(1) (a) In a cubic unit cell, sketch $(10\bar{3})$ and $[10\bar{3}]$. (8%)
(b) The crystal structure of dalium (Da) is BCC. Its molar volume is 9.99 cm^3 mol. Calculate the linear packing density along [011] in Da. Express your answer in atoms cm^{-1}. (10%)

(2) Give one example and briefly explain the following types of defect. (a) 0 –dimensional defect (4%), (b) 1–dimensional defect (4%) and (c) 2–dimensional defect. (4%)

(3) (a) A membrane is to be manufactured to the following specification. At 700°C, the leak rate of hydrogen at steady state is not to exceed 10^{-3} mol cm^{-2} hr^{-1} when the concentrations of hydrogen are maintained at C_s^{high} = 7.7 X 10^{19} atom cm^{-3} on one side of the membrane and C_s^{low} = effectively zero on the other side. What is the minimum thickness, T, of iron foil that will meet these requirements? The diffusion coefficient of atomic hydrogen in iron, D_H, at 700 °C is 3.091X 10^{-4} cm^2 s^{-1}. Express your answer in units of cm. (10%)
(b) You are given two specimens of iron, each of identical purity. Specimen A has a grain size of 3.39 micrometer; specimen B has a grain size of 444 micrometer. Which specimen will exhibit a higher rate of diffusion of hydrogen through it? Explain the reason for your choice.(10%)

(4) (a) Illustrate the typical engineering stress-strain and true stress-strain behaviors, label the corrected stress and explain why the stress needs to be corrected. (5 %)
(b) For an alloy, the stress at which plastic deformation begins is 325 MPa, and the modulus of elasticity is 230 GPa.
(b-1) What is the maximum load that may be applied to a cylindrical specimen having an original diameter of 10 mm without plastic deformation? (5 %)
(b-2) If the original specimen length is 120 mm, what is the maximum length to which it may be stretched without causing plastic deformation? (10 %)

(5) (a) Sketch the B-H curves of ferromagnetic and ferromagnetic materials and give the meanings of important terms of B-H curve. (5 %)
(b). If domain boundary movement were hindered, what would occur on the B-H hysteresis loop? Please sketch it. (5 %)
(c) The saturation magnetization flux density (Ms) of Fe_2O_3 is 5.0 x 10^5 A/m each unit cell contains 8 Fe^{2+}, and the magnetic moment of Fe^{2+} is 4 Bohr magneton. Now, we want to design the magnet with the saturation magnetization flux density of 4.5 x 10^5 A/m, what's the content of Fe^{2+} should be replaced by Ni^{2+} ? (The magnetic moment of Ni^{2+} is 2 Bohr magneton) (10 %)

(6) Please define the light-emitting diodes (LEDs)? What's the working principle of LEDs? (5 %)

(7) An gold wire 10 m long is cooled from 150 °C to 10 °C. How much change in length will it experience? The coefficient of thermal expansion of gold is 1.4 x 10^{-5} (1/K) (5 %)