Solution

STRUCTURE OF ATOM WS 1

Class 11 - Chemistry

Section A

1.

(c) at very low pressure and high voltage

Explanation: Production of cathode rays Cathode rays are produced in the discharge tube by applying the following conditions:

- A high potential difference (>1200 V) is applied across the two aluminium electrodes.
- The length of the tube is 30 cm and the diameter is 3 cm.
- Pressure inside the tube is maintained below 0.01 mm of Hg.

2.

(c) charge on the electron

Explanation: charge on the electron

3.

(d) (A)-(q), (B)-(s), (C)-(p), (D)-(r)

Explanation: (A)-(q), (B)-(s), (C)-(p), (D)-(r)

4. **(a)** determine the mass of an atom

Explanation: determine the mass of an atom

5.

(d) charge on the electrons

Explanation: The oil drop experiment was performed by Robert A. Millikan and Harvey Fletcher in 1909 to measure the elementary electric charge (the charge of the electron). The experiment entailed observing tiny electrically charged droplets of oil located between two parallel metal surfaces, forming the plates of a capacitor.

6.

(b) fluorescence of cathode rays on the television screen

Explanation: Cathode rays (also called an electron beam or e-beam) are streams of electrons observed in vacuum tubes. If an evacuated glass tube is equipped with two electrodes and a voltage is applied, the glass behind of the positive electrode is observed to glow, due to electrons emitted from and traveling away from the cathode (the electrode connected to the negative terminal of the voltage supply).

Cathode ray tubes (CRTs) use a focused beam of electrons deflected by electric or magnetic fields to create the image in a television set.

7.

(b) $\alpha < \mathrm{p} < \mathrm{e}$

Explanation: α-particle (He^{2+}) has a very high mass compared to proton and electron, therefore a very small $\frac{e}{m}$ ratio. Proton and electron have the same charge (magnitude) but former is heavier, hence has a smaller value of $\frac{e}{m}$.

8. **(a)** Alpha particle (He^{2+})

Explanation: $\lambda = \frac{h}{mv} = \frac{h}{p}$

The higher the mass, the shortest is the wavelength. since alpha particles have the highest mass ($6.68*10^{-24}$g), they have the shortest wavelength.

9.

(c) R.A. Millikan's oil drop experiment

Explanation: In 1909, Robert Millikan and Harvey Fletcher conducted the oil drop experiment to determine the charge of an electron. They suspended tiny charged droplets of oil between two metal electrodes by balancing downward gravitational force with upward drag and electric forces.

The experiment helped earn Millikan a Nobel prize in 1923

10.

(b) at very low pressure and high voltage

Explanation: Production of cathode rays: Cathode rays are produced in the discharge tube (by low pressure and high temperature) by applying the following conditions:

- A high potential difference (>1200 V) is applied across the two aluminium electrodes.
- The length of the tube is 30 cm and the diameter is 3 cm.
- The pressure inside the tube is maintained below 0.01 mm of Hg.

11. **(a)** electric and magnetic fields

Explanation: When an electric field is applied to a stream of cathode rays, they get deflected towards the positive plate. On the application of a magnetic field perpendicular to the path of the cathode rays, they get deflected in the direction expected of negative particles.

12.

(c) electrons

Explanation: Cathode rays - In 1897, British physicist J. J. Thomson showed the rays were composed of a previously unknown negatively charged particle, which was later named the electron.

13.

(c) all of these

Explanation: all of these

14.

(c) a neutron

Explanation: a neutron

15. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation: In an electric field, negatively charged particles always move towards the positive plate and its vice-versa.

16. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation: Both A and R are true and R is the correct explanation of A.

17.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation: Both A and R are true but R is not the correct explanation of A.

18. **(a)** electrons

Explanation: Towards the end of the 19th century, Joseph J.Thomson (1856-1940) was studying electric discharges. It was known that the discharge and the glow in the gas were due to something coming from the cathode, the negative pole of the applied high voltage. Thomson made a series of experiments to study the properties of the rays coming from the cathode. He observed that the cathode rays were deflected by both electric and magnetic fields - they were obviously electrically charged. Thomson's result was $\frac{e}{m} = 1.8 \times 10^{-11}$ coulombs kg

The particle that J.J.Thomson discovered in 1897, the electron, is a constituent of all the matter we are surrounded by. All atoms are made of a nucleus and electrons. He received the Nobel Prize in 1906 for the discovery of the electron, the first elementary particle.

