CBSE Test Paper 01

Chapter 04 Structure of Atom

1. Nitrogen is**: (1)**

   a. Diatomic
   b. Monatomic
   c. Triatomic
   d. Tetratomic

2. Na^+ has 12 neutrons and 10 electrons. Which of the following statement is correct? **(1)**

   a. Na+ has atomic number equal to 10 and mass number 23
   b. Na+ has atomic number equal to 11 and mass number 23
   c. Na+ has atomic number equal to 11 and mass number 22
   d. Na+ has atomic number equal to 10 and mass number 22

3. Which of the following statements is/are correct about β-particles**: (1)**
   (a) They are electrons.
   (b) They are deflected towards positive electrode.
   (c) They travel at the speed of sound.
   (d) They are deflected towards negative electrode.

   a. All of these
   b. (a) and (b) are correct
   c. (b) and (c) are correct
   d. (a), (b) and (c) are correct

4. What is the e/m value of an electron? **(1)**

   a. $1.8 \times 10^{12}\ \mathrm{C/kg}$
   b. None of these
   c. $1.76 \times 10^{11}\ \mathrm{C/kg}$
   d. $1.6 \times 10^{11}\ \mathrm{C/kg}$

5. Atomic number of an element is equal to: **(1)**

a. Number of Protons
b. Number of neutrons
c. Both a) and b)
d. Number of electrons

6. On the basis of Rutherford's model of an atom, which sub-atomic particle is present in the nucleus of an atom? **(1)**

7. Are mass number and atomic mass of an element equal in all respects? **(1)**

8. What are ions? What are its two types? **(1)**

9. The element aluminium is written by the symbol $^{27}_{13}Al$. Write the number of protons, electrons and neutrons present in it. **(1)**

10. Out of C-12 and C-14 isotopes of carbon, which is of radioactive nature? **(1)**

11. Which of the two will be chemically more reactive ; element X with atomic number 16 or element Y with atomic number 17? **(3)**

12. How do you know that nucleus is very small as compared to the size of atom? **(3)**

13. The average atomic mass of a sample of an element X is 16.2 u. What are the percentages of isotopes $^{16}_{8}X$ and $^{18}_{8}X$? **(3)**

14. Explain the variation of atomic radius along a period and down a group. **(5)**

15. Describe valency by taking the examples of silicon and oxygen. **(5)**

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Answers

1. a. Diatomic

   Explanation: Nitrogen (N_2) is diatomic. A **nitrogen** atom has 5 electrons in its outer shell. It forms three covalent bonds with another nitrogen atom and makes a nitrogen molecule.

2. b. Na^+ has atomic number equal to 11 and mass number 23

   Explanation: Atomic number of sodium = 11

   Therefore number of electrons = 11

   Na^+ has 12 neutrons and 10 electrons.

   So, atomic number of Na^+ = 11 and

   Mass number = 12 + 11 = 23

3. b. (a) and (b) are correct

   Explanation: β - particles are electrons. They are deflected towards the positive electrode.

4. c. $1.76 \times 10^{11}\ \mathrm{C/kg}$

   Explanation: The charge on an electron is 1.6 x 10^{-19} C and mass of one electron is 9.1 x 10^{-31} kg. Therefore e/m ratio will be 1.6 x 10^{-19} C / 9.1 x 10^{-31} kg = 1.76 x 10^{11} C/kg

5. a. Number of Protons

   Explanation: **Atomic number** (Z) of a chemical element is the **number of protons** in the nucleus of that atom. It is a characteristic of the element and determines its place in the periodic table. Atomic number = number of protons.

6. The scientific idea is that an atom has electrons surrounding a nucleus that contains protons and neutrons. The nucleus of atom is positively charged according to Rutherford's model of an atom. All the proton's in an atom are therefore, present in the nucleus.

7. It is not necessary that they be numerically same.

The mass number of the atom (M) is equal to the sum of the number of protons and neutrons in the nucleus.
Mass number = No. of protons + No. of nuetrons
The number of protons in the nucleus of the atom is equal to the atomic number (Z).
Atomic number = number of protons.
This is not necessary that every atom has same no. of neutrons as protons.

