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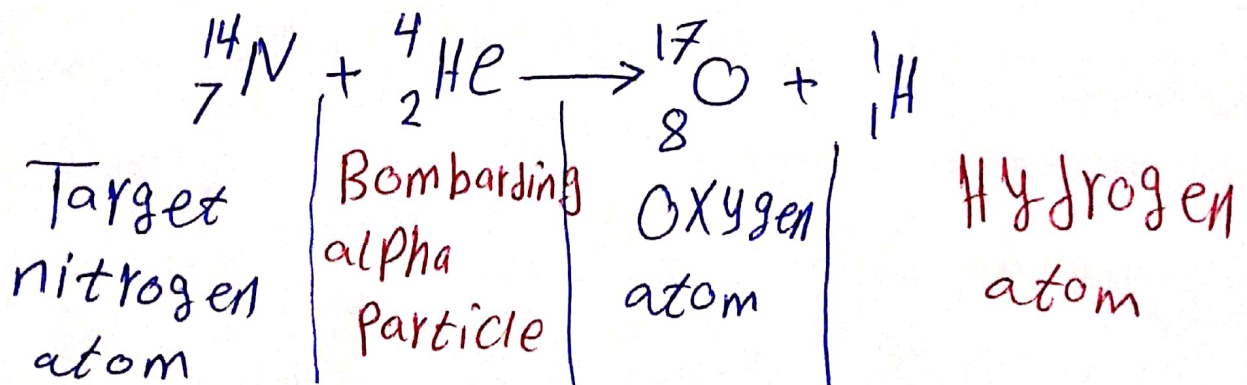
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SECTION 3 Nuclear Reactions

* Induced Transmutation: التحول النووي المستحث

- The Process which involves striking nuclei with high velocity particles. [with] [neutron or with high energy alpha, beta or gamma radiation]
- * The incident particles must be moving at extremely high speeds to overcome the electrostatic repulsion between them selves and the target nucleus.
- Rutherford performed the first Laboratory. Conversion of one element into another element.



* Particle accelerators: مسرعات الجسيمات
are machines built to produce the high speed particles needed to induce transmutation

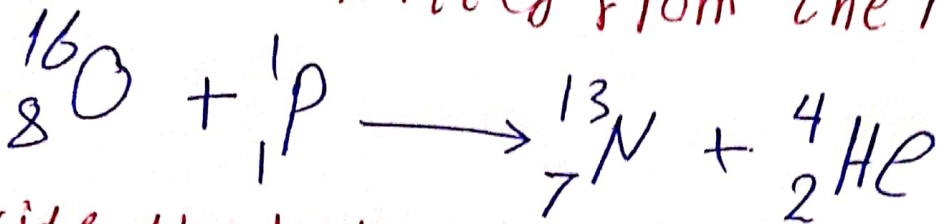
* Transuranium elements:

العناصر فائقة الثقل
عناصر ما فوق اليورانيوم

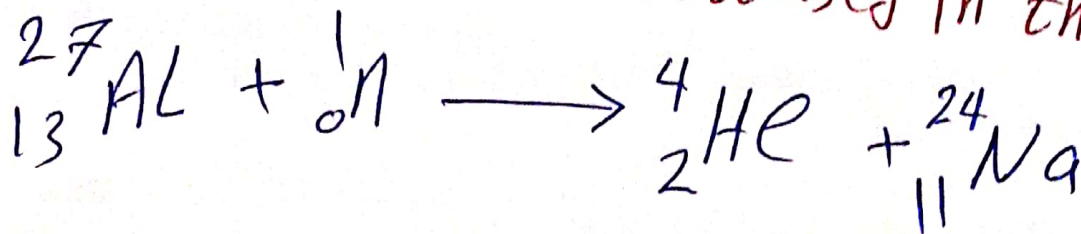
* The elements immediately following uranium in the periodic table elements with atomic numbers 93 and greater.

* EXAMPLE:

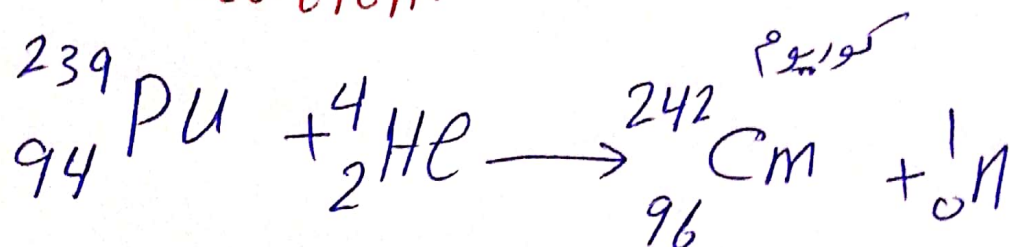
① Write a balanced nuclear equation for the induced transmutation of oxygen-16 into nitrogen-13 by proton bombardment. An alpha particle is emitted from the nitrogen atom.



