1. Which of the following correctly represent the electronic distribution in the Mg atom?

(a) 3, 8, 1 **(b)** 2, 8, 2 **(c)** 1, 8, 3 **(d)** 8, 2, 2

Answer: (b) 2, 8, 2

Explanation: At most two electrons can be found in the first shell. Hence option 'b' is correct while options (a) and (d) are incorrect.

2. Rutherford's 'alpha (α) particles scattering experiment' resulted in the discovery of:

(a) Electron **(b)** Proton **(c)** Nucleus in the atom **(d)** Atomic mass

Answer: (c) Nucleus in the atom

Explanation: The presence of a nucleus at the center of an atom was demonstrated by the discovery that some alpha particles returned on their original route.

3. The number of electrons in an element X is 15 and the number of neutrons is 16. Which of the following is the correct representation of the element?

a) $^{31}X_{15}$

b) $^{31}X_{16}$

c) $^{16}X_{15}$

d) $^{15}X_{16}$

Answer : (a) $^{31}X_{15}$

Explanation: Number of protons in an element depicts atomic number. A number of protons and electrons are equal in an element. Hence atomic number is written in subscript whereas the mass number is written in the subscript before the symbol of the element.

4. Dalton's atomic theory successfully explained:

(i) Law of conservation of mass (ii) Law of constant composition

(iii) Law of radioactivity (iv) Law of multiple proportions

(a) (i), (ii) and (iii)

(b) (i), (iii) and (iv)

(c) (ii), (iii) and (iv)

(d) (i), (ii) and (iv)

Answer: (d) (i), (ii) and (iv)

Explanation: Dalton's theory explained the law of conservation of mass, the law of constant composition and the law of multiple proportions. Dalton's theory did not talk about any law of radioactivity.

5. Which of the following statements about Rutherford's model of atom are correct?

(i) considered the nucleus was positively charged.

(ii) established that the α–particles are four times as heavy as a hydrogen atom.

(iii) can be compared to the solar system.

(iv) was in agreement with Thomson's model.

(a) (i) and (iii)

(b) (ii) and (iii)

(c) (i) and (iv)

(d) only (i)

Answer: (a) (i) and (iii)

Explanation: Alpha particles are positively charged and are deflected by the nucleus. This showed that the nucleus is positively charged. Rutherford also proposed that electrons in an atom are organized around the nucleus in the same way that planets in the Milky Way are clustered around the Sun.

6. Which of the following are true for an element?

(i) Atomic number = number of protons + number of electrons

(ii) Mass number = number of protons + number of neutrons

(iii) Atomic mass = number of protons = number of neutrons

(iv) Atomic number = number of protons = number of electrons

(a) (i) and (ii)

(b) (i) and (iii)

(c) (ii) and (iii)

(d) (ii) and (iv)

Answer: (d) (ii) and (iv)

Explanation: Atomic number (Z) = number of protons = number of electrons. Since an electron has negligible mass, the mass of protons and the mass of neutrons are taken into consideration while calculating the mass number (A).

Mass number (A) = number of protons + number of neutrons = number of nucleons

7. In Thomson's model of atoms, which of the following statements are correct?

(i) the mass of the atom is assumed to be uniformly distributed over the atom.

(ii) the positive charge is assumed to be uniformly distributed over the atom.

(iii) the electrons are uniformly distributed in the positively charged sphere.

(iv) the electrons attract each other to stabilize the atom.

(a) (i), (ii) and (iii)

(b) (i) and (iii)

(c) (i) and (iv)

(d) (i), (iii) and (iv)

Answer: (a) (i), (ii) and (iii)

Explanation: Thomson proposed that negatively charged electrons are stabilized by positively charged nuclei. Hence, option (iv) is not correct as ike charges cannot attract each other. The rest of the options are correct according to Thomson's model of atom

8. Rutherford's α- particle scattering experiment showed that:

(i) electrons have negative charge.

(ii) the mass and positive charge of the atom is concentrated in the nucleus.

(iii) neutrons exist in the nucleus.

