

Weird Chemist

Early Atomic Models — DPP-1 Solutions

Chapter: Structure of Atom

“Samajh aaya toh mazaa aaya. Samajh nahi aaya? Dubara padho, bhai!”

TYPE 1 : Counting Protons / Electrons / Neutrons

Q.1 The number of protons, electrons and neutrons respectively in ${}^{237}_{93}\text{Y}$ are:

Explanation

For any nuclide ${}^A_Z\text{X}$:

- Atomic number Z = number of **protons** = number of **electrons** (neutral atom)
- Mass number A = protons + neutrons \Rightarrow neutrons = $A - Z$

Here, $Z = 93$, $A = 237$.

Protons = 93, Electrons = 93, Neutrons = $237 - 93 = 144$

Approach

Think of the nucleus like a bus (mass number A). The bus carries two types of passengers: protons (Z) and neutrons ($A - Z$). Electrons are the people *standing outside* the bus — always equal to protons for a neutral atom.

Answer

Option (3): 93, 93, 144

Q.2 In ${}^{27}_{13}\text{Al}$, proton = a , electron = b , neutron = c . Ratio $c : b : a$ is:

Explanation

$Z = 13 \Rightarrow a = 13$, $b = 13$; Neutrons $c = 27 - 13 = 14$

Ratio $c : b : a = 14 : 13 : 13$

Approach

Order matters here — $c : b : a$ is neutrons : electrons : protons, not the usual Z, A order. Read the question carefully!

Answer

Option (3): 14 : 13 : 13

Common Student Mistake

Students often write ratio as $a : b : c$ (protons : electrons : neutrons) = 13:13:14 and pick option (1). Always check which letter maps to what!

Q.3 A ($Z = 27$) and B ($Z = 30$) have same atomic weight. Atomic weight of A = 57. Neutrons in B?

Explanation

Both A and B are **isobars** (same mass number = 57).
Neutrons in B = $A - Z_B = 57 - 30 = 27$

Approach

Isobars = same total mass, different identity. Like two different people with the same body weight — what's inside (protons vs neutrons) differs.

Answer

Option (1): 27

Common Student Mistake

Many students subtract from $Z_A = 27$ giving 30, confusing the two elements. Always use the atomic number of the element asked (B, not A).

Q.4 If no. of protons in $X^{2-} = 16$, find electrons in X^{2+} .

Explanation

Protons = 16 always (protons never change with ionisation).
For neutral X: electrons = 16.
 X^{2+} means 2 electrons *removed*: electrons = $16 - 2 = 14$

Approach

Protons are the atom's *identity card* — they never change. Only electrons are added/removed during ion formation. X^{2-} gave you the atomic number; X^{2+} just means 2 electrons removed from neutral.

Answer

Option (1): 14

Common Student Mistake

Classic trap: students see X^{2-} has 18 electrons ($16+2$) and subtract 2 to get 16, choosing option (2). But X^{2+} removes 2 electrons from the *neutral* atom (16), not from the anion.

Q.5 Metal in M^{2+} state has e^- config. 2,8,14 and atomic weight 56. Neutrons?

Explanation

M^{2+} has configuration 2,8,14 \Rightarrow total electrons in ion = $2 + 8 + 14 = 24$.
Neutral metal M has $24 + 2 = 26$ electrons $\Rightarrow Z = 26$.
Neutrons = $A - Z = 56 - 26 = 30$

Approach

Think of M^{2+} as a person who lost 2 items from their bag. To find what they originally had, add those 2 back. The cation lost 2 electrons, so neutral atom has $Z = 24 + 2 = 26$ (Iron, Fe!).

Answer

Option (1): 30

Common Student Mistake

Students forget to add back the 2 lost electrons and take $Z = 24$, then get neutrons = $56 - 24 = 32$. Always recover the neutral atom's electron count first.

Q.6 X^{2-} has 18 neutrons and 18 extranuclear electrons. Mass number of most abundant isotope?

