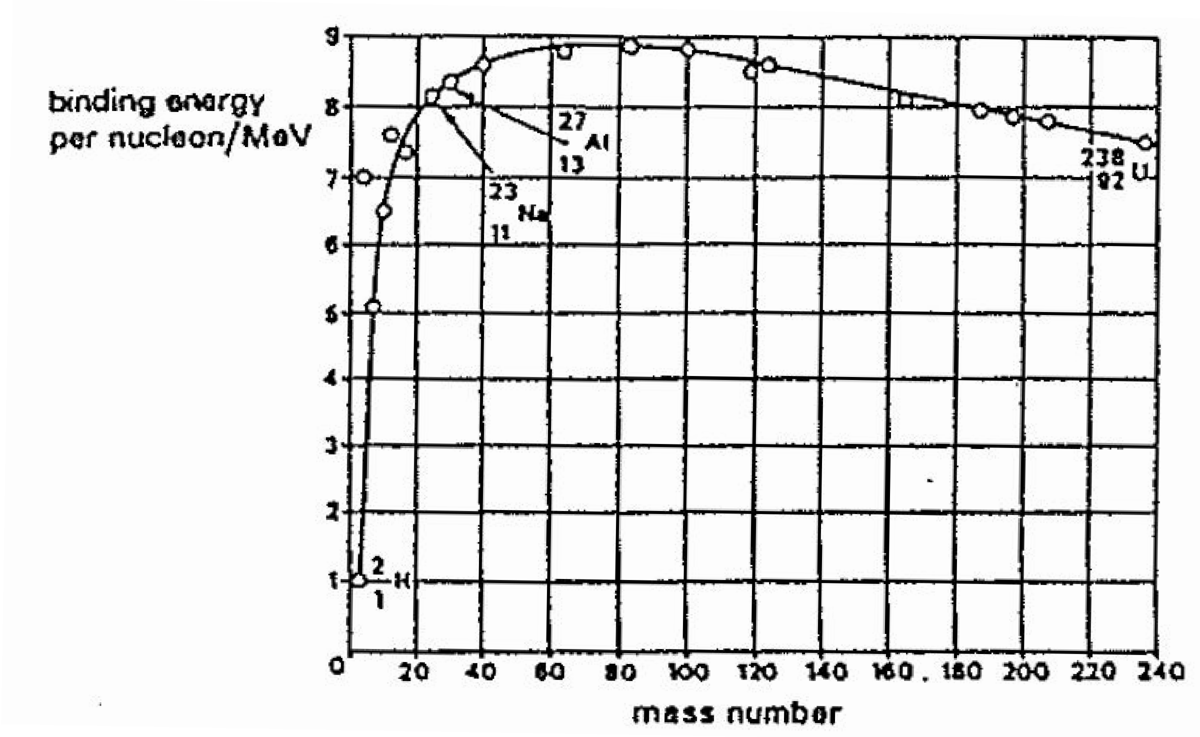
**Nuclear Physics Binding Energy and Mass Defect**

**1** The figure below shows the graph of the binding energy per nucleon for a number of naturally-occurring nuclides plotted against their mass number.




Which of the following statement is a correct deduction from the graph?

**A** Binding energy is the energy used to bind protons and neutrons in a nucleus.

**B** ${}^{27}_{13}Al$ will not spontaneously emit an alpha particle to become ${}^{23}_{11}Na$

**C** The binding energy of ${}^{27}_{13}Al$ is greater than ${}^{238}_{92}U$

**D** ${}^{23}_{11}Na$ is more stable than ${}^{27}_{13}Al$

**2** Helium nuclei may result from the bombardment of lithium nuclei with protons. The reaction can be represented by the following nuclear equation:

$$ {}^{7}_{3}Li + {}^{1}_{1}p \rightarrow 2\,{}^{4}_{2}He + energy $$

The speed of light is $c$, and the masses of the particles are:
Lithium $m_L$ Helium $m_H$ Proton $m_p$

What is the net energy released during such a reaction?