(iv) most of the space inside an atom is empty.

Which of the above statements are correct?

(a) (i) and (iii)

(b) (ii) and (iv)

(c) (i) and (iv)

(d) (iii) and (iv)

Answer: (b) (ii) and (iv)

Explanation: The mass and positive charge of the atom are concentrated in the nucleus, and most of the atom's space is empty, according to Rutherford's particle scattering experiment.

9. The ion of an element has 3 positive charges. Mass number of the atom is 27 and the number of neutrons is 14. What is the number of electrons in the ion?

(a) 13 (b) 10 (c) 14 (d) 16

Answer: (b) 10

Explanation: Mass number (A) of the element = 27

Number of neutrons in the atom =14

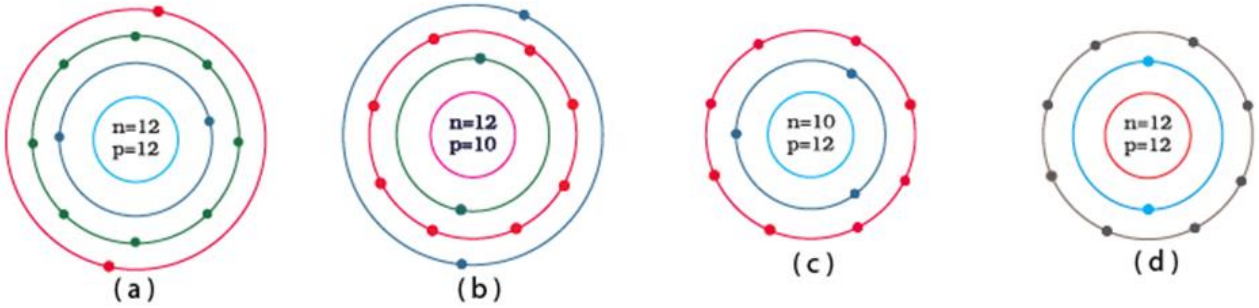
Hence, the number of electrons in atom = Mass number(A) – number of neutrons in atom

=27 – 14 = 13

Since the ion of the element has 3 positive charges, so number of electrons in the ion is 13 - 3.

The number of electrons in the ion is 10.

10. Identify the Mg2+ ion from the Fig.4.1 where, n and p represent the number of neutrons and protons respectively.



Answer: d)

Explanation:

Number of protons in Mg atom = 2 + 8 + 2 = 12

Number of neutrons in Mg atom = 24 - 12 = 12

[as mass number of Mg atom = 24 and number of neutrons = mass number – number of protons]

11. In a sample of ethyl ethanoate ($CH_3COOC2H5CH3COOC_2H_5$**), the two oxygen atoms have the same number of electrons but different number of neutrons. Which of the following is the correct reason for it?**

(a) One of the oxygen atoms has gained electrons.

(b) One of the oxygen atoms has gained two neutrons.

(c) The two oxygen atoms are isotopes.

(d) The two oxygen atoms are isobars.

Answer: (c) The two oxygen atoms are isotopes.

Explanation: Isotopes are atoms of the same element (with same atomic number) with different mass numbers. The difference in mass number is because of the different number of neutrons present in the atoms.

12. Elements with valency 1 are:

(a) always metals. (b) always metalloids.

(c) either metals or non-metals. (d) always non-metals.

Ans: (c) either metals or non-metals.

Explanation: If an element shows positive valency (like sodium), it is a metal; otherwise (negative valency like chlorine) it is a non-metal.

13. The first model of an atom was given by:

(a) N. Bohr **(b) E. Goldstein**

(c) Rutherford **(d) J.J. Thomson**

Answer: (d) J.J. Thomson

14. An atom with 3 protons and 4 neutrons will have a valency of:

(a) 3 (b) 7 (c) 1 (d) 4

Answer: (c) 1

Explanation: Electronic configuration of this element will be 2, 1 (Atomic number Z = 3) Since the number of electrons in the outermost shell is 1, hence the valency of the atom will be 1.