8. When one or more electron(s) is / are removed from / added to a neutral atom, a positively / negatively charged particle is formed. This charged particle is called an ion. An ion can be of two types**:**-
   1) Cation (positively charged ion)
   2) Anion (negatively charged ion)

9. Atomic number =13, mass number = 27
   Atomic number = number of protons = 13
   Number of neutron = Mass number – number of proton = 27 – 13 = 14
   Number of electron = No. of protons = 13

10. Carbon-12 and carbon-14 are two isotopes of the element carbon. The difference between carbon-12 and carbon-14 is the number of neutrons in each atom. Because of the different number of neutrons, carbon-12 and carbon-14 differ with respect to radioactivity. Carbon-12 is a stable isotope. Carbon-14, on the other hand, undergoes radioactive decay.

11. The electronic configuration of the two elements are as follows :
   X (Z = 16) : K (2), L(8), M(6) = (2,8,6)
   Y(Z = 17) : K(2), L(8), M(7) = (2,8,7)
   To complete its octet, X will gain 2 electrons and Y will gain only 1 electron, therefore element Y will be more reactive than element X.

12. Rutherford observed in his experiment that when alpha-particles were bombarded on a very thin foil of gold, some of them bounced back. The number of alpha-particles that deflected by more than 180 degrees was very less as compared to the number of electrons that passed through without deflection. Moreover, when he doubled the thickness of the gold foil, the number of alpha-particles bouncing back got doubled.

Therefore, he concluded that the volume of the nucleus (positive region) was very small in comparison to the total volume of the atom.

13. Let the percentage of isotope ${}^{16}_{8}X$ in the sample be x %.

    Then the percentage of isotope ${}^{18}_{8}X$ in the sample will be (100 – x) %.

    Average atomic mass of element X = 0.01 [(Atomic mass of isotope ${}^{16}_{8}X$) (Percentage of isotope ${}^{16}_{8}X$) + (Atomic mass of isotope ${}^{18}_{8}X$) (Percentage of isotope ${}^{18}_{8}X$)]

    Therefore, average atomic mass = $\frac{16\times x+18\times(100-x)}{100}$
    or 16.2 = $\frac{16x+1800-18x}{100}$
    or 1620 = 1800 – 2x
    or 2x = 1800 – 1620
    or x = 180 / 2

    or x = 90

    Percentage of X-16 isotope in the sample = 90 %

    Percentage of X-18 isotope in the sample = 100 – 90 = 10 %

14. Atomic radius **decreases along a period.** The first member of each period is the largest in size. As we move from left to right along a period, the atomic number of the atom increases, the positive charge inside the nucleus increases and electrons are added to the same orbit. The increased nuclear charge increases the force of attraction between the nucleus and the electrons. Group-1 atoms are the largest in their respective periods.

    Atomic radius **increases down a group.** As we move down in a group, the atomic number increases, the number of shells increases and the distance of the outermost electrons from the nucleus increases.

15. The valency of an element is the combining capacity of that element. It is determined by the number of electrons present in the outermost shell (valence shell) of an atom of that element, if the number of valence electrons of an atom of an element is less than or equal to 4, then the valency of that element is equal to the number of valence

electrons.

On the other hand, if the numbcr of valence electrons of the atom of an element is greater than 4, then the valency of that element is obtained by subtracting the number of valence electrons from 8.

Valency of Silicon (Si) : Atomic number of the element is 14. Its electronic distribution is; K(2), L(8), M(4).

As silicon atom has four valence electrons, it can lose four electrons to complete its octet. At the same time, it can also gain four electrons. Thus, the valency of silicon is 4.

Valency of oxygen (O) : Atomic number of the element is 8. Its electronic distribution is : K(2), L(6)

As oxygen atom has six valence electrons, it needs two electrons to complete its octet (8 - 6 = 2). Therefore, valency of oxygen is 2.

