

- (i) Light spectroscopy may be used as a qualitative analysis technique because the spectrum of each element is unique. Light spectroscopy is used to identify the composition of stars as well as trace elements in food and building materials.
- (j) Even though helium is the second most abundant element in the universe, it was only discovered about 140 years ago. It is the only element that was first discovered on the Sun and only later on Earth. In 1869, J. Norman Lockyer, a civil servant, examined the light coming from the Sun using a spectroscope and observed a yellow line that had not been seen before. That same year, Pierre Jules Cesar Janssen, a French astronomer, observed the same yellow line while working in India. Both astronomers tried to recreate their results in a laboratory, but failed. Lockyer proposed that the spectrum belonged to a new element but was ignored. It was not until 1895 that the element helium was discovered on Earth. William Ramsay, a Scottish chemist, was looking at the spectrum of gases emitted by the mineral cleveite. Ramsay observed a yellow line. He sent samples to Lockyer and William Crookes (cathode ray tubes), who confirmed that the yellow line produced by the gases from cleveite was the same line that Lockyer had seen years before. Given that helium is odourless, tasteless, generally nontoxic, and colourless, it is not surprising that it took so long for it to be discovered!

1.6 THE BOHR MODEL OF THE HYDROGEN ATOM

SECTION 1.6 QUESTIONS

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Understanding Concepts

1. According to classical physics, the orbiting negatively charged electron should eventually run out of energy and collapse into the positively charged nucleus. From observation, we see that matter is very stable. We therefore infer that electrons do not collapse into the nuclei of atoms. Rutherford's model of the atom could not explain why.
2. In Bohr's and Rutherford's models, the atom consists of a nucleus, with protons having a positive charge and neutrons carrying zero charge, surrounded by empty space. In Rutherford's model, the electrons orbit the nucleus like planets around the Sun. In Bohr's model, the electrons are found in fixed energy levels around the nucleus. The first energy level holds a maximum of two electrons, while the second energy level holds a maximum of eight electrons. The amount of potential energy an electron has depends on the energy level in which it is located.
3. Spectroscopy revealed that all the elements have characteristic line spectra. Bohr came up with his model of the atom to explain these observations. Spectroscopy provided the empirical evidence on which Bohr's theory is based.
4. An electron in its ground state is in the lowest possible energy level, where it is most stable. At this level, the electron does not emit any electromagnetic radiation because it cannot drop to a lower energy level. When an electron is in the excited state, it has absorbed energy and is in a higher energy level. An electron in the excited state can drop to a lower energy level and release a fixed amount of energy as electromagnetic radiation that appears in a line spectrum.
5. Bohr's atomic model could only explain the line spectrum of hydrogen. It could not accurately predict the line spectra of more complex elements.
6. An electron in a lower energy level has less energy than an electron in a higher energy level. Therefore, when an electron drops from a higher energy level to a lower energy level, it emits the excess energy in the form of light.
7. Energy levels have a specific energy value. Electrons in the same energy level have the same amount of energy. To jump to a higher energy level, they must absorb a specific amount of energy. To drop to a lower energy level, they must release a specific amount of energy. Electrons cannot be found between energy levels.

Applying Inquiry Skills

8. Plug one of the discharge tubes into an electrical source. Observe the gas discharge tube through a spectroscope and record the line spectrum of the gas. To determine the identity of the gas, compare its line spectrum to the line spectra of identified gases in a resource. Repeat for the second discharge tube.

Making Connections

9. In Bohr's atomic model, electrons can only possess specific amounts of energy, depending on the energy level in which they are found. When electrons of an element are excited, they always jump to specific higher energy levels. When the electrons drop to lower energy levels, they always release specific amounts of energy, equal to the difference between the higher and lower energy levels. Since each element has a unique electron configuration, it has a characteristic line spectrum.