1. Structure of atom

Let us assess

1. Question

Names of some scientists and their contributions are given in a disordered way in the following table. Match them suitably.

Scientist	Contribution
John Dalton	Law of conservation of mass
Lavoisier	Law of constant proportion
Joseph Proust	Planetary model of atoms
J. J. Thomson	Atomic theory
Rutherford	Plum pudding model of atom

Answer

Scientist	Contribution
John Dalton	Atomic theory
Lavoisier	Law of conservation of mass
Joseph Proust	Law of constant proportion
J. J.Thomson	Plum pudding model of atom
Rutherford	Planetary model of atoms

2 A. Question

Atomic number of an atom Z = 17, Mass number = 35.

Find the number of protons, electrons and neutrons in the atom.

Answer

Since, atomic number of an atom = the number of protons.

Hence, the number of protons is 17.

Now, the number of protons = the number of electrons.

∴ The number of electrons is also 17.

Given: Mass number = 35

We know that mass number = number of protons + number of neutrons.

∴ Number of protons + number of neutrons = 35

⇒ 17 + number of neutrons = 35

⇒ Number of neutrons = 35 – 17

⇒ Number of neutrons = 18

2 B. Question

Atomic number of an atom Z = 17, Mass number = 35.

Write the electronic configuration of different shells.

Answer

The electronic configuration of different shells is as follows : -

K shell - 2 electrons

L shell – 8 electrons

M shell – 7 electrons

2 C. Question

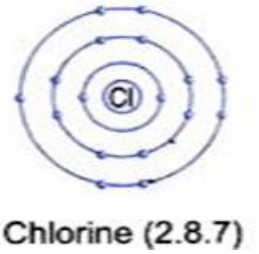
Atomic number of an atom Z = 17, Mass number = 35.

Draw the Bohr model of atom.

Answer

The given atom in the question is that of the Chlorine atom as it's atomic number is 17.

Hence, the Bohr model of atom (Chlorine atom) is: -



Chlorine (2.8.7)

3 A. Question

The mass number of an atom is 31. The M shell of this atom contains 5 electrons.

Write the electronic configuration.

Answer

The mass number of the atom is 31.

We know that mass number = number of protons + number of neutrons.

The M shell of this atom contains 5 electrons.

This condition could only be satisfied when the M shell has the following electronic

Configuration :- $3s^2\ 3p^3$ (5 electrons)

Upon filling the subsequent inner shells we have the following electronic configuration –

K shell - 2 electrons

L shell – 8 electrons

M shell – 5 electrons

Hence, the total number of electrons is 15.

3 B. Question

The mass number of an atom is 31. The M shell of this atom contains 5 electrons.

What is the atomic number of this atom?

Answer

As the given atom is electrically neutral.

Hence, the number of protons = the number of electrons

∴ Number of protons = 15

Since, atomic number of an atom = the number of protons

∴ Atomic number of an atom = 15.

3 C. Question

The mass number of an atom is 31. The M shell of this atom contains 5 electrons.

How many neutrons does this atom have?

Answer

We know that mass number = number of protons + number of neutrons.

∴ Number of protons + number of neutrons = 31

⇒ 15 + number of neutrons = 31

⇒ Number of neutrons = 31 – 15

⇒ Number of neutrons = 16

Hence, the atom is having 16 neutrons.

3 D. Question

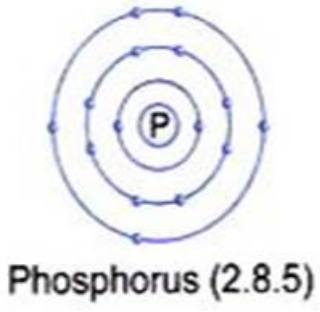
The mass number of an atom is 31. The M shell of this atom contains 5 electrons.

Draw the Bohr model of the atom.

Answer

The atom as mentioned in the question is that of the phosphorus atom as it is having an atomic number 15 with 15 electrons and protons and 16 neutrons.