Explanation

X^{2-} has 18 electrons.

Neutral X has $18 - 2 = 16$ electrons $\Rightarrow Z = 16$ (Sulfur).

Mass number = $Z + n = 16 + 18 = 34$ for *this* isotope.

But the question asks for the **most abundant** isotope of S. The most abundant sulfur isotope is ^{32}S (95% abundance).

Approach

The isotope given in the question ($A = 34$) is *one* of sulfur's isotopes, but not the most common one. The question is testing whether you know the most abundant isotope of sulfur is ^{32}S .

Answer

Option (2): 32

Common Student Mistake

Students calculate $16 + 18 = 34$ and stop there, picking option (3) = 36. The question specifically says "most abundant isotope" — that's a factual recall point for ^{32}S .

Q.7 Anion X^{3-} has mass number 14 and 10 electrons. Neutrons in X_2 nucleus?

Explanation

X^{3-} has 10 electrons.

Neutral X: $Z = 10 - 3 = 7$ (Nitrogen).

Neutrons in one X nucleus = $14 - 7 = 7$.

X_2 has **2 nuclei**: total neutrons = $7 \times 2 = 14$.

Approach

X_2 is a diatomic molecule — like two identical boxes glued together. Each box has 7 neutrons, so the combined box has $7 + 7 = 14$. Don't forget the subscript 2!

Answer

Option (2): 14

Common Student Mistake

Students find 7 neutrons in one atom and stop there, picking option (3). The question asks for X_2 — a diatomic molecule — so multiply by 2.

TYPE 2 : Effect of Mass Change on Atomic Weight

Q.8 Mass of e^- halved, proton doubled, neutron $\times \frac{3}{4}$. New atomic weight of ^{16}O ?

Explanation

^{16}O : $Z = 8$, so 8 protons, 8 electrons, 8 neutrons.

Original masses: $m_p \approx 1$ amu, $m_n \approx 1$ amu, $m_e \approx 0$ amu (negligible).

New atomic mass:

$$\begin{aligned} &= 8 \times (2m_p) + 8 \times (0.5 m_e) + 8 \times (0.75 m_n) \\ &= 8(2 \times 1) + 8(0.5 \times 0) + 8(0.75 \times 1) \\ &= 16 + 0 + 6 = 22 \text{ amu} \end{aligned}$$

Original mass = 16 amu.

$$\% \text{ increase} = \frac{22 - 16}{16} \times 100 = 37.5\%$$

Approach

Electron mass is so tiny (1/1836 of proton) it's essentially 0 in these calculations. Only proton and neutron masses matter for atomic weight.

Answer

Option (1): Increases by 37.5%

Common Student Mistake

Students include electron mass in their calculation and get slightly different answers. For JEE purposes, $m_e \approx 0$ amu — always ignore it unless specifically given a numerical value.

Q.9 In $^{14}_7\text{N}$, electron mass doubled, proton mass halved. New atomic mass?

Explanation

$^{14}_7\text{N}$: 7 protons, 7 electrons, 7 neutrons.

New mass:

$$\begin{aligned} &= 7 \times (0.5 m_p) + 7 \times (2 m_e) + 7 \times m_n \\ &= 7(0.5) + 7(0) + 7(1) = 3.5 + 0 + 7 = 10.5 \text{ amu} \end{aligned}$$

$$\text{Reduction: } \frac{14 - 10.5}{14} \times 100 = 25\%$$

Approach

Halving proton mass cuts the contribution of 7 protons from 7 amu to 3.5 amu. Neutrons unchanged. So total drops by 3.5 out of 14, i.e., 25%.

Answer

Option (3): Reduced by 25%

Q.10 Neutron mass doubled, electron mass halved. New atomic mass of $^{12}_6\text{C}$?

Explanation

$^{12}_6\text{C}$: 6 protons, 6 electrons, 6 neutrons.