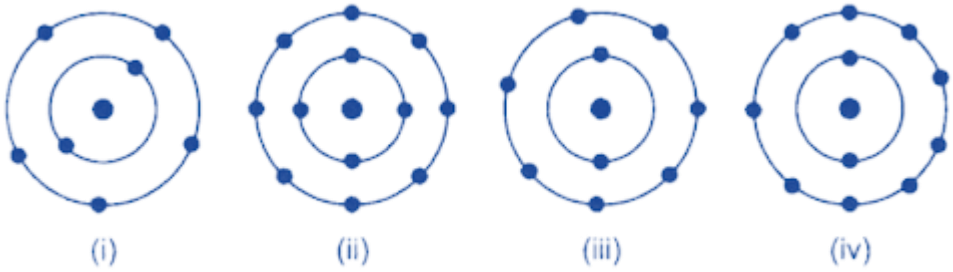
15. The electron distribution in an aluminium atom is:

(a) 2, 8, 3 (b) 2, 8, 2 (c) 8, 2, 3 (d) 2, 3, 8

Ans: (a) 2, 8, 3

Explanation: The atomic number of aluminium is 13 and the first shell can have at the most two electrons. Hence, option (a) is correct.

16. Which of the following in Fig. 4.2 do not represent Bohr's model of an atom correctly?



(a) (i) and (ii)

(b) (ii) and (iii)

(c) (ii) and (iv)

(d) (i) and (iv)

Answer: (c) (ii) and (iv)

Explanation: The first shell cannot have more than 2 electrons and the second shell cannot have more than 8 electrons.

17. Which of the following statements is always correct?

(a) An atom has an equal number of electrons and protons.

(b) An atom has an equal number of electrons and neutrons.

(c) An atom has an equal number of protons and neutrons.

(d) An atom has an equal number of electrons, protons and neutrons.

Answer: (a) An atom has an equal number of electrons and protons.

Explanation: An atom is electrically neutral. As a result, the number of protons and electrons should be equal.

18. Atomic models have been improved over the years. Arrange the following atomic models in the order of their chronological order:

(i) Rutherford's atomic model

(ii) Thomson's atomic model

(iii) Bohr's atomic model

(a) (i), (ii) and (iii)

(b) (ii), (iii) and (i)

(c) (ii), (i) and (iii)

(d) (iii), (ii) and (i)

Answer: (c) (ii), (i) and (iii)

Explanation:

Thomson's atomic model was proposed in the year 1904

Rutherford's atomic model was proposed in the year 1911

Bohr's atomic model was proposed in the year 1913

Short Answer Questions

19. Is it possible for the atom of an element to have one electron, one proton and no neutron? If so, name the element.

Answer: Yes, this is true for protium, a common and stable hydrogen isotope which is represented as ${}_{1}^{1}H$.

20. Write any two observations which support the fact that atoms are divisible.

Answer: The discovery of electrons and protons bolsters the idea that atoms are divisible. During a chemical reaction, electrons are transferred or shared between distinct atoms, causing atoms to rearrange.

21. Will ^{35}Cl and ^{37}Cl have different valencies? Justify your answer.

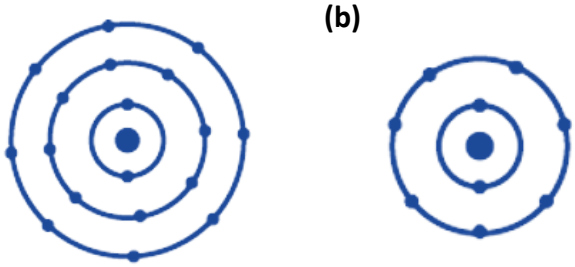
Answer: ^{35}Cl and ^{37}Cl are isotopes of the same element - chlorine. Isotopes have the same number of electrons. Hence, their valencies do not differ. They have the same valency.

22. Why did Rutherford select a gold foil in his α–ray scattering experiment?

Answer: Rutherford sought a metal sheet that could be as thin as feasible for the scattering experiment. The most malleable of all known metals is gold. It's simple to make very thin sheets out of it. Rutherford chose gold foil for his alpha-ray scattering experiment as a result.