The Bohr model of the atom is –

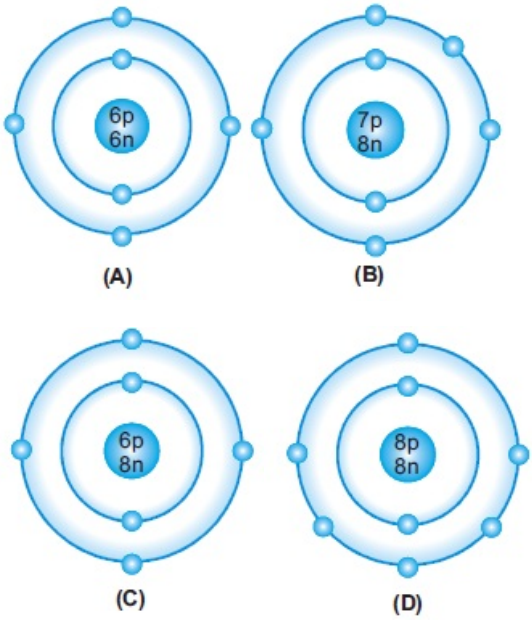


4. Question

Bohr models of atoms A, B, C, D are given (Symbols are not real).

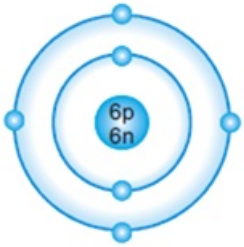
a) Write the atomic number, mass number and electronic configuration of the atoms,

b) Among these, which are isotxopes? Why?



Answer

a.



(A)

Here number of protons = the number of electrons = 6

Since, atomic number of an atom = the number of protons

Hence the atomic number of the atom = 6

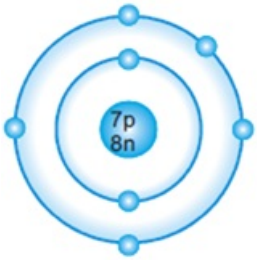
We know that mass number = number of protons + number of neutrons

∴ Mass number = 6 + 6 =12

Electronic configuration of the atom : -

K shell - 2 electrons

L shell – 4 electrons



(B)

Here number of protons = the number of electrons = 7

Since, atomic number of an atom = the number of protons

Hence the atomic number of the atom = 7

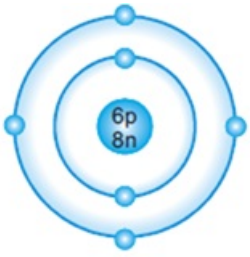
We know that mass number = number of protons + number of neutrons

∴ Mass number = 7 + 8 =15

Electronic configuration of the atom : -

K shell - 2 electrons

L shell – 5 electrons



(C)

Here number of protons = the number of electrons = 6

Since, atomic number of an atom = the number of protons

Hence the atomic number of the atom = 6

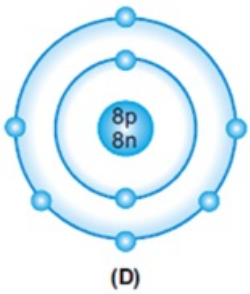
We know that mass number = number of protons + number of neutrons

∴ Mass number = 6 + 8 =14

Electronic configuration of the atom : -

K shell - 2 electrons

L shell – 4 electrons



(D)

Here number of protons = the number of electrons = 8

Since, atomic number of an atom = the number of protons

Hence the atomic number of the atom = 8

We know that mass number = number of protons + number of neutrons

∴ Mass number = 8 + 8 =16

Electronic configuration of the atom: -

K shell - 2 electrons

L shell – 6 electrons

b). Isotopes – These are the chemical species having the same atomic number but different mass numbers.

In the above given atoms A and C have the same atomic number and differ only in the matter of number of neutrons present in their respective nucleus.

Hence, atom A and C are isotopes.

5 A. Question

Symbols (not real symbols) of some atoms are given.

$^{17}_{8}\mathrm{P}$ $^{36}_{18}\mathrm{Q}$ $^{16}_{8}\mathrm{R}$

Find the atomic number and mass number of these elements.

