

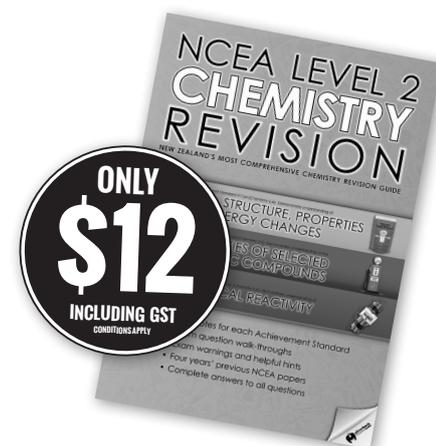
## Suggested Answers - Chemistry 2.4 Exam

### QUESTION ONE

- Sodium bromide is an ionic substance. It is made up of sodium cations ( $\text{Na}^+$ ) and bromide anions ( $\text{Br}^-$ ). As a solid these cations and anions are held together by strong electrostatic forces of attraction between oppositely charged ions. For the solid to melt these strong bonds must be overcome. As the bonds are strong a lot of heat energy is required to overcome the attractive forces between ions.
- Sodium bromide is an ionic substance. It is made up of sodium cations ( $\text{Na}^+$ ) and bromide anions ( $\text{Br}^-$ ). As a solid these cations and anions are held together by strong electrostatic forces of attraction between oppositely charged ions. Water molecules are polar, meaning they have a slight positive charge on one end of the molecule (the hydrogen end), and a slight negative charge on the other (the oxygen atom). When sodium bromide dissolves the cations and anions are removed from the crystal lattice and become surrounded by water molecules. The sodium cations have the negative charge on the oxygen facing them, and the positively charged hydrogen faces the bromide anions.
- $\text{H}_2\text{S}$  is **bent**. There are four regions of negative charge surrounding the central sulfur atom. These repel for maximum separation into a tetrahedral shape. There are two bonding regions and two lone pairs of electrons so the molecule is bent, with a bond angle of approximately  $109^\circ$ .  
 $\text{CH}_4$  is **tetrahedral**. There are four regions of negative charge surrounding the central carbon atom. These repel for maximum separation into a tetrahedral shape. All four regions are bonding regions, there are no lone pairs of electrons, so the molecule is tetrahedral with a bond angle of approximately  $109^\circ$ .
  - $\text{H}_2\text{S}$  is **polar**  
 $\text{CH}_4$  is **non-polar**
  - $\text{H}_2\text{S}$  molecules have 2 polar covalent bonds, with the negative dipole on the more electronegative sulfur atom. The molecule is bent so it is asymmetrical in regard to these bonds. The bond dipoles do not cancel so there is a molecular dipole so  $\text{H}_2\text{S}$  is polar.  
 $\text{CH}_4$  molecules have 4 polar covalent bonds, with the negative dipole on the more electronegative carbon atom. The molecule is tetrahedral so it is symmetrical and the bond dipoles cancel. There is no molecular dipole so  $\text{CH}_4$  is non-polar.
- Diamond **does not** conduct electricity and is hard. Graphite **does** conduct electricity and is soft.
  - Diamond consists of C atoms each covalently bonded to four other C atoms, forming a 3-D tetrahedral arrangement. Graphite consists of C atoms each covalently bonded to three other C atoms in a 2-D (or layered) arrangement with weak intermolecular forces of attraction between the layers or sheets.  
  
In diamond, the covalent bonds between the carbon atoms are very strong and hold the atoms in place, making it difficult to break the bonds. Therefore, diamond is a very hard substance. However in graphite, although the bonds between the covalently bonded carbon atoms in the layers are strong, the forces between the layers are weak, resulting in the layers sliding over each other. Therefore, graphite is a soft substance.  
  
In diamond, all of the valence electrons in each carbon atom are involved in bonding to other carbons. There are no mobile electrons to carry charge. Therefore, diamond is unable to conduct. However, in graphite each carbon atom is bonded to three others in the layers and has one valence electron which is free to move. These delocalised electrons result in the ability of graphite to conduct electricity.

### QUESTION TWO

- Exothermic  
Exothermic  
Endothermic  
Exothermic
- $n(\text{NH}_3)$  in 12.2 g sample =  $12.2 / 17.0 = 0.718 \text{ mol}$  (3 s.f.)  
 4 mol releases  $4 \times 275 / 0.718 = 1530 \text{ kJ}$  (3 s.f.)
- |               |            |                 |         |          |  |
|---------------|------------|-----------------|---------|----------|--|
| Bonds broken: | 4 x C-H    | = 1 648 kJ      |         |          |  |
|               | 2 x O=O    | = 996 kJ        | Total = | 2 644 kJ |  |
| Bonds formed: | 2 x C=O    | = 1 490 kJ      |         |          |  |
|               | 4 x O-H    | = 1 852 kJ      | Total = | 3 342 kJ |  |
|               | Difference | = 2 644 - 3 342 | =       | - 698 kJ |  |



$$\Delta_r H = -698 \text{ kJ mol}^{-1}$$