New mass = $6(m_p) + 6(0.5 m_e) + 6(2m_n) = 6(1) + 0 + 6(2) = 6 + 12 = 18$ amu.

% increase = $\frac{18 - 12}{12} \times 100 = 50\%$

Answer

Option (1): 18 amu and 50%

Q.11 Neutron doubled, proton halved, electron doubled. New mass of $^{12}_6\text{C}$?

Explanation

$^{12}_6\text{C}$: 6p, 6e, 6n.

New mass = $6(0.5) + 6(0) + 6(2) = 3 + 0 + 12 = 15$ amu.

% change = $\frac{15 - 12}{12} \times 100 = 25\%$ increase.

Answer

Option (2): 15 amu, increases by 25%

TYPE 3 : Isoelectronic Species

Q.12 Find atoms which are isoelectronic.

Explanation

Isoelectronic = same number of electrons. Check each option:

- $^{14}_6\text{C}$ (6e), $^{14}_7\text{N}$ (7e), $^{19}_9\text{F}$ (9e) — all *different* \Rightarrow Not isoelectronic
- $^{12}_6\text{C}$ (6e), $^{14}_7\text{N}$ (7e), $^{19}_9\text{F}$ (9e) — *different*
- $^{14}_6\text{C}$ (6e), $^{14}_7\text{N}$ (7e), $^{17}_9\text{F}$ (9e) — *different*
- $^{14}_6\text{C}$ (6e), $^{14}_7\text{N}$ (7e), $^{19}_9\text{F}$ (9e) — *different*

*Note: Neutral atoms are isoelectronic only if they have the same Z. None of the options show truly isoelectronic neutral atoms. Among the given choices, option (4) is the intended correct answer per the question pattern, as the question may intend isoelectronic in their ion forms or there may be a printing error — answer as per answer key is **option (4)**.*

Approach

For neutral atoms, isoelectronic simply means same atomic number. For ions, it means total electron count matches after accounting for charge.

Answer

Option (4): $^{14}_6\text{C}$, $^{14}_7\text{N}$, $^{19}_9\text{F}$ (as per standard answer key)

Common Student Mistake

This question is about neutral atoms — don't confuse with isoelectronic *ions*. For neutral atoms, same number of electrons = same atomic number (Z).

Q.13 Isoelectronic species among: CN^- , OH^- , CH_3^+ , N_2 , CO ?

Explanation

Count electrons in each:

- CN^- : $\text{C}(6)+\text{N}(7)+1 = 14\text{e}$
- OH^- : $\text{O}(8)+\text{H}(1)+1 = 10\text{e}$
- CH_3^+ : $\text{C}(6)+3\text{H}(3)-1 = 8\text{e}$
- N_2 : $\text{N}(7)+\text{N}(7) = 14\text{e}$
- CO : $\text{C}(6)+\text{O}(8) = 14\text{e}$

CN^- , N_2 , and CO all have 14 electrons \Rightarrow isoelectronic.

Approach

CN^- , N_2 , CO are the classic isoelectronic trio — famous because they all have 14 electrons and a triple bond. Remember them as a set!

Answer

Option (3): a, d, e

Q.14 Which pairs are isoelectronic?

Explanation

- Na^+ ($11-1=10\text{e}$), Ne (10e) \checkmark
- K^+ ($19-1=18\text{e}$), O (8e) \times
- Ne (10e), O (8e) \times
- Na^+ (10e), K^+ (18e) \times

Answer

Option (1): Na^+ , Ne

Q.15 Isoelectronic species set?

Explanation

Check option (1): $\text{CO}(14\text{e})$, $\text{CN}^-(14\text{e})$, $\text{NO}^+(14\text{e})$, $\text{C}_2^{2-}(14\text{e})$.

NO^+ : $\text{N}(7)+\text{O}(8)-1 = 14\text{e}$ \checkmark

C_2^{2-} : $\text{C}(6)+\text{C}(6)+2 = 14\text{e}$ \checkmark

All four species have 14 electrons.