Answer

For P the atomic number is 8 and the mass number is 17.

For Q the atomic number is 18 and the mass number is 36.

For R the atomic number is 8 and the mass number is 16.

5 B. Question

Symbols (not real symbols) of some atoms are given.

$^{17}_{8}\mathrm{P}$ $^{36}_{18}\mathrm{Q}$ $^{16}_{8}\mathrm{R}$

Which among these are isotopic pairs?

Answer

Isotopes are the chemical species which have the same atomic number but different mass numbers.

In the given atoms, atom P and R have the same atomic number but different mass numbers.

Hence atoms P and R makes an isotopic pair.

5 C. Question

Symbols (not real symbols) of some atoms are given.

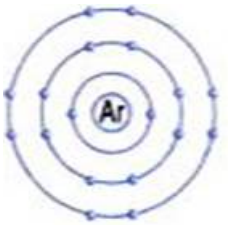
$^{17}_{8}P$ $^{36}_{18}Q$ $^{16}_{8}R$

Draw the Bohr model of atom Q.

Answer

Atom Q with atomic number 18 and mass number 36 is an Argon atom.

The Bohr model of an Argon atom is : -



Argon (2.8.8)

Extended activities

1. Question

Prepare a science magazine including photos, profiles and contributions of philosophers and scientists related to the history of atoms.

Answer

History of Atomic Theory

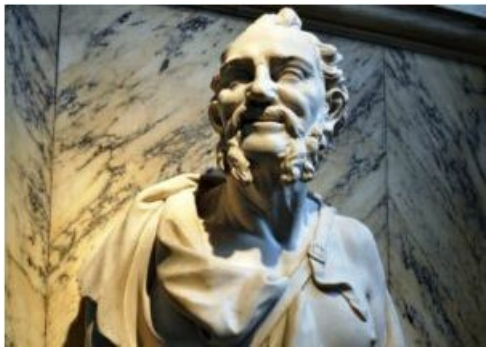
Picture an atom. What does it look like? Most likely it will resemble something like this: a fairly large nucleus surrounded by orbiting electrons whizzing around the nucleus. This image is a popular icon of the atom, but it only vaguely represents our current model of what the atom looks like.

The Early Greeks

Travelling back a little over 2,000 years ago to the times of Aristotle and Democritus. The Greek philosopher Aristotle believed that matter could be divided infinitely without changing its properties. Democritus disagreed. He thought that matter could only be divided until you got to the smallest particle (which he called the atom, coming from the Greek word *atomos*, meaning *indivisible*). So, who was right? Aristotle was very convincing and did many experiments using the scientific method, so more people believed him.

Scientists related with Atomic Theory

Democritus



Democritus was the world’s first great atomic philosopher. He was born in Thrace, Greece around 460 B.C. Democritus studied under Leucippus in Abdera, and spent his inheritance in research abroad.

Democritus was interested in all branches of philosophy, mathematics, astronomy, and medicine. He wrote many books. He was a cheerful philosopher and lived to the age of 80. Meanwhile, his theories now is used

as the basic knowledge in many basic fields.

Democritus’s Contribution to The Atom Theory

Democritus said the world was made of only two things: “The vacuum of empty space and the fullness of matter.” All matter consisted of particles, so small that nothing smaller could be imagined. These particles were indivisible, the word atom itself mans “that which cannot be cut.” These atoms were eternal, unchangeable, and indestructible. Beside this great theory, his idea were based strictly on deductive reasoning, not on experimenting and testing.

Rhazes

He is also known as Abu Bakr Muhammad bin Zakariyya, he was born on 854 – 930, in Rayy near the city of Teheran, in Abbasyid Calliphate era (now Iran). He was a Persian. Meanwhile, Rhazes is famous as a polymath, because he is a physician, a philosopher, and an alchemist.

In Rayy, his homeland, he was well trained in the Greek Sciences. He loved musical field and he learned the musical performance in his youth. In middle age, he works in chemistry field and he invented many contributions to chemistry.

