Classroom VIDEO

Teacher's Notes

HISTORY OF THE ATOM PART 2

Atomic Structure

Duration: 19 mins

Years: 11-12

PROGRAM CONTENT

MIn	Topic
00:11	Historic Experiments from Crookes to Chadwick
01:06	Cathode rays in discharge tupes
04:24	Sir Joseph John Thompson
06:22	Robert Millikan
11:42	Ernst Rutherford
14:01	The Nucleus of the Atom
15:35	James Chadwick
17:51	Neils Bohr
20:19	End Credits

INTRODUCTION

Scientists have only been able to "see" and manipulate individual atoms in the last decade or so. How then were scientists able to probe the structure of an atom between 1870 and 1940 using simple apparatus?

This video describes four key experiments which identified the fundamental particles, leading to the present nuclear model of the atom used by chemists.

The experiments which showed how the electrons were arranged in atoms are described in the next video in the series - Electron Arrangement in Atoms.

Also in this video - the concept of a scientific model derived by experiment, the way a TV tube works, and the essential features of a mass spectrometer. Students will also appreciate how small the nucleus is relative to the atom's electron cloud, using a memorable analogy.

The video concludes with atomic notation, and its use to represent isotopes.

SECTION 1:
MENTAL MODELS AND EXPERIMENTAL VERIFICATION

All students will have experienced the properties of graphite in pencils. The way we imagine graphite's structure is a mental model which must explain the observed properties. Subsequent experiments can verify, refine, or change the model. This theme continues through this video, and the next in the series.

SECTION 2:
CATHODE RAYS - PROPERTIES AND INTERPRETATION

Using real discharge tubes the electromangnetic and particular properties of cathode rays are illustrated. J.J. Thomson adapted these tubes to measure accurately the charge to mass ratio of the electron. He also unwittingly built the basic skeleton of the television tube.

SECTION 3:
MILLIKAN'S OIL DROP EXPERIMENT

Millikan's elegant method for measuring the charge on an electron enabled it's mass to be calculated from Thomson's result.

SECTION 4:
CANAL RAYS - PROPERTIES AND INTERPRETATION

Detection of the positive ions produced from ionization of atoms, when bombarded with cathode rays, was a great leap forward. The properties of these canal rays led to Rutherford's discovery of the proton. Accurate measurement of the masses of the ionized atoms, using a mass spectrometer, enabled an atomic mass scale based on ^{12}C to be developed.

SECTION 5:
RUTHERFORD'S GOLD FOIL EXPERIMENT

One of the most famous experiements in this video challenged the accepted Thomson "plum pudding" model and was performed by Rutherford's collaborators - Geiger and Marsden. Bombardment of gold foil with alpha particles, and analysis of the scattering pattern, was an elegant way to probe the density of atoms. The results were striking, and the accepted model had to change.

The nuclear model of the atom requires a very small nucleus. How small? The football stadium analogy nicely illustrates the scale.

SECTION 6:
ATOMIC NOTATION

Atoms are represented symbolically using a specific convention to enable isotopes to be identified unequivocally. What particles determine the **type** of atom?

These questions are answered using the notation.

Chemistry deals with the interaction between the electron clouds in atoms. Do these electron clouds have a structure? Some preliminary points are illustrated, to be further elaborated upon in **"Electron Arrangement in Atoms".**

SECTION 7:
HOW ARE ELECTRONS ARRANGED IN AN ATOM?

What arrangement of electrons makes electrical and mechanical sense? How can we visualise electrons in atoms consistent with what we know of atomic interaction?

The history of some ideas for arranging electrons is broadly outlined.

SUGGESTIONS ON USING THE VIDEO

Educational research shows that videos are most effective if shown in short "topic segments". The audience should be kept in an "active processing" mode by being required to:

* answer specific questions known to them before the video is presented;

* label key diagrams shown in the video.

