

CM3230, Fall 2014

Quiz 4a

Name _____

Answer 5 items for full 100 points. The 6th correct answer will be considered a 20 point bonus.

1. The isothermal departure function for internal energy is defined as $\Delta u^{\text{dep}}(T, v) = u(T, v) - [\lim_{v \rightarrow \infty} u(T, v)]$. Thus, for a gas behaving according to the van der Waals equation,

$$P = \frac{RT}{v - b} - \frac{a}{v^2}$$

- a. $\Delta u^{\text{dep}}(T, v) = c_v T + (RTv/(v - b))$
b. $\Delta u^{\text{dep}}(T, v) = a/v$
c. $\Delta u^{\text{dep}}(T, v) = aRT/v^2$
d. None of the above
2. At a temperature T_o and pressure P_o , $(\partial h/\partial P)_T > 0$. Then at this temperature and pressure the Joule Thomson coefficient, $\mu_{JT} = (\partial T/\partial P)_h$ is (Hint: use cyclic relation for $\{h, T, P\}$):
a. $\mu_{JT} > 0$
b. $\mu_{JT} = 0$
c. $\mu_{JT} < 0$
d. Insufficient data
3. A gas following the behavior of a virial equation given by

$$\frac{Pv}{RT} = 1 + \gamma P \quad (\text{where } \gamma \text{ is constant})$$

undergoes an isothermal expansion at temperature T from pressure P_1 to P_2 accompanied by a change in enthalpy given by Δh . The change in entropy is then given by

- a. $\Delta s = \Delta h - RT[P_2 - P_1]$
b. $\Delta s = \Delta h/T - \gamma R \ln(P_2/P_1)$
c. $\Delta s = \Delta h/T - R[\gamma(P_2 - P_1) + \ln(P_2/P_1)]$
d. None of the above

4. A rigid insulated cylinder separated by a membrane contains 10 moles of a gas at temperature T_i having $c_v^{\text{real}} = 5R/2$ on one side having a volume of V_1 . The other side is evacuated and has a volume $V_2 = 2V_1$. Assuming the gas behaves according to the equation of state given by

$$P = \frac{RT}{v - b} - a \quad ; \quad a, b = \text{constant}$$

The final temperature after the membrane breaks, is given by

- $T_f = T_i - (4/5)(aV_1/R)$
 - $T_f = T_i - (2/25)(aV_1/R)$
 - $T_f = T_i$
 - None of the above
5. The isothermal departure function for internal energy is defined as $\Delta s^{\text{dep}}(T, P) = s(T, P) - [\lim_{P \rightarrow 0} s(T, P)]$. Thus, for a gas behaving according to the equation of state given by

$$P + \alpha = \frac{RT}{v - \gamma} \quad ; \quad \alpha, \gamma \text{ constant}$$

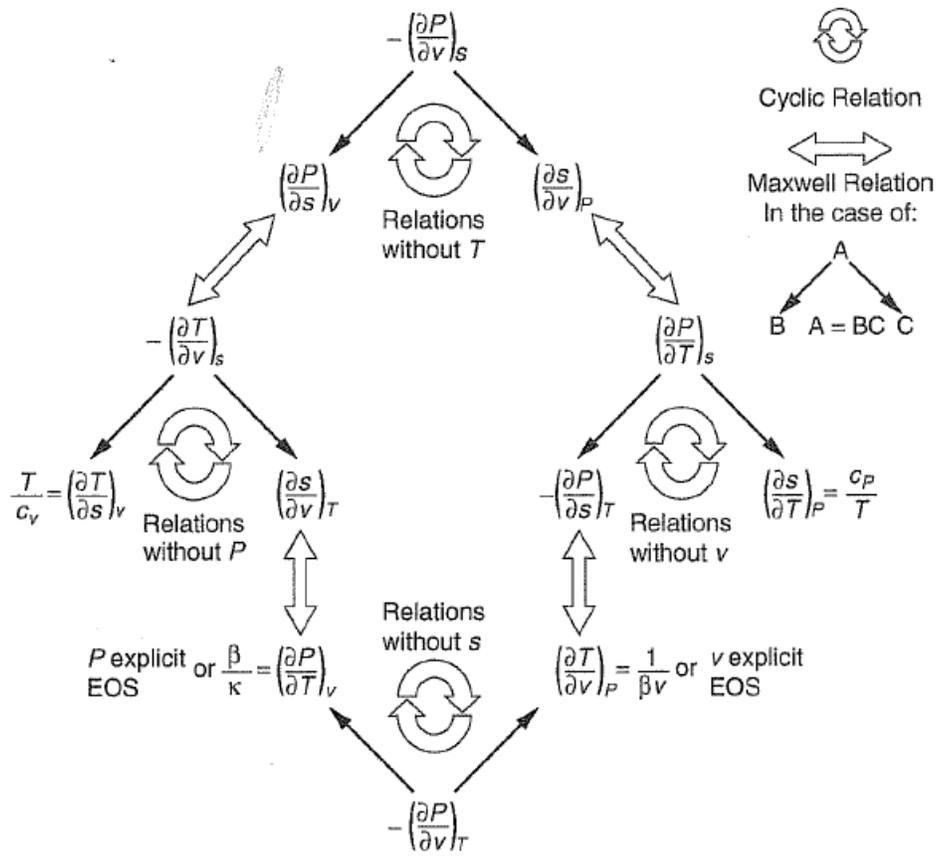
- $\Delta s^{\text{dep}}(T, P) = \alpha R/P$
 - $\Delta s^{\text{dep}}(T, P) = R \ln(\alpha/(\alpha + P))$
 - $\Delta s^{\text{dep}}(T, P) = R(1 + (\alpha/P) + \gamma)$
 - None of the above
6. A real gas undergoes an expansion process from $(T_1, P_1) = (300K, 10 \text{ bar})$ to $(T_2, P_2) = (400K, 1 \text{ bar})$. Assuming that the ideal gas heat capacity is given by