Answer

Option (1): CO , CN^- , NO^+ , C_2^{2-}

Q.16 Which ion is isoelectronic with CO ?

Explanation

CO has 14 electrons. Check options:

- CN^- : $6+7+1 = 14$ ✓
- N_2^+ : $7+7-1 = 13$ ×
- O_2^- : $8+8+1 = 17$ ×
- N_2^- : $7+7+1 = 15$ ×

Answer

Option (1): CN^-

Q.17 Which pairs are isoelectronic *and* isostructural?

Explanation

Isostructural = same shape. Count electrons and structure:

- CO_3^{2-} : 32e, trigonal planar
- NO_3^- : 32e, trigonal planar
- SO_3^{2-} : 32e (*but pyramidal due to lone pair on S*)
- ClO_3^- : 32e (*pyramidal*)

CO_3^{2-} and NO_3^- : both 32 electrons, both trigonal planar \Rightarrow isoelectronic + isostructural.

Approach

Isostructural needs the same number of bond pairs AND lone pairs on the central atom. SO_3^{2-} and ClO_3^- have a lone pair on the central atom making them pyramidal, unlike the flat CO_3^{2-} / NO_3^- .

Answer

Option (4): CO_3^{2-} , NO_3^-

Common Student Mistake

Students confuse isoelectronic (same electron count) with isostructural (same shape). Having the same number of electrons does NOT guarantee the same structure if the distribution of lone pairs differs.

Q.18 Select isoelectronic sets.

Explanation

Set (a): Na^+ (10e), H_3O^+ ($8+3-1=10\text{e}$), NH_4^+ ($7+4-1=10\text{e}$). All 10e. ✓

Set (b): CO_3^{2-} (32e), NO_3^- (32e), H_2CO_3 (32e). All 32e. ✓

Set (c): P^{3-} (18e), HCl (18e), C_2H_5^- ($10+1+5+1=17\text{e}$... wait): $\text{C}(6)+\text{C}(6)+5\text{H}(5)+1=18\text{e}$ ✓, PH_3 ($15+3=18\text{e}$) ✓. All 18e. ✓

Set (d): F^- (10e), Ne (10e), Na^+ (10e). All 10e. ✓

All four sets are isoelectronic.

Answer

Option (4): a, b, c, d

TYPE 4 : Isotopes, Isobars, Isotones and Isodiaphers

Q.19 Isobars have:

Explanation

Definitions:

- Isotopes: same Z , different A (same protons)
- Isobars: same A , different Z (same mass number = same nucleons)
- Isotones: same neutron number
- Isolectronic: same electron count

Nucleons = protons + neutrons = mass number A . Isobars share the same A .

Approach

Memory trick: **Iso-BAR** — think of a BAR of gold. Two bars with the same *weight* (mass number) but different purity (element identity) are isobars.

Answer

Option (3): Same number of nucleons

Q.20 Isotone of ${}^{76}_{32}\text{Ge}$?

Explanation

Neutrons in ${}^{76}_{32}\text{Ge} = 76 - 32 = 44$.

Check candidates:

- (i) ${}^{77}_{32}\text{Ge}$: $77 - 32 = 45$ ×
- (ii) ${}^{77}_{33}\text{As}$: $77 - 33 = 44$ ✓
- (iii) ${}^{77}_{34}\text{Se}$: $77 - 34 = 43$ ×
- (iv) ${}^{78}_{34}\text{Se}$: $78 - 34 = 44$ ✓

(ii) and (iv) are isotones.

Answer

Option (3): (ii) and (iv)

Common Student Mistake

Students often pick options with the same mass number (isobars) instead of same neutron number. Always calculate $A - Z$ for each candidate when checking isotones.

Q.21 Which pair is correctly matched?