The key diagrams are included in these notes for photocopying for students. Some questions you might like the students to consider are listed below:

1. Using the graphite structure model to explain why a graphite crystal is slippery.

2. Try to define what an atom is.

3. What are cathode rays? What experiemental evidence supports your answer?

4. How is a television image produced on the screen?

5. How was the mass of an electron determined experimentally?

6. What are canal rays? What experimental evidence supports your answer?

7. What observation in Rutherford's Gold Foil Experiment showed that the positively charged particles must be grouped together in a tiny nucleus, rather than evenly distributed within the atom?

8. Using the X atomic notation to describe an isotope, which number indicates the TYPE of atom, and which number is a measure of the isotype's MASS?

Credits

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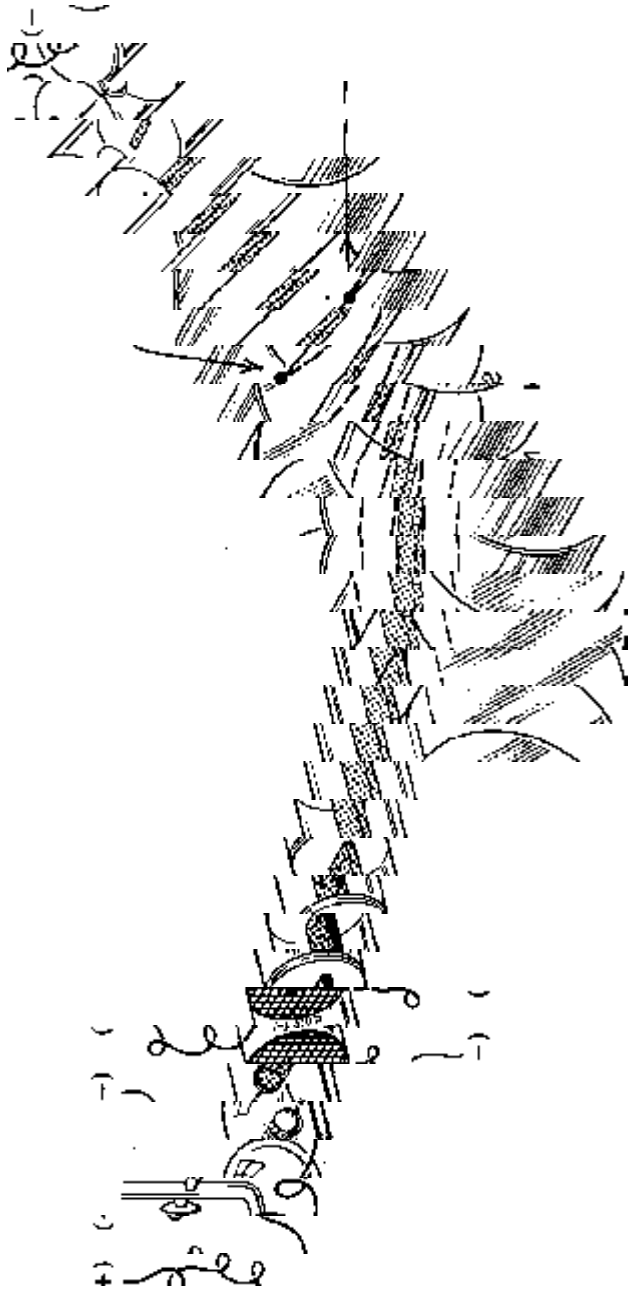