$$c_p^{\text{ideal}} = (1 + 0.002 T) \frac{J}{\text{mol} \cdot K}$$

and the departure functions at both conditions are given by $\Delta h_{T_1, P_1}^{\text{dep}} = -100 \text{ J/mol}$ and

$\Delta h_{T_2, P_2}^{\text{dep}} = -10 \text{ J/mol}$. Then the change in enthalpy is closest to

- $\Delta h = 520 \text{ J/mol}$
- $\Delta h = 400 \text{ J/mol}$
- $\Delta h = 260 \text{ J/mol}$
- $\Delta h = 0 \text{ J/mol}$



(Figure taken from M. Koretsky, "Engineering and Chemical Thermodynamics, 2nd Ed.", J. Wiley, 2013, p. 274)

CM3230, Fall 2014

Quiz 4b

Name _____

Answer 5 items for full 100 points. The 6th correct answer will be considered a 20 point bonus.

1. A gas following the behavior of a virial equation given by

$$\frac{Pv}{RT} = 1 + \gamma P \quad (\text{where } \gamma \text{ is constant})$$

undergoes an isothermal expansion at temperature T from pressure P_1 to P_2 accompanied by a change in enthalpy given by Δh . The change in entropy is then given by

- $\Delta s = \Delta h/T - R[\gamma(P_2 - P_1) + \ln(P_2/P_1)]$
 - $\Delta s = \Delta h - RT[P_2 - P_1]$
 - $\Delta s = \Delta h/T - \gamma R \ln(P_2/P_1)$
 - None of the above
2. At a temperature T_o and pressure P_o , $(\partial h/\partial P)_T > 0$. Then at this temperature and pressure the Joule Thomson coefficient, $\mu_{JT} = (\partial T/\partial P)_h$ is (Hint: use cyclic relation for $\{h, T, P\}$):
- $\mu_{JT} > 0$
 - $\mu_{JT} < 0$
 - $\mu_{JT} = 0$
 - Insufficient data
3. A rigid insulated cylinder separated by a membrane contains 10 moles of a gas at temperature T_i having $c_v^{\text{real}} = 5R/2$ on one side having a volume of V_1 . The other side is evacuated and has a volume $V_2 = 2V_1$. Assuming the gas behaves according to the equation of state given by

$$P = \frac{RT}{v - b} - a \quad ; \quad a, b = \text{constant}$$

The final temperature after the membrane breaks, is given by

- $T_f = T_i - (2/25)(aV_1/R)$
- $T_f = T_i - (4/5)(aV_1/R)$
- $T_f = T_i$
- None of the above

4. A real gas undergoes an expansion process from $(T_1, P_1) = (400K, 10 \text{ bar})$ to $(T_2, P_2) = (300K, 1 \text{ bar})$. Assuming that the ideal gas heat capacity is given by

$$c_p^{\text{ideal}} = (1 + 0.002 T) \frac{J}{\text{mol} \cdot K}$$

and the departure functions at both conditions are given by $\Delta h_{T_1, P_1}^{\text{dep}} = -100 \text{ J/mol}$ and $\Delta h_{T_2, P_2}^{\text{dep}} = -10 \text{ J/mol}$. Then the change in enthalpy is closest to

