character decreases within a period.

Thus, B has higher metallic character.

Note: More easily an element loses electrons, higher will be its metallic character (electropositive character)

6 G. Question

An incomplete form of the periodic table is given below. Write answers to the questions connecting the position of elements in it.



Which among these are included in the halogen family?

Answer

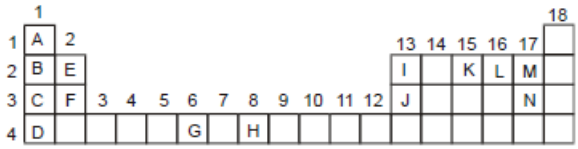
Elements M and N

The elements which belongs to group 17are called halogens. These elements only need one electron to achieve noble gas configuration.

M and N belong to group. Hence, they are halogens.

6 H. Question

An incomplete form of the periodic table is given below. Write answers to the questions connecting the position of elements in it.



Which is the element that resembles E the most in its properties?

Answer

Aluminium

Beryllium resembles aluminium because:

i. Both form covalent compounds.

ii. Both have high melting point.

Extended activities

1. Question

Prepare a paper to be presented at a seminar based on the topic ‘Earlier attempts of classification of elements’

Answer

‘Earlier attempts of classification of elements’

i. In 1789, the French scientist Antoine Lavoiser classify the known elements into metals and non-metals. But by that time, he was not able to classify metalloids which show the properties of both metals and non-metals.

ii. In 1807, John Dalton discovered an Atomic Theory. He concluded that each element has a fixed mass.

iii. In 1829, the German Chemist, J.W Dobereiner was the first to consider the idea of trends among properties of elements. He showed that the atomic mass of the middle element was approx. equal to the mean of atomic masses of other two elements.

iv. In 1862, ChanCourtoise put forward the idea of “Telluric helix” to classify elements. He arranged the atoms in spirally ascending order of their atomic masses in a cylindrical way. He noticed that elements of similar properties will line up vertically.

v. In 1863, John Alexander Newlands proposed the law of octaves. Law of octaves states that “every eighth element has properties similar to the firsts element”

vi. In 1868, The German scientist Julius Lothar Meyer plotted a graph of atomic volume against the atomic mass of theelements. He concluded that atomic mass is the fundamental property of elements.

2. Question

Prepare the biographical notes of scientists related to the classification of elements.

Answer

i. Antoine Lavoiser

He was born in 19^{th} of August, 1830 in Germany. He was an German chemist. He was one of them who made periodic table successful.

ii. John Dalton

He was born in 6^{th} of September, 1766 in England. He was an English chemist, physicist, meteorologist. He discovered atomic theory. He discovered gas laws too.

iii. ChanCourtois

He was born in 20^{th} January 1820. He was French geologist and mineralogist. He died in 1886 in Paris. He was also one of them who made periodic table successful.

iv. John Alexander Newlands:

He was born in 26^{th} of November, 1837 in London. He was an English chemist who discovered the “law of octaves”. It was a significant attempt to classify the elements.

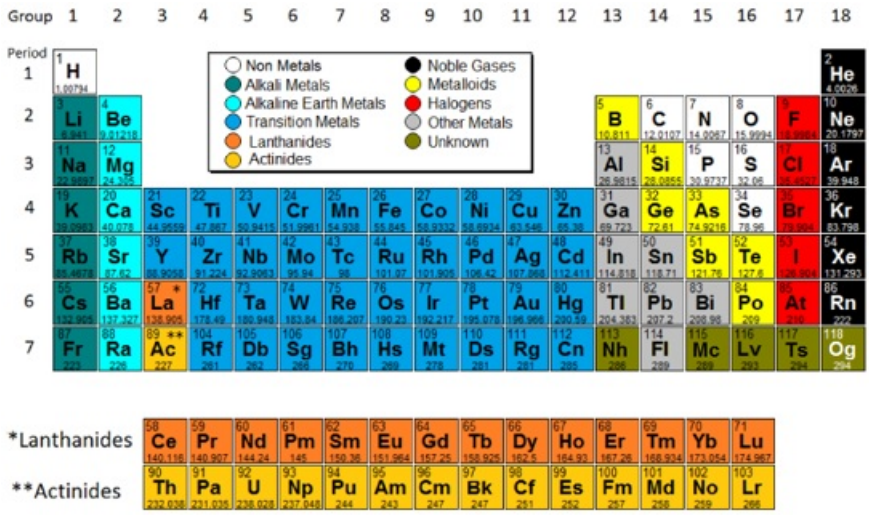
v. Julius Lothar Meyer

He was born in 13^{th} of December, 1780 in London. He was an English chemist who discovered the “law of octaves”. It was a significant attempt to classify the elements.

3. Question

Draw a model of the modern periodic table and exhibit in classroom.

Answer



4. Question

Find the uses of transition elements familiar to you. Prepare a note and present it.

Answer

Uses of transition elements:

i. They are used in the formation of alloys (a mixture of metal-metal or metal-non-metal)

ii. They are used as catalysts (increases the rate of reaction)

iii. They are used in the automobiles industries.

iv. They are also used in paints.

v. They are used in fertilizers.

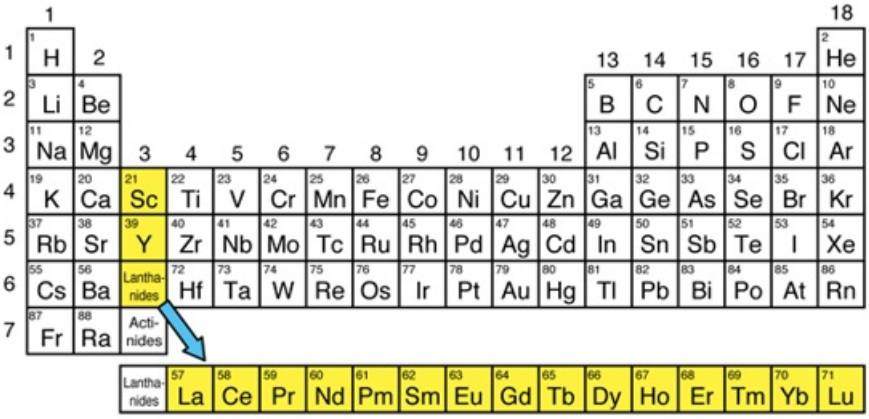
vi. They are used in the construction of building materials.

vii. They are used in cosmetics.

5. Question

Collect more information about rare earth elements. Prepare a note and present it in your class.

Answer



The elements with yellow boxes are rare earth metals.

Some information on rare earth metals:

i. They are silvery white soft metals.

ii. They are good conductors of heat and electricity.

iii. They have high melting point.

iv. They are used in the glass industries for polishing glass.

v. They give protection against UV light.

vi. They are used in making magnetic and electronic devices.

vii. They are quite reactive.

viii. They readily lose electrons and are thus good reducing agents.

ix. They have low ionization enthalpies.

x. They are used in making bullets and shells.