請於答案卷上依序作答，並清楚標明題號

1. A pressure cooker cooks a lot faster than an ordinary pan by maintaining a higher pressure and temperature inside. The lid of a pressure cooker is well sealed, and steam can escape only through an opening in the middle of the lid. A separate metal piece, the petcock, sits on top of this opening and prevents steam from escaping until the pressure force overcomes the weight of the petcock. The periodic escape of the steam in this manner prevents any potentially dangerous pressure buildup and keeps the pressure inside at a constant value. Determine the mass of the petcock of a pressure cooker whose operation pressure is 100 kPa gage and has an opening cross-sectional area of 4 mm^2. Assume an atmospheric pressure of 101 kPa. (15%)

2. The densities of solid and liquid bismuth are 9.673 and 10.0 g/ cm^3 respectively at the normal melting point 270 °C . The heat of fusion of bismuth is 11.02 kJ/mol. Calculate the change in melting point of bismuth under a pressure of 100 atm. Atomic weight of bismuth is 209 [hint: 1 joule = 9.87 cm^3 . atm] (20%)

3. The Fe and O phase diagram has three stoichiometric compounds, FeO, Fe$_3$O$_4$ and Fe$_2$O$_3$. There is a composition X as 24 wt% O, 76 wt% Fe in the system Fe-O. This composition X can equivalently be calculated as being in the following two systems. (a) the system Fe-Fe$_3$O$_4$,(10%) and (b) the system FeO – Fe$_3$O$_4$. (10%)
   [Fe atomic weight: 56, O$_2$ atomic weight: 32]

4. The initial state of one mole of a monatomic ideal gas is P=10 atm and T=300 K. calculate the change in entropy of the gas for (a) an isothermal decrease in the pressure to 5 atm; (6%)(b) a reversible adiabatic expansion to a pressure of 5 atm;(6%) (c) a constant-volume decrease in the pressure to 5 atm. (8%)

5. The molar excess Gibbs free energy of formation of a binary A-B solution is given as $G^{xs} = (a + bX_B)X_A X_B$; the constants a and b are simply parameters the value of which can be adjusted in an attempt to fit the equation to experimentally measured data. Derive expressions for the partial molar excess Gibbs free energies of the components A and B. (25%)