BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
FIRST SEMESTER 2007-2008

CHE UC311 Chemical Engineering Thermodynamics

Surprise QUIZ - 7

(Closed Book)

DATE: 13../..12./...07.

DURATION: 15 MINUTES **MAXIMUM MARKS: 09**

Name of the student: ---------- I.D.: ----------

1. The equilibrium constant K for a chemical reaction is _____ of pressure (dependent, independent). (1 mark)

2. The chemical equilibrium constant K _____ with increasing temperature, provided that the standard enthalpy change of reaction $\Delta H°$ is positive. (increases, decreases) (1 mark)

3. Ethanol may be formed by the reaction

   $C_2H_4 + H_2O \longrightarrow C_2H_5OH$

   for which $\Delta G = -9670 + 6.43\ T \ln T - 9.01\ T - 0.00665\ T^2$

   Where T is in K. Calculate the equilibrium constant for this reaction at 200°C

   (7 marks)

BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
FIRST SEMESTER 2007-2008

CHE UC311 Chemical Engineering Thermodynamics

Surprise QUIZ - 6

(Closed Book)

DATE: 27/11/07

DURATION: 15 MINUTES **MAXIMUM MARKS: 09**

Name of the student: ---------- I.D.: ----------

1. Values of Henry's constant determined by
   (a) experiment (b) theoretical (c) empirical correlations (d) a,b,c.

2. The fugacity coefficient has units of
   (a) pressure (b) dimensionless (c) energy (d) none

3. Sufficiently dilute solutions always obeys
   (a) Raoult's law (b) Henry's law (c) a,b (d) none

4. Define retrograde condensation.
   Liquefaction occurs up on reduction of the pressure and reaches a maximum, after which vaporization takes place until the dew point is reached. This phenomenon is called retrograde condensation.

5. Match the following
   a) solution properties Mi
   b) partial properties M
   c) purespecies properties Mi

6. For the ideal – gas state fugacity of pure species
   a) equal to its pressure b) equal to its temperature c) a & b d) none

BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
FIRST SEMESTER 2007-2008

CHE UC311 Chemical Engineering Thermodynamics

Surprise QUIZ - 5

(Closed Book)

DATE: 20./.11../.07..

DURATION: 15 MINUTES **MAXIMUM MARKS: 09**

Name of the student: ---------- I.D.: ----------

1. Characteristics of flow for a nozzle
   (a) subsonoic : M>1 (b) supersonic: M< 1 (c) a,b (d) none

2. Liquefaction process:
   (a) by a throttling process (b) by heat exchange at constant pressure (c) by an expansion process from which work is obtained (d) a,b,c (e) a,b (f) a,c (g) none

3. The heat pump, a reversed heat engine, is a device for heating houses and commercial buildings during the summer and cooling them during the winter. (True / False)

4. VLE is a
   a) Quantity behavior b) Qualitative behavior c) a,b d) none

5. Mention the major assumptions required to reduce VLE calculations to Raoult's law.

6. When degree of freedom is zero both variables
   (a) must be extensive (b) must be intensive (c) a or b (d) none

7. Distillation process are usually carried out
   (a) at constant pressure than at constant temperature (b) at constant temperature than at constant pressure (c) a or b (d) none.

8. Refrigeration implies the maintenance of a temperature _____ that of the surroundings. (below, above, any)

9. Define K value correlations for VLE calculations.

BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
FIRST SEMESTER 2007-2008

CHE UC311 Chemical Engineering Thermodynamics

Surprise QUIZ - 4

(Open Book)

DATE: 13./ 11../.07..

DURATION: 15 MINUTES **MAXIMUM MARKS: 09**

Name of the student: ---------- I.D.: ----------

A heat pump is to be installed to heat a building winter and cool the building in summer. The optimum temperature desired during winter and summer is 297K. In order to maintain the difference of the building at 294.15K, a fluid is circulated in a radiator coils. An underground coil provides energy for heating and rejects energy during cooling. From the following temperature data, compute heating requirements for the building in winters and cooling requirements for the building in the summers.

