

- Briefly discuss the relationship between the electron configuration of an element and its position in the Periodic Table.

Marks
6

Elements in the Periodic Table belong to groups and periods. For main group elements (i.e. those in Groups 1, 2 and 13-18), elements in a group have the same outer shell electron configuration (i.e they have the same number of valence electron). Each period (row) of the Table has a set number of inner electron shells, those holding the non-valence electrons.

Carbon and lead are both in Group 14. One is a non-metal and the other is a metal. Outline one physical and one chemical characteristic of a non-metal and a metal and explain the reason for the trend from one to another in Group 14.

	Non-metal	Metal
Physical characteristic	dull, brittle, non-conductor	malleable, ductile, conductor
Chemical characteristic	forms covalent bonds with non-metals	forms ionic bonds with non-metals

Explanation for trend in Group 14

Going down the group, the elements change from non-metals (C) to semi-metals (Si, Ge) to metals (Sn, Pb). As the atoms become bigger, the valence electrons are further from the nucleus and less tightly bound. Bonding therefore tends to involve loss of electrons, typical fo metallic behaviour.

- Silicon and carbon are both in Group 14 and form dioxides. Carbon dioxide is a gas at room temperature while silicon dioxide (sand) is a solid with a high melting point. Describe the bonding in these two materials and explain the differences in properties they show.

Marks
3

CO₂ contains discrete molecules. Carbon makes four bonds by making two C=O double bonds. The C=O double bonds have strong σ and π components. Although these bonds are quite polar, these molecules are linear and do not possess dipole moments. Only very weak dispersion intermolecular forces hold the molecules together and CO₂ is a gas at room temperature.

SiO₂ is a network covalent solid. Each silicon makes four bonds by making four Si-O single bonds. The covalent network leads to a very strongly bonded solid with a very high melting point.

- In the Periodic Table given, hydrogen is placed at the top of Group 1. List reasons for and against placing hydrogen in this position.

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For:

- **It has one valence electron, just like the other members of Group 1**
- **This electron is in a s-orbital, just like the other members of Group 1**
- **It has a valency of 1, just like the other members of Group 1**
- **It has low electronegativity, just like the other members of Group 1**

Against:

- **Unlike the other members of Group 1, it is a non-metal**
- **Unlike the other members of Group 1, it exists as diatomic molecules**
- **Unlike the other members of Group 1, it can form both a cation (H^+) and an anion (H^-)**
- **Unlike the other members of Group 1, it is 1 electron short of a noble gas configuration**
- **It forms covalent molecules with non-metals rather than ionic compounds**
- **It is much more electronegative than the other members of Group 1**

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.

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- The element titanium is used as a structural material for bone in joint replacement surgery. Discuss the properties of titanium that make it suitable for this application.

Marks
3

Titanium is inert. It will not corrode nor dissolve and poison the patient.

Titanium is a light-weight metal with a similar density to bone.

Titanium is strong and will not break, so is suitable for supporting the patient's weight.