Worksheet 5.1
Covalent network lattices

NAME: **CLASS:**

INTRODUCTION

This worksheet looks at the covalent network lattices of diamond, graphite, silicon, silicon carbide and silicon dioxide, their properties and structure.

No.	Question	Answer
1	**a** Using lines to represent the bonds between the atoms, draw a small section of the diamond lattice. **b** What type of bond is between the atoms?	
2	Name an element and a compound that have a network lattice structure that is similar to diamond. What properties do these substances share with diamond?	
3	Draw a small section of the graphite layer lattice to demonstrate how it differs from diamond.	
4	Graphite and diamond are allotropic forms of carbon. Explain why graphite conducts electricity whereas diamond does not.	
5	Diamond is the hardest natural substance known, with the maximum rating of 10 on the Mohs scale of hardness. Why is diamond so hard?	

6	State two practical uses of diamond that rely on its extreme hardness.	
7	The oxides of the first two elements in group 14 exhibit dramatically different properties. Carbon dioxide changes state from a solid to a gas (it sublimes) at a temperature of –78°C, whereas silicon dioxide melts at 1700°C. Explain these very different melting points in terms of the structures of the two oxides.	
8	Silicon and phosphorus are non-metal elements adjacent to one another on the periodic table. Silicon has a melting point of 1410°C, compared to just 44°C for phosphorus. Explain this substantial difference.	
9	Graphite is a soft and slippery substance and, as such, can be used as a 'dry' lubricant in racing car engines. Explain these properties of graphite in terms of its structure and bonding.	
10	Nanotubes are a recently developed example of another allotropic form of carbon. In what way is the structure of nanotubes similar to that of: **a** diamond? **b** graphite?	

Worksheet 5.1: Solutions
Covalent network lattices

No.	Answer
1	**a** See Figure 5.7, page 111 in text book. **b** Between the carbon atoms there are covalent bonds.
2	Silicon (element) and silicon carbide (compound) or silicon dioxide (compound) have similar structures to diamond. They are all extremely hard, have high melting points and are not soluble in water. None of these substances conduct electricity in either the solid or liquid states.
3	See Figure 5.9, page 112 in textbook. Graphite is a layer lattice structure of carbon atoms bonded in an interlocking hexagon arrangement, which is very different to the tetrahedral network lattice of diamond. Each carbon atom only has three covalent bonds. The fourth electron is delocalised between the layers.
4	Graphite is able to conduct electricity because each carbon atom is bonded to only three others, leaving one valence electron free on every carbon atom. These delocalised electrons can move between the layers of hexagonally arranged carbon atoms and so conduct electricity. Diamond has no free electrons, as all four valence electrons are involved in covalent bonds.
5	Diamond is extremely hard because of the very strong covalent bonds, between the carbon atoms, that occur in all three dimensions in its network lattice structure.
6	Diamond is used on drill bits and saws to cut through rock and metal, and can be used to cut glass.
7	Carbon dioxide exists as discrete molecules with only very weak intermolecular forces attracting adjacent molecules to one another. Silicon dioxide exhibits a similar tetrahedral network lattice structure to that of diamond. The strong covalent bonds in all three dimensions ensure that silicon dioxide is very hard and has a high melting point.
8	Elemental silicon exhibits a similar tetrahedral network lattice structure to that of diamond. The strong covalent bonds in all three dimensions ensure that silicon is hard and brittle and has a high melting point. Elemental phosphorus exists in a number of allotropic forms, but mainly as discrete molecules with only weak intermolecular forces between them.
9	Graphite is able to act as a lubricant due to its layer lattice structure. The layers are held together by only weak (dispersion) forces and so they can readily slide past one another, making this substance an excellent lubricant. Its very high melting point means that it is able to withstand the high temperatures generated inside an engine. This high melting point occurs because covalent bonds between the carbon atoms in the layers must be broken when graphite is melted. These bonds are very strong.
10	**a** Both have large numbers of carbon atoms covalently bonded together in a lattice. **b** Both have repeating hexagons consisting of six covalently bonded carbon atoms. Nanotubes are similar to a sheet of graphite rolled into a cylinder.