Seat No: _____ **Enrollment No: _____**

PARUL UNIVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

Diploma Engineering, Mid semester Examination

Semester: 5th **Date: 04/08/2022**
Subject Code: 03602315 **Time: (1hr: 30min)**
Subject Name: Chemical Engineering Thermodynamics **Total Marks: 40**

Instructions:
1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. English version is considered to be Authentic.

Q.1 Answer any six out of Ten. (2 Marks Each) **(12)**

1. Define Derived properties with example
2. Define standard heat of reaction with formula
3. Define Reference Properties with examples.
4. What is Hess's law ?
5. Define standard heat of formation with formula
5. What is temperature of reaction
7. Define Extensive & Intensive Properties.
8. Define standard heat of combustion with formula
9. Define Energy Properties with examples.
10. What is Adiabatic flame temperature?

Q.2 A)Calculate ΔH for the following reaction: **(03)**

$8\ Al(s) + 3\ Fe_3O_4(s) \rightarrow 4\ Al_2O_3(s) + 9\ Fe(s)$

The standard heat of formation at 298 K are-1669.8 kJ for Al_2O_3 and -1120.9 kJ for Fe_3O_4

OR

A) Calculate the standard heat of reaction for the following reaction: **(03)**

2 FeS2 (s) + O2 (g) → Fe2O3 (s) + 4 SO2 (g)

The standard heat of formation at 298 K are –178.02 kJ/mol for FeS2 (s), –822.71 kJ/mol for Fe2O3 (s) and –297.10 kJ/mol for SO2 (g).

B) Select Extensive and Intensive Properties from following. **(03)**

Pressure, Enthalpy, Internal Energy, Entropy, Gibb's Free Energy, Helmholtz Free Energy.

OR

B)The standard heat of combustion of benzene at 298 K is – 3269.5 kJ/mol when burnt completely to CO2 and liquid water. The standard heat of combustion of hydrogen to liquid water is –286.04 kJ/mol and that of carbon to carbon dioxide is – 393.78 kJ/mol. Calculate the standard heat of formation of liquid benzene. **(03)**

C) What is the standard enthalpy of reaction for the reduction of iron(II) oxide by carbon monoxide? **(04)**

$FeO(s) + CO(g) \text{ ---> } Fe(s) + CO_2(g)$

given the following information:

$3Fe_2O_3(s) + CO(g) \text{ ---> } 2Fe_3O_4(s) + CO_2(g) \quad \Delta H = -48.26\ kJ$

$Fe_2O_3(s) + 3CO(g) \text{ ---> } 2Fe(s) + 3CO_2(g) \quad \Delta H = -23.44\ kJ$

$Fe_3O_4(s) + CO(g) \text{ ---> } 3FeO(s) + CO_2(g) \quad \Delta H = +21.79\ kJ$

OR

C) Calculate the value of ΔH° for the following reaction: **(04)**

$P_4O_{10}(s) + 6PCl_5(g) \text{ ---> } 10Cl_3PO(g)$

using the following four equations:

a) $P_4(s) + 6Cl_2(g) \text{ ---> } 4PCl_3(g) \quad \Delta H° = -1225.6\ kJ$

b) $P_4(s) + 5O_2(g) \text{ ---> } P_4O_{10}(s) \quad \Delta H° = -2967.3\ kJ$

c) $PCl_3(g) + Cl_2(g) \text{ ---> } PCl_5(g) \quad \Delta H° = -84.2\ kJ$

d) $PCl_3(g) + \frac{1}{2}O_2(g) \text{ ---> } Cl_3PO(g) \quad \Delta H° = -285.7\ kJ$

D) The heat of reaction at 300 K and one atmosphere pressure for the following gasphase reaction: **(04)**

A + 3B→ C

is –200 kJ per mol of A converted. Data on the molar heat capacity at constant pressure (kJ/mol K) for the various components are: : CP for A = $-1.7 * 10^{-3} + 3.4 * 10^{-4}$ T, where T is in K, CP for B = 0.03 and CP for C = 0.1. Calculate the heat of reaction at 500 K and at a pressure of 100 kPa.

Q.3 A) Derive Fundamental Properties Relations. **(03)**

OR

A) Explain Entropy and Enthalpy in detail. **(03)**

B) Explain Gibb's Free Energy. **(03)**

OR

B) Explain Helmholtz Free Energy. **(03)**

C) Derive Clausius Clapeyron Equation. **(04)**

OR

C) Derive Clapeyron Equation. **(04)**

D) Derive Maxewell's Equation. **(04)**

ગુજરાતી

□□□□□□.□ □□□□□□□□ □□□□□□ □ □□□□□ □□□□.(□□□□□ □□□□□ □ □□□□) **(□2)**

□.□□□□□□□□□□□ □□□□□□□□□□□ □□□□□□□ □□□□□ □□□□□□□□□□□□ □□□□.

□.□□□□□□ □□□□□ □□□□□□□□□□□□□□□ □□□□□□□□□□ □□□□□ □□□□□□□□□□□□ □□□□.

□. □□□□□□□□ □□□□□ □□□□□□□ □□□□□□□□□ □□□□□□□□□□□□ □□□□.

□.□□□□□□ □□□□□□ □□□□ □□?

□.□□□□□□□□□□□ □□□□□ □□□□□□□ □□□□□□□□□□ □□□□□□□ □□□□□□□□□□□□ □□□□

□.□□□□□□□□□□□□□□□□ □□□□□□□ □□□□ □□

□. □□□□□□□□ □□□□ □□□□ □□□□□□□□□ □□□□□□□□□□□□ □□□□.

□.□□□□□□ □□□□□ □□□□□□ □□□□□□□□□□ □□□□□□□ □□□□□□□□□□□□ □□□□

□. □□□□□□ □□□□□□□□□□□□ □□□□□□□□ □□□□□ □□□□□□□□□□□□ □□□□.

□□□□□□□□□□□ □□□□□□□□□ □□□□□□□ □□□□ □□?

□□□□□□.□ **(□□)**

□) □□□□□□□ □□□□□□□□□□□□□ □□□□□ ΔH □□ □□□□□□ □□□□:

$8\ Al(s) + 3\ Fe3O4(s) \rightarrow 4\ Al2O3(s) + 9\ Fe(s)$

298 K □□ □□□□□□□□□□ □□□□□□□□□□ □□□□□ Al2O3 □□□□□ -1669.8 kJ □□□ Fe3O4 □□□□□ -1120.9 kJ □□.

□□□□

(□□)

□) □□□□□□□ □□□□□□□□□□□□□ □□□□□ □□□□□□□□□□□□□□□ □□□□□□□□□□ □□□□□□□ □□□□□□ □□□□:

$2\ FeS2\ (s) + O2\ (g) \rightarrow Fe2O3\ (s) + 4\ SO2\ (g)$

298 K □□ □□□□□□□□□□ □□□□□□□□□□ □□□□□ FeS2 (s) □□□□□ –178.02 kJ/mol, Fe2O3 (s) □□□□□ –822.71 kJ/mol □□□ SO2 (g) □□□□□ –297.10 kJ/mol □□.

(□□)

□□) □□□□□□□□□□□□ □□□□□□□□ □□□ □□□ □□□□□□□□□ □□□□□ □□□.

□□□□□□□, □□□□□□□□□□, □□□□□□□ □□□□□□, □□□□□□□□□□, □□□□□□ □□□□□ □□□□□□□, □□□□□