19.

(c) α < p < e

Explanation: α-particle (He^{2+}) has a very high mass compared to proton and electron, therefore very small $\frac{e}{m}$ ratio. Proton and electron have the same charge (magnitude) but former is heavier, hence has a smaller value of $\frac{e}{m}$.

20.

(b) The mass of electron is equal to the mass of neutron.

Explanation: Mass of one electron= 9.1×10^{-31} kg

Mass of neutron =1.67×10^{-27} kg. Therefore, they are not equal.

21.

(d) Characteristics of cathode rays depend upon the nature of gas present in the cathode ray tube.

Explanation: The characteristics of cathode rays (electrons) do not depend upon the material of electrodes and the nature of the gas present in the cathode ray tube. while other are a character of the cathode ray.

22. i. The mass of 1 mole neutron = mass of 1 neutron $\times$ 6.02 $\times$ 10^{23} = 1.676$\times 10^{-24}$ $\times$ 6.02 $\times$ 10^{23} = 1 gm
    ii. Neutron is electrically neutral i.e. it has no charge.
23. The charge on electron was measured from Millikan's oil drop experiment.

    The charge on an electron (e) = -1.602 $\times$ 10^{-19} C.
24. According to J.J.Thomson's experiment, $\frac{e}{m}$ ratio for an electron =1.76$\times 10^{11}$ C/kg.
    Where, e = Charge on electron and m= Mass of electron.
25. i. Mass of one mole proton = mass of 1 proton $\times$ 6.02 $\times$ 10^{23}

    = 1.67 $\times$ 10^{-24} $\times$ 6.02 $\times$ 10^{23} = 10.05 $\times$ 10^{-1} = 1.00 gm (approximately)

    ii. The charge of one proton = +1.602 $\times 10^{-19}$ C
26. There is no neutron present in hydrogen atom. It consists of only one proton.
27. Cathode rays originate from the cathode whereas anode rays are not obtained from the anode. Actually, anode rays are produced from the gaseous atoms by bombardment of the electrons by high-speed cathode rays. Cathode is made perforated, so that anode rays can pass through it.
28. Helium nucleus contains 2 protons in the nucleus and

    the charge present on it = (+2) $\times$ 4.8 $\times 10^{-10}$ = + 9.6 $\times 10^{-10}$ esu.
29. Sub-atomic particles of an atom are electron, proton and neutron.

Section B

30. Fill in the blanks:
    (i) 1. Hydrogen
    (ii) 1. Sub-atomic
31. Out of proton, cathode rays, electron, and neutron. The neutral particles are only neutron. So, it will not show deflection from the path on passing through an electric field.
32. Charge on oil droplet = -1.282 $\times$ 10^{-18} C

    Charge on an electron = -1.602 $\times$ 10^{-19} C

    Number of electrons = $\frac{q}{e} = \frac{(-1.282\times10^{-18}\text{C})}{(-1.602\times10^{-19}\text{C})}$ = 8
33. Anode ray are produced in the discharged tube when high electrical voltage is applied to the gas present in the discharge tube at very low pressure. The gaseous atoms break down into negatively and positively ions. These positively charged particles are anode rays.Thus anode rays are not emitted from anode but are produced space from space between anode and cathode. Since, the nature of anode rays depends upon the gas which is taken in the tube. Therefore, the ions remaining after the loss of electrons might have the same magnitude of charge, but different masses. Hence, they will have a different charge-to-mass ratio. Cathode rays are made up of electrons and all electrons have the same charge-to-mass ratio. That's why charge to mass ratio of all cathode rays is the same.
34. i. Mass of one electron = 9.11 $\times$ 10^{-31} kg

    $\therefore$ 9.11 $\times$ 10^{-31} kg = 1 electron

    1 g or 10^{-3} kg = $\frac{1}{9.11\times10^{-31}}$

    = 1.098 $\times$ 10^{27} electrons

    ii. Mass of one electron = 9.11 $\times$ 10^{-31} kg

    Mass of 1 mol of electrons = 9.11 $\times$ 10^{-31} $\times$ 6.022 $\times 10^{23}$

