**Nuclear fission – mass defect and energy released**

**Key ideas**:

* Nuclear fission is the splitting of a large, unstable nucleus into (typically) two smaller nuclei.
* The mass of the products (including released neutrons) is less than the mass of the original nucleus plus absorbed neutron.
* The difference in mass (Δm) is referred to as the **mass defect**.
* The energy released in the fission of a nucleus is calculated using Einstein’s mass-energy relationship (ΔE = Δmc2).

**To do**

* Copy and complete each of the following nuclear equations describing nuclear fission.
* For each reaction, calculate a) the mass defect in i) atomic mass units (u) and ii) kg, and b) the energy (Q) released in i) J and ii) MeV.
1. $$
2. $$
3. $$
4. $$
5. $ 3$

**Data** – masses of nuclei appearing in the equations above:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Nucleus** | **mass / u** |  | **Nucleus** | **mass / u** |  | **Nucleus** | **mass / u** |
| neutron | 1.008 67  |  | Kr-90 | 89.919 52  |  | Sr-95 | 94.919 36 |
| Ba-141 | 140.914 41 |  | Kr-92 | 91.926 16  |  | U-235 | 235.042 77 |
| Ba-145 | 144.927 63  |  | La-146 | 145.925 79 |  | Xe-138 | 137.913 95 |
| Br-87 | 86.920 71  |  | Pu-239 | 239.052 16 |  |  |  |
| Ce-147 | 146.922 67  |  | Sr-93 | 92.914 03 |  |  |  |

**Answers**:

**Q1 a) i)** Δm=0.192 12 u **ii)** 3.189 x 10-28 kg **b) i)** Q = 2.87 x 10-11 J **ii)** Q = 179.4 MeV

**Q2** **a) i)** Δm=0.178 93 u **ii)** 2.970 x 10-28 kg **b) i)** Q = 2.67 x 10-11 J **ii)** Q = 167.1 MeV

**Q3** **a) i)** Δm=0.184 86 u **ii)** 3.069 x 10-28 kg **b) i)** Q = 2.76 x 10-11 J **ii)** Q = 172.6 MeV

**Q4** **a) i)** Δm=0.201 83 u **ii)** 3.350 x 10-28 kg **b) i)** Q = 3.01 x 10-11 J **ii)** Q = 188.5 MeV

**Q5** **a) i)** Δm=0.192 63 u **ii)** 3.198 x 10-28 kg **b) i)** Q = 2.88 x 10-11 J **ii)** Q = 179.9 MeV