Conditions	During heating	During cooling
Temp of fluid in the radiator, K	333.15	278.15
Temp of fluid underground, K	278.15	294.15
Minimum power requirement in HP	7	5

The ground temperature remains constant during both winter and summer at 286.15K

BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
FIRST SEMESTER 2007-2008

CHE UC311 Chemical Engineering Thermodynamics

Surprise QUIZ - 3

(Closed Book)

DATE: 30./.10./.07.

DURATION: 15 MINUTES **MAXIMUM MARKS: 09**

Name of the student: ---------- I.D.: ----------

Note: Attempt ALL questions. Mention appropriate units in your answers. Without units, the answer will not be deemed as correct, even if the numerical value is correct.

Q	1	2
Marks		

1. The _____increases at constant _____ and, the _____ decreases at constant_____ as per moiller chart.
   (temperature, volume, enthalpy, entropy) (2 marks)

2. Wet steam at 15 bar is throttled adiabatically in a steady flow process to 2 bar. The resulting stream has a temperature of 130°C.What are the temperature and quality of the wet steam? Calculate ΔS of the steam as a result of the process.
   (7 marks)

BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
FIRST SEMESTER 2007-2008
III Year Chemical Engineering
CHE UC311 Chemical Engineering Thermodynamics
Surprise QUIZ - 2
(Closed Book)

DATE: 9../10../..07.

DURATION: 15 MINUTES **MAXIMUM MARKS: 09**

Name of the student: ---------- I.D.: ----------

Q	1	2	3	4
Marks	2	2	1	4

1. Calculate the enthalpy change for the following reaction at 25°C.

$$C_2H_6(g) + 7/2\ O_2(g) \rightarrow 2CO_2(g) + 3\ H_2O(l)$$

Use the enthalpy of formation of the reactants and products from the following data:

$\Delta H_f°(\ C_2H_6) = -84.5$ KJ, $\Delta H_f°(CO_2) = -393.5$ KJ, $\Delta H_f°(\ H_2O) = -285.8$ KJ

2. Define thermal efficiency.

3. The entropy of a system is _____during a reversible adiabatic process and process is said to be _____.

(vary, isothermal, constant, isobaric, isochoric, isentropic, polytropic)

4. The 2 basic types of steady flow heat exchanger are characterized by their flow patterns: cocurrent and counter current. For each of the following specifications, T_{H1} = 400K, T_{H2} = 350K, T_{C1} = 300K, $\acute{n}_H$ = 1 mol S^{-1}, T_σ = 300K.The minimum temperature difference between the flowing streams is 10K.Assume both the streams are ideal gases with Cp = 7/2 R. Lost work done for cocurrent was found as 200JS^{-1}.Find the lost work done for counter current flow, compare and comment on the result. Assume negligible PE, KE and pressure change.

3rd year

BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
FIRST SEMESTER 2007-2008

CHE UC311 Chemical Engineering Thermodynamics

Surprise QUIZ - 1

(Closed Book)

DATE: 26/9/08

DURATION: 15 MINUTES **MAXIMUM MARKS: 09**

Name of the student: ---------- I.D.: ----------

Q	1	2	3	4
Marks	1	2	2	4

1. Define internal energy.

2. Indicate the type of system for the following cases:
   (homogeneous, heterogeneous, open closed system)

   (a)Water plus steam

   (b) Liquid cooling system

3. Find the volume (in cc) occupied by 3 mol of an ideal gas at 2bar and 350K

4. Deduce the equations for ΔU, ΔH, Q and W for n moles of an ideal gas undergoing mechanically reversible for constant temperature process. (one mark for each equation)

BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI

First Semester 2007-2008

CHE UC311 Chemical Engineering Thermodynamics

Comprehensive Examination

(Closed Book)

DURATION: 3 hours

DATE: 06-01-08
MAXIMUM MARKS: 120

Instructions:

1. Attempt ALL questions.
2. Make suitable assumptions wherever necessary and state them clearly.
3. Be brief and precise. Illegibility will cost you marks.
4. Some useful correlations are given at the end of question paper.
5. Assume missing data, if any, reasonably.