    = 5.486 $\times$ 10^{-7} kg

    Charge on one electron

    = 1.602 $\times$ 10^{-19} C

    Charge of 1 mol of electrons

    = 1.602 $\times$ 10^{-19} $\times$ 6.022 $\times$ 10^{23} Coulombs

    = 9.647 $\times$ 10^{4} C
35. One mole of electrons = 6.022 $\times 10^{23}$ electrons

    Mass of 1 electron = 9.1 $\times 10^{-31}$ kg

    Mass of 6.022 $\times 10^{23}$ electrons = (9.1 $\times 10^{-31}$ kg) $\times$ (6.022 $\times 10^{23}$)

= 5.48 × 10^{-7} kg

Charge on one electron = 1.602 × 10-^{19} coulomb

Charge on one mole electrons = 1.602 × 10-^{19} × 6.022 × 10^{23}

= 9.65 × 10^{4} coulomb.

36. We know that, Nucleus of ^{7}Li atom has 3 protons and 4 neutrons.

    We know that, Charge on one proton = 1.60 × 10^{-19} C.

    ∴ Charge on 3 protons (i.e, charge on nucleus) = 3 × 1.60 × 10^{-19} C = 4.80 × 10^{-19} C

    Also, Mass of Proton = Mass of neutron = 1.67 × 10^{-27} kg

    ∴ Mass of nucleus = Number of nucleons × Mass = (3+4) × 1.67 × 10^{-27} kg = 7 × 1.67 × 10^{-27} kg = 11.69 × 10^{-27} kg

37. Mass of an electron (m_e) = $\frac{Charge\ on\ electron}{Charge\ to\ Mass\ ratio} = \frac{e}{\frac{e}{m}} = = \frac{1.602\times10^{-19}C}{1.76\times10^{8}Cg^{-1}} = = 9.10 \times 10^{-28}g = 9.1 \times 10^{-31}kg$

    Therefore, the mass of an electron is $9.1 \times 10^{-31}kg$.

    Mass of an electron = $\frac{1}{1837}$ th of the mass of a hydrogen atom.

38. Mass of an electron = 9.1 × 10^{-28} g

    9.1 × 10^{-28} g is the mass of = 1 electron

    1.0 g is the mass of = $\frac{1}{9.1\times10^{-28}}$ = 1.098 × 10^{27} electrons

Section C

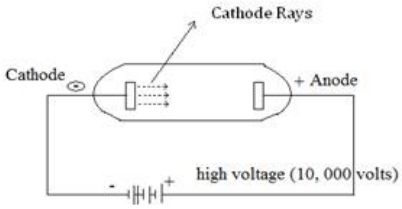
39. Magnitudes of charge (q) = 2.5 × 10-16 C

    Charge on one electron (e) = 1.602 × 10^{-19} C

    ∴ No. of electrons present = $\frac{(2.5\times10^{-16}\text{C})}{(1.602\times10^{-19}\text{C})}$ = 1560

40. The cathode ray discharge tube experiment performed by J.J. Thomson led to the discovery of negatively charged particles called electron.

    A cathode-ray tube is made of glass containing two thin pieces of metal, called electrodes, sealed in it. The electrical discharge through the gases could be observed only at very low pressures and at very high voltages. The pressure of different gases could be adjusted by evacuation. When sufficiently high voltage is applied across the electrodes, current starts flowing through a stream of particles moving in the tube from the negative electrode (cathode) to the positive electrode (anode). These were called cathode rays or cathode ray particles. When these rays, after passing through the anode, strike the zinc sulphide coating, a bright spot on the coating is developed. In the presence of the electrical or magnetic field, the behaviour of cathode rays is similar to that expected from negatively charged particles, suggesting that the cathode rays consist of negatively charged particles, called electrons.