CBSE Test Paper 02

Chapter 04 Structure of Atom

1. Which of the following was not observed by Rutherford in α-particle scattering experiment? **(1)**

   A. Most of the α-particles rebounded after hitting the gold foil.

   B. Some of the α-particles were deflected from their path.

   C. Some of the α-particles did not pass through the goil foil.

   D. Most of the α-particles passed straight through the gold foil.

   a. B and C
   b. C and D
   c. All of these
   d. A and C

2. Which of the following correctly represent the electronic distribution in the Mg atom? **(1)**

   a. 8, 2, 2
   b. 2, 8, 2
   c. 3, 8, 1
   d. 1, 8, 3

3. In neutral atoms, number of electrons are equal to number of _____ **(1)**

   a. Mass number
   b. Protons
   c. Neutrons
   d. Nuclear charge

4. If K, L, M, N, shells of an atom are full. The total number of electrons in that atom are: **(1)**

   a. 26
   b. 36

c. 60
d. 42

5. The $\frac{charge}{mass}$ ratio of electron **(1)**
   a. depends upon nature of electrodes
   b. depends upon nature of gas
   c. remains constant
   d. depends upon both nature of gas and nature of electrodes

6. Atomic mass of oxygen is 16u. What does it indicate? **(1)**

7. What are canal rays? **(1)**

8. i. Why chemical properties of all the isotopes of an element are same?
   ii. Name the isotopes used in the treatment of goitre and cancer.
   iii. An element 'X' has 2 electrons in its M shell. What is its atomic number? **(1)**

9. Name the three sub-atomic particles of an atom. **(1)**

10. What is the maximum number of electrons which can be accommodated in 'N' shell? **(1)**

11. How many electrons, protons and neutrons will be there in an element $_{9}X^{19}$? What will be the valency of the element? **(3)**

12. Nucleus of an atom has positive charge on it. Establish. **(3)**

13. The atomic number of Al and Cl are 13 and 17 respectively. What will be number of electrons in Al^{3+} and Cl^{-}? **(3)**

14. If Z = 3, what would be the valency of the element? Also, name the element. **(5)**

15. What is the gold foil experiment? Name the scientist who performed this experiment. Write the conclusions and shortcomings of Rutherford’s model of atom. **(5)**

CBSE Test Paper 02

Chapter 04 Structure of Atom

Answers

1. d. A and C

   Explanation: Rutherford had observed in the scattering experiment that most of the α-particles went straight through the gold foil while some of the α-particles were deflected from their path by different angles.

2. b. 2, 8, 2

   Explanation: Atomic number of magnesium = 12

   Therefore number of electrons = 12

   Thus, electronic configuration of magnesium is Magnesium = 2,8,2.

3. b. Protons

   Explanation:

   i. The number of protons in the nucleus of the atom is equal to the atomic number (Z).

   ii. The number of electrons in a neutral atom is equal to the number of protons.

   iii. The mass number of the atom (M) is equal to the sum of the number of protons and neutrons in the nucleus.

   iv. The number of neutrons is equal to the difference between the mass number of the atom (M) and the atomic number (Z).

4. c. 60

   Explanation: Maximum number of electrons in K-shell i.e. 1st shell = 2

   maximum number of electrons in L-shell = 8

   maximum number of electrons in M-shell = 18

   maximum number of electrons in N-shell = 32

   2 + 8 +18 + 32 = 60

5. c. remains constant

   Explanation: The $\frac{charge}{mass}$ on the type of ray one is passing. Since we are talking about electron, the cathode ray particles are nothing but a beam of electrons. Since, the

charge as well as mass is constant for electron no matter any gas we take in during the experiment in the discharge tube. So, their charge/mass ratio remains constant for electron.

6. Mass of atom is called atomic mass.
   The atomic mass of hydrogen atom = 1u.
   The atomic mass of oxygen is 16u, this means one atom of oxygen is 16 times heavier than $\frac{1}{12^{th}}$ of carbon atom.

7. Canal rays also called anode rays, are seen moving from the anode towards the cathode in the specially designed discharge tube. However, they do not originate from the anode. They were discovered by Goldstein in 1886.

8. i. This is because isotopes have same atomic number, so the number of valence electrons present in them are same and it is the valence electrons which take part in chemical reactions. So the isotopes of an element have same chemical properties.
   ii. Goitre - Isotope of iodine
   Cancer - Isotope of cobalt
   iii. Atomic number of X = 12

9. The three sub-atomic particles of an atom are as follows:-

   a. **Proton** (positively-charged particle)
   b. **Neutron** (neutral particle)
   c. **Electron** (negatively-charged particle)

10. The maximum number of electrons present in a shell is given by the formula $\mathbf{2n^2}$, where 'n' is the orbit number or the energy level (1, 2, 3, ...)

    The value of n for N shell is 4. So, the maximum number of electrons = 2 x $(4)^2$ = 2 x 16 = 32

    N shell (n = 4) can accommodate a maximum of **32 electrons**.

