UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2008/2009

November 2008

ZCT 212/2 – Thermodynamics
[Termodinamik]

Duration: 2 hours
[Masa : 2 jam]

Please ensure that this examination paper contains **FIVE** printed pages before you begin the examination.
*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **LIMA** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

Instruction: Answer all **FOUR** questions. Students are allowed to answer all questions in Bahasa Malaysia or in English.

*[**Arahan**: Jawab semua **EMPAT** soalan. Pelajar dibenarkan menjawab semua soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]*

...2/-

1. (a) Define heat, work, internal energy, Zeroth Law and First Law used in thermodynamics.
[Huraikan maksud haba, kerja, tenaga dalam, Hukum Sifar dan Hukum Pertama dalam termodinamik]

(5/25)

(b) The equilibrium states of superheated steam are represented by Callendar's equation
[Keadaan mantap stim dipanaskan secara tinggi diwakili oleh persamaan Callendar's]

$$v-b=\frac{rT}{P}-\frac{a}{T^m}$$

where *b, r, a* and *m* are constants.
[di mana b, r, a dan m adalah pemalar]

Calculate the volume expansivity β as a function of *T* and *P*.
[Hitungkan pengembangan isipadu β sebagai fungsi kepada T dan P]

(10/25)

(c) During a quasi-static expansion of a gas in an adiabatic container, the pressure at any moment is given by the equation
[Semasa pengembangan kuasi-statik suatu gas dalam bekas adiabatik, tekanan pada sebarang masa adalah diwakili oleh persamaan]

$$PV^{\gamma}=K$$

where γ and *K* are constants.
[di mana γ dan K adalah pemalar]

Show that the work done in expanding from a state (P_i, V_i) to a state (P_f, V_f) is
[Tunjukkan bahawa kerja yang dilakukan untuk mengembang dari keadaan (P_i, V_i) ke keadaan (P_f, V_f) adalah]

$$W=-\frac{P_iV_i-P_fV_f}{\gamma-1}$$

(10/25)

...3/-

2. (a) Using the mathematical formulation of the First Law for a hydrostatic system and choosing U as a function of T and V, show that
[Dengan menggunakan persamaan matematik Hukum Pertama untuk sistem hidrostatik dan memilih U sebagai fungsi kepada T dan V, tunjukkan bahawa]

(i) $$d'Q=\left(\frac{\partial U}{\partial T}\right)_V dT+\left[\left(\frac{\partial U}{\partial V}\right)_T+P\right]dV$$

(ii) $$\left(\frac{\partial U}{\partial T}\right)_V=C_V$$

(iii) $$\left(\frac{\partial U}{\partial V}\right)_T=\frac{C_P-C_V}{V\beta}-P$$

(9/25)

(b) One mole of a gas obeys the van der Waals equation of state:
[Suatu mol gas mematuhi persamaan keadaan van der Waals]

$$\left(P+\frac{a}{v^2}\right)(v-b)=RT$$

and its molar internal energy is given by
[dan tenaga dalam molar diwakili oleh]

$$u=cT-\frac{a}{v}$$

where a, b, c, and R are constants.
[di mana a, b, c, dan R adalah pemalar]

Calculate the molar heat capacities C_V and C_P.
[Hitungkan muatan haba molar C_V dan C_P]

(8/25)

(c) Starting from the First Law of thermodynamics and ideal gas equation, where both undergo an infinitesimal quasi-static process, show that
[Mulai dengan persamaan matematik Hukum Pertama dan persamaan gas unggul, di mana kedua-duanya mengalami proses kuasi-statik secara kecil takterhingga, tunjukkan bahawa]

$$C_P = C_V + nR$$

(8/25)

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3. (a) Explain briefly the following:
[Terangkan secara ringkas berikut:-]

(i) adiabatic process *[proses adiabatik]*

(ii) isobaric process *[proses isobarik]*

(ii) isothermal process *[proses isoterma]*

(iv) quasi-static process *[proses kuasi-statik]*

(4/25)

(b) One mole of an ideal monoatomic gas is taken through the cycle shown in Figure 1. The process AB is a reversible isothermal expansion, calculate
[Satu mol gas monoatom unggul dibawa melalui suatu kitaran seperti Rajah 1. Proses AB ialah pengembangan isoterma berbalik, hitungkan]