But in his later life, there was an accident that almost made him eyes blind. Because of this accident, he decided not to work in chemistry field anymore, he switch to another medicine field. He was founded the first hospital in Rayy, Iran. This hospital later became his most valuable legacy in medieval Islamic golden age .Today many scientist argued he was The Creator of Modern Science, because many his contribution that influenced the chemistry world.

Rhazes’s Contribution in Atom Theory

Rhazes wrote many literature about nature of matter, his expose of the risks of ignoring the axioms of geometry, may aim at kalam defenders of dimensional atoms. It became the famous theory known as The Physical *Theory of Kalam*. This theory has a unique history, when Rhazes tried for searched about the soul where he thought the atom is the smallest unit in our soul.

At the beginning of development *Theory of Kalam,* he wanted contribute for philosophy science, but later he felt this theory could influence chemistry area, especially in Atomic Theory subject. Rhazes had analyzed the concept of atoms as a ‘space-occupying object’ without dimension yet having magnitude. It examines the manner of the atom‘s occupation of space, and discusses arguments for and against unoccupied spaces of the void.

His *Kalam Theory* was influenced by Pythagoreanism about square side with it’s diagonal effect to atom and his view also influenced by Aristotle theory The Four Elements which made change to atom movement in the space. Today, he became known for his contribution about his systematize chemistry laboratory practice where this method is common used in today chemistry experiment.

Robert Boyle

Robert Boyle was born on January 25, 1627 . He was a British natural philosopher, particularly in the field of

chemistry. In 1654, he was invited to Oxford, and he took up residence at the university from 1656 until 1668. His mother died when he was three years old, so his very loving father raised him. In 1654, he settled in Oxford, where he did much of his work with Robert Hooke.

He wrote in his book, *The Philosophical Works of the Honourable Robert Boyle*, about the many conflicting remedies and various diagnoses of the physicians of his time. He classified substances as acids, bases, or salts. Boyle was the pioneer in collect and isolate a gas.

Boyle's contribution to Atom Theory

His contributed to chemistry, especially in Atomic Science. His brand of atomism which claimed that everything was composed of minute but not indivisible particles, of a single universal matter and that these particles were only differential by their shape and motion. His most famous contribution was the definition of an element which the element could be made from 2 or more substance which is not an element.

John Dalton

John Dalton was born on September 5, 1766 in England. Dalton's father owned a house and a small land which made Dalton easier for took his education in his childhood. From his childhood he was a smart person, because he had interest about his surroundings and he always tried for learning this as much as he could. When he became adult, he explored in Meteorological Field. He had been a meteorologist and later he became a chemist.

John Dalton was famous because he was a pioneer in the development of modern atomic theory. Dalton had published a famous essays with the title Meteorological Observations and Essays. Today, Dalton become famous because he is the first pioneer in modern atomic theory. Many people consider him as the Creator of the Modern Atom Science.

Dalton's Contribution to Atom Theory

Dalton's most influential work in chemistry was his atomic theory. The theoretical foundation of Dalton's atom theory was mainly based on the law of conservation of mass and the law of definite proportional), both of which had already been established, he based his theory of partial pressures on the idea that only like atoms in a mixture of gases repel one another, whereas unlike atoms appear to react indifferently toward each other.

The atom of Democritus may be said to be as a kind of miniature of matter. Dalton used the term 'particle' for what we now call a 'molecule', the smallest part of a substance. He used the word 'atom' to refer to the tiniest part of a simple body or an element. Hence the number of the type of atoms is equal to that of the type of matter. On the other hand, Dalton's atom is a constituent of matter, and many compounds are formed by the combination of a limited number of atoms.

Amedeo Avogadro

Avogadro was born on August 9, 1776, Italy. An Italian mathematical physicist. At first he followed the family route by taking studies in law and theology. He attended the campus *l'Avvocatura dei Poveri* in 1896, then *l'Avvocatura Generale.*

Avogadro became *Secrétaire du Département* d'Eridanus in 1801. At this time, he was started interest in natural sciences and mathematics and he pursued it. Then, he entered a university course in physics. In 1804, aged 28, he sent two essays on electricity to the Academy of Sciences of Turin, of which he became a corresponding member.