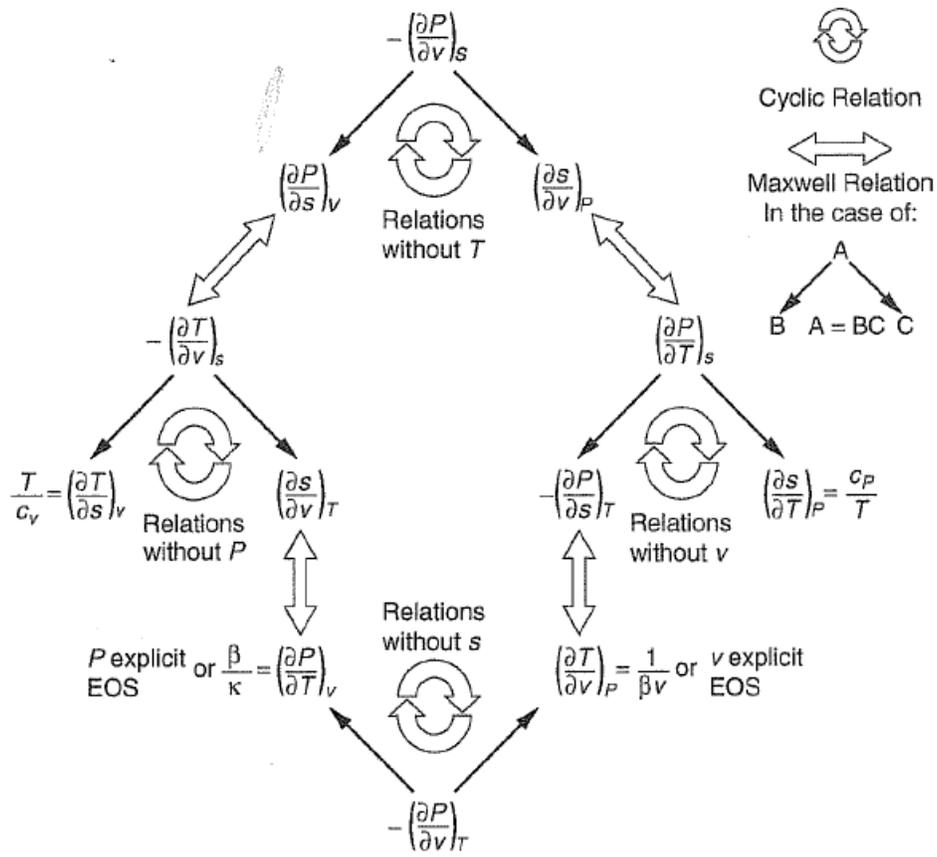
- $\Delta h = 0 \text{ J/mol}$
 - $\Delta h = 260 \text{ J/mol}$
 - $\Delta h = 410 \text{ J/mol}$
 - $\Delta h = 600 \text{ J/mol}$
5. The isothermal departure function for internal energy is defined as $\Delta s^{\text{dep}}(T, P) = s(T, P) - [\lim_{P \rightarrow 0} s(T, P)]$. Thus, for a gas behaving according to the equation of state given by

$$P + \alpha = \frac{RT}{v - \gamma} \quad ; \quad \alpha, \gamma \text{ constant}$$

- $\Delta s^{\text{dep}}(T, P) = \alpha R/P$
 - $\Delta s^{\text{dep}}(T, P) = R \ln(\alpha/(\alpha + P))$
 - $\Delta s^{\text{dep}}(T, P) = R(1 + (\alpha/P) + \gamma)$
 - None of the above
6. The isothermal departure function for internal energy is defined as $\Delta u^{\text{dep}}(T, v) = u(T, v) - [\lim_{v \rightarrow \infty} u(T, v)]$. Thus, for a gas behaving according to the van der Waals equation,

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- $\Delta u^{\text{dep}}(T, v) = a/v$
- $\Delta u^{\text{dep}}(T, v) = aRT/v^2$
- $\Delta u^{\text{dep}}(T, v) = c_v T + (RTv/(v - b))$
- None of the above



(Figure taken from M. Koretsky, "Engineering and Chemical Thermodynamics, 2nd Ed.", J. Wiley, 2013, p. 274)