Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Science and Technology
100 level 2nd Semester Examination – Jan. / Feb. 2016
SCT 152-2 Properties of Matter

Uva Wellassa University

Instructions to candidates
Duration: 02 hours
Number of questions: 04
Answer all questions
Mark allocation: 120

1.

a. Anything that has a mass and occupies a space is defined as **Matter**.

i. What are the three (03) main states of matter? Briefly describe characteristic features of each state.

(06 marks)

ii. What is the difference between extensive and intensive properties of matter? Give one (01) example for each case.

(04 marks)

b. Briefly describe how atomic structure and interatomic bonding determine the properties of matter.

(05 marks)

c. Electron distribution around the nucleus can be described using Bohr atomic model and electron cloud model. Compare the differences between these two models using a schematic plot for the probability of electron distribution for the hydrogen atom.

(05 marks)

d. Every electron in an atom is characterized by four (04) parameters called quantum numbers.

i. What are these four (04) quantum numbers? Write the possible values they can have.

(04 marks)

ii. Write the complete set of quantum numbers that represent the **valence electrons** for helium (He) and Bromine (Br).

(06 marks)

27

2.

a. Draw the dependence of repulsive, attractive, and net energies with interatomic seperation for two isolated atoms. Clearly lable your diagram. (06 marks)

b. Draw a rough sketch showing the differences between the net potential energy curves for Diamond and a polymeric material.

(04 marks)

c. The net potential energy between two adjacent ions, E_N, is a function of the interatomic distance (r) and may be represented by the following equation.

$$E_N = -\frac{A}{r} + \frac{B}{r^n}$$

In this expression, A, B, and n are constants whose values depend on the particular ionic system. Calculate the bonding energy E_0 in terms of the parameters A, B, and n using the following procedure:

i. Differentiate E_N with respect to r, and then set the resulting expression equal to zero, since the curve of E_N versus r is a minimum at E_0.

(04 marks)

ii. Solve for r in terms of A, B, and n, which yields r_0, the equilibrium interionic spacing.

(03 marks)

iii. Determine the expression for E_0 by substituting r_0 into the above equation.

(03 marks)

d. The physical properties of materials can be predicted by their interatomic bonding and these bonds are catogarized as primary and secondary bonds.

i. What are the different types of primary and secondary bonds? Give one (01) example for each case.

(06 marks)

ii. MgO has a higher melting temperature than NaCl. Why?
(Hint: electronegativities of Mg, Na, Cl, and O are 1.2, 0.9, 3.0, and 3.5 respectively)

(04 marks)

3.

a. Briefly describe the differences between crystalline solids and amorphous solids.

(05 marks)

b.

i. How do you distingush single crystal solids and polycrystalline solids? Explain your answer using rough sketches of atomic arrangments.

(06 marks)

ii. Why solids tend to exist in the crystalline state rather than amorphous state?

(03 marks)

c. Plot the temperature dependence of specific volume of a liquid as it forms a crystalline or an amorphous solid (glass phase). (05 marks)

d.

i. A piece of metal originally 500 mm long is pulled in tension with a stress of 375 MPa. If the deformation is entirely elastic, what will be the resultant elongation? (The modulus of elasticity of this metal is 207 GPa) (05 marks)

ii. Consider a cylindrical metal sample that has a diameter of 12 mm. When a tensile force of 1200 N produces an elastic reduction in diameter of 3.2×10^{-4} mm, calculate the modulus of elasticity for this metal. (Poisson's ratio of the metal is 0.32).

(06 marks)

4.

a. Obtain the relationship for volume modulus of elasticity of a liquid (E_v) using specific volume (v) and pressure (p).

(05 marks)

b.

i. Fluids, either liquids or gases, can be defined as ideal fluids and real fluids. What are the main diffrences between these two?

(05 marks)

ii. Draw the viscosity variation with temperature for liquids and gases in the same plot. Why do they behave differently?

(06 marks)

27

c. Obtain the Newton's equation of viscosity for liquids using appropriate physical quantities.

(08 marks)

d. Water at 10 °C stands in a clean glass tube of 3 mm diameter at a height of 40 mm. What is the true static height?
(At 10 °C, specific weight of water is 9804 Nm^{-3} and surface tension is 0.0742 Nm^{-1})

(06 marks)