Avogadro's Contribution to Atom Theory

The first of his work, known as Avogadro's hypothesis, lead to the present notion of the mole, and is characterized by the Avogadro number (N). The second allowed for a distinction to be made between O and O2, namely, the atom and its molecule, and is the basis for the notion of a molecule.

Many Avogadro's ideas and methods anticipated later development in physical chemistry. His hypothesis is now regarded as a law, and the value known as Avogadro's number (6.02214179 x 1023), the number of molecules in a gram molecule, or model, of any substance, has become a fundamental constant of physical science. This atomic theory became a common knowledge for chemistry students today.

Dmitry Ivanovich Mendeleev

Mendeleev was born on January 27 1834, Russian Empire (now is Russia). His grandfather was Pavel Maximovich Sokolov, a priest of the Russian Orthodox Church and a teacher of fine arts, politics and philosophy.

Mendeleev was raised as an Orthodox Christian. In 1850, Mendeleev entered to Saint Petersburg University and after graduation he moved to the Crimean Peninsula in the northern coast of the Black Sea in 1855. He had won the Demidov Prize of the Petersburg Academy of Sciences. By his textbook,"Organic Chemistry."

Mendeleev's Contribution to Atom Theory

After studying the alkaline earth elements , Mendeleev established that the order of atomic weights could be used not only to arrange the elements within each group but also to arrange the group themselves. His effort was discovered the periodic law. This periodic law known as periodic table.

Mendeleev became famous for his table and periodic law. Now many students use his table to learn Chemist. Mendelev also created the atomic data which made him discovered what is called the Periodic Law. In purpose for increasing atomic mass, he was arranged the elements. From his atom experiment, he discovered the properties was repeated. On his table, periodically the properties were repeated. Because of this, this system is known as periodic table.

famous of his table and periodic law. Now many students use his table to learn Chemist.

Homi Jehangir Bhabha

Homi Jehangir Babha was born on 30 October 1909 in Mumbai, India. In Mumbai, he attended the Cathedral & John Connon School and then Elphinstone College, followed by the Royal Institute of Science. He earned his engineering degree in the year 1930 and Ph.D. in 1934.

He wrote his doctorate in nuclear physics The Absorption of Cosmic Radiation about absorption features and electron shower production in cosmic rays, made him win the Issac Newton Studentship in 1934. Bhabha

established the Tata Institute of Fundemental Research(TIFR) for carrying out nuclear science research in 1945. This made him as “The Father of India’s Nuclear Program”.

Bhabha’s Contribution in Atom Theory:

In 1937, together with W.Heitler, a German physicist, Bhabha solved the riddle about cosmic rays. Cosmic rays are fast moving, extremely small particles coming from outer space. When these particles enter the earth’s atmosphere, they collide with the atoms of air and create a shower of electrons. Bhabha’s discovery of the presence of nuclear particles (which he called mesons) in these showers was used to validate Einstein’s theory of relativity making him world famous.

Meanwhile, there are many scientist who contributed to the atomic theory such as Einstein, Boyle, and more. Their theories now is used in many applications of life, mostly in chemistry studies. Indeed, we may look better on their movements, researches, and knowledge.

Some scientists and their contribution to Atomic Structure

Wilhelm Röntgen (1845-1923)

He is german physicist who discovered X-rays in 1895 after observing that a sheet of paper coated with barium platinocyanide glowed when a cathode ray tube (CRT) was turned on. (A CRT is a high-vacuum tube in which cathode rays produce a luminous image on a fluorescent screen, used chiefly in televisions and computer terminals.) X-rays are electromagnetic radiation of high energy that is able to pass through many materials opaque to visible light. He received the first Nobel Prize in physics in 1901.