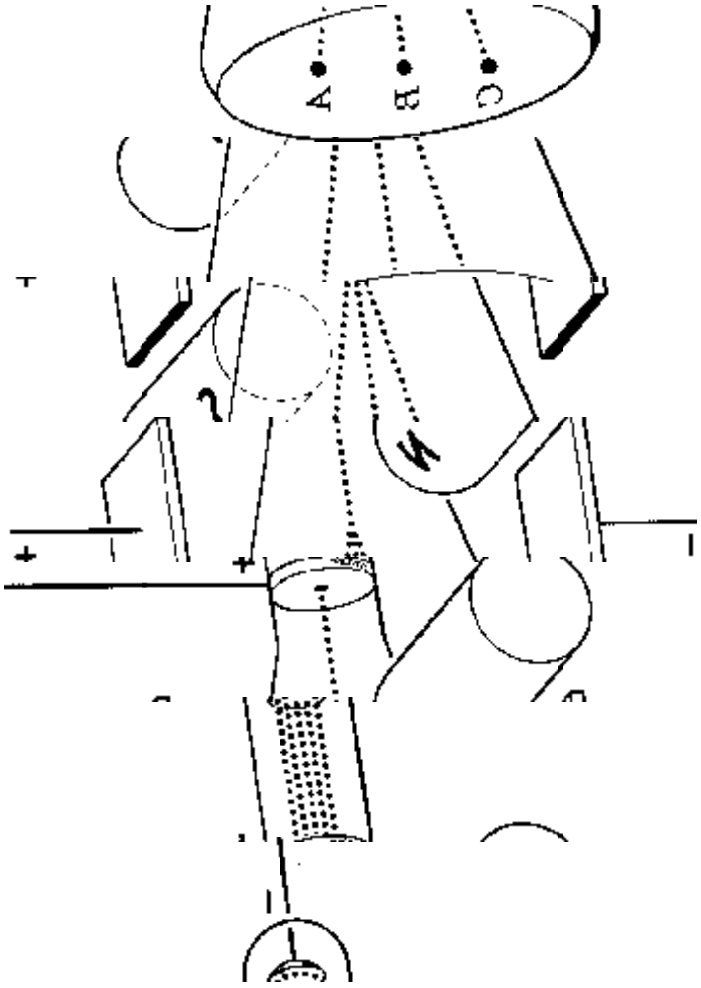
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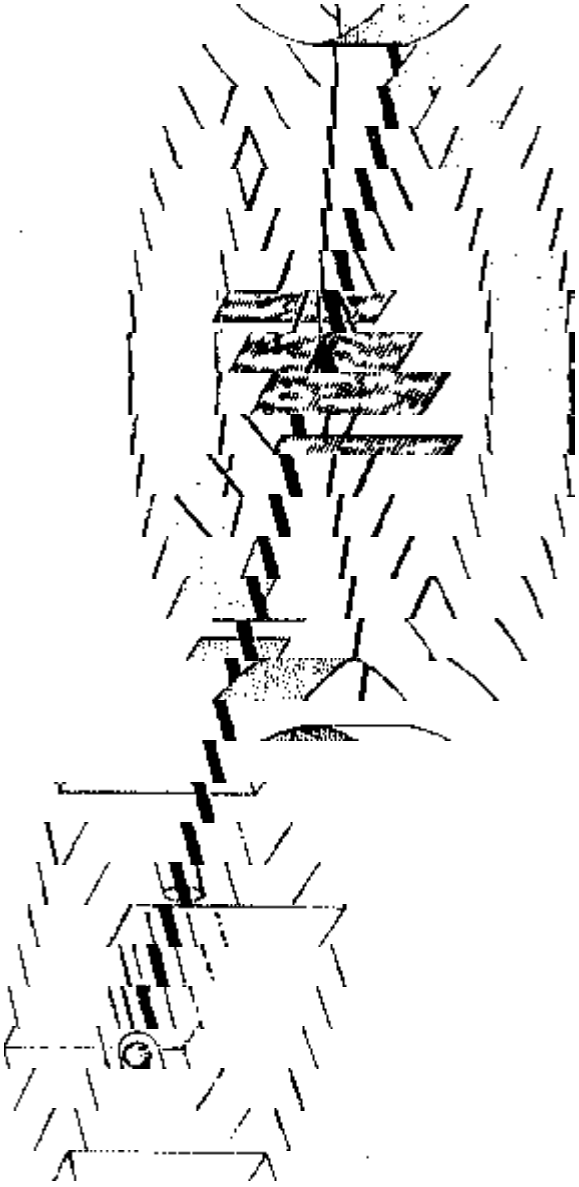

