一、解釋下列各名詞:

a). State property: (4%)

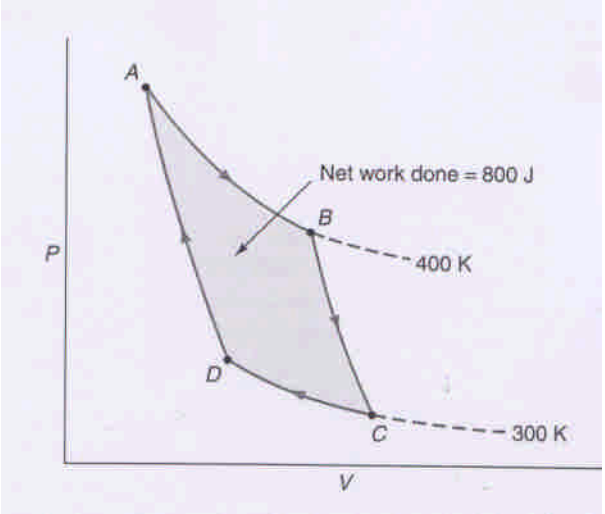
b). Inversion temperature: (4%)

c). Chemical potential: (4%)

d). Exact differential: (4%)

e). Eutectic: (4%)

二、**The accompanying diagram represents a reversible Carnot cycle for an ideal gas: (a). What is the thermodynamic efficiency of the engine? (3%) (b). How much heat is absorbed at 500 K? (3%) (c). How much heat is rejected at 200 K? (3%) (d). In order for the engine to perform 1.00 kJ of work, how much heat must be absorbed? (3%) (e). What is the overall entropy change for the entire cycle? (3%)**



三、**Calculate the change in Helmholtz energy,** △A, for a process in which 3.00 moles of an ideal gas expands from 2.00 L to 10.0 L (a). against a constant pressure of 800 mmHg and a constant temperature of 27.0 ℃？(5%) (b). expands isothermally and reversibly at 27.0 ℃？(5%)

四、**For the following reaction: SO_2 (g) + 1/2 O_2 (g)** $\rightleftharpoons$ **SO_3 (ℓ) the** ΔG_f^0 data is given as below:

Substance	SO_2(g)	O_2(g)	SO_3(ℓ)
△G_f^0 kJ/mol	-300.13	0.0	-368.0

(a). Write the expression for K for this equilibrium？(3%) (b). Calculate the value of △G^0 for this equilibrium？(4%) (c). Calculate the value of K for this equilibrium？(4%) (d). If 0.010 bar of SO_2 and 0.020 bar of O_2 are enclosed in a system in the presence of some SO_3 liquid, in which direction would the equilibrium move？P^0 = 1 bar (4%)

五、**Trouton's rule is useful in estimating the vapor pressure of a substance for which only the standard boiling point is known. For example, at what temperature would you expect aniline to boil in a vacuum at 20 Torr pressure? The normal boiling point of aniline is 185℃.** (10%)

六、**Calculate (a) $\triangle H_{mix}$ (1%)(b) $\triangle U_{mix}$ (1%)(c)$\triangle G_{mix}$ (4%)(d)$\triangle S_{mix}$ (4%) for a system that mixes 3.00 mol of benzene and 2.00 mol of toluene at 25℃？**

七、**A voltaic cell is based upon the half-reactions below.**

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ $E° = +0.339$ V

$NO_3^-(aq) + 4H^+(aq) + 3e^- \rightarrow NO(g) + 2H_2O$ $E° = +0.964$ V

Calculate (a). $\Delta G°$ (5%) (b). the equilibrium constant for the overall chemical reaction at 25°C？(5%)

八、**Use the equilibrium constants for the following reactions at 700°C**

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $K_1 = 4.8$

$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$ $K_2 = 16$

to determine the equilibrium constant for the following reaction. (10%)

$SO_3(g) + NO(g) \rightleftharpoons SO_2(g) + NO_2(g)$