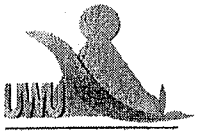


1. A. Electrons in atoms have a big role for finding properties of matter and the distribution of electrons around the nucleus can be described using different models.

   i. What is the main difference between "Bohr model" and "electron cloud model"? (06 marks)

   ii. Draw a schematic diagram for the probability of electron distribution of hydrogen atom using above two models. (10 marks)

   B. 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 K and L shells, and note which correspond to the s and p subshells. (10 marks)

2. A. 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.

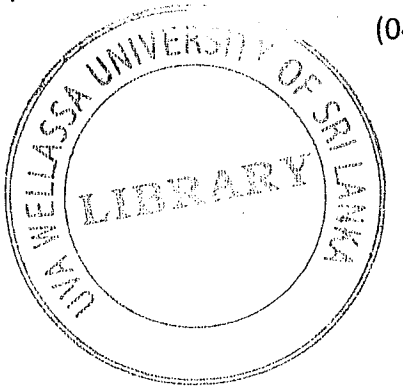
i. Differentiate E_N with respect to r and set the resulting expression equal to zero. (10 marks)

ii. Solve for A in terms of B, k, and r_0. (05 marks)

iii. Determine the expression for E_0 by substituting for A in the above equation. (05 marks)

B. According to the atomic arrangement, solid state materials can be mainly found as crystalline or amorphous. Describe briefly the differences between these two types. (06 marks)

C. What is the meaning of *Polymorphism*? Give two exmples where we can find polymorphism. (04 marks)



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3. A village maintains a large tank with an open top, containing water for emergencies. The water can drain from the tank through a hose of diameter 6.60 cm. The hose ends with a nozzle of diameter 2.20 cm. A rubber stopper is inserted into the nozzle. The water level in the tank is kept 7.50 m above the nozzle.

   a. Calculate the friction force exerted by the nozzle on the stopper. (8 Marks)

   b. The stopper is removed. What mass of water flows from the nozzle in 2.00 h? (7 Marks)

   c. Calculate the gauge pressure of the flowing water in the hose just behind the nozzle. (15 Marks)

4. A cylinder that has a 40.0 cm radius and is 50.0 cm deep is filled with air at 20.0 °C and 1.00 atm (Fig. 1 (a)). A 20.0 kg piston is now lowered into the cylinder, compressing the air trapped inside (Fig. 1 (b)). Finally, a 75.0 kg man stands on the piston, further compressing the air, which remains at 20°C (Fig. 1 (c)).

   a. How far down (Δh) does the piston move when the man steps onto it? (20 Marks)

   b. To what temperature should the gas be heated to raise the piston and man back to h_i? (10 Marks)

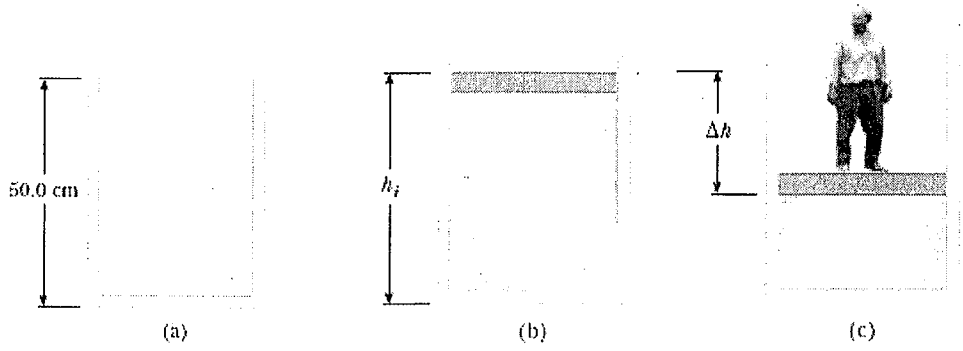

Figure 01