1. DIAMOND AND GRAPHITE ARE COVALENT CRYSTALS, COMPARE THEIR PROPERTIES

SIMILARITIES

- Both graphite and diamonds are made out of pure carbon. The chemical composition of the two is exactly the same.
- In both graphite and diamonds the carbon atoms share valence electrons, electrons in the outermost electron shell, with other carbon atoms in the structure
- The melting points of both graphite and diamond are very high. The melting point of graphite is 4200 degrees Kelvin, and diamond's melting point is 4500 degrees Kelvin.
- Both graphite and diamond are naturally occurring on Earth.

PROPERTY	**DIAMOND**	**GRAPHITE**
Hardness	Very hard	Soft and slippery
Hybridisation	Sp^3 with no ∏ electrons	Sp^2 with ∏ electrons
Melting point	3930^oC	3000^oC
Structure	Tetrahedral bonded in all directions	Layer structure with fused ring
Density (g/cm^3)	3.51	2.22
forces	Strong covalent force	Vander waal force

2. BINARY HYDRIDES

A. **Ionic hydrides:** they are formed when molecular H_2 reacts with alkali and alkaline earth metals. These halides are solids with high meting point temperatures. The halides are string bronzed bases that accept protons from donors like water.

$2Li + H_2 \rightarrow 2LiH$

B. **Covalent hydrides**: they are formed when a hydrogen atom and one or more non-metals form compounds. This occurs when hydrogen covalently bonds to a more electropositive element by sharing electron pairs. These hydrides can be volatile or non-volatile. Volatile simply means being readily able to be vaporized at low temperatures. One such example of a covalent hydride is when hydrogen bonds with chlorine and forms hydrochloric acid (HCl). Also CH_4, H_2S, NH_3, PH_3. Some re polymeric boranes, silanes and hydrocarbons.

C. **Interstitial hydrides:** these are also known as metallic hydrides. They are non-stoichiometric hydrides (meaning that the fraction of H atoms to the metals are not fixed) formed when hydrogen bonds with transition metals like iron, vanadium, nickel etc. The molecular hydrogen dissolves into metals only to be released on heating.

3. COMPARE AND CONTRAST THE FOUR TYPES OF CRYSTALS

Ionic crystals	Covalent crystals	Molecular crystals	Metallic crystals

Composed of charged species and constitutes of different sizes of anions and cations	The atoms are held in an extensive three-dimensional network entirely by covalent bond	The lattice are occupied by molecules rather than atoms held by intermolecular forces	The lattice points are occupied by atoms the same metals held by metallic bonds
High melting points	High melting points	Low melting points	Low melting points
They conduct electricity in molten or aqueous state	They don't conduct electricity because they're made up of atoms	Por conductors of electricity	They are good conductors of electricity due to mobility of delocalised electrons

4. SIMILARITIES AND DIFFERENCES BETWEEN GROUP 5,6 & 7 ON THE PERIODIC TABLE

Similarities

i. They are electronegative elements
ii. They are non-metallic solids which occur in several allotropic modifications and they readily burn in air.
iii. They do not react with air at room temperatures

Differences

i. They all have different valence electron in their outermost shells
ii. Groups 5 & 6 belong to a class of transition metals while group 7 belongs to halogen class

5. SHORT NOTE ON THE 5 CLASSES OF OXIDES

A. **Acidic oxides (acid anhydrides):** these are oxide of non-metals that dissolve in, and react with water to produce acids e.g CO_2, SO_2, NO_2 & P_2O_5 [exists as a dimer (P_4O_{10})]

- Sulphur (VI) oxide is the acid anhydride of teraoxosulphate(VI) acid

$$SO_{3(g)} + H_2O_{(l)} \rightarrow H_2SO_{4(aq)}$$

- Nitrogen (IV) oxide is a mixed anhydride because it produces 2 acids when it reacts with water

$$2NO_{2(g)} + H_2O_{(l)} \rightarrow HNO_{2(aq)} + HNO_{3(aq)}$$

B. **Basic oxides**: these are oxides of metals e.g Na_2O, CaO, CuO, MgO and Fe_2O_3 that react with acids to form salt and water only. They are solids.

$$CuO_{(s)} + H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + H_2O_{(l)}$$

(blue) (colourless) (blue)

Basic oxides that dissolve in water to form basic hydroxides are called ***alkalis*** e.g Calcium oxide CaO reacts with water to form calcium peroxide solution.

$$CaO_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2(aq)}$$

❖ Water solution of an alkali gives an alkaline solution

C. **Amphoteric oxides:** these are oxides of metals that have both acidic and basic properties e.g Aluminium oxide (Al_2O_3), Zinc oxide (ZnO), Lead (II) oxide (PbO) and Tin (IV) oxide (SnO_2).

   a. Reaction of zinc oxide:

      $\mathbf{ZnO_{(S)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_2O_{(l)}}$
      (base) (acid) (salt) (water)

      $\mathbf{ZnO_{(s)} + 2NaOH_{(aq)} \rightarrow Na_2ZnO_{2(aq)} + H_2O_{(l)}}$
      (acid) (base) (salt) (water)

D. Neutral oxides: these are oxides of non-metals that have no basic or acidic properties (they have no action on litmus paper) e.g steam ($H_2O_{(g)}$); carbon (II) oxide (CO); nitrogen (I) oxide (N_2O) and nitrogen (II) oxide (NO).

E. Peroxides: these are higher oxides of metals. They have one oxygen atom more than the normal oxides e.g Sodium peroxide (Na_2O_2), Lead (IV) oxide (PbO_2) and barium peroxide (BaO_2). They react with an acid to form hydrogen peroxide

   $\mathbf{Na_2O_{2(s)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + H_2O_{2(l)}}$

   Higher oxides or peroxides do not undergo neutralisation with acids. For instance, lead (II) oxide reacts with concentrated HCl to give a salt, water and chlorine.

   $\mathbf{PbO_2 + 4HCl_{(aq)} \rightarrow PbCl_{(aq)} + 2H_2O_{(l)} + Cl_{2(g)}}$