(i) the net work done by the gas,
[kerja bersih yang dilakukan oleh gas]

(ii) the heat added to the gas,
[haba yang ditambah kepada gas]

(iii) the heat expelled by the gas,and
[haba yang dibuangkan oleh gas, dan]

(iv) the efficiency of the cycle. (Given: R = 8.314 J/K.mol)
[kecekapan dalam kitaran ini. (Diberi: R = 8.314 J/K.mol)]

(12/25)

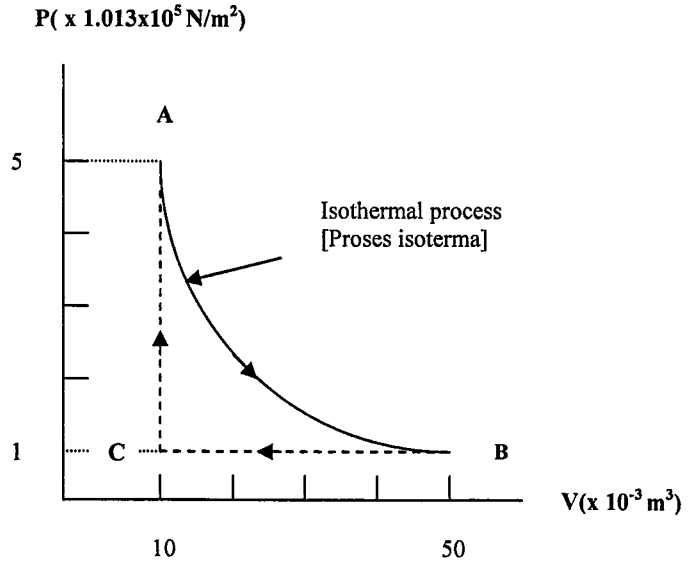

Figure 1 *(Rajah 1)*

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(c) Sketch a PV diagram of a Carnot Cycle. Label the isothermal and adiabatic region.
[Lakar suatu gambarajah PV Kitaran Carnot. Tandakan kawasan isoterma dan adiabatik]

If the equation of state of a gas is $P(v - b) = R\Theta$ and whose heat capacity C_v is a function of Θ only through a Carnot Cycle, prove that $\Theta = T$
[Jika persamaan keadaan untuk suatu gas ialah $P(v - b) = R\Theta$ dan muatan haba C_v adalah fungsi Θ sahaja melalui suatu Kitaran Carnot, buktikan $\Theta = T$]

(9/25)

4. (a) Differentiate between reversible and irrevisible process.
[Bezakan antara proses berbalik dan tak berbalik]

(4/25)

(b) Show that ΔS for the process of taking n moles of an ideal gas with constant heat capacity from T_1 and V_1 to T_2 and V_2 is :-
[Tunjukkan bahawa ΔS untuk proses mengambil n mol gas unggul dengan muatan haba malar dari T_1 dan V_1 ke T_2 dan V_2 ialah :-]

$$\Delta S = C_v \ln \frac{T_2}{T_1} + nR \ln \frac{V_2}{V_1}$$

(Given : Maxwell equation, $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$)

[Diberi: Persamaan Maxwell, $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$]

(9/25)

(c) 10 kg of water at 20^0C is heated until it becomes superheated steam at 250^0C at constant pressure. Calculate the water entropy change in the process if :-
[10 kg air pada 20^0C di panaskan sehingga ia menjadi stim lampaupanas dan mencapai suhu 250^0C pada tekanan malar. Hitungkan perubahan entropi air dalam proses jika:-]

C_p (water) = 4180 J/(kg-K)
[C_p (air) = 4180 J/(kg-K)]

C_p (steam) = $1670 + 0.494\,T + 1.86 \times 10^6\,T^{-2}$ J/ (kg-K)
[C_p (stim) = $1670 + 0.494\,T + 1.86 \times 10^6\,T^{-2}$ J/ (kg-K)]

Latent heat of evaporation of water (at 100^0C) = 22.6×10^5 J/kg
[Haba pendam sejatan air (pada 100^0C) = 22.6×10^5 J/kg]

(12/25)

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