Explanation

- (1) Isotopes of Ca: ${}^{40}_{20}\text{Ca}$ and ${}^{40}_{19}\text{K}$ — same A , *different* $Z \Rightarrow$ these are **isobars**, not isotopes. ×
- (2) Isotones: ${}^{30}_{14}\text{Si}(n=16)$, ${}^{31}_{15}\text{P}(n=16)$, ${}^{32}_{16}\text{S}(n=16)$ — all have 16 neutrons. ✓
- (3) Isobars of O: ${}^{16}\text{O}$, ${}^{17}\text{O}$, ${}^{18}\text{O}$ — same Z , different $A \Rightarrow$ these are **isotopes**, not isobars. ×
- (4) Isolectronic: $\text{N}^{3-}(10\text{e})$, $\text{O}^{2-}(10\text{e})$, $\text{Cr}^{3+}(21\text{e})$ — Cr^{3+} has 21 electrons, not 10. ×

Answer

Option (2): Isotones $^{30}_{14}\text{Si}$, $^{31}_{15}\text{P}$, $^{32}_{16}\text{S}$

Q.22 A [$Z=90, n=146$], B [$Z=92, n=146$], C [$Z=90, n=148$]. Identify wrong statements.

Explanation

- A: $A = 90 + 146 = 236$; C: $A = 90 + 148 = 238$; B: $A = 92 + 146 = 238$
- **1. A and C – Isotones:** A has $n=146$, C has $n=148$ — different. **WRONG** ×
- **2. A and C – Isotopes:** A and C have same $Z=90$, different A. **CORRECT** ✓
- **3. A and B – Isobars:** A($A=236$), B($A=238$) — different. **WRONG** ×
- **4. B and C – Isobars:** B($A=238$), C($A=238$) — same mass number. **CORRECT** ✓
- **5. B and C – Isotopes:** B($Z=92$), C($Z=90$) — different Z, so not isotopes. **WRONG** ×

Wrong statements: 1, 3, 5 \Rightarrow a, c, e.

Answer

Option (4): a, c, e only

Q.23 Match the following:

Explanation

- (i) $^{54}_{26}\text{Fe}$, $^{56}_{26}\text{Fe}$, $^{57}_{26}\text{Fe}$, $^{58}_{26}\text{Fe}$ — same $Z=26$, different A \Rightarrow **Isotopes (a)**
- (ii) ^3_1H , ^2_1He — wait: ^3_1H (1p, 2n) and ^2_1He doesn't exist stably. As given: same $A=3$, different Z \Rightarrow **Isobars (d)**. [Note: ^3_2He would be isotone with ^3_1H ; question likely means ^3_2He]
- (iii) $^{76}_{32}\text{Ge}$ ($n=44$), $^{77}_{33}\text{As}$ ($n=44$) — same neutrons \Rightarrow **Isotones (b)**
- (iv) $^{235}_{92}\text{U}$: $A - 2Z = 235 - 184 = 51$; $^{231}_{90}\text{Th}$: $A - 2Z = 231 - 180 = 51$ — same ($A-2Z$) \Rightarrow **Isodiaphers (c)**
- (v) ^1_1H , ^2_1D , ^3_1T — same $Z=1$, different A \Rightarrow **Isotopes (a)**

Approach

Isodiaphers are rare — they have the same neutron excess ($A - 2Z$), i.e., same difference between neutrons and protons. Think of it as the “surplus neutron count” being equal.

Answer

Option (1): (i)–a, (ii)–d, (iii)–b, (iv)–c, (v)–a

Common Student Mistake

Most students have never heard of isodiaphers! The formula is: **Isodiaphers** have same $(n - p) = (A - 2Z)$. This is a scoring differentiation question.

Q.24 Relationship between $^{13}_6\text{C}$ and $^{17}_8\text{O}$?

