

Structure of The Nucleus Assignment **SOLUTIONS**

1.

Number of protons	Number of neutrons	Mass number	Atomic number
6		12	
10	10		10
20	22	42	20
13			13
	132	216	84

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2. All nucleons exert a strong attractive force over very small distances

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3.

a) A variation of the element (nucleus) with a particular number of neutrons

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b) Chemical behaviour depends only on the electronic configuration (electrons and protons), and isotopes have the same number of those (neutrons are neutral).

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4.

a)

$$m_{\text{initial}} = 7 \times m_p + 7 \times m_n = 7 \times 1.673 \times 10^{-27} + 7 \times 1.675 \times 10^{-27} = 2.3436 \times 10^{-26} \text{ kg}$$

$$m_{\text{final}} = 2.32 \times 10^{-26} \text{ kg}$$

$$\Delta m = m_{\text{final}} - m_{\text{initial}} = -2.36 \times 10^{-28} \text{ kg} = 2.36 \times 10^{-28} \text{ kg lost}$$

$$E_b = \Delta mc^2 = 2.36 \times 10^{-28} \times (3.00 \times 10^8)^2 = 2.12 \times 10^{-11} \text{ J (3 s.f.)}$$

$$\frac{2.12 \times 10^{-11}}{1.60 \times 10^{-19}} = 1.33 \times 10^8 \text{ eV} = 133 \text{ MeV (3 s.f.)}$$

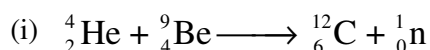
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b) Released (mass after is less than mass before)

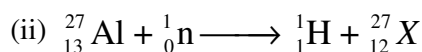
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5.

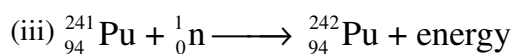
a)



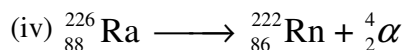
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b) $E_b = \Delta mc^2$

$$\therefore \Delta m = \frac{E_b}{c^2} = \frac{504 \times 10^6 \times 1.60 \times 10^{-19}}{(3.00 \times 10^8)^2} = 8.96 \times 10^{-28} \text{ kg}$$

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6. a) Let the helium nucleus be body 1, and let the thorium nucleus be body 2.

Conservation of momentum states that total change is zero:

$$\Delta\vec{p}_1 + \Delta\vec{p}_2 = 0$$

$$\therefore \Delta\vec{p}_1 = -\Delta\vec{p}_2$$

$$\therefore \Delta p_1 = \Delta p_2 \quad \{\text{considering only magnitudes}\}$$

$$\therefore p_1 = p_2 \quad \{\text{since they start at rest}\}$$

$$\therefore m_1 v_1 = m_2 v_2$$

$$\therefore \frac{v_2}{v_1} = \frac{m_1}{m_2} = \frac{234}{4} = 58.5$$

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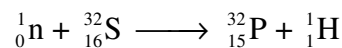
- b) In order for momentum to be conserved for two products, they must both move off in opposite directions with equal magnitude of momentum. A product with less mass then will have more velocity, since $p = mv$. Since $K = \frac{1}{2}mv^2$, the smaller product will have more kinetic energy.

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7.

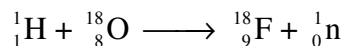
a)

- (i) neutrons emitted from a nuclear reactor hit nuclei of sulphur-32. The sulphur nuclei eject a photon in the process and the phosphorus-32 is created:



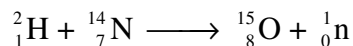
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- (ii) hydrogen nuclei (protons) are accelerated to high energies in a cyclotron and then allowed to bombard oxygen-18 nuclei. A neutron is displaced from the oxygen and the fluorine absorbs the proton creating fluorine-18:



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- (iii) nitrogen-14 is bombarded with deuterons (hydrogen-2 nuclei). The deuteron's proton is absorbed, a neutron is emitted during the reaction, and oxygen-15 is created:



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- c) The treatment of excess blood cells, since phosphorus-32 suppresses the production of red blood cells in bone marrow.

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TOTAL /31