EVALUATING STUDENT ANSWERS

a) Explain why monatomic substances all have very low melting and boiling points. (2)

Response 1 Student refers to bonds between atoms – this is not suitable as there are no bonds at all, just weak van der Waals' forces between the atoms

Response 2 Student talks about weak forces holding *them* together but should indicate what the *them* is, namely *atoms*.

Response 3 Very good answer

ANSWER There are weak van der Waals' forces between the atoms that only take a small amount of energy to overcome.

b) Explain why simple molecular substances

i) Usually have low melting and boiling points. (2)

ii) Do not conduct electricity (1)

Response 1
(i) Good answer
(ii) While this is true, it does not fully answer the question as it could have had delocalised electrons instead and still conduct. A better answer might be to say it has no mobile charged particles (electrons or ions)

Response 2
(i) Good answer
(ii) Good answer

Response 3
(i) Poor answer as it states that intermolecular forces are between *atoms* rather than between *molecules*
(ii) Poor answer – all substances are themselves neutral, such as metals which do conduct electricity. The student should be referring to the charge of any mobile particles rather than the substance as a whole. Simple molecular substances do not conduct as the molecules are neutral.

ANSWER
(i) There are weak forces between the molecules take a small amount of energy to overcome.
(ii) There are no mobile charged particles (ions or electrons). The molecules are neutral.

c) Explain why giant covalent substances

i) have very high melting and boiling points. (3)

ii) Do not conduct electricity (except graphite) (4)

Response 1
(i) The answer makes a good start but it should state that the bonds are covalent and most importantly that they need to be broken. (remember – simple molecular substances have covalent bonds as well which are strong, but they do not break when simple molecular substances are melted or boiled).

Response 2
(i) This is quite good but could be improved by stating that they are *covalent* bonds that are broken.

Response 3
(i) This is good but could be improved by stating that *many* covalent bonds have to be broken
(ii) This answer explains well why graphite conducts (though the student could add that the delocalised electrons move between the layers of atoms), but does not explain why other giant covalent substances do not. It states that they are neutral but so are all substances that do conduct – it is that it has no mobile charged particles (electrons or ions) that matters.

Response 4 (ii) In terms of graphite, the answer suggests it is just *one* electron that causes it to conduct – there is one from each atom but many in graphite as a whole. In terms of other substances, the answer could be improved by stating that they contain no mobile charged particles (ions or electrons).

Response 5 (ii) Quite a good response although not all of graphite's outer shell electrons are delocalised, just one of them from each atom.

ANSWER (i) In order to melt and boil these substances, many strong covalent bonds need to be broken.

(ii) Graphite conducts as there are delocalised electrons that can move between the layers of atoms. Other giant covalent substances do not have any mobile charged particles (ions or electrons).

d) Explain why metallic substances

i) usually have high melting and boiling points. (2)

ii) can conduct electricity (3)

iii) are malleable and ductile (2)

Response 1 (i) While this is true the answer does not state what the electrostatic attraction is between, namely the lattice of positive metal ions and the cloud of delocalised electrons.

Response 2 (i) Good answer

(ii) Good answer but should also state that it is the *outer shell* electrons that are delocalised.

ANSWER (i) A lot of energy is needed to overcome the strong electrostatic attraction between positive and negative ions.

(ii) Metals conduct as their outer shell electrons are delocalised.

(iii) Layers of ions can slide over each other while maintaining the attraction between the lattice of positive ions and cloud of delocalised electrons.

e) Explain why ionic substances

i) have high melting and boiling points. (2)

ii) can conduct electricity when molten or dissolved, but not when solid (3)

iii) are brittle (3)

Response 1 (i) The attraction is between the positive and negative ions, rather the nucleus and electrons.

(ii) It conducts when molten or dissolved due to *ions* that can move not *electrons*. The answer does not explain why they do not conduct as solids, that is because the ions cannot move.

(iii) Poor answer. First of all it is made of *ions* not *atoms*. It makes no reference to the idea of ions of opposite charge repelling each other if ions are moved.

Response 2 (i) The answer does not explain why they do conduct when molten or dissolved, that is because the ions can move.

ANSWER (i) A lot of energy is need to overcome the strong electrostatic attraction between the lattice of positive metal ions and cloud of delocalised electrons.

(ii) When molten or dissolved the ions can move, but they cannot move when solid.

(iii) If the ions are moved then ions of opposite charge will be next to each other and so repel each other.

5) a) Answer suggests that there are only two aluminium ions and three oxide ions, whereas there are very many ions. They are in the ratio of two aluminium ions for every three oxide ions.

b) Answer should refer to the strong electrostatic attraction being between the positive and negative ions.

c) The answer explains why it does not conduct as a solid, but does not explain why it does when melted, that is because the ions can move.

a) Silicon dioxide, also known as silica, has a giant covalent structure with the formula SiO_2. In your own words, explain what the formula SiO_2 tells you about silicon dioxide. (2)

Excellent answer.

b) Sulphur dioxide has a simple molecular structure with the formula SO_2. In your own words, explain what the formula SO_2 tells you about sulphur dioxide. (2)

Poor answer. The formula means that in each molecule there is one S atom and two O atoms. The answer as written is nonsense!

c) Sodium oxide has an ionic structure with the formula Na_2O. In your own words, explain what the formula Na_2O tells you about sodium oxide. (2)

Excellent answer.

d) Explain why it would be wrong to describe Na_2O as "a molecule". (1)

Excellent answer.

Phosphorus exists in several different forms, two of which are white phosphorus and red phosphorus. White phosphorus consists of P_4 molecules, and melts at 44°C. Red phosphorus is macromolecular, and has a melting point above 550°C.

Explain what is meant by the term *macromolecular*. By considering the structure and bonding present in these two forms of phosphorus, explain why their melting points are so different. (5)

Response 1 Macromolecular is an alternative term for giant covalent – however it does not mean it is a big molecule. No, it has on ongoing giant lattice of atoms linked by covalent bonds and no molecules at all. It does though explain the difference in melting and boiling points quite well.

Response 2 Very good answer.

Response 3 This student has the wrong idea of macromolecular meaning molecules joined together. There are no molecules, it is a giant lattice of atoms linked by covalent bonds. The answer also does not explain why white phosphorus has a low boiling point.

ANSWER White phosphorus has a simple molecular structure. It is made of P_4 molecules containing atoms joined by covalent bonds, but only weak van der Waals' forces between molecules that do not take much energy to overcome.

Red phosphorus has a giant covalent structure (macromolecular). This is a giant lattice of P atoms linked by covalent bonds. To melt this the many, strong covalent bonds must be broken which requires a lot of energy.