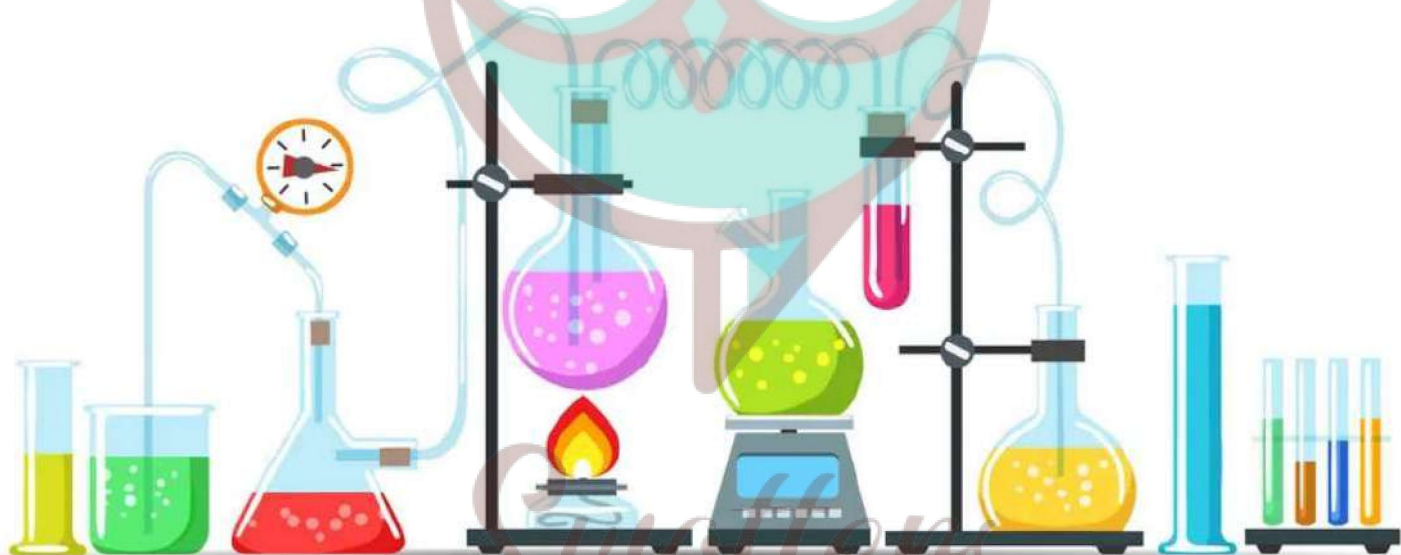


CHEMISTRY

Chapter 4: Structure of the Atom



Important Question

➤ Multiple Choice Questions:

1. Who discovered the electron?

- (a) Rutherford
- (b) Chadwick
- (c) Thomson
- (d) Goldstein

2. Which isotope is used in the nuclear power plants to generate electricity?

- (a) Uranium 235
- (b) Iodine 131
- (c) Cobalt 60
- (d) Uranium 238

3. Why was the Thomson's Model of an atom failed?

- i. It could not explain the screening of negative charges from that of positive
- ii. It did not tell about the presence of electrons
- iii. It did not give an idea about the discrete energy levels
- iv. It explained the atom as a whole to be electrically neutral

Choose the correct option from the following:

- (a) Only (iii)
- (b) Both (i) & (iii)
- (c) Only (i)
- (d) Both (ii) & (iv)

4. What was the source of alpha particles in Rutherford scattering experiment?

- (a) Hydrogen nucleus
- (b) Argon nucleus
- (c) Helium nucleus
- (d) None of these

5. What property of an element determines its chemical behaviour?

- (a) Size of an element
- (b) Valency of an element
- (c) Molar mass of the element

(d) None of these

6. Which of the following does not match the characteristics of an Isotope?

- (a) Isotopes of some elements are radioactive
- (b) Isotopes are the atoms of different elements
- (c) Isotopes differ in number of neutrons
- (d) Isotopes have similar chemical properties

7. Which of the two will be chemically more reactive, Sulphur(S) with atomic number 16 or Chlorine (Cl) with atomic number 17?

