Ionisation energy

1. (b) I.E.(II) of Na is higher than that of Mg because in case of Na, the second e^- has to be remove from the noble gas core while in case of Mg removal of second e^- gives a noble gas core.
Mg has high first ionisation potential than Na because of its stable ns^2 configuration.

2. **(c)** Remove one mole of electron from one mole of **monovalent gaseous cation** of the element.
(That is, $X^+(g) \rightarrow X^{2+}(g) + e^-$.)

3. **(d)** The energy required to remove the outermost electron of an atom of the element.
(IE = energy to remove an electron from a gaseous atom/ion.)

4. **(a)** There is increase in the nuclear charge of the alkaline earth metals. (Alkaline earths have one more proton for similar shell structure → stronger attraction → higher IE.)

5. **(c)** *"The first ionisation energies along a period do not vary in a regular manner with increase in atomic number."*
(First IEs generally show a regular trend across a period with known small exceptions — the statement as written is false.)

6. **(a)** Ionization energy and electron affinity increase across a period. (Both generally become larger (IE increases; EA becomes more exothermic / increases in magnitude) left → right, with a few exceptions.)

7. (c) Ionization potential decreases. Since, atomic size increases.

8. (d) Alkali metals, lower the no. of valence e^-, lower is the value of ionization potential.

9. (a) The ionization energy of hydrogen is to high for group of alkali metals, but too low for halogen group.

10. **(a) Nitrogen has half filled p-orbitals**

Explanation: Half-filled 2p32p^32p3 configuration in nitrogen is extra stable, so more energy is required to remove an electron compared to oxygen (2p42p^42p4).

11. **(b) Ionization energy**

Explanation: Ionization energy = minimum energy required to remove the most loosely bound electron from a gaseous atom in its ground state.

12. **(c) Boron has only one electron in p-sub-shell**

Explanation: The 2p12p^12p1 electron in boron is less tightly held (higher energy orbital) than the 2s22s^22s2 electron of beryllium, so boron's IE is lower despite higher nuclear charge.

13. (a) $E_1 < E_2$ because second I.E. is greater than first I.E.

14. **(a) V**

We are comparing **first ionisation potential (IE_1)** among **V (23), Ti (22), Cr (24), Mn (25)**.

Trend: Across a period (left → right), ionization energy **increases** due to increasing nuclear charge.
But **Cr ($3d^5 4s^1$)** and **Mn ($3d^5 4s^2$)** have relatively lower IE due to stability/exchange energy effects.
Ti ($3d^2 4s^2$) and **V ($3d^3 4s^2$)** → V is slightly to the right, so it has higher IE than Ti.
Among the four, **V** has the **maximum first ionization potential**.

15. (b) Due to high stability of half-filled orbitals.

16. (a) In Cu it has completely filled *d*-orbital so highest energy is absorbed when it convert in Cu^+ ion.

17. **(c) Ionization energies (kJ/mol):**

Na → **496**
Mg → **738**
Al → **578**
Si → **786**
Order (lowest → highest):
Na (496) < Al (578) < Mg (738) < Si (786)

18. (c) The energy required to remove an electron from outermost orbit of an isolated gaseous atom is called I.E. Now carbon has $4e^{-}$ in outermost shell. Thus it has 4 ionization energies.

19. (a) Since, stable half filled configuration.

20 **(b) (b) Small size**
Hydrogen vs alkali metals (Li, Na, K…):

Hydrogen has **1 electron in the 1s orbital**, very close to the nucleus.
Alkali metals have their single valence electron in a **larger outer shell (ns^1)**.
Ionization energy (IE) depends on **how tightly the electron is held**.
Since hydrogen's electron is **closer to the nucleus**, it requires **more energy to remove**.
Reason: Small atomic size → strong attraction → high ionization energy.

21. (d) First I.P. of $Be > B$ because of stable ns^2 configuration.

22. (b) $K^{+} \rightarrow K^{2+} + e^{-}$. Since e^{-} is to be removed from stable configuration.

23. **(d) Mg**

Mg (738) > Al (578) > Na (496) > K (419)

Reason: Mg is to the right of Na and K in the same period → higher nuclear charge, smaller atomic size → higher IE.

24. (c) Since the IV, I.E. is very high. Thus electron is to be removed from stable configuration.

25. (b) Li and Cs belong to Ist group but Cs has larger size, hence low nuclear attraction force, thus low ionization energy.

26. (c) Li belongs to Ist group. There is $1e^-$ in outermost shell. Thus low I.E.

27. (b) Increases from left to right. Since, the size decreases.

28. (a) As the e^- is to be removed from stable configuration.

29. (c) Since e^- is to be removed from exactly half filled *p*-orbital.

30. **(b) O**

Oxygen (O) has slightly lower IE than nitrogen due to **electron–electron repulsion in paired 2p electrons** (half-filled stability of N makes its IE higher).

Reason: Paired electron in O's 2p orbital experiences repulsion → easier to remove → lower IE than N.