



Sample: Atomic Physics - Physics Assignment

Atomic Physics.

Some questions ask for brief descriptions. This usually means only three or four sentences in your own words, perhaps with sketch graphs or a few formulae, not a whole essay. There are no marks for copying text from the internet or textbooks as such answers may be more correct but do not show understanding.

In calculation questions assume:

$$c = 3 \times 10^8 \text{ ms}^{-1}$$

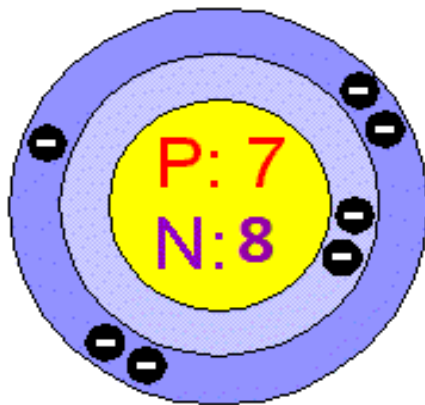
$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$$

$$\text{Planck's constant } h = 6.6 \times 10^{-34} \text{ Js} = 4.14 \times 10^{-15} \text{ eV.s}$$

$$1 \text{ amu} = 1.66 \times 10^{-27} \text{ Kg}$$

Section One

Nitrogen-15 is a stable isotope of nitrogen which is often used in research which involves nuclear magnetic resonance. Draw a simple, labeled diagram of the atom. You should indicate the number of protons, neutrons and electrons.



Number of protons – 7

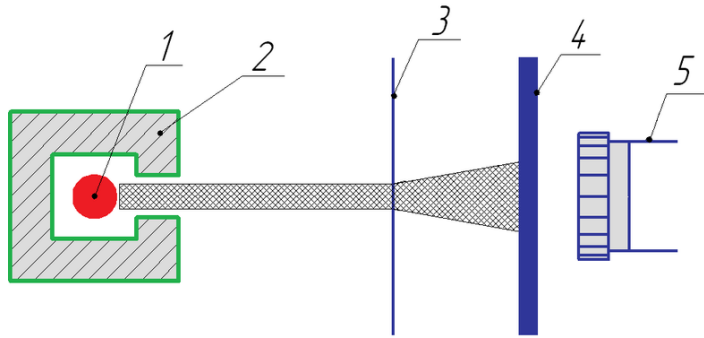
Number of neutrons – 8

Number of electrons - 7

Chlorine has an atomic mass of 35.5. Write a short explanation of why this is so, using the words 'proton', 'neutron', 'isotope', 'atomic number', 'mass number' etc.

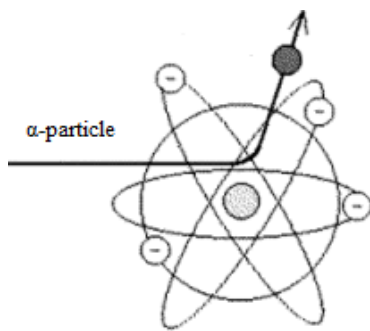
Atomic mass is the average of all the elements of the atomic masses of the isotopes, taking into account the proportion of these isotopes. All isotopes of Chlorine share the same number of protons and electrons; each isotope differs from others in its number of neutrons. Chlorine has two stable isotopes with atomic masses of 35 and 37. A mixture of these isotopes in a ratio 3:1 gives atomic mass of 35.5.

In 1909, at /Manchester University, Hans *Gelger* and Ernest Marsden carried out an experiment under the direction of Ernest Rutherford which changed the accepted model of the atom. Give a brief description of the experiment - with a diagram, and explain what it showed.



The experimental scattering α -particles. 1 - a radioactive prepare, 2 - lead cylinder, 3 - foil of the material, 4 - translucent screen, covered with ZnS, 5 - microscope.

Together with Hans Geiger and Ernest Marsden in 1909, he conducted an experiment Geiger - Marsden, who demonstrated the existence of a nucleus in an atom. Rutherford asked the Geiger-Marsden experiment in the search for alpha particles with very high deflection angles, which is not expected from the Thomson model of the atom at the time. Such deviations, although rare, have been found, and were a smooth function of the angle of deflection of higher order.



Later Rutherford admitted that when he offered his students to conduct an experiment on the scattering of alpha particles at large angles, he does not believe in a positive result.

2.1 Given that the mass of a proton is 1.00728 amu and a neutron is 1.00866 amu, calculate the mass deficit (in amu) of a Carbon-12 nucleus. Find the equivalent binding energy in Joules, and convert your answer to MeV

$$m_p = 1.00728 \text{ amu}$$

$$m_n = 1.00866 \text{ amu}$$

$$m_a (^{12}\text{C}) = 12.0000 \text{ amu}$$

$$Z = 6 \quad A = 12$$

Calculate mass-defect

$$\Delta m = Z \cdot m_p + (A - Z) \cdot m_n - m_a (^{12}\text{C}) = 6 \cdot 1.00728 + 6 \cdot 1.00866 - 12.0000 = 0.09564 \text{ amu}$$

the equivalent binding energy

$$E = \Delta m \cdot c^2 = 0.09564 \cdot 1.66 \cdot 10^{-27} \cdot (3 \cdot 10^8)^2 = 1.42886 \cdot 10^{-11} \text{ J}$$

$$1 \text{ eV} = 1.6 \cdot 10^{-19} \text{ J}$$

$$E = 89.3 \text{ MeV}$$

2.2 Explain three uses of radioactive isotopes. (One or two sentences each)

For example, ^{235}U is capable of sustaining fission chain reaction with thermal neutrons and can be used

1. ^{235}U - use as fuel in nuclear reactors.

2. ^{235}U - use for nuclear weapons.

Radionuclides ^{60}Co and ^{137}Cs are used to sterilize γ -rays (radiation sterilization) as a method of physical sterilization of instruments, bandages and other things.