- (a) Chlorine
- (b) Sulphur
- (c) Both are equally reactive
- (d) Can't say

8. Which of the following elements does not exhibit the electrovalency?

- (a) Sodium
- (b) Calcium
- (c) Carbon
- (d) Chlorine

9. Which of the following statements is incorrect about the structure of an atom?

- i. The whole mass of an atom is concentrated in the nucleus
- ii. The atom is an indivisible particle
- iii. The atom as a whole is neutral
- iv. All the atoms are stable in their basic state

Choose the right option among the following:

- (a) (i) and (iii)
- (b) only (ii)
- (c) (ii) and (iv)
- (d) none of these

10. Which scientist gave the concept of fixed energy levels around the nucleus?

- (a) Ernest Rutherford
- (b) Neils Bohar
- (c) J.J.Thomsan
- (d) None of these

11. What prevents an atom from being collapsed?

- (a) The nuclear forces
- (b) Movement of electrons in discrete energy levels
- (c) The electron-electron repulsions
- (d) All of these

12. Which of the following pairs are isobars?

- (a) ${}_{17}\text{Cl}^{35}$ & ${}_{17}\text{Cl}^{37}$
- (b) ${}_{18}\text{Ar}^{40}$ & ${}_{20}\text{Ca}^{40}$
- (c) ${}_{6}\text{C}^{12}$ & ${}_{6}\text{C}^{14}$
- (d) None of these

13. Which of the following is an incorrect statement in reference with observation in Rutherford's α -particle scattering experiment?

- (a) Some of the α -particles rebound after hitting the gold foil
- (b) Some of the particles deflected from their path
- (c) Some of the particles not pass through the gold foil
- (d) Most of the particles pass straight through the gold foil

14. Which radioactive element is used in the treatment of cancer?

- (a) Iodine-131
- (b) Uranium-234
- (c) Plutonium-239
- (d) Cobalt-60

15. Why do most of the elements try to participate in the chemical combinations?

- i. To gain more electrons
- ii. To achieve Inert Gas configuration
- iii. To complete their octet
- iv. To complete their inner shells

Choose the correct option among the following

- (a) Both (i) & (iii)
- (b) Both (ii) & (iii)
- (c) Only (ii)
- (d) Both (i) & (iv)

➤ Very Short Question:

1. Draw the atomic structure of hydrogen atom.
2. Why are some elements chemically inert?
3. Why is atom electrically neutral?
4. What is the charge and mass of α -particles?
5. What are valence electrons?
6. An atom has atomic number 12, what is its valency and name the element?
7. Find the number of neutrons in ${}^{27}_{13}\text{X}$.
8. Where is the mass of atom concentrated?
9. Name two elements with same number of protons and neutrons?
10. Draw the atomic structure of sodium atom.

➤ Short Questions:

1. Name the scientist who discovered protons and neutrons in an atoms.
2. What is the contribution of Bohr and Bury together in the structure of atom's explanation?
3. Draw the atomic structure of (i) an atom with same number of sub-atomic particles, (ii) an atom with same number of electrons in L and M shell.
4. What is an octate? Why would atoms want to complete their octate?
5. Find the valency of ${}^{14}_7\text{N}$ and ${}^{35}_{17}\text{Cl}$.
6. Pick up the isotopes among the following and state reason.



7. Pick up atoms which have same number of neutrons from the following:



8. What are nucleons? What is the name given to those atoms which have same number of nucleons in it?

➤ Long Questions:

1. Give an activity to understand the implications of Rutherford's α scattering experiment by a gold foil.
2. What are isotopes? State its characteristics, give uses of isotopes?
3. Explain Rutherford's α -particle scattering experiment and give its observation and conclusion drawn.

➤ Assertion Reason Questions:

1. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

- Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
- Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
- Assertion is true but Reason is false.
- Both Assertion and Reason are false.

Assertion: No. of electrons always equal to the proton no. of atom.

Reason: Atom is always made-up of proton and electron.

2. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

- Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
- Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
- Assertion is true but Reason is false.
- Both Assertion and Reason are false.

Assertion: No. of electrons always equal to the proton no. of atom.

Reason: Atoms are always made up of proton, electron, and neutron.