Henri Becquerel (1852-1908)

French physicist who, in 1896, while investigating fluorescence in uranium salts, accidentally discovered radioactivity, the spontaneous emission of radiation by a material. Later, Becquerel demonstrated that the radiation emitted by uranium shared certain characteristics with X rays but, unlike X rays, these could be deflected by a magnetic field and therefore must consist of charged particles. The full impact of Becquerel's discovery was not appreciated, however, until the work of Marie and Pierre Curie, with whom he shared the 1903 Nobel Prize in physics.

Sir Joseph John Thomson (1856-1940)

English physicist who conducted a series of experiments on cathode rays. He observed that the beam of light in the cathode ray tube is attracted to a positive charge and repelled by a negative charge. In 1897 he concluded that the rays consist of a stream of small, negatively charged particles that have a mass less than one thousandth the mass of a hydrogen atom. Thomson has discovered the electron. From this point onward,

it becomes increasingly clear that atoms are not fundamental particles, but in fact are made up of smaller particles. He received the Nobel Prize in physics in 1906.

Max Planck (1858-1947)

German physicist who formulated an equation describing the blackbody spectrum in the year 1900. Planck's spectrum was obtained by postulating that energy was directly proportional to frequency, $E = h\nu$. Planck believed that this quantization applied only to the absorption and emission of energy by matter, not to electromagnetic waves themselves. However, it turned out to be much more general than he could have imagined. Planck received the Nobel Prize in physics in 1918 for his quantum theory after it was successfully applied to the photoelectric effect by Einstein and the atom by Niels Bohr.

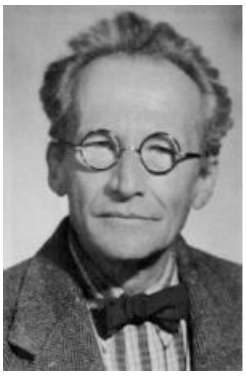
Ernest Rutherford (1871-1937)

English physicist born in Nelson, New Zealand. In 1906, his students Geiger and Marsden conducted the classic gold foil alpha particle scattering experiment which showed large deflections for a small fraction of incident particles. This led Rutherford to propose that the atom was "nuclear." For his discoveries, Rutherford was awarded the 1908 Nobel Prize in chemistry. Rutherford suggested the fundamental positive charged particle, which he called the proton in 1914.

Niels Bohr (1885-1962)

Danish physicist who proposed a successful quantum model for the atom in 1913. His model assumed that (1) the electron exists at precise distances from the nucleus, (2) as long as an electron remains in one location, no energy is given off, (3) electrons have circular orbits (this is only correct for s orbitals), and (4) the angular momenta associated with allowed electron motion are integral multiples of $h/2\pi$. Awarded Nobel Prize in physics, 1922.

Erwin Schrödinger (1887-1961)



Austrian physicist who invented wave mechanics in 1926. Wave mechanics was an independent formulation of quantum mechanics to Heisenberg's matrix mechanics. Like matrix mechanics, wave mechanics mathematically described the behaviour of electrons and atoms. The central equation of wave mechanics, now known as the Schrödinger equation, turned out to be much simpler for physicists to solve in most cases. He was awarded Nobel Prize in physics, 1933.

James Chadwick, (1891-1974)

English physicist who worked with Rutherford on the experiment of bombardment of elements with alpha particles. In the 1920s, Rutherford and Chadwick attempted to find a uncharged elementary particle, but failed. Then, Chadwick repeated the earlier experiment of Bothe and Frédéric and Iréne Joliot-Curie by exposing beryllium to alpha particles. The beryllium then gave off radiation which could eject protons from paraffin. In 1932, Chadwick showed that a neutral particle beam was the only way to interpret the ejection of protons. This amounted to the discovery of the neutron. For this, he received the 1935 Nobel Prize in physics.

2. Question

Construct and exhibit Bohr models of various atoms using different materials viz. beads, seeds, etc.

Answer

We can construct to exhibit the Bohr models of various atoms using beads or seeds and perform this as a class learning activity to understand the underlying principles more clearly.

To perform the activity we need to first arrange some items as follows: -

1. Coloured beads or seeds of different colours. If using coloured bead choose three different colours as white, blue and grey. The quantity of the bead required should be as per requirement.