Section D

41. J.Thomson determined the value of e/m for electron by the study of deflection of electron beam under the simultaneous influence of electric and magnetic field perpendicular to each other, the e/m value is 1.76 × 10^{8} coulomb per gram of electrons.
42. The charge/mass (e/m) ratio for the particles in the cathode rays (i.e., electron) is found to be the same irrespective of the nature of the cathode or the nature of the gas taken in the discharge tube. This shows that electrons are universal constituents of all matter.
43. The mass number of atoms and stability of the nucleus cannot be explained.
44. 1

    Molecule of methane (CH_4) contains electrons = 6 + 4 = 10

    1 Mole, i.e., 6.022 × 10^{23} molecules will contain electrons = 6.022 × 10^{24}
45. State True or False:

    (i) **(a)** True

    Explanation: True

(ii) **(b)** False
Explanation: False

(iii) **(b)** False
Explanation: False

(iv) **(b)** False
Explanation: False

46. i. (b) Assertion and reason both are correct statements and reason is not the correct explanation for assertion.
ii. (a) Assertion and reason both are correct statements and reason is the correct explanation for assertion.
iii. (d) Assertion is the wrong statement but reason is correct statement.
iv. (b) Assertion and reason both are correct statements and reason is not the correct explanation for assertion.

OR

(c) Assertion is the correct statement but reason is wrong statement.

Section E

47. **(b)** Both A and R are true but R is not the correct explanation of A.
Explanation: Both A and R are true but R is not the correct explanation of A.

48. **(a)** Both A and R are true and R is the correct explanation of A.
Explanation: Both A and R are true and R is the correct explanation of A.

49. **(d)** A is false but R is true.
Explanation: A is false but R is true.

50. **(b)** Both A and R are true but R is not the correct explanation of A.
Explanation: Both A and R are true but R is not the correct explanation of A.

51. **(c)** A is true but R is false.
Explanation: A is true but R is false.

52. i. As we know in 1 molecule of methane, 1 carbon atom and 4 atoms of hydrogen is present.
In carbon, there are six electrons and hydrogen consist of one electron each.
So a total number of electrons in methane = 6 + 4 = 10 electrons
By Avogadro's Law, we know that
1 mole of methane contains 6.023×10^{23} atoms. So the total number of electrons of in 1-mole methane = $10 \times 6.023 \times 1023 = 6.0^{23} \times 10^{24}$ electrons
So the total number of electrons in 1 mole of methane is 6.023×10^{24} electrons

ii. Mass of one neutron = 1.675×10^{-27} kg
1 mole of Carbon atom = 6.023×10^{23} atoms
Number of neutrons in 1 carbon atom = 14 - 6= 8
So the total number of neutrons in 14g of Carbon = $6.023 \times 10^{23} \times 8$ neutrons
So 7mg of Carbon will contain = $\frac{6.023 \times 10^{23} \times 8 \times 7 \times 10^{-3}}{14}$
= $[3.37288 \times 10^{22}] / 14$
= 2.4092×10^{21} neutrons
So, Mass of 2.4092×10^{21} neutrons = $[2.4092 \times 10^{21}] \times [1.675 \times 10^{-24}]$
= 4.035×10^{-3} g
So, in 7 mg of carbon total number of neutrons is 2.41×10^{21} and the total mass of the neutrons is 4.035×10^{-3} g

iii. Molecular Mass of Ammonia = 17g
By Avogadro's Law,
1 mole of Ammonia = 17g of Ammonia = 6.023×10^{23} atoms
Total Number of Protons in Ammonia = 7 + 3= 10
So the total number of protons in Ammonia = 6.023×10^{24} protons
17g of Ammonia contains 6.023×10^{24} protons
So, 34 mg of Ammonia will contain X number of protons
$x = \frac{6.023 \times 10^{24} \times 34 \times 10^{-3}}{17}$

$X = [6.023 \times 10^{24}] \times [2 \times 10^{-3}]$

$X = 1.2046 \times 10^{22}$ protons

Mass of one proton = 1.6726×10^{-24}g

So, Mass of 1.2046×10^{22} protons = $[1.6726 \times 10^{-24}] \times [1.2046 \times 10^{22}]$

$= 20.148 \times 10^{-3}$ g

So, in 34 mg of ammonia total number of protons is 1.205×10^{22} and the total mass of the protons is 20.148×10^{-3} g.

No, the answer will not vary with the change in temperature and pressure because the number of subatomic particles like protons, neutrons, and electrons is fixed for each and every element and it does not vary with temperature and pressure.