1. (a) One mole of an ideal gas is expanded isothermally and reversibly at 27°C from a volume of 2.28 m^3 to 4.56 m^3. Calculate q, w, ΔE and ΔH. (10)

   (b) Over the range 298 – 848 K, the heat capacity of quartz (SiO_2) at atmospheric pressure is approximated as

   $$C_p = 40.5 + (44.6 \times 10^{-3})\,T - (8.32 \times 10^{5})\,T^{-2}$$

   Where T is kelvins and C_p is in $J.mol^{-1}K^{-1}$. If 1000 kg of quartz is heated from 300 to 700 K at atmospheric pressure, how much heat is required? (10)

2. (a) Calculate the heat required to raise the temperature of 1 mol of methane from 533.15 to 873.15 K in a steady-flow process at a pressure sufficiently low that methane may be considered an ideal gas. (10)

   (b) An inventor claims to have developed an engine which is capable of delivering 20.4 HP while operating between a heat source at 400K and heat sink at 200K. The engine receives 25,000 J/sec of heat and rejects 12,000 J/sec of heat. Justify the inventor's claim. (07)

   (c) Name the various empirical relations to calculate latent heat. (03)

3. (a) Consider 2 tanks, each of volume 1 L. Tank A is filled with saturated-liquid water and tank B is filled with saturated vapor (steam), both at a pressure of 10 bar. If both tanks undergo sudden, catastrophic failure and that the contents of the tanks expand rapidly to a pressure

of 1 bar in an adiabatic process, which tank will do the greater damage? (Damage is assumed to be proportional to the work done by the system and also reversible explosion) (16)

(b) Mention the characteristics of flow for a nozzle. (04)

4. (a) What are the temperature and the entropy changes that result when an ideal gas undergoes a throttling process from 200 KPa to 100 KPa? (04)

(b) A hydrocarbon mixture contains methane (1), ethane(2), and propane (3). Its overall composition is $Z_1 = 0.1$, $Z_2 = 0.2$, and $Z_3 = 0.7$. At 10°C and 15 bar, equilibrium K-values are, approximately $K_1 = 10$, $K_2 = 1.76$ and $K_3 = 0.52$. Determine for these conditions the fraction of the system that is liquid and the compositions of the equilibrium liquid and vapor phases. (10)

(c) What are the characteristics of an ideal refrigerant? (06)

5. (a) A gas obeys the equation of state $P(V_m - b) = RT$. For this gas $b = 0.0391\ dm^3\ mol^{-1}$. Calculate fugacity and fugacity coefficient for the gas at 1000°C and 1000 atm. (10)

(b) Deduce Gibbs energy of an ideal gas mixture (10)

6. (a) Calculate the values of K at 25°C and 800°C for the water gas reaction,

$$CO + H_2O \longrightarrow H_2 + CO_2$$

using the following data at 298 K 1 atm. State whether reactions is exothermic or endothermic.

	CO	H_2O	CO_2
ΔG°_f KJ mol^{-1}	-137.27	-228.59	-394.38
ΔH°_f KJ mol^{-1}	-110.52	-241.83	-392.51

(10)

(b) Five moles of hydrogen, two moles of CO, and 1.5 moles of CH_3OH vapor combined in a closed system methanol synthesis reactor. Determine expressions for the mole factions y_i as functions of ε (10)

$$2H_2 + CO \longrightarrow CH_3OH$$

Some useful equations:

Sensible Heat

$$\int_{T_o}^{T} \frac{C_p}{R} dT = AT_o(\tau - 1) + \frac{B}{2} T_0^2 \ (\tau^2 - 1) + \frac{C}{3} T_0^3 \ (\tau^3 - 1) + \frac{D}{T_o}\left(\frac{\tau - 1}{\tau}\right)$$