11. No. of protons = Atomic number = 9

No. of (protons + neutrons) = Mass number = 19
Number of electrons = 9
Number of protons = 9
Number of neutrons = Mass number - Atomic number = 19 - 9 = 10
Electronic configuration of X = 2, 7
Valency of X = 1 (since it requires one electron to complete its octet)

12. This can be established on the basis of Rutherford experiment. Since some alpha particles were repelled by the nucleus of the atom, it is expected to have the same charge as on alpha particles. Therefore, nucleus of an atom has positive charge.
The nucleus of an atom contains two things: Protons and neutrons. Because neutrons have no charge and protons have positive charge, the overall charge of the nucleus is positive.

13. Number of electrons in Al = Number of protons in Al = Atomic number (Z) of Al = 13
Number of electrons in Al^{3+} = 13 - 3 = **10**
Number of electrons in Cl = Number of protons in Cl = Atomic number (Z) of chlorine = 17
Number of electrons in Cl^- = 17 + 1 = **18**

14. When atomic number Z = 3, the element will have 3 protons in its nucleus.

Since the atom is electrically neutral, the number of electrons in its shells will be equal to the number of protons .

The element will have 3 electrons in its different shells.

The maximum number of electrons that can be accommodated in the first orbit (n = 1) or K-shell will be = $2n^2$ = 2

So, the 3 electrons in the element would be distributed as 2, 1.

The number of valence electrons (i.e. electrons in the outermost shell) is 1.

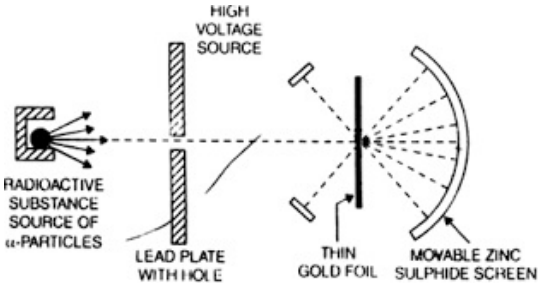
Valency = number of valence electrons (for 4 or lesser valence electrons)

The element can easily give away its outermost single electron for achieving a duplet

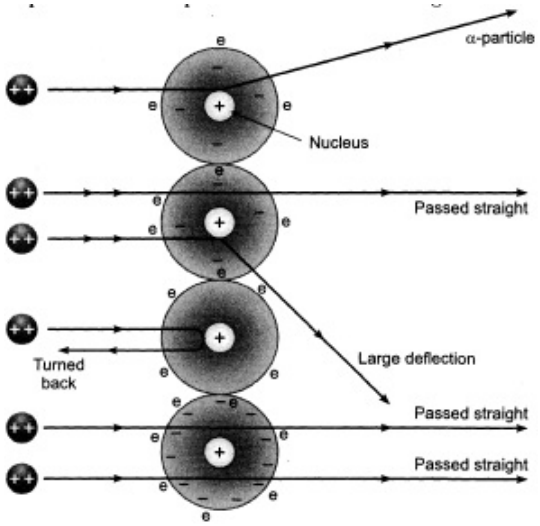
(Helium) configuration.

The valency of the element is 1. The given element is Lithium (Li).

15. **Rutherford's α-particles scattering Experiment:** In 1911, Rutherford performed the gold foil experiment. He bombarded a stream of α-particles on a gold foil, a thin sheet which was 0.00006 cm thick in an evacuated chamber. An α-particle is a positively charged helium ion (He^{2+}). A simplified picture of this experiment is shown in the figure.

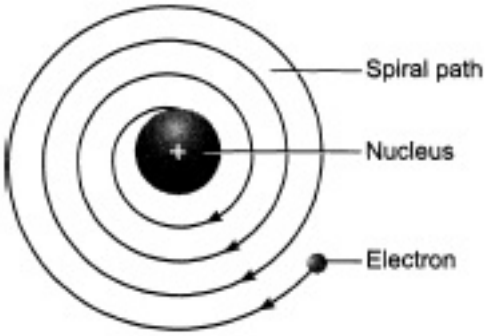


Observation:



Conclusion:

Structure of atom: On the basis of gold foil experiment, Rutherford concluded that an atom consists of nucleus which has positive charge and it is surrounded with electrons which are moving around the nucleus. The number of electrons and protons are equal and the entire mass of the atom is concentrated at its nucleus. He compared the model of an atom with solar system, in which sun as a nucleus is at center and planets as electrons revolve around the sun.