23. Find out the valency of the atoms represented by the Fig. 4.3 (a) and (b).

(a) **(b)**



Answer: Because it has 8 electrons in the valence shell and has acquired a stable conformation, atom (a) has zero valency. Because it has seven electrons in its valence shell, atom (b) has a valence of one. In order to obtain a stable (octet) configuration, atom (b) can receive more electrons.

24. One electron is present in the outermost shell of the atom of an element X. What would be the nature and value of charge on the ion formed if this electron is removed from the outermost shell?

Answer: When the single electron present in the outermost shell of the atom of an element X is removed, the atom loses negative charge and forms a positively charged ion with + 1 charge. The amount of charge present on one electron equals the value of the net charge on the ion.

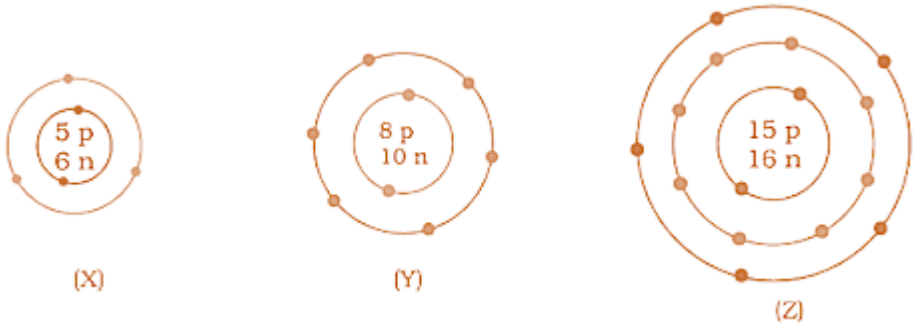
25. Write down the electron distribution of chlorine atoms. How many electrons are there in the L shell? (Atomic number of chlorine is 17).

Answer: Chlorine's electrical configuration will be 2, 8, 7 since its atomic number (Z) is 17. The L shell consists of eight electrons (second shell).

26. In the atom of an element X, 6 electrons are present in the outermost shell. If it acquires a noble gas configuration by accepting a requisite number of electrons, then what would be the charge on the ion so formed?

Answer: Since 6 electrons are already present in the outermost shell of the atom, this element requires two more electrons in order to acquire the noble gas configuration. When the atom accepts 2 more electrons , the charge on the ion formed would be -2.

27. What information do you get from the given figure about the atomic number, mass number and valency of atoms X, Y and Z? Give your answer in a tabular form.



Answer: The atomic number, mass number and valency of the atoms X, Y and Z are given on the table below:-

	Atomic No.	**Mass No.**	**Valency**
X	5	11	3
Y	8	18	2
Z	15	31	3,5

28. In response to a question, a student stated that in an atom, the number of protons is greater than the number of neutrons, which in turn is greater than the number of electrons. Do you agree with the statement? Justify your answer.

Answer: The statement of the student is not correct. The number of protons in an atom can never be greater than the number of neutrons. The number of protons will be equal to or less than the number of neutrons. In a neutral atom, the number of electrons and protons is always the same.

29. Calculate the number of neutrons present in the nucleus of an element X which is represented as $^{31}_{15}X$

Answer: Mass number (A) = No. of protons (Z) + No. of neutrons

The mass number, on the other hand, is provided as 31, and the number of protons is reported as 15.

No. of protons (Z) + No. of neutrons = 31

Number of neutrons = 31 − number of protons= 31 − number of protons

Number of neutrons = 31 − 15 = 16

16 neutrons are present in the nucleus of the element X.