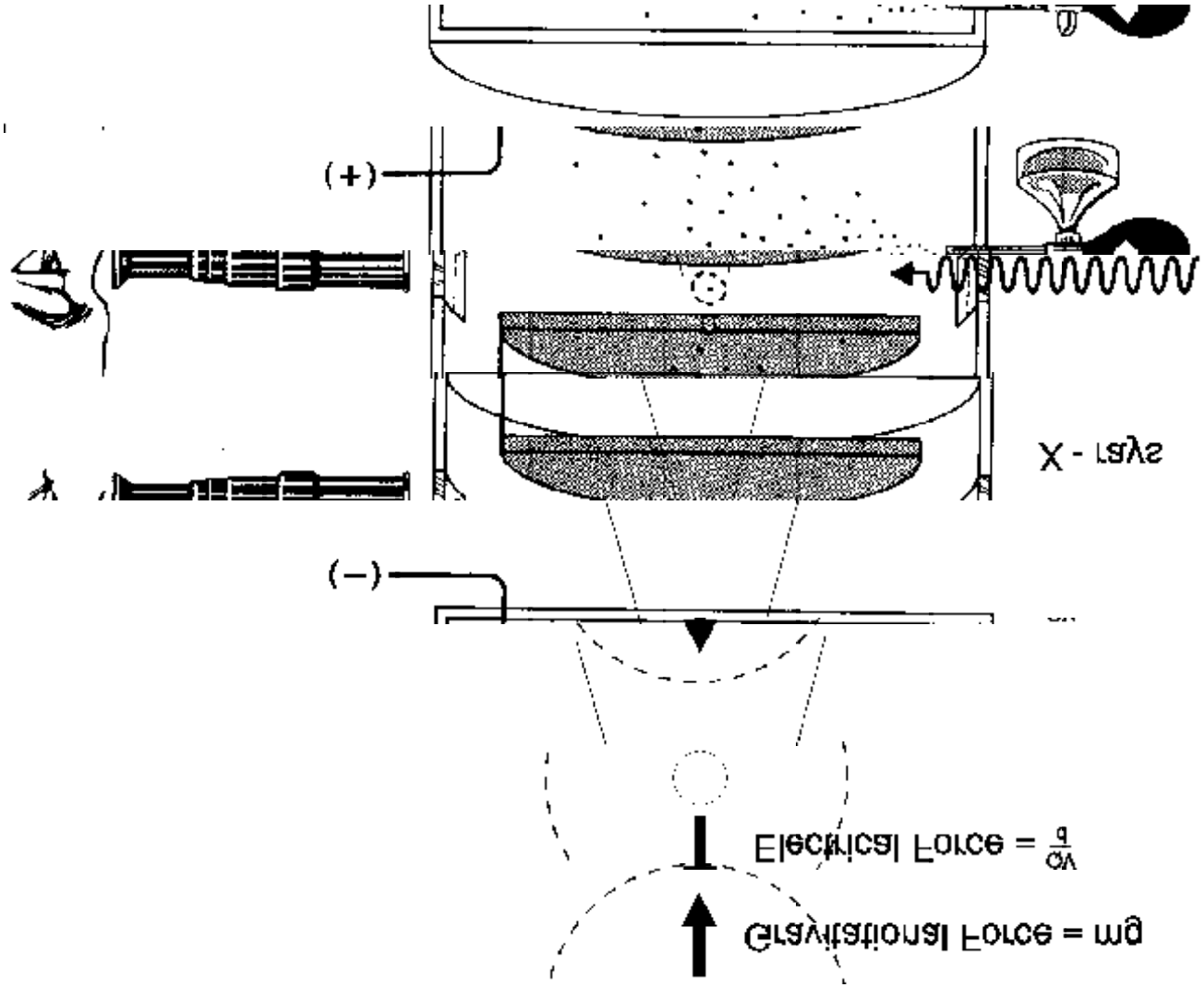
(+)
X - rays
(−)
Electrical Force = $\frac{q}{cv}$
Gravitational Force = mg