Explanation

$$^{13}_6\text{C}: A - 2Z = 13 - 12 = 1$$

$$^{17}_8\text{O}: A - 2Z = 17 - 16 = 1$$

Same neutron excess \Rightarrow **Isodiaphers**

Answer

Option (3): Isodiaphers

Q.25 Choose the false statement about deuterium.

Explanation

Deuterium (${}^2_1\text{D}$): 1 proton, 1 electron, 1 neutron.

- (1) Isotope of hydrogen: TRUE ✓
- (2) Contains 1e + 1p + 1n: TRUE ✓
- (3) Contains only 1p + 1n (no mention of electron): **FALSE** — nucleus has 1p+1n, but the atom has 1 electron too. This statement says “only 1p+1n” ignoring the electron. ×
- (4) D₂O is heavy water: TRUE ✓

Answer

Option (3) — False statement (ignores the electron)

TYPE 5 : Average Atomic Mass

Q.26 Rb isotopes: mass 85 (75%) and 87 (25%). Average atomic weight?

Explanation

$$\bar{A} = \frac{85 \times 75 + 87 \times 25}{100} = \frac{6375 + 2175}{100} = \frac{8550}{100} = 85.5$$

Approach

Average atomic mass is like a *weighted average of marks*. More abundant isotope pulls the average closer to itself. Here 75% weight on 85 pulls average closer to 85, giving 85.5.

Answer

Option (2): 85.5

Q.27 Element with isotopes 11 (85%), 12 (10%), 13 (5%). Average atomic weight?

Explanation

$$\bar{A} = \frac{11 \times 85 + 12 \times 10 + 13 \times 5}{100} = \frac{935 + 120 + 65}{100} = \frac{1120}{100} = 11.2$$

Answer

Option (1): 11.2

Q.28 Average mass of M = 51.7. Isotopes ${}^{50}\text{M}$ and ${}^{52}\text{M}$. % of ${}^{50}\text{M}$?

Explanation

Let % of $^{50}\text{M} = x$, then % of $^{52}\text{M} = (100 - x)$.

$$51.7 = \frac{50x + 52(100 - x)}{100}$$

$$5170 = 50x + 5200 - 52x = 5200 - 2x$$

$$2x = 30 \Rightarrow x = 15\%$$

Approach

Set up one variable and one equation. The heavier isotope (52) makes up the larger share since the average 51.7 is much closer to 52. So ^{50}M should be less abundant — answer 15% makes sense.

Answer

Option (2): 15%

Common Student Mistake

Students often assign x to the lighter isotope but then forget which percentage they solved for and report 85% (the heavier isotope's share). Always label your variable clearly.

Q.29 Atomic weight of Ne = 20.2. Mixture of ^{20}Ne and ^{22}Ne . % of heavier isotope?

Explanation

Let % of $^{22}\text{Ne} = x$, % of $^{20}\text{Ne} = (100 - x)$.

$$20.2 = \frac{20(100 - x) + 22x}{100} = \frac{2000 + 2x}{100}$$

$$2020 = 2000 + 2x \Rightarrow 2x = 20 \Rightarrow x = 10\%$$

Answer

Option (4): 10

TYPE 6 : Atomic Mass Scale Conversion

Q.30 If O is assigned 200, what is the mass of C?

Explanation

Standard scale: $^{12}\text{C} = 12$, $^{16}\text{O} = 16$.

Ratio of C to O (on any scale) remains fixed: $\frac{C}{O} = \frac{12}{16} = \frac{3}{4}$

New mass of C = $\frac{3}{4} \times 200 = 150$

Approach

Think of it as a currency conversion. The exchange rate between C and O never changes. If O is now worth 200 (instead of 16), carbon's value scales proportionally.

Answer

Option (2): 150

Common Student Mistake

Students divide 200 by 12 and multiply by 16 (inverting C and O). Always use the ratio $C/O = 12/16$, not O/C .

Q.31 If O is assigned 100, what is the mass of C?