2. Threads (to be distributed as per requirement of length).

3. Pipe cleaners

4. Periodic table.

5. Holder

Demonstration

We would build the model of a Boron atom. A Boron atom has 5 electrons, 5 neutrons and 5 protons.

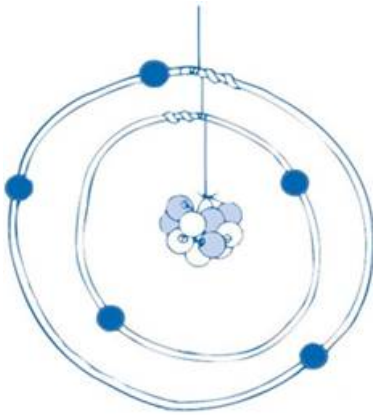
Before starting construction it should be assumed that the blue beads are the electrons, the grey ones the protons and the white ones are the neutrons.

1. Take a pipe cleaner and insert two blue beads into it to represent the 2 electrons in the inner shell and then tie the two ends of the cleaner with a thread.

2. Take another pipe cleaner and insert three blue beads into it to represent the 3 electrons in the outer

shell and then again tie the two ends of the cleaner with a thread.

3. Attach five white beads and 5 grey beads as a bunch with the help of a thread and knot them as shown in the following figure and thus completing the construction of the Boron atom model.



Construct the models for other atoms as well by referring to the periodic table.

3. Question

Prepare a table illustrating the electronic configuration of elements with atomic number from 1 to 36.

Answer

Table illustrating the electronic configuration of elements with atomic number from 1 to 36 : -

Element	Atomic Number	Number of Electrons	Electronic Configuration (shell wise)			
			K	L	M	N
H	1	1	1			
He	2	2	2			
Li	3	3	2	1		
Be	4	4	2	2		
B	5	5	2	3		
C	6	6	2	4		
N	7	7	2	5		
O	8	8	2	6		
F	9	9	2	7		
Ne	10	10	2	8		
Na	11	11	2	8		
Mg	12	12	2	8	1	
Al	13	13	2	8	2	
Si	14	14	2	8	3	
P	15	15	2	8	4	
S	16	16	2	8	5	
Cl	17	17	2	8	6	
Ar	18	18	2	8	7	

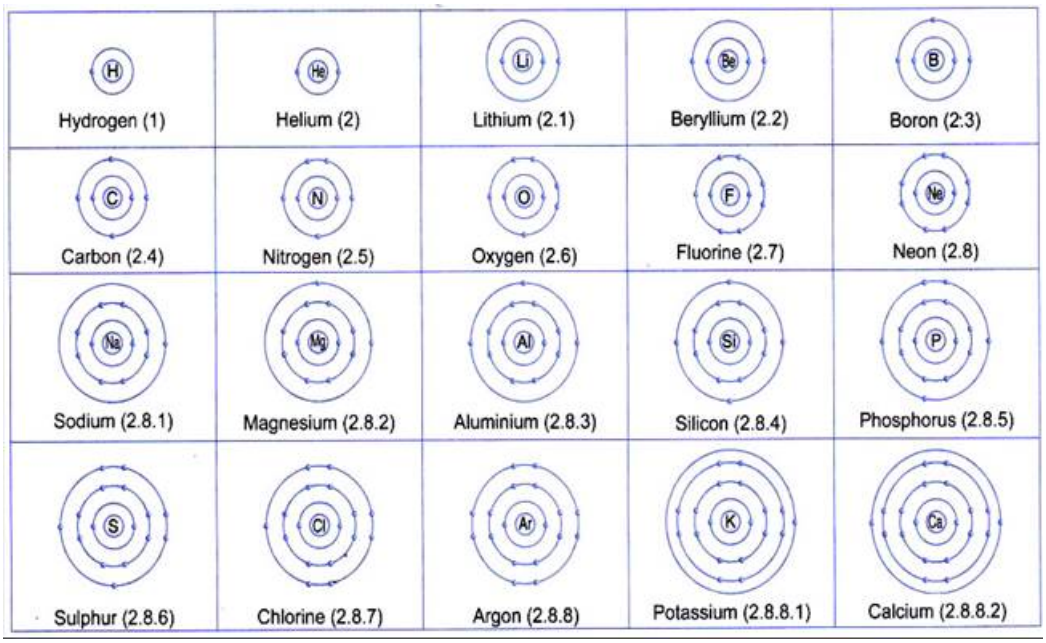
K	19	19	2	8	8	1
Ca	20	20	2	8	8	2
Sc	21	21	2	8	9	2
Ti	22	22	2	8	10	2
V	23	23	2	8	11	2
Cr	24	24	2	8	13	1
Mn	25	25	2	8	13	2
Fe	26	26	2	8	14	2
Co	27	27	2	8	15	2
Ni	28	28	2	8	16	2
Cu	29	29	2	8	18	1
Zn	30	30	2	8	18	2
Ga	31	31	2	8	18	3
Ge	32	32	2	8	18	4
As	33	33	2	8	18	5
Se	34	34	2	8	18	6
Br	35	35	2	8	18	7
Kr	36	36	2	8	18	8

