CLASS 12 PHYSICS NCERT SOLUTIONS

NCERT Solutions for Class 12 Physics Chapter 13: Nuclei – Free PDF Download

Chapter 13 covers nuclear physics — nuclear size and density, mass defect and binding energy, nuclear fission, nuclear fusion, and radioactivity. This chapter has no separate "Additional Exercises" section even in older editions, and all 10 main exercises remain current under the 2026-27 syllabus; each numeric ans...

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NCERT Exercise Solutions

13.1 Find the binding energy of a nitrogen nucleus ($^{14}_{7}N$), given its atomic mass is 14.00307u.
Ans: Using $BE=[Zm_H+(A-Z)m_n-M]\times931.5MeV$, with Z=7, A=14: mass defect=(7×1.007825+7×1.008665)−14.00307=0.11243u. BE=0.11243×931.5≈**104.66MeV**, giving a binding energy per nucleon of **≈7.48MeV**.

13.2 Obtain the binding energy of the nuclei $^{56}_{26}Fe$ and $^{209}_{83}Bi$ in units of MeV, given their respective atomic masses 55.934939u and 208.980388u. Which nucleus has the greater binding energy per nucleon?
Ans: For Fe-56 (Z=26,A=56): BE≈**492.26MeV**, BE/nucleon≈**8.79MeV**. For Bi-209 (Z=83,A=209): BE≈**1640.26MeV**, BE/nucleon≈**7.85MeV**. **Iron-56 has the higher binding energy per nucleon** — consistent with iron sitting near the peak of the binding-energy-per-nucleon curve, the most stable region for nuclei.

13.3 A 3.0g copper coin is made entirely of $^{63}_{29}Cu$ atoms (atomic mass 62.92960u). Calculate the nuclear energy that would be required to separate all the neutrons and protons in this coin from one another.
Ans: BE per Cu-63 atom≈551.39MeV (Z=29,A=63). Number of atoms in the coin=$(3.0/62.9296)\times6.022\times10^{23}\approx2.87\times10^{22}$. Total separation energy=BE×number of atoms≈1.58×10^{25}MeV≈**2.53×10^{12}J** — an enormous amount, illustrating just how much energy binds ordinary nuclear matter together.

13.4 The nuclear radius of $^{197}_{79}Au$ is compared with that of $^{107}_{47}Ag$. Find the ratio of their nuclear radii.
Ans: Since nuclear radius $R=R_0A^{1/3}$, the ratio only depends on the mass numbers: $R_{Au}/R_{Ag}=(197/107)^{1/3}\approx$**1.23**.

13.5 Calculate the Q-value (energy released or absorbed) for these two nuclear reactions, and state whether each is exothermic or endothermic: (a) $^{1}_{1}H+^{3}_{1}H\rightarrow^{2}_{1}H+^{2}_{1}H$, using $m(^{1}H)=1.007825u$, $m(^{3}H)=3.016049u$, $m(^{2}H)=2.014102u$; (b) $^{12}_{6}C+^{12}_{6}C\rightarrow^{20}_{10}Ne+^{4}_{2}He$, using $m(^{12}C)=12.000000u$ and $m(^{20}Ne)=19.992439u$.
Ans: (a) $Q=[m(^{1}H)+m(^{3}H)-2m(^{2}H)]\times931.5=(4.023874-4.028204)\times931.5\approx$**−4.03MeV (endothermic)** — energy must be supplied for this reaction to proceed. (b) Using the standard mass of $^{4}He=4.002603u$: $Q=[2m(^{12}C)-m(^{20}Ne)-m(^{4}He)]\times931.5=(24.000000-23.995042)\times931.5\approx$**+4.62MeV (exothermic)** — this reaction releases energy.

13.6 Is the fission of $^{56}_{26}Fe$ into two $^{28}_{13}Al$ nuclei energetically feasible? Use the given atomic masses m(Fe-56)=55.93494u and m(Al-28)=27.98191u to justify your answer with a Q-value calculation.
Ans: Q=[m(Fe-56)−2m(Al-28)]×931.5=(55.93494−55.96382)×931.5≈**−26.90MeV**. Since Q is **negative**, this fission is **not energetically feasible** — energy would have to be supplied rather than released, unlike the fission of very heavy nuclei (uranium, plutonium), which do release energy.

13.7 Consider 1kg of pure $^{239}_{94}Pu$, where each fission event releases 180MeV on average. Calculate the total energy released if the entire sample undergoes fission.

Ans: Number of atoms in 1kg=(1000/239)×6.022×10^{23}≈2.52×10^{24}. Total energy=2.52×10^{24}×180MeV≈4.54×10^{26}MeV≈**7.26×10^{13}J**.

13.8 Suppose a 100W electric lamp is powered entirely by the fusion energy released from 2.0kg of deuterium, with each fusion event ($^2_1H+^2_1H$) releasing 3.27MeV. For roughly how long could the lamp be kept running?
Ans: Number of deuterium atoms=(2000/2.014)×6.022×10^{23}≈5.98×10^{26}. Since each fusion event consumes 2 deuterium atoms, number of events≈2.99×10^{26}. Total energy released≈2.99×10^{26}×3.27MeV≈1.56×10^{14}J. Time=energy/power=1.56×10^{14}/100≈1.56×10^{12}s, or roughly **5×10^4 years** — illustrating the vast energy density of nuclear fusion fuel.

13.9 Two deuterons, each treated as a hard sphere of radius 2.0fm, approach each other head-on. Estimate the height of the Coulomb potential barrier that must be overcome for them to fuse.
Ans: The barrier height equals the Coulomb potential energy at closest approach, when the two deuteron surfaces just touch (separation d=2.0+2.0=4.0fm): $V=ke^2/d=(8.99\times10^9\times(1.6\times10^{-19})^2)/(4.0\times10^{-15})$≈**0.36MeV (360keV)**.

13.10 Show, using the relation $R=R_0A^{1/3}$ for the nuclear radius (R_0 a constant, A the mass number), that nuclear matter density is approximately the same for all nuclei, independent of A.
Ans: Nuclear density=mass/volume≈$(Am_N)/(\frac{4}{3}\pi R^3)$, where m_N is the average nucleon mass. Substituting $R=R_0A^{1/3}$ gives volume=$\frac{4}{3}\pi R_0^3A$, so density=$(Am_N)/(\frac{4}{3}\pi R_0^3A)=m_N/(\frac{4}{3}\pi R_0^3)$ — the mass number A **cancels out completely**, leaving a density that depends only on universal constants (m_N and R_0), and is therefore **the same for all nuclei**, light or heavy.

Class 12 Physics Chapter 13 – Notes and Extra Questions

Along with these NCERT Solutions, students can also use the Class 12 Physics Chapter 13 Extra Questions and Class 12 Physics Chapter 13 Revision Notes for quick revision and extra practice.

See also: Chapter 1 | Chapter 2 | Chapter 3 | Chapter 4 | Chapter 5 | Chapter 6 | Chapter 7 | Chapter 8 | Chapter 9 | Chapter 10 | Chapter 11 | Chapter 12

Practice more: Chapter 1 | Chapter 2 | Chapter 3 | Chapter 4 | Chapter 5 | Chapter 6 | Chapter 7 | Chapter 8 | Chapter 9 | Chapter 10 | Chapter 11 | Chapter 12

Quick revision: Chapter 1 | Chapter 2 | Chapter 3 | Chapter 4 | Chapter 5 | Chapter 6 | Chapter 7 | Chapter 8 | Chapter 9 | Chapter 10 | Chapter 11 | Chapter 12