**A** $(m_H - m_L - m_p)\,c^2$

**B** $(2m_H - m_L - m_p)\,c^2$

**C** $(m_L + m_p - m_H)\,c^2$

**D** $(m_L + m_p - 2m_H)\,c^2$

**3** Carbon nuclei may result from the bombardment of Beryllium nuclei with Helium. The reaction can be represented by the following nuclear equation:

$$^{9}_{4}Be + \, ^{4}_{2}He \rightarrow \, ^{1}_{0}n + \, ^{12}_{6}C + energy$$

The binding energy per nucleon of the particles are:
Beryllium $E_B$ Helium $E_H$ Carbon $E_C$

What is the net energy released during such a reaction?

**A** $(E_B + E_H - E_C)$

**B** $(9E_B + 4E_H - 12E_C)$

**C** $(12E_C - 9E_B - 4E_H)$

**D** $(E_C - E_B - E_H)$

**4** A nucleus has a mass number A, atomic number Z and a binding energy B. The mass of the neutron and proton are $m_n$ and $m_p$ respectively and $c$ is the speed of light.

Which of the following expression correctly represents the mass of the nucleus?

**A** $(\mathrm{A} - \mathrm{Z})m_n + \mathrm{Z}m_p - B / c^2$

**B** $(\mathrm{A} - \mathrm{Z})m_n + \mathrm{Z}m_p + B / c^2$

**C** $\mathrm{A}m_n + \mathrm{Z}m_p - B / c^2$

**D** $\mathrm{A}m_n + \mathrm{Z}m_p + B / c^2$

**5** A nuclide $^{X}_{Y}Z$ has a mass M. The mass of the neutron and proton are $m_n$ and $m_p$ respectively and $c$ is the speed of light.

What is the binding energy per nucleon of the nuclide?

**A** $\left(\frac{\mathrm{Y}m_p + (\mathrm{X}-\mathrm{Y})m_n - \mathrm{M}}{\mathrm{X}}\right) c^2$

**B** $\left(\frac{\mathrm{M} - \mathrm{Y}m_p - (\mathrm{X}-\mathrm{Y})m_n}{\mathrm{X}}\right) c^2$

**C** $\left(\frac{\mathrm{Y}m_p + (\mathrm{X}-\mathrm{Y})m_n - \mathrm{M}}{\mathrm{Y}}\right) c^2$

**D** $\left(\frac{\mathrm{M} - \mathrm{Y}m_p - (\mathrm{X}-\mathrm{Y})m_n}{\mathrm{Y}}\right) c^2$

List of Extension Qn

Instruction: Attempt these when you have finished your Group Discussion.
Draw your answers on the table, take a pic and send it back to me via AirDrop.
Do indicate your group member.

Q1

} The relative atomic masses, $A_r$, of a number of nuclides are listed below:

| nuclide | $A_r$ |
|---|---|
| $^{4}_{2}He$ | 4.0026 |
| $^{23}_{11}Na$ | 22.9898 |
| $^{27}_{13}Al$ | 26.9815 |

Discuss whether it is possible for $^{27}_{13}Al$ spontaneously to emit an alpha particle. J77/I/10

Q2

Calculate the binding energy of the deuteron $^{2}_{1}H$, given the following data:

mass of proton $= 1.672648 \times 10^{-27}$ kg;
mass of neutron $= 1.674954 \times 10^{-27}$ kg,
mass of deuteron $= 3.344275 \times 10^{-27}$ kg;
speed of light $= 2.997925 \times 10^{8}$ m s$^{-1}$.

**Common misconception (by test results)**

Q1:  B
option C: binding energy vs binding energy per nucleon

Q2: D
option C: did not take into account of 2 helium

Q3: C
Option A: binding energy vs binding energy per nucleon
Option B: binding energy vs mass defect

Q4: A

Q5: A