4. Question

Draw and exhibit Bohr models of atoms of elements with atomic number 1 to 20.

Answer

Bohr models of atoms of elements with atomic number 1 to 20



5. Question

Prepare a table featuring more examples of isotopes, isobars and isotones.

Answer

Isotopes – These are the atoms of the same element having the same number of protons but different number of neutrons or we could also say that these are the chemical species having the same atomic number but different mass numbers.

Table featuring examples of isotopes : -

Isotope	Atomic No. (Z)	Mass No. (A)	Protons (= Z)	Neutrons (= A – Z)
Hydrogen–1	1	1	1	0
Hydrogen–2	1	2	1	1
Hydrogen–3	1	3	1	2
Helium–3	2	3	2	1
Helium–4	2	4	2	2
Lithium–6	3	6	3	3
Lithium–7	3	7	3	4
Beryllium–9	4	9	4	5
Boron–10	5	10	5	5
Boron–11	5	11	5	6
Carbon–12	6	12	6	6
Carbon–13	6	13	6	7
Carbon–14	6	14	6	8
Nitrogen–13	7	13	7	6
Nitrogen–14	7	14	7	7
Nitrogen–16	7	16	7	9
Oxygen–16	8	16	8	8
Oxygen–17	8	17	8	9
Oxygen–18	8	18	8	10
Fluorine–19	9	19	9	10
Neon–20	10	20	10	10
Neon–21	10	21	10	11
Neon–22	10	22	10	12

Isobars – The atoms which have the same mass number but different atomic number are called isobars.

Table featuring examples of isobars

Equivalent mass number	Elements with the same mass number (Isobars)
40	Ar(Z=18, A=40), Kr(Z=19,A=40), Ca(Z=20,A=40)
37	Cl (Z = 17, A=37) , Ar (Z=18 , A =37)
235	U (Z = 92 , A =235) , Np (Z= 93, A =235), Pu (Z =94 , A = 235)

Isotones - Two atoms are called isotones if they have the same number of neutrons N, but different number of protons Z.

Table featuring examples of isotones

Equivalent number of neutrons	Elements with the same number of neutrons (Isotones)
7	B (A=12) , C (A = 13)
16	Si (A = 30) , P (A = 31) , S (A = 32)
8	C (A = 14), N (A = 15) , O (A = 16)
2	Li (A = 5) , Be (A = 6)
3	He (A =5) , Li (A =6)
4	He (A = 6), Li (A = 7) , Be (A = 8)
20	S (A = 36) , Cl (A = 37) , Ar (A = 38) , K (A =39), Ca (A = 40)
50	Kr (A = 86) , Sr (A =88), Y (A = 89) , Zr (A = 90) , Mo (A = 92)
82	Ba (A = 138), La (A = 139), Ce (A = 140), Pr (A = 141), Nd (A = 142), Sm (A = 144)