7.2 Nuclear Reactions

Question Paper

Course	DP IB Physics
Section	7. Atomic, Nuclear & Particle Physics
Topic	7.2 Nuclear Reactions
Difficulty	Medium

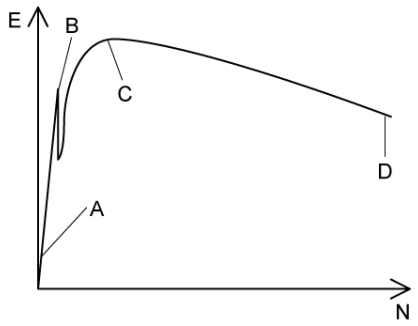
Time allowed: 20

Score: /10

Percentage: /100

Question 1

The image below shows a simplified version of the binding energy per nucleon *E* of nuclei versus the nucleon number *N*. Which of the following positions represents nuclei that are the most stable?



[1 mark]

Question 2

The rest mass of a nucleus of Boron-11 ($^{11}_{5}B$) can be considered as m_B. The rest-masses of a neutron and proton can be considered as m_N and m_P respectively. Which of the following equations is the correct representation for the binding energy of Boron-11?

A. $(5m_P + 6m_N - m_B)c^2$

B. $(5m_P + 6m_N + m_B)c^2$

C. $(5m_P + 11m_N - m_B)c^2$

D. $(6m_P + 5m_N - m_B)c^2$

[1 mark]

Question 3

Which statement about nuclear binding energy is correct?

A. It is the energy equivalent of the mass of the neutrons in a nucleus

B. It is the energy required to separate nucleons in a nucleus

C. It is the energy required to overcome the electrostatic force between nucleons in the nucleus

D. It is the energy required to remove a single nucleon from a nucleus

[1 mark]

Question 4

The binding energy per nucleon is 7.98 MeV for an atom of $^{16}_{8}O$. Approximately how much energy would be needed to completely separate the nucleons of this atom?

A. 33.2 MeV

B. 63.9 MeV

C. 88.5 MeV

D. 127.7 MeV

[1 mark]

Question 5

The mass defect for Helium-4 is 5.04×10^{-29} kg. What is the binding energy of Helium-4 closest to?

A. 0.02 MeV

B. 28 MeV

C. 190 MeV

D. 1225 MeV

[1 mark]

Question 6

Which of the following isotopes releases the least amount of potential energy during nuclear fission?

A. Uranium-235

B. Thorium-231

C. Radon-222

D. Osmium-190

[1 mark]

Question 7

Two identical nuclei of mass *m* fuse to form a single heavier nucleus (with no other products) with mass *M*. Which of the following statements is correct?

A. $m = M$

B. $2m = M$

C. $2m > M$

D. $2m < M$

[1 mark]

Question 8

Alchemists investigated the process of transmutation of mercury into gold. This can be represented by the following equation:

$$^{2}_{1}\mathrm{H} + ^{199}_{80}\mathrm{Hg} \rightarrow ^{197}_{79}\mathrm{Au} + ^{4}_{2}\mathrm{He}$$

The sum of the rest masses of deuterium and mercury is 202.60 u and the sum of the rest masses of gold and helium are 200.97 u.

Take the energy equivalent of 0.001 u to be 1 MeV.

Which of the following can be determined from the information provided?

A. Energy of approximately 2000 MeV has been converted to a mass of 2 u

B. The kinetic energy of the products exceeds the kinetic energy of the reactants by 2000 MeV

C. The number of nuclei of gold is not equal to the number of nuclei of mercury

D. The kinetic energy of the deuterium nucleus was 2000 MeV

[1 mark]

Question 9

Nitrogen-14 can be transformed into Oxygen-17 by bombardment with high energy alpha particles, as described in the nuclear reaction equation below:

$$^{14}_{7}N + ^{4}_{2}He \rightarrow ^{17}_{8}O + ^{1}_{1}H$$

The total rest mass of the reactants is 18.006 u and total rest mass of the products is 18.007 u.

Which of the following statements about this reaction is **correct**?

A. A mass of 0.001 u has been converted to about 1 MeV of energy

B. The kinetic energy of the products exceeds the kinetic energy of the reactants by about 1 MeV

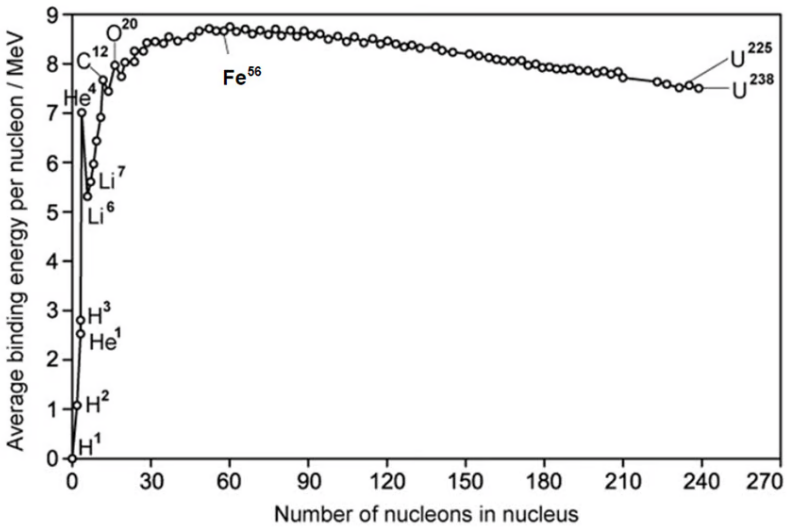
C. The kinetic energy of the reactants exceeds the kinetic energy of the products by about 1 MeV

D. The mass defect of this reaction is 0.002 u

[1 mark]

Question 10

The graph below shows how the average binding energy per nucleon varies with nucleon number for stable nuclei.



Approximately how much energy is released when the nucleus forms?

A. 7.90 MeV

B. 1430 MeV

C. 533 MeV

D. 888 MeV

[1 mark]