Note: These questions will be discussed during the tutorial sessions on September **10th** and **14th**. The In-Tutorial Exercise will be on September **17th** and **21st**.

Question 1:

i) For each of the following compounds, state whether the bonding is essentially metallic, covalent, ionic, van der Waals, or hydrogen:

(a) Ni, (b) ZrO_2, (c) graphite, (d) solid Kr, (e) Si, (f) BN, (g) SiC, (h) Fe_2O_3, (i) MgO, (j) W, (k) H_2O within the molecules, (l) H_2O between the molecules.

If ionic and covalent bonds are involved in the bonding of any of the compounds listed, calculate the percentage ionic character in the compound.

ii) Describe the atomic bonding between magnesium and chlorine.

Question 2:

The interaction energy between Na^+ and Cl^- ions in the NaCl crystal can be written as:

$$E(r) = -\frac{4.03 \times 10^{-28}}{r} + \frac{6.97 \times 10^{-96}}{r^8}$$

Where the energy is given in joules per ion pair, and the interionic separation r is in meters. Calculate the binding energy and the equilibrium separation between the Na^+ and Cl^- ions. Also estimate the elastic modulus Y of NaCl given that:

$$Y = \frac{1}{6r_0}\left[\frac{d^2E}{dr^2}\right]_{r=r_0}$$

Question 3:

a) A gold wire is 0.70 mm in diameter and 8.0 cm. in length. How many atoms does it contain?

b) Calculate and compare the number of atoms per cubic centimeter in lead and lithium.

c) An intermetallic compound has the general chemical formula Mg_xAl_y, where x and y are simple integers. What is the simplest chemical formula of a magnesium aluminide intermetallic compound that consists of 15.68 wt % Mg and 84.32 wt % Al?

Question 4:

From the pictures below, materials can be classified into four general categories.

a) What are these categories?
b) Based on these categories, label the blocks in the figure below to match with their suitable densities.
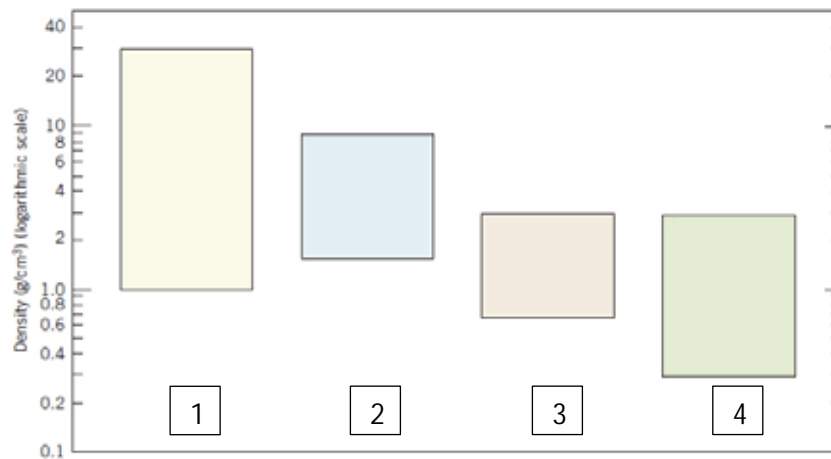
c) What is the difference between composites and other types of materials? Give an example for composite materials.