**Bonding and Properties – Part 1**

**Data Table – Properties of Substances**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test of property** | **NaCl** | **Sugar (sucrose)** | **Copper** | **Unknown 1** | **Unknown 2** | **Unknown 3** | **Unknown 4** |
| Appearance | White, crystal | White, small crystals | Solid, smooth, brown/broze colour | White/blue, crystal, some other colours | Glass-like/transparent stone, shiny, solid, smooth | Liquid, metallic look, shiny metallic grey colour | Small brown/bronze granules |
| Solubility in water | Fully dissolved | Fully dissolved | None | Fully dissolved | None | None | None |
| Melting point | High | Low | High | High | High | Already liquid | Low |
| Conductivity (solid) | No | No | Yes | No | No | Already liquid | No |
| Conductivity (liquid) | Yes | No | Yes | Yes | Does not melt | Yes | No |
| Conductivity (dissolved in water) | Yes | No | Does not dissolve | Yes | Does not dissolve | Does not dissolve | Does not dissolve |

**Bond Type Comparison**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test of property** | **Substances that have ionic bonds** | **Substances that have covalent bonds** | **Substances that have metallic bonds** |
| Appearance | powdery or granular | powdery or granular | shiny |
| Solubility in water | yes | sometimes yes, sometimes no | no |
| Melting point | does not melt easily | melts | does not melt easily |
| Conductivity (solid) | no | no | yes |
| Conductivity (liquid) | yes | no | yes |
| Conductivity (dissolved in water) | yes | no | N/A (not soluble) |

**Bond Type Determination**

Use the information in the data and bond type table to identify the type of bond in each of the following substances.

|  |  |
| --- | --- |
| **Substance** | **Type of bonds** |
| NaCl | Ionic |
| Sugar (sucrose) | Covalent |
| Copper | Metallic |
| Unknown 1 | Ionic |
| Unknown 2 | Covalent |
| Unknown 3 | Metallic |
| Unknown 4 | Covalent |

**EXTENSION**

**Unknown Identification**

|  |  |
| --- | --- |
| **Unknown** | **Formula** |
| Unknown 1 | CaCl2 |
| Unknown 2 | C (must be diamond) |
| Unknown 3 | Hg |
| Unknown 4 | C10H8 |

**6.** **Inferring Unknown Identities** The four unknowns have the following chemical formulas: C, C10H8, CaCl2, and Hg. Can you assign the correct formula to each unknown in the “Unknown Identification” table, using your observations of the properties of the unknowns and what you know about bonds and the periodic table?

**7.** **Evaluating Methods** What information from this lab helped you identify the unknowns? Explain how this information helped you reach conclusions about the identities of the unknowns.

|  |
| --- |
| Observations of properties helped identify the bond types.  Bond types helped identify unknowns.  Unknown 1 🡪 ionic bond (so metal and non-metal) 🡪 CaCl2  Unknown 2 🡪 covalent bond, very high MP, must be covalent giant network 🡪 C (must be diamond form rather than graphite)  Unknown 3 🡪 metallic bond 🡪 Hg  Unknown 4 🡪 covalent bond, low MP, must be covalent simple molecular 🡪 C10H8 |

**8.** **Evaluating Methods** Your results for Unknowns 2 and 3 may not have been quite as clear-cut as the results for other substances. Now that you’ve made a conclusion about their identities, are you surprised that the bond types for these substances were not easily classified? Explain your answer.

|  |
| --- |
| As Unknown 2 is a covalent giant network, it is difficult to classify this as a high MP can sometimes mislead to an ionic compound identification, but it should not conduct electricity. However, some covalent giants can such as C (graphite).  Unknown 3 is challenging, as it’s the only metal that naturally exists in liquid form. Most metal properties relate to their solid form, so it can be a challenge to identify Hg as a metal. |

**9.** **Making Inferences** Carbon, C, is an element that can take several different forms. The most common forms are graphite, the substance found in pencils and referred to as “pencil lead,” and diamond. Based on the properties you observed in the virtual lab, which form of carbon was one of the unknowns? Explain the evidence that supports your inference.

|  |
| --- |
| It is diamond. Graphite conducts well, diamond doesn’t. Diamond is shiny and transparent. |

**Bonding and Properties – Part 2**

Analyse the information in the table below to identify the most likely type of bonding for each substance. Justify your choices using evidence from the table.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Substance | Type of bonding | Phase at room temp. | Hardness | Melting point (◦C) | Electrical conductivity without water | Electrical conductivity Dissolved (or melted) | Solubility in water (does it dissolve) |
| A | Covalent | Liquid | n/a | 0 | No | No | n/a |
| B | ionic | solid | brittle | 808 | no | Yes | yes |
| C | ionic | Solid | brittle | 680 | No | yes | Yes |
| D | covalent | solid | hard | 186 | No | no | yes |
| E | covalent | liquid | n/a | -6 | No | no | no |
| F | metallic | solid | Hard, malleable | 1085 | yes | yes | No |
| G | covalent | liquid | n/a | -114 | No | no | yes |
| H | covalent | solid | hard | Decomposes at high temp | No | no | no |
| I | Covalent network | solid | Very hard | 4000 | No | no | no |
| J | covalent | Liquid | n/a | 18 | No | No | no |
| K | ionic | solid | brittle | 772 | No | yes | yes |
| L | Covalent network | solid | Soft, greasy | 4000 | yes | yes | no |

Note: L may have been interpreted as metallic due to solid, high melting point and able to conduct electricity as both solid and liquid.

Justifications should use evidence about hardness (being brittle or hard) for ionic or covalent, low melting points for covalent, high melting points for covalent network, high melting points for ionic and metallic and electrical conductivity as solid for metallic and liquid for ionic.