30. Match the names of the Scientists given in column A with their contributions towards the understanding of the atomic structure as given in column B

Column A	Column B
(a) Ernest Rutherford	(i) Indivisibility of atoms
(b) J.J. Thomson	(ii) Stationary orbits
(c) Dalton	(iii) Concept of nucleus
(d) Neils Bohr	(iv) Discovery of electrons
(e) James Chadwick	(v) Atomic number
(f) E. Goldstein	(vi) Neutron
(g) Mosley	(vii) canal ray

Answer: (a) - (iii); (b) - (iv); (c) - (i); (d) - (ii); (e) - (vi); (f) - (vii); (g) - (v)

31. The atomic number of calcium and argon are 20 and 18 respectively, but the mass number of both these elements is 40. What is the name given to such a pair of elements?

Answer: Elements with the same mass number (A) but different atomic numbers (Z) are called isobars. Calcium and Argon are isobar

32. Complete the Table 4.1 on the basis of information available in the symbols given below:

(a) $^{35}_{17}Cl$

(b) $^{12}_{6}C$

© $^{81}_{35}Br$

Element	n_p	n_n

Ans: The table can be completed as follows:-

Element	n_p	n_n
Cl	17	18
C	6	6
Br	35	46

n_p of Cl = Atomic number = 17

n_n of Cl = Mass number − Atomic number = A – Z = 35 − 17

n_p o f C = Atomic number= 6

n_n of C = Mass number − Atomic number = A – Z = 12 – 6 = 6

n_p of Br = Atomic number = 35

n_n of Br= Mass number − Atomic number = A – Z = 81 – 35 = 46

33. Helium atom has 2 electrons in its valence shell but its valency is not 2. Explain.

Answer: The outermost shell of the helium atom possesses two electrons, and the duplet is complete. As a result, the helium atom's valency is zero. It has no proclivity for giving or receiving electrons.

34. Fill in the blanks in the following statements:

(a) Rutherford's α-particle scattering experiment led to the discovery of the _____.

Answer: atomic nucleus

(b) Isotopes have the same _____ but different _____.

Answer: atomic number, mass number

(c) Neon and chlorine have atomic numbers 10 and 17 respectively. Their valencies will be _____ and _____ respectively.

Answer: 0 and 1

(d) The electronic configuration of silicon is _____ and that of Sulphur is _____.

Answer: Silicon — 2, 8, 4; Sulphur— 2, 8, 6

35. An element X has a mass number 4 and atomic number 2. Write the valency of this element?

Answer: Valency of the element is zero as the K shell is completely filled with 2 electrons.

Long Answer Questions

36. Why do Helium, Neon and Argon have a zero valency?

Answer: Helium's lone energy shell has two electrons. The valence shells of Argon and Neon each have eight electrons. The elements have little tendency to mix with other elements because they have the most electrons in their valence shells (resulting in duplet and octet configurations). As a result, the valency of Helium, Neon, and Argon is zero.

37. The ratio of the radii of hydrogen atom and its nucleus is ~ 105. Assuming the atom and the nucleus to be spherical,

(i) What will be the ratio of their sizes?

(ii) If atom is represented by planet earth 'Re ' = 6.4 ×106 m, estimate the size of the nucleus.

Answer:

Assuming the atom and the nucleus to be spherical.

(a) Atomic size is represented in terms of atomic radius, $\frac{r_H}{r_n} = 10^5$

As volume of sphere $= \frac{4}{3}\pi r^3$, therefore, $V_H = \frac{4}{3}\pi r_H^3$ and $V_n = \frac{4}{3}\pi r_n^3$

Thus, the ratio of volumes $\frac{V_H}{V_n} = \frac{\frac{4}{3}\pi r_H^3}{\frac{4}{3}\pi r_n^3} = \frac{r_H^3}{r_n^3} = \left(\frac{r_H}{r_n}\right)^3 = (10^5)^3 = 10^{15}$

(b) $\frac{V_n}{V_H} = 10^{-15}$ or $V_n = 10^{-15} \times V_H$

If atom is represented by planet earth with $R_e = 6.4 \times 10^6 \text{m}$

Then, volume of atom $(V_H) = \frac{4}{3}\pi R_e^3 = \frac{4}{3} \times 3.14 \times (6.4 \times 10^6 \text{m})^3$

$= 1097.5 \times 10^{18} \text{m}^3 = 1.0975 \times 10^{21} \text{m}^3$

$\therefore$ Volume of nucleus $= 10^{-15} \times (1.0975 \times 10^{21}) \text{m}^3$

$= 1.0975 \times 10^6 \text{m}^3$

38. Enlist the conclusions drawn by Rutherford from his α-ray scattering experiment.

Answer: Rutherford concluded from the α-particle scattering experiment that :–

(i) Because most -particles passed through the gold foil with no deflection, the majority of the space inside the atom was vacant.