➤ Case Study Questions:

1. Dalton's atomic theory suggested that the atom was indivisible and indestructible. But the discovery of two fundamental particles (electrons and protons) inside the atom, led to the failure of this aspect of Dalton's atomic theory. It was then considered necessary to know how electrons and protons are arranged within an atom. For explaining this, many scientists proposed various atomic models. J.J. Thomson was the first one to propose a model for the structure of an atom.

J.J. Thomson (1856- 1940) was a British physicist, He was awarded the Nobel Prize in Physics for his work on the discovery of electrons. Thomson proposed the model of an atom to be similar to that of a Christmas pudding. The electrons, in a sphere of positive charge. We can also think of a watermelon, the positive charge in the atom is spread all over like the red edible part of the watermelon, while the electrons are studded in the positively charged sphere, like the seeds in the watermelon. Thomson proposed that: An atom consists of a positively charged

sphere and the electrons are embedded in it. The negative and positive charges are equal in magnitude. So, the atom as a whole is electrically neutral.

(i) Identify the correct statement

Statement 1 – Dalton's atomic theory suggested that the atom was indivisible and indestructible.

Statement 2 – Electrons and protons are present inside the atom.

Statement 3 – J.J. Thomson was the first one to propose a model for the structure of an atom.

Statement 4 – Protons are positively charged particle.

- (a) Only 2
- (b) Both 3 & 4
- (c) Both 1 & 2
- (d) All of the above

(ii) According to Dalton's Atomic Theory, matter consists of indivisible _____

- (a) Molecules
- (b) Atoms
- (c) Ions
- (d) Mixtures

(iii) Who was the first to propose atomic theory?

- (a) J.J. Thomson
- (b) John Dalton
- (c) E. Rutherford
- (d) Neilsbhere

(iv) "Atom is indivisible and indestructible" why this aspect of Dalton's atomic theory leads to the failure?

(vi) Explain the J.J. Thomson's model for the structure of an atom?

2. Rutherford (1871-1937) was known as the 'Father' of nuclear physics. He is famous for his work on radioactivity and the discovery of the nucleus of an atom with the gold foil experiment. Ernest Rutherford was interested in knowing how the electrons are arranged within an atom. Rutherford designed an experiment for this. In this experiment, fast moving alpha (α)-particles were made to fall on a thin gold foil. On the basis of his experiment, Rutherford put forward the nuclear model of an atom, which had the following features:

- There is a positively charged centre in an atom called the nucleus. Nearly all the mass of an atom resides in the nucleus.
- The electrons revolve around the nucleus in circular paths.

- The size of the nucleus is very small as compared to the size of the atom.

Drawbacks of Rutherford's model of the atom: The revolution of the electron in a circular orbit is not expected to be stable. Any particle in a circular orbit would undergo acceleration. During acceleration, charged particles would radiate energy. Thus, the revolving electron would lose energy and finally fall into the nucleus. If this were so, the atom should be highly unstable and hence matter would not exist in the form that we know. We know that atoms are quite stable.

(i) Which of the following scientist was known as the 'Father of nuclear physics?'

- (a) J.J. Thomson
- (b) John Dalton
- (c) E. Rutherford
- (d) Neilsbhore

(ii) Positively charged centre in an atom is termed as

- (a) Nucleus
- (b) Molecule
- (c) Atom
- (d) Protons

(iii) Identify the correct statement

Statement 1 – Positively charged centre in an atom called the nucleus.

Statement 2 – The electrons revolve around the nucleus in circular paths.

Statement 3 – Nearly all the mass of an atom resides in the nucleus.

Statement 4 – The size of the nucleus is very small as compared to the size of the atom.

- (a) Only 2
- (b) Both 3 & 4
- (c) Both 1 & 2
- (d) All of the above

(iv) Write the features of Rutherford's nuclear model of an atom?

(v) Define Nucleus.