A = 1.702, B = 9.081×10^{-3}, C = -2.164×10^{-6}

Compositions of the equilibrium liquid and vapor phases

$$\sum\left(\frac{z_i K_i}{1 + \nu(K_i - 1)}\right) = y_i$$

$$x_i = \frac{y_i}{K_i}$$

Thermal efficiency = $\frac{T_1 - T_2}{T_1}$

Fugacity coefficient ln f/p = $\int \left[V_{m(real)} - V_{m(ideal)}\right] dP$

Generalized correlations for gases $\Delta S = \int Cp \frac{dT}{T} - R \ln \frac{P_2}{P_1}$

BITS, PILANI-DUBAI CAMPUS, ACADEMIC CITY, DUBAI
FIRST SEMESTER 2007-2008
III Year Chemical Engineering
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Test -2 (Open Book) 06.11.2007

DURATION: 50 MINUTES **MAXIMUM MARKS: 60**

Note: Attempt ALL questions. Mention appropriate units in your answers. Without units, the answer will not be deemed as correct, even if the numerical value is correct.

Answer all the questions

1. Superheated steam at 2100 kpa and 300°C expands through a nozzle to 125 kpa. What would be the state of the steam and enthalpy change at the exit of the nozzle? Assume the process is reversible and adiabatic. (17 marks)

2. A test made on a stand-by turbine power unit produced the following results. With steam supplied to the turbine at 1350 kpa and 375°C the exhaust from the turbine at 10 kpa was saturated vapor only. What is the efficiency of the turbine? Neglect the heat transfer and kinetic and potential energy terms. (17 marks)

3. Assuming the validity of Raoult's law, determine y_1 and P for the benzene (1), toluene (2) system with $x_1 = 0.33$ and $T = 373.15K$. Correlations for the activity coefficients are $\ln \gamma_1 = a (x_2)^2$, $\ln \gamma_2 = a (x_1)^2$ where $a = 2.271 - 0.00523\ T$ and vapor pressure is $\ln P^{sat} = A - B/(T+C)$ (17 marks)

4. Throttling of wet steam to sufficiently low pressure may cause the liquid to evaporate and the vapor to become superheated. (True / False) (4 marks)

5. Define one ton of refrigeration. (5 marks)

BITS, PILANI-DUBAI CAMPUS, ACADEMIC CITY, DUBAI
FIRST SEMESTER 2007-2008
III Year Chemical Engineering
CHE UC331 Chemical Engineering Thermodynamics

Test -1 21.10.2007
(Closed Book)

DURATION: 50 MINUTES **MAXIMUM MARKS: 40**

1. State first and second law of thermodynamics. (1+1 marks)

2. What velocity must be attained by a mass of 1kg in order that it have a kinetic energy of 1KJ?To what elevation must a mass of 1 kg be raised in order that it have a potential energy of 1KJ? (2+2 marks)

3. If an ideal gas for which $C_v^{ig} = (3/2)$ R and $C_p^{ig} = (5/2)$ R expands reversibly and adiabatically from an initial state $T_1 = 450K$ and $V_1 = 3L$ to final volume $V_2 = 5L$, the final temperature is given by

$$T_2 = T_1(V_1/V_2)^{\gamma-1}$$

Calculate the work done and enthalpy change of the gas. (10 marks)

4. Sketch PT diagram for a pure substance and explain. (5 marks)

5. Explain sensible and latent heat. (4 marks)

6. Calculate the heat of formation of benzene from the following data:

$$C_6H_6(l) + 15/2\ O_2(g) \rightarrow 6CO_2(g) + 3\ H_2O(l) \qquad \Delta H° = -3303\ KJ$$

$\Delta H_f°(CO_2) = -393.5$ KJ, $\Delta H_f°(H_2O) = -285.8$ KJ (5 marks)

7. Heat is transferred directly from a heat reservoir at 280°C to another heat reservoir at 5°C. If the amount of heat transferred is 100KJ, what is the total entropy change as a result of this process? (8 marks)

8. How the Vander waals equ of state approaches to ideal gas equation? (2 marks)