② Write the balanced nuclear equation for the induced transmutation of aluminum-27 into sodium-24 by neutron bombardment. An alpha particle is released in the reaction.



3] Write the balanced nuclear equation for the alpha particle bombardment of ${}_{94}^{239}\text{Pu}$. One of the reaction products is a neutron.



* Nuclear Reactions and Energy:

التفاعلات النووية والطاقة

* Einstein's equation: معادلة أينشتاين:

- relates mass and energy.
- It states that any reaction produces or consumes energy due to a loss or gain in mass

Energy Equivalent of mass

$$\Delta E = \Delta m c^2$$

ΔE is the change in energy. in Joules (J) or MeV

Δm is the change in mass, in kg.

c is the speed of light. $= 3 \times 10^8 \text{ m/s}$

Mass defect and binding energy نقص الكتلة والطاقة

* mass defect: The difference in mass between a nucleus and its component nucleons.

* The nuclear binding energy: Can be defined as the amount of energy needed to break one mole of nuclei into individual nucleons.

① Note that the binding energy per nucleon reaches a maximum around a mass number 60.

Figure 14
55p

② Elements with a mass number near 60 are the most stable.

* Calculating Mass Defect

$$\text{Mass defect} = m_{\text{isotope}} - [N_p m_H + N_n m_n]$$

$$\Delta m = [N_p m_H + N_n m_n] - m_{\text{isotope}}$$

$$m_H = m_p = 1.007825 \text{ amu}$$

$$m_n = 1.008665 \text{ amu}$$

N_n = mass number - atomic number

$$\Delta E = \Delta m \times 931 \text{ MeV/amu}$$

* Calculate the mass defect and binding energy to Lithium ${}^7_3\text{Li}$:

Lithium isotope mass = 7.016003 amu

$$N_p = 3$$

$$m_H = 1.007825 \text{ amu}$$

$$m_n = 1.008665 \text{ amu}$$

$$N_n = 7 - 3 = 4$$

$$m_{\text{isotope}} = 7.016003$$

~~$$\Delta m = m_{\text{isotope}} - [N_p m_H + N_n m_n]$$~~

$$\Delta m = [N_p m_H + N_n m_n] - m_{\text{isotope}}$$

$$\Delta m = [(3 \times 1.007825) + (4 \times 1.008665)] - 7.016003 = 0.042132 \text{ amu}$$

$$\Delta E = \Delta m \times 931 = 0.042132 \times 931$$

$$\boxed{31} \quad \Delta m = 39.22 \text{ MeV}$$

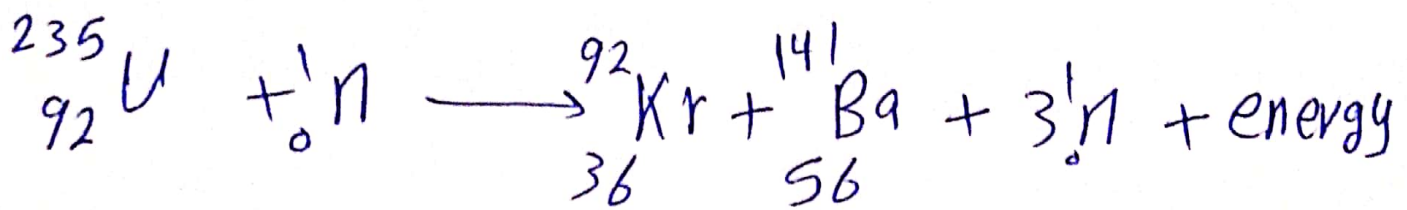
* Nuclear fission [الانشطار النووي]

The nuclei of atoms with masses greater than 60 are split into smaller parts to increase stability

هي انقسام أنوية الذرات ذات العدد الكتلي الأكبر منه إلى أجزاء أصغر لزيادة استقرارها.

The first nuclear fission was for Uranium
It is accompanied by the release of energy

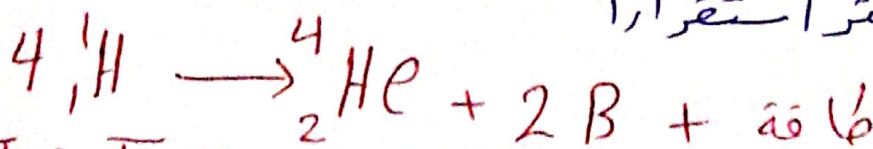
أول انشطار كان لليورانيوم ويصحبها انطلاق طاقة



* Nuclear fusion [الاندماج النووي]

It is the process of combining light atomic nuclei to form one more stable nucleus

هي عملية اتحاد الأنوية الذرية الخفيفة لتكوين نواة واحدة أكثر استقراراً



* The Tokamak reactor is used to contain the fusion reaction
يستخدم مفاعل توكوماك لإحتواء تفاعل الاندماج.