✓ **Answer Key-**

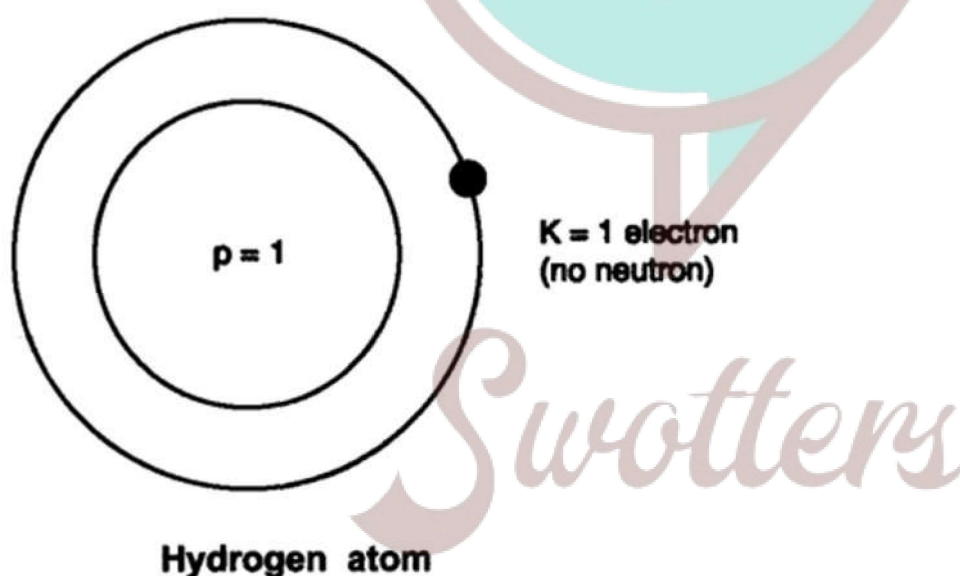
➤ **Multiple Choice Answers:**

1. (c) Thomson
2. (a) Uranium 235
3. (b) Both (i) & (iii)

4. (c) Helium nucleus
5. (b) Valency of an element
6. (b) Isotopes are the atoms of different elements
7. (a) Chlorine
8. (c) Carbon
9. (c) (ii) and (iv)
10. (b) Neils Bohar
11. (b) Movement of electrons in discrete energy levels
12. (b) $^{18}\text{Ar}40$ & $^{20}\text{Ca}40$
13. (a) Some of the α -particles rebound after hitting the gold foil
14. (d) Cobalt-60
15. (b) Both (ii) & (iii)

➤ Very Short Answers:

1. Answer:



2. Answer: Because their outermost shell is completely filled.
3. Answer: It has same number of protons and electrons, (positive charge = negative charge).
4. Answer: Charge is + 2
Mass is 4 a.m.u.
5. Answer: Electrons present in the outermost shell of an atom are called valence electrons.
6. Answer: Atomic number = 12
 \therefore Protons = Electrons = 12
Electrons Configuration = K L M -2 8 2

\therefore Valency = 2

Element is magnesium.

7. Answer: Mass number = 27

$\therefore p + n = 27$ $p = 13$, (Atomic No. = Number of protons)

$\therefore 13 + n = 27$

$\therefore n = 14$

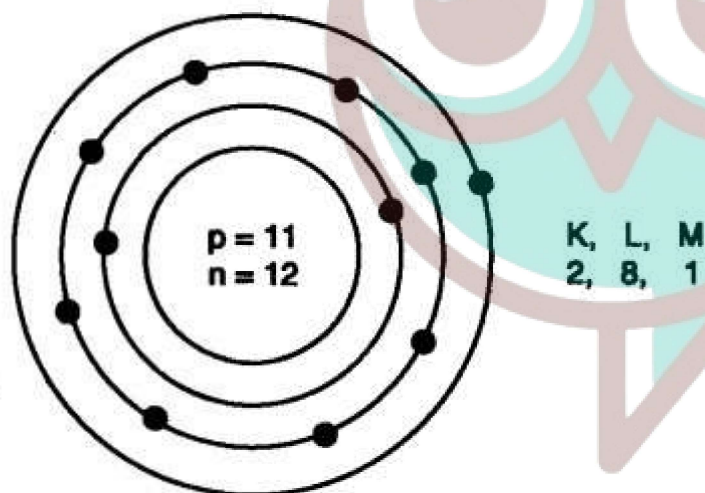
\therefore Neutron = 14

8. Answer: Mass of an atom is concentrated in nucleus.

9. Answer: Carbon (Protons = Neutrons = 6)

Oxygen (Protons = Neutrons = 8)

