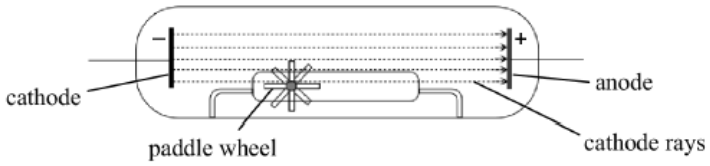
The Atomic Structure

Question 1

5. (*a*) During the 1870s Crookes investigated cathode rays using vacuum tubes like that shown below.



(*i*) Give one way of detecting the presence of cathode rays in a vacuum tube.

(*ii*) Name the scientist who around 1897 identified cathode rays as subatomic particles and, using a vacuum tube, measured their charge-to-mass ratio.

What name was given to the subatomic particle he identified? (9)

(*b*) Name one of the three scientists who shared the 1903 Nobel prize in Physics for their pioneering work on radioactivity which provided evidence for subatomic particles. (3)

(*c*) Rutherford concluded around 1910 that the electrons in an atom are located in a large, almost empty space surrounding a tiny, dense, positive nucleus.

State three observations made by Rutherford's team when they bombarded gold foil with alpha-particles.

Explain how Rutherford deduced from these observations that the nucleus is

(*i*) positive,

(*ii*) small *and* dense. (15)

Question 2

(*b*) Describe the structure of Thomson's 'plum pudding' model of the atom.

Question 3

(*a*) In 1909 Rutherford bombarded a very thin sheet of gold foil with alpha particles, most of which passed straight through it undeflected. Some alpha particles, however, were deflected at large angles and a very small number were reflected back along their original paths. The first of these observations was not inconsistent with the 'plum pudding' model of the atom that had been proposed by Thomson in 1904, but Rutherford had to formulate a new model of atomic structure to account for the other two observations.

(*i*) What are alpha particles? (4)

(*ii*) Describe the structure of Thomson's 'plum pudding' model of the atom. (6)

(*iii*) Explain why some alpha particles were deflected at large angles as they passed through the gold foil. (6)

(*iv*) Why were some alpha particles reflected back along their original paths?

Why did this happen to only a very small number of alpha particles? (6)

(*v*) Draw a labelled diagram to show the new structure of the atom proposed by Rutherford. (3)

Question 4

5. (*a*) State **two** assumptions of Dalton's atomic theory of 1808. (8)

(*b*) The electron was the first of the sub-atomic particles to be discovered. It was identified in experiments using cathode rays that were carried out in the late nineteenth century.

Name the scientist

(*i*) who, about 1897, measured the ratio of charge to mass of the electron, e/m,

(*ii*) who, about 1910, proved that the electrons in an atom reside in an electron cloud surrounding a small dense positive central nucleus,

(*iii*) who, about 1911, measured the charge on the electron, e. (9)

(*c*) The arrangement of the electrons in the electron cloud proposed in 1913 by Bohr, pictured on the right, was consistent with the hydrogen emission spectrum.

Outline Bohr's atomic theory based on the hydrogen emission spectrum. (15)

(*d*) State **two** limitations of Bohr's theory that led to its modification. (6)

(*e*) Define *atomic orbital*.

Draw the shape of the *p*-orbital.

State the maximum number of electrons that can be accommodated in a *p*-orbital. (12)

Question 5

(*a*) The scientist pictured on the right used charged oil drops to determine the size of the charge on a sub-atomic particle. Name the scientist, and the sub-atomic particle involved in his experiments.

Question 6

11. Answer any **two** of the parts (*a*), (*b*) and (*c*). (2 × 25)

(*a*) In 1910 Rutherford (pictured right) and his co-workers carried out an experiment in which thin sheets of gold foil were bombarded with alpha particles. The observations made during the experiment led to the discovery of the atomic nucleus.

(*i*) Describe the model of atomic structure which existed immediately *prior* to this experiment. (7)

(*ii*) In this experiment it was observed that most of the alpha particles went straight through the gold foil. Two other observations were made. State these other observations and explain how each helped Rutherford deduce that the atom has a nucleus. (12)