Drawbacks in the Rutherford's model:

i. Most of the α-particles passed straight through the foil without any deflection.
ii. A few α-particles were deflected through a small angle and few through larger angles.
iii. The number of α-particles which bounced back was very small.
iv. The most of the space inside of an atom is empty.
v. The heavy positively charged 'core' is present at the centre of atom named as nucleus.
vi. The volume of the nucleus is very small in comparison to the total volume of the atom.
vii. According to classical electromagnetic theory, a moving charged particle, such as an electron under the influence of attractive force loses energy continuously in the form of radiations. As a result of this, electron should lose energy and therefore, should move in even smaller orbits ultimately falling into the nucleus. But the collapse does not occur.
viii. Rutherford did not specify the number of orbits and the number of electrons in each orbit.

CBSE Test Paper 03

Chapter 04 Structure of Atom

1. There are 14 protons and 13 neutrons in the nucleus of an element. What is its mass number? **(1)**
   a. 29
   b. 27
   c. 13
   d. 17
2. Out of electron, positron, alpha particle and proton, which particle is regarded as the universal particle? **(1)**
   a. Alpha particle
   b. Positron
   c. Proton
   d. Electron
3. Which of the following statements is incorrect? **(1)**
   a. ${}_{1}^{2}H$ is used to determine the age of old samples of water and wine.
   b. Co-60 is used in treatment of cancer.
   c. I-132 is used in thyroid scan and treatment of goiter.
   d. C-14 is used to determine the age of old samples of living organisms.
4. How many times is the radius of extra nuclear portion more than that of the nucleus of an atom? **(1)**
   a. Five times
   b. 3 times
   c. 2 times
   d. 10 times
5. Atomic number of an element during a chemical reaction**: (1)**
   a. Either increase or decrease
   b. Decreases
   c. Increases
   d. Remains constant
6. Does the atomic number of the element change when its atom gets converted into

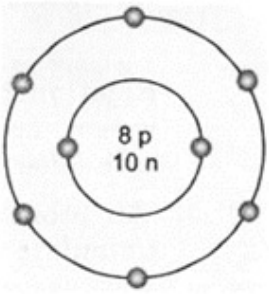
cation and anion? **(1)**

7. If an atom contains one electron and one proton, will it carry any charge or not? **(1)**
8. What is relative mass and charge of an electron? **(1)**
9. State Mendeleev's periodic law. **(1)**
10. How many times is radius of extra nuclear portion more than that of the nucleus of an atom? **(1)**
11. Do isobars have also identical chemical characteristics like isotopes? **(3)**
12. How will you find the valency of chlorine, sulphur and magnesium? **(3)**
13. List any three distinguishing features between the models of an atom proposed by J.J. Thomson and Ernest Rutherford. **(3)**
14.

Atomic number	Mass number	Number of neutrons	Number of protons	Number of electrons	Name of the atomic species
9	-	10	-	-	-
16	32	-	-	-	Sulphur
-	24	-	12	-	-
-	2	-	1	-	-
-	1	0	1	0	-

(5)

15. The given figure depicts the atomic structure of an atom of an element 'X'. Write the following information about the element 'X'. **(5)**



a. Atomic number of 'X'
b. Atomic mass of 'X'
c. Valence electrons
d. Valency of 'X'
e. 'X' should be metal or non-metal.

CBSE Test Paper 03

Chapter 04 Structure of Atom

Answers

1. b. 27

   Explanation: The mass number (A) of an atom is equal to the sum of the number of protons and neutrons present in the nucleus of the atom.

   So, the mass number (A) of the given element = number of protons + number of neutrons = 14 +13 = 27 u

2. d. Electron

   Explanation: Electron is considered as a universal particle as it is present in all atoms. It also provides the chemical properties to the atoms.

3. a. ${}_{1}^{2}H$ is used to determine the age of old samples of water and wine.

   Explanation: An isotope of iodine is used in treatment of goitre.

   Carbon – 14 is used in carbon dating.

   The age of wine can be determined by measuring the trace amount of radioactive tritium, 3H, present in a sample.

   So given statement is incorrect.