10. Answer:

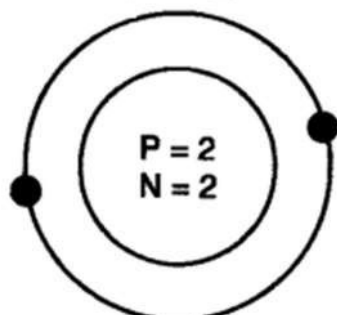


Na atom

➤ Short Answer:

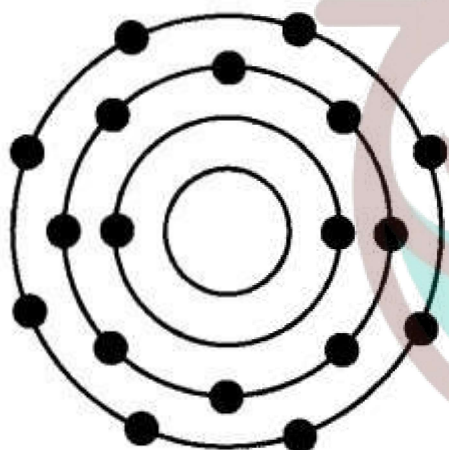
1. Answer: Protons were discovered by E. Goldstein in 1866 and neutrons were discovered by J. Chadwick in 1932.
2. Answer: Both Bohr and Bury gave the distribution of electrons into different atoms by giving the formula $2n^2$, where n = shell number.
3. Answer: (i) An atom with same number of sub-atomic particles is ${}^4_2\text{He}$
 No. of protons = 2
 No. of electrons = 2

No. of neutrons = 2



Helium atom

(ii) An atom with L and M shell filled \rightarrow K L M- 2 8 8



Argon

4. Answer: When the outermost shell of an atom i.e., L, M or N are completely filled with 8 electrons in the shell, it is said an octate. Atoms would want to complete their octate because they want to become stable.
5. Answer: The atomic number of nitrogen = 7, No. of protons = 7, No. of electrons = 7
 Electronic configuration = K L M = 2 5 –
 Valency = 3
 Because either it will gain three electrons or share 3 electrons to complete its octate.
 The atomic number of chlorine = 17, p = 17, e=17
 Electronic configuration = K L M = 2 8 7
 Valency = 1
 Because it will gain 1 electron to complete its octate.
6. Answer: The isotopes are $^{35}_{17}\text{X}$ and $^{37}_{17}\text{X}$ as both the atoms show same atomic number but different mass number.
7. Answer:

${}_{11}^{23}\text{Y}$ and ${}_{12}^{24}\text{Y}$ – have same number of neutrons, 12 in each.

${}_{14}^{28}\text{Y}$ and ${}_{13}^{27}\text{Y}$ – have same number of neutrons, 14 in each.

8. Answer: Protons and neutrons present in the nucleus are called nucleons. Isobaric elements have same number of nucleons in it.

<i>E.g.,</i>	Element	Protons	Neutrons	(Protons + Neutrons)
	Argon	18	22	40
	Calcium	20	20	40
	Potassium	19	21	40

➤ Long Answer:

1. Answer: To understand the implications of Rutherford's α -particle scattering experiment:

Activity: Let a child stand in front of a wall with his eyes closed. Let him throw stones at the wall from a distance. He will hear sound for each strike of stone on the wall. This is like a nucleus of the atom. But if a blind-folded child has to throw stones at a barbed-wire fence, most of the stones would not hit the fencing and no sound would be heard.

This is because there are lots of gap in the fence which allows the stone to pass through them. This is like empty space in an atom through which α -particles will pass through. Based on the above activity and similar reasoning Rutherford concluded the α -particle scattering experiment as:

- Most of the space inside the atom is empty as α -particles passed through the foil.
 - Very few particles deflected from their path, this shows that positive charge occupies less space.
 - A very small fraction of α -particles are deflected by 180° , this shows that all the positive charge and mass of the gold atom were concentrated in a very small volume within the atom.
2. Answer: Atoms of same element with same atomic number but different mass number are isotopes.