Explanation

$$C = \frac{12}{16} \times 100 = 75$$

Answer

Option (2): 75

Q.32 If $^{12}\text{C} = 150$ units, what is mass of ^{16}O ?

Explanation

Ratio of O to C: $\frac{16}{12} = \frac{4}{3}$
New mass of O = $\frac{4}{3} \times 150 = 200$ units

Answer

Option (3): 200 units

TYPE 7 : Thomson's & Rutherford's Atomic Model

Q.33 “Positive charge uniformly distributed, electrons embedded like plum in pudding” — whose model?

Explanation

This is the classic description of **Thomson's Plum Pudding Model** (1904). Electrons are embedded in a uniform positive sphere — like raisins in a pudding.

Approach

Remember: **Thomson** = Plum Pudding. **Rutherford** = Solar system (nucleus at center). **Bohr** = Quantised orbits. Chadwick discovered the neutron — no atomic model.

Answer

Option (1): Thomson's atomic model

Q.34 Why do most α -particles pass undeflected?

Explanation

Most α -particles pass through undeflected because the nucleus is **extremely small** compared to the total atom volume. Most of the atom is empty space — so most α -particles miss the nucleus entirely.

Approach

Imagine throwing marbles into a cricket stadium trying to hit the wicket (nucleus). The stadium (atom) is mostly empty, so most marbles fly through without hitting anything. Only the rare marble aimed directly at the wicket bounces back.

Answer

Option (4): Nucleus occupies much smaller volume compared to the atom

Q.35 When α -rays strike thin gold foil:

Explanation

Rutherford's observations:

- Most α -particles pass straight through (atom is mostly empty).
- A few deflect at small angles.
- Very few (1 in ~ 20000) bounce back.

Answer

Option (4): Most α -rays pass through without any deviation

Q.36 Rutherford's α -particle scattering experiment proved atom has:

Explanation

The backward scattering of some α -particles (positively charged) proved the existence of a small, dense, positively charged **nucleus** at the center of the atom.

Answer

Option (3): Nucleus

Q.37 Rutherford's scattering is related to the size of the:

Explanation

The scattering experiment helped estimate the size of the **nucleus** (approximately 10^{-15} m), not the whole atom.

Answer

Option (1): Nucleus

TYPE 8 : Charge-to-Mass Ratio (e/m)

Q.38 Charge-to-mass ratio of electron:

Explanation

Millikan's oil drop experiment: $e = 1.6022 \times 10^{-19} \text{ C}$.

Electron mass: $m_e = 9.109 \times 10^{-31} \text{ kg}$.

$$e/m = \frac{1.6022 \times 10^{-19}}{9.109 \times 10^{-31}} = 1.758 \times 10^{11} \text{ C kg}^{-1}$$

Approach

This is a *must memorise* value for JEE: $e/m_e = 1.758 \times 10^{11} \text{ C/kg}$. Note the unit: C kg^{-1} .

Answer

Option (3): $1.758 \times 10^{11} \text{ C kg}^{-1}$

Q.39 Ratio of specific charge (e/m) of proton to α -particle:

Explanation

Proton: charge = e , mass = $m_p \Rightarrow e/m = e/m_p$

α -particle: charge = $2e$, mass = $4m_p \Rightarrow e/m = 2e/4m_p = e/2m_p$

$$\text{Ratio: } \frac{e/m_p}{e/2m_p} = \frac{1}{1/2} = 2 : 1$$

Answer

Option (1): 2 : 1

Common Student Mistake

Students often get the ratio inverted by forgetting that α carries charge $2e$ (not e) and mass $4m_p$ (not $2m_p$).

Q.40 e/m ratio is maximum for:

Explanation

Higher e/m means higher charge per unit mass. Compare:

• D^+ (deuteron): charge = e , mass = $2m_p \Rightarrow e/m = e/2m_p$

• He^+ : charge = e , mass = $4m_p \Rightarrow e/m = e/4m_p$

• H^+ : charge = e , mass = $m_p \Rightarrow e/m = e/m_p$ (largest!)

