Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.Tech/FT(N)/SEM-3/FT-301/2012-13

2012

THERMODYNAMICS & KINETICS

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10

i) A closed system can exchange

a) energy with surrounding

b) mass with surrounding

c) both energy & mass with surrounding

d) none of these.

ii) Which of the following is a state function ?

a) Internal energy b) Enthalpy

c) Entropy d) All of these.

iii) Mathematical expression for enthalpy is

a) H = U + PV　　b) H = U – PV

c) H = Q – PV　　d) none of these.

iv) At triple point the degrees of freedom is

a) 1　　b) 2

c) 0　　d) 3.

v) An isothermal process is a process of

a) no heat exchange between system & surrounding

b) constant volume

c) constant temperature

d) constant pressure.

vi) The dimensionless ratio fugacity coefficient is represented by

a) f_i / P　　b) f_i / T

c) f_i　　d) $f_i P$.

vii) The first law of thermodynamics is concerned with the

a) direction of energy transfer

b) reversible process only

c) irreversible process only

d) none of these.

viii) The unit of isothermal compressibility is

a) K^{-1} b) bar^{-1}

c) ˚C d) bar.

ix) Hydrolysis of ethyl acetate follows the

a) 1st order reaction kinetics

b) 2nd order reaction kinetics

c) zero order reaction kinetics

d) pseudo 1st order reaction kinetics.

x) Throttling (Joule-Thomson effect) process is a constant process of

a) entropy b) enthalpy

c) pressure d) volume.

xi) Which one is true ?

a) $dG = TdS + VdP$ b) $dG = VdP - SdT$

c) $dG = PdV - TdS$ d) $dG = SdT + PdV$.

xii) For sparingly soluble gases, Henry's law constant is

a) very high b) very low

c) moderate d) all of these.

xiii) The vapour-liquid equilibrium of a binary system can be better represented by

a) $T - X - Y$ diagram b) $P - X - Y$ diagram

c) $P - T$ diagram d) all of these.

xiv) As the time is passing entropy of the universe

a) is decreasing

b) remains constant

c) is increasing

d) insufficient data for prediction.

xv) Recirculation fraction for Lindey liquefaction process is

a) zero b) less than one

c) greater than one d) none of these.

GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Write down Gibbs phase rule. What do you mean by critical point ? 2 + 3

3. Show P-T diagram of pure substance & comment on it.

4. Write short note on any one of the following :

   a) Heat Engine

   b) Heat Pump.

5. Prove that enthalpy change of mixing for ideal gas is zero. Give the expression for chemical potential in terms of Gibbs energy. 3 + 2

6. Derive the working equation for liquid-liquid equilibria.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) Prove that $RT\ ln\phi = G_i^R$ where the symbols have their usual meaning in thermodynamics. 5

   b) What is 'Ton of refrigeration' ? Calculate the amount of heat removed for one ton of refrigeration. 1 + 4

   c) Show that for an ideal gas $\mu_\pi = 0$, where μ_π is the Joule-Thomson coefficient. 5

8. With very neat diagram explain the steps involved in absorption refrigeration system by using ammonia. 6 + 9

9. Write the two forms of the virial equation. Define volume expansibility & isothermal compressibility. For acetone at 293.15 K (20°C) and 1 bar,

$B = 1.487 \times 10^{-3}\ K^{-1}$

$K = 62 \times 10^{-6}\ bar^{-1}$

$V = 1.287 \times 10^{-3}\ m^3\ kg^{-1}$

Find :

a) the value of $(\delta P / \delta T)\ v$

b) the pressure generated when acetone is heated at constant volume from 293.15K(20°C) & 1 bar to 303.15K (30°C).

c) the volume change when acetone is changed from 293.15K (20°C) & 1 bar to 273.15K (0°C) & 10 bar.

2 + 3 + 10

10. a) Show that half value period for first order kinetics is not dependent on initial concentration of reactant. State Duhem's theorem. 3 + 2

b) In an isomerisation process, the following first order constants are found :

Temp (°C)	120	130	140
K (sec^{-1})	5.0	11.5	26.4

Calculate (i) the activation energy (ii) frequency factor of the process. 10

11. a) Define COP value of a refrigerator. Temperature of a refrigerator space is – 10°C and that of surrounding is 30°C. Calculate the COP value of that refrigerator. Derive an expression for the amount of heat absorbed by the refrigerator. 7

b) Define fugacity and fugacity coefficient. How can you evaluate fugacity coefficient using second virial coefficeint ? Prove that for multiple phases at the same temperature & pressure in equilibrium the chemical potential of each species is the same in all phases.

2 + 3 + 3

12. a) Explain with the help of examples the kinetic properties of unimolecular, bimolecular and pseudomolecular reactions. Name the controlling factors of reaction rate.

4 + 2

b) A certain substance R_1 is mixed with equal moles of another substance R_2. At the end of 30 seconds, R_1 is 25% reacted. How much of R_1 and R_2 be left untreated at the end of 35 seconds, if the reaction is

i) first order in R_1 and independent of R_2

ii) first order in both R_1 and R_2. 4 + 5