CONCEPT 4

Atomic theory continues to develop.

Activity

Atomic Theory in the Future

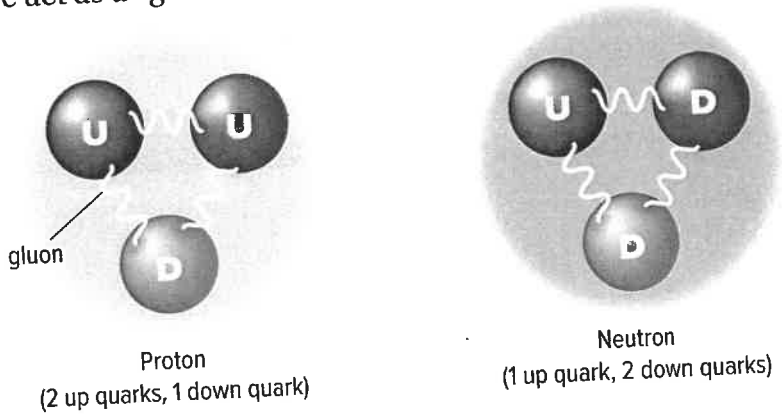
Do you think atomic theory is likely to change in the future? Write a brief blog post explaining your position. Support your ideas with examples.

According to Dalton's theory, atoms were indivisible and indestructible. Then Thomson discovered the electron and Rutherford discovered the nucleus, which was later found to be made up of neutrons and protons. The atom was not indivisible at all: it was made up of even smaller particles—*subatomic particles*. As scientists continued to study matter throughout the 20th century, they discovered that some of these subatomic particles were made up of still smaller particles.

Quarks

You may have heard the term "quark" before, perhaps in the title of CBC Radio's science program, Quirks and Quarks. According to current theories, quarks are *elementary particles*, meaning that they cannot be split apart into smaller particles. There are six different types, called *flavours* (really!) of quarks. They are classified based on their properties, which include mass and electric charge, and have the following creative names: *up*, *down*, *strange*, *charm*, *top*, and *bottom*.

Protons and neutrons are known as composite particles. As shown in **Figure 2.32**, they are both made up of quarks. Protons and neutrons also contain elementary particles called gluons. These act as a "glue" that binds quarks to one another.



Proton
(2 up quarks, 1 down quark)

Neutron
(1 up quark, 2 down quarks)

Figure 2.32 Protons and neutrons are made up of smaller elementary particles.

Leptons

Unlike protons and neutrons, electrons are themselves elementary particles. They are a type of elementary particle called *leptons*. Like quarks, leptons come in six flavours, as shown in **Table 2.4**. The key difference between quarks and leptons is that quarks experience the strong force, while leptons do not.

Table 2.4 Characteristics of Leptons

Lepton	Description
electron	• The electron is the lepton found in atoms. • Compared to the electron, muon and tau particles have the same charge (1^-) but a much greater mass.
muon	
tau	
electron neutrinos	• Neutrinos are very difficult to detect. They have no charge and are nearly massless. • Trillions of them pass through our bodies each second. • Neutrinos are produced by high-energy processes such as nuclear reactions in the Sun.
muon neutrinos	
tau neutrinos	

Research Continues

Today, engineers and scientists continue to work together to probe the atom even further. One local example, the TRIUMF cyclotron, is shown in **Figure 2.33**. Located in Vancouver, the cyclotron was built to research the particles that make up matter. Electromagnets in the cyclotron accelerate protons to extraordinary speeds. The resulting proton beam is allowed to collide with various materials, and specialized detectors provide data about the products of the collisions.

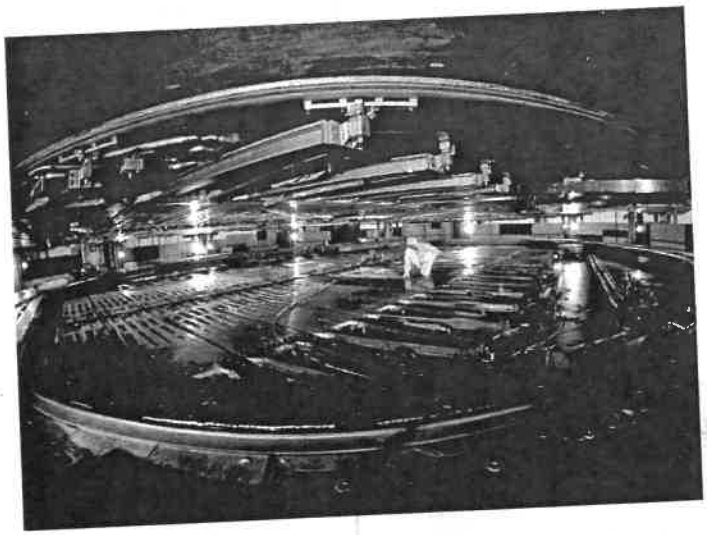


Figure 2.33 The TRIUMF cyclotron is a particle accelerator that produces a high-speed beam of protons. People come to Vancouver from all over the world to use it to run experiments.

Extending the Connections

Beyond the Atom

Choose one of these terms or another of your choice to research: dark matter, antimatter, the Higgs boson, superstring theory, or quantum mechanics.

Before you leave this page . . .

1. Describe the structure of a proton.
2. Compare neutrinos and electrons.