Characteristics:

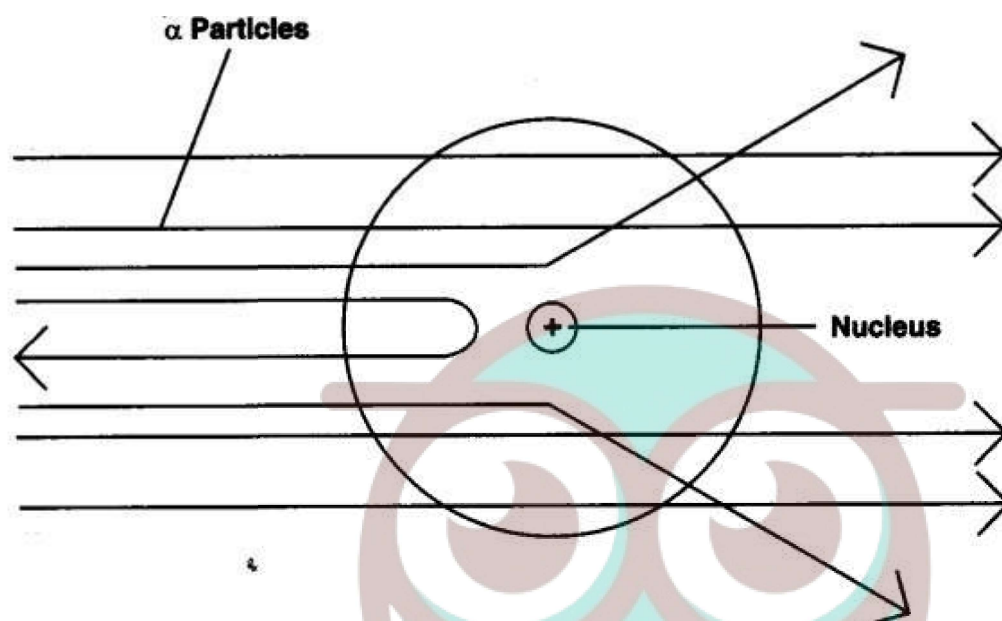
- Physical properties of the isotopes are different e.g. mass, density.
- Chemical properties of the isotopes are same due to same number of electrons.

Uses:

- Uranium isotope is used as a fuel in nuclear reactor (U-235).
- Cobalt isotope is used for treatment of cancer (Co-60).
- Iodine isotope is used in the treatment of goitre.

3. Answer: Rutherford's α -particle scattering experiment:

Fast moving α -particles were made to fall on a thin gold foil. Particles have + 2 charge and $4u$ mass, and considerable amount of energy.



Observations:

- Most of the α -particles passed straight through the foil.
- Some of the α -particles were deflected by small angles by the foil.
- One out of every 12000 particles rebounded.

Conclusion from observation:

- Most of the space inside the foil is empty.
- Positive charge of atom occupies very less space.
- Mass of the atom is concentrated in the centre with all positive charge concentrated in small volume within the atom.

➤ Assertion Reason Answer:

1. (c) Assertion is true but Reason is false.
2. (b) Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

➤ Case Study Answers:

1.

(i) (d) All of the above

(ii) (b) Atoms

(iii) (b) John Dalton

(iv) Dalton's atomic theory suggested that the atom was indivisible and indestructible. But the discovery of two fundamental particles (electrons and protons) inside the atom, led to the failure of this aspect of Dalton's atomic theory.

(v) Thomson was the first one to propose a model for the structure of an atom:

Postulate 1: An atom consists of a positively charged sphere with electrons embedded in it.

Postulate 2: An atom as a whole is electrically neutral because the negative and positive charges are equal in magnitude

Thomson atomic model is compared to watermelon. Where he considered:

- Watermelon seeds as negatively charged particles.
- The red part of the watermelon as positively charged.

2.

(i) c

(ii) a

(iii) d

(iv) Rutherford put forward the nuclear model of an atom, which had the following features:

- There is a positively charged centre in an atom called the nucleus. Nearly all the mass of an atom resides in the nucleus.
- The electrons revolve around the nucleus in circular paths.
- The size of the nucleus is very small as compared to the size of the atom.

(v) There is a positively charged centre in an atom called the nucleus. Nearly all the mass of an atom resides in the nucleus.



Swotters