Suggested Answers - Chemistry 2.4 Exam

QUESTION ONE

1. Sodium bromide is an ionic substance. It is made up of sodium cations (Na^+) and bromide anions (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.

2. Sodium bromide is an ionic substance. It is made up of sodium cations (Na^+) and bromide anions (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.

3. (a) H_2S 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°.

   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°.

   (b) H_2S is **polar**

   CH_4 is **non-polar**

   (c) H_2S 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 H_2S is polar.

   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 CH_4 is non-polar.

4. (i) Diamond **does not** conduct electricity and is hard. Graphite **does** conduct electricity and is soft.

   (ii) 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

1. Exothermic
   Exothermic
   Endothermic
   Exothermic

2. $n(NH_3)$ in 12.2 g sample = 12.2 / 17.0 = 0.718 mol (3 s.f.)
   4 mol releases 4 × 275 / 0.718 = 1 530 kJ (3 s.f.)

3.

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