(ii) Because only a few particles deviated from their course, the positive charge occupied very little space inside the atom.

(iii) Small fraction of α-particles were deflected by 180° , this shows that the positive charge as well as the mass of the gold atom were concentrated in a very small volume within the atom.

From the data he also calculated that the radius of the nucleus was about 10^5 times smaller than the radius of the atom.

39. In what way is Rutherford's atomic model different from that of Thomson's atomic model?

Answer: Rutherford suggested a model in which electrons moved in well-defined orbits around the nucleus. There is a positively charged centre (later called "nucleus") in an atom. He also proposed that the nucleus is extremely small in comparison to the size of the atom, and that the nucleus contains virtually all of an atom's mass. The model of an atom proposed by Thomson was similar to that of a Christmas pudding. The electrons are strewn about like currants in a positively charged pudding spherical, and the atom's mass was expected to be spread evenly.

40. What were the drawbacks of Rutherford's model of an atom?

Answer: Rutherford suggested a model in which the electrons moved in well-defined orbits around the nucleus. However, it was believed that the electron's orbital revolution would not be stable. Any charged particle in a circular orbit would accelerate and emit energy. As a result, the spinning electrons lose energy and fall into the nucleus. The atom would become extremely unstable as electrons whirled about it, and matter would cease to exist. This, however, goes against what we've seen before.

41. What are the postulates of Bohr's model of an atom?

Answer: The following are Neils Bohr's postulates regarding the model of an atom::-

(i) Only certain special orbits known as discrete orbits, are allowed inside the atom. These discrete orbits are called energy levels. Concentric circles depict the energy levels in an atom. The letters K, L, M, N,..., or the integers n = 1, 2, 3, 4,...., are used to indicate these orbits.

(ii) While revolving in the discrete orbits, the electrons do not radiate any energy.

42. Show diagrammatically the electron distributions in a sodium atom and a sodium ion and also give their atomic number.

Sodium atom

Sodium ion

Answer: Atomic number of sodium (Z) =11 Mass number of sodium (A) = 23

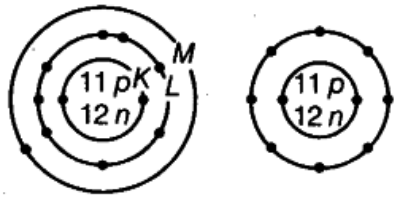
Number of protons in the nucleus = 11 Number of neutrons in the nucleus = 23 - 11 = 12

Number of electrons = 11

Electronic configuration of Na-atom = 2, 8, 1 (K, L, M)

Na+ ion is formed from sodium atom by loss of an electron (present in the outermost shell). Hence,

the electronic configuration is 2, 8(K, L). However, the number of protons and neutrons remains the same.



Sodium atom Sodium ion

43. In the Gold foil experiment of Geiger and Marsden, that paved the way for

Rutherford's model of an atom, ~ 1.00% **of the α-particles were found to deflect at angles** >50°**. If one mole of α-particles were bombarded on the gold foil, compute the number of α-particles that would deflect at angles less than** 50°**.**

Ans: Percentage of α-particles deflected by more than 50° = 1% of total α-particles.

% of α-particles deflected by less than 50°= 100% − 1% = 99% of total α-particles.

1 mole = number of α-particles blasted on gold foil

The number of particles that were deflected by an angle of less than 50°

$= \frac{99}{100} \times 6.022 \times 10^{23}$

$= \frac{596.178}{100} \times 10^{23} = = 5.96 \times 10^{23}$