4. a. Five times

   Explanation: The nuclear region is a small portion of the atom as compared to the space inside an atom.

5. d. Remains constant

   Explanation: Atomic number (number of protons) of an element remains constant during a chemical reaction.

6. No, the atomic number of the element remains the same.

   The size of an anion is larger than the parent atom. The electrons decrease due to the addition of an electron. A cation is smaller than the parent atom. The electrons increase due to the removal of an electron.

7. An electron is a negatively charged particle, whereas a proton is a positively charged particle. The magnitude of their charges is equal. Therefore, an atom containing one

electron and one proton will not carry any charge. Thus, it will be a neutral atom.

8. The mass of electron is about $\frac{1}{1840}$ of the mass of hydrogen. The absolute mass of an electron is 9×10^{-28} gram. The absolute charge on an electron is coulomb of negative charge which is smallest, carried by any particle. Thus, it is taken as unit of negative charge.

9. According to **Mendeleev's periodic law**, the physical and chemical properties of elements are a periodic function of their atomic weight (atomic mass).

10. The nucleus of an atom has diameter of 10^{-14} to 10^{-15} meters(m). The extranuclear space where its electrons are found is a much larger volume with a diameter of approximately 10^{-10}m.
    So, Radius of extra nuclear portion is nearly five times more as compared to the nucleus.

11. No, these are not identical because the isobars have different atomic numbers as well as different electronic configurations. Isotope compound have same number of electrons. Isotopes have same chemical properties as the number of electrons present in them are same because only electrons participate in chemical reactions. While isobar compounds have same mass number but different atomic number and chemical properties depend upon number of electrons so isobars have different chemical properties.

12. The electrons present in the outermost shell of an atom are known as the valence electrons. Valence electrons determine the valency (combining capacity) of that atom.
    The atomic number of chlorine is 17. The electronic configuration is 2, 8, 7.
    So the number of valence electrons for chlorine is 7 and it needs 1 more electron to complete its octet (8 electrons in its outermost shell).
    Therefore, its valency is one (8 - 7).
    The atomic number of sulphur is 16. The electronic configuration is 2, 8, 6.
    So the number of valence electrons for sulphur is 6 and it needs 2 more electrons to complete its octet (8 electrons in its outermost shell).
    Therefore, its valency is two (8 - 6).
    The atomic number of magnesium is 12. The electronic configuration is 2, 8, 2.

It is easier for magnesium to give away its two valence electrons rather than try to acquire 6 more electrons to complete its octet.
Therefore its valency is two.

13.

J. J.Thomson Model of Atom	Rutherford's Model of Atom
1. Positive charge forms a kernel.	1. Nucleus (dense positive charge) is in the centre of the atom.
2. Electrons are present (embedded in positive charge) throughout the atom.	2. Electrons revolve around the nucleus in orbits.
3. No space inside the atom is empty. Thomson likened an atom to a pudding or a watermelon.	3. According to Rutherford, most of the space inside the atom is empty.

14.

Atomic number	Mass number	Number of neutrons	Number of protons	Number of electrons	Name of the atomic species
9	19	10	9	9	Fluorine
16	32	16	16	16	Sulphur
12	24	12	12	12	Magnesium
1	2	1	1	1	Deuterium (Isotope of Hydrogen)
1	1	0	1	0	Hydrogen ion

Mass number of atomic species (A) = Number of protons (Z) + Number of neutrons
Number of neutrons = Mass number (A) - Atomic number (Z)
Atomic number (Z) = Number of protons = Number of electrons
When the number of protons is equal to the number of electrons, the atomic species is a neutral atom.
When the number of protons is not equal to the number of electrons, the atomic species is an ion (either cation or anion).

15. a. Atomic number of 'X' = Number of protons in 'X' = 8

b. Atomic mass of 'X' = Number of protons in 'X' + Number of neutrons in 'X' = 8 + 10 = 18 u
c. Valence electrons = Electrons in outermost shell = 6
d. Valency = Number of valence electrons (for 4 or lesser valence electrons); Valency = 8 - Number of valence electrons (for more than 4 valence electrons)
   Therefore, valency of ‘X’ = 8 - 6 = 2
e. ‘X’ should be non-metal because there are six valence electrons, hence it will tend to gain two more electrons to complete its outermost shell in order to achieve a noble gas configuration.