Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Science and Technology
100 level 2nd Semester Examination – Dec./Jan. 2017

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. According to the state of matter, materials can be found as solid, liquid, and gas. Describe briefly each state according to their density, fluidity, and compressibility.

(06 marks)

b. Every matter undergoes physical & chemical changes. Physical changes occur when the substance changes its form or appearance without varying its chemical composition. Write four (04) examples of physical changes of matter that we find in day today life.

(04 marks)

c. Electrons in atoms have a big role for finding properties of matter and the distribution of electrons around the nucleus can be described using different models.

i. What is the main difference between "Bohr model" and "electron cloud model"?

(02 marks)

ii. Draw a schematic digram for the probability of electron distribution of hydrogen atom using above two models.

(04 marks)

d. The quantum numbers are parameters that describe the distribution of electrons in the atom.

i. What does each of the four (04) quantum numbers represent?

(04 marks)

ii. Write the four quantum numbers for all of the electrons in the M shell, and note which correspond to the s, p, and d subshells.

(10 marks)

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2. The physical properties of materials are predicted based on the knowledge of the interatomic forces and bonding energies that bind the atoms together.

a. Draw a schematic diagram showing the dependence of repulsive, attractive, and net potential energies on interatomic separation for two isolated atoms. Clearly lable the diagram.

(06 marks)

b. The net potential energy E_N between two adjacent ions is sometimes represented by following equation,

$$E_N = -\frac{A}{r} + B\, exp(-\frac{r}{k})$$

where r is the inter-ionic seperation and A, B, and k are constants whose values depend on the specific material.

Derive an expression for the bonding energy E_0 in terms of the equilibrium interionic seperation r_0 using the following procedure.

i. Differentiate E_N with respect to r and set the resulting expression equal to zero.

ii. Solve for A in terms of B, k, and r_0.

iii. Determine the expression for E_0 by substituting for A in the above equation.

(08 marks)

c. Three different types of primary bonds found in solids are ionic, covalent, and metallic. Describe each type using the involvement of the valance electrons and the electronic structure of the constituent atoms.

(12 marks)

d. Explain why hydrogen fluoride (HF) has a higher boiling temperature than hydrogen chloride (HCl), even though HF has a lower molecular weight.

(04 marks)

3. a. Solid state materials can be mainly found as crystalline or non-crystalline (amorphous). Describe briefly the differences between crystalline solids and amorphous solids.

(06 marks)

b. i. What is the meaning of *Polymorphism*? Give two exmples where we can find polymorphism.

(04 marks)

ii. Write down four (04) materials that show liquid crystalline properties.

(04 marks)

c. i. Why and how do we study mechanical properties of solids?

(06 marks)

ii. A piece of metal (300 mm long) is subjected to a load with a stress of 275 MPa. If the deformation is entirely elastic, what will be the resultant elongation? The modulus of elasticity of this metal is 115 GPa.

(04 marks)

d. Consider a cylindrical brass rod that has a diameter of 10 mm. When a tensile stress is applied along the long axis of this rod, determine the magnitude of the load required to produce a 2.5 X 10^{-3} mm change in diameter, if the deformation is entierly elastic. The modulus of elasticity and Poission's ratio of brass are 97 GPa and 0.34 respectively.

(06 marks)

4. a. What is the main difference between:

i. compressible fluids and incompressible fluids?

ii. perfect gas and ideal gas?

iii. ideal fluid and real fluid?

(06 marks)

b. Equal masses of three liquids of densities d_1, d_2, and d_3 are added together. If the liquids mix together without causing any change, obtain the relationship for the composite liquid using the given information.

(04 marks)

c. i. Draw a graph showing the viscosity change of liquids and gases with respect to temperature.

(04 marks)

ii. Describe briefly the difference between Newtonian and non-Newtonian fluids using an appropriate diagram.

(06 marks)

d. i. Obtain the capillary rise (h) for a liquid using its surface tension (σ), wetting angle (θ), specific weight of liquid (γ), and radius of tube (r).

(04 marks)

ii. Calculate the gauge pressure inside a soap bubble 2 X 10^{-4} m in radius. Note that the surface tension for soapy water is 0.037 Nm^{-1}. Convert this pressure to mm Hg.

(06 marks)