• He^{2+} : charge = $2e$, mass = $4m_p \Rightarrow e/m = e/2m_p$

H^+ (proton) has the highest e/m among these.

Answer

Option (3): H^+

Q.41 e/m ratio would be greater for:

Explanation

Among proton, electron, neutron, and alpha:

- Electron: $e/m_e = 1.758 \times 10^{11}$ C/kg (very high — tiny mass!)
- Proton: $e/m_p \approx 9.58 \times 10^7$ C/kg
- Neutron: no charge, $e/m = 0$
- α : $2e/4m_p \approx 4.79 \times 10^7$ C/kg

Electron has by far the highest e/m due to its tiny mass.

Answer

Option (2): Electron

Q.42 Which pair has identical e/m ?

Explanation

- Proton (e, m_p) vs Neutron ($0, m_p$): neutron has zero charge $\Rightarrow e/m = 0$. \times
- Proton (e, m_p) vs Deuteron ($e, 2m_p$): different e/m . \times
- Deuteron ($e, 2m_p$): $e/m = e/2m_p$; α -particle ($2e, 4m_p$): $e/m = 2e/4m_p = e/2m_p$. **Identical!** \checkmark
- Electron vs γ -rays: γ -rays have no mass or charge as particles. \times

Approach

Deuteron and α -particle both have the same charge-to-mass ratio because doubling charge and doubling mass keeps the ratio the same. Remember: $e/2m_p$ for both.

Answer

Option (3): Deuteron and α -particle

TYPE 9 : Nuclear Radius & Density

Q.43 Radius of nucleus of ${}_{13}^{27}\text{Al}$? ($r = R_0 A^{1/3}$, $R_0 = 1.4 \times 10^{-15}$ m)

Explanation

$A = 27$, so $A^{1/3} = 27^{1/3} = 3$.

$r = 1.4 \times 10^{-15} \times 3 = 4.2 \times 10^{-15} \approx 4 \times 10^{-15}$ m

Approach

Think of $A^{1/3}$ as the cube root. $27^{1/3} = 3$ is a clean number — Al is conveniently chosen for this reason! For other mass numbers, look for perfect cubes first.

Answer

Option (4): 4×10^{-15} m

Q.44 Which element has maximum nuclear density?

Explanation

$$\text{Nuclear density} \propto \frac{\text{Mass}}{\text{Volume}} = \frac{A \cdot m_p}{\frac{4}{3}\pi r^3} = \frac{A \cdot m_p}{\frac{4}{3}\pi (R_0 A^{1/3})^3} = \frac{A \cdot m_p}{\frac{4}{3}\pi R_0^3 \cdot A} = \frac{m_p}{\frac{4}{3}\pi R_0^3}$$

The A cancels! Nuclear density is **constant for all nuclei**, independent of mass number.

Approach

This is one of the most beautiful results in nuclear physics: all atomic nuclei have the same density, regardless of element! The nucleus scales its size exactly with the cube root of mass number — like all nuclei are made of the same *nuclear material* packed at the same density.

Answer

Option (4): All have same density

Common Student Mistake

Students intuitively think heavier elements have denser nuclei. This is a conceptual trap. Because nuclear radius $\propto A^{1/3}$, the volume $\propto A$, and since mass $\propto A$ too, the density is constant for all nuclei.

Answer Key — DPP-1

Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	3	12	4	23	1	34	4
2	3	13	3	24	3	35	4
3	1	14	1	25	3	36	3
4	1	15	1	26	2	37	1
5	1	16	1	27	1	38	3
6	2	17	4	28	2	39	1
7	2	18	4	29	4	40	3
8	1	19	3	30	2	41	2
9	3	20	3	31	2	42	3
10	1	21	2	32	3	43	4
11	2	22	4	33	1	44	4

“Revision = Retention. Ek baar aur padho!”

— **Weird Chemist**