1. A steam engine operates between 138 and 38°C. What is the minimum amount of heat that must be withdrawn from the hot reservoir to obtain 1000 J work? (5%)

2. Calculate ΔS when 0.5 mole liquid water at 273K is mixed with 0.5 mole liquid water at 373K, and the system is allowed to reach equilibrium in an adiabatic enclosure. Assume C_p=77 J.K^{-1}mol^{-1} from 273 to 373K. (5%)

3. Calculate ΔU, ΔH, ΔS, ΔA and ΔG in expanding one mole of ideal gas at 25°C from 10 to 100 dm^3. (5%)

4. For each of the following processes, state which of the quantities, ΔU, ΔH, ΔS, ΔA and ΔG, are equal to zero for system specified. (a) A nonideal gas is taken around a Carnot cycle, (b) A nonideal gas is adibatically expanded through a throttling valve, (c) An ideal gas is adibatically expanded through a throttling valve, (d) Liquid water is vaporized at 100°C and 1 atm, (e) H_2 and O_2 react to form H_2O in a thermally isolated bomb, and (f) HCl and NaOH react to form H_2O and NaCl in an aqueous solution at constant T and P. (10%)

5. Sketch graphs of G, S, V, and C_p, against T at constant P for typical first- and second-order phase transitions. (5%)

6. The vapor pressure of water at 298K is 23.76 torr. What is ΔG_{298} at one atm for the change of $H_2O_{(g)} \rightarrow H_2O_{(l)}$? (5%)

7. The human body contains about 150 g of potassium in ionized form distributed so that the concentration inside cells is 0.155 mol.dm^{-3} and that outside cells is 0.005 mol.dm^{-3}. What is the total Gibbs energy ΔG associated with this unequal distribution compared to that for a uniform concentration? (5%).

8. The vapor pressure of a liquid that obeys Trouton's rule increases by 20 torr.K^{-1} at temperatures around its normal boiling point (T_b). Estimate the ΔH (vaporization) and T_b for this liquid. (5%).

9. At 1000°C, K_p for $CO_{2\,(g)} + C(c) \longleftrightarrow 2CO_{(g)}$ is 121.5 atm. (a) calculate K_c (equilibrium constant in terms of concentrations), (b) if a vessel initially contained carbon and CO_2 at 10 atm and 1000°C, what would be the total pressure at equilibrium? (5%)

10. 請提出一種測量重量平均分子量的方法及其限制。（10%）

11. 在張力係數、膨脹係數、電阻、 induced dipole 及 permanent dipole 中，何者不隨溫度而變？又為什麼？　（10%）

12. 下列 a 到 e 五個分子中，何者結構不是平面？ (10%)
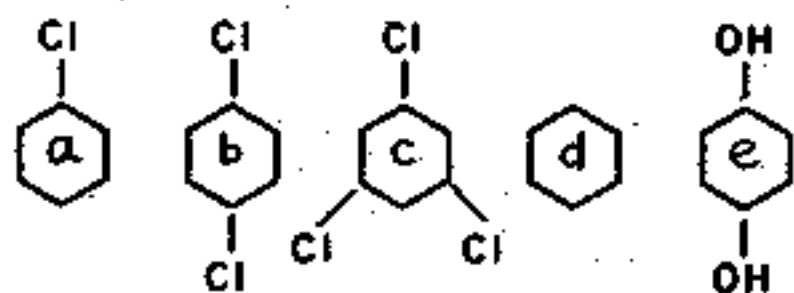
13. 請找出是屬於 P-type 之半導體　(a) Si doped with P　(b) Si doped with Li (c) Si doped with B　(d) Ge doped with In　(e) Ge doped with Li　　(10%)

14. 二氧化碳排放增多，造成地球溫室效應加劇，二氧化碳的偵測，相形重要；它可為紅外線（IR）光譜儀所偵測，　是因為二氧化碳分子的振動模式中的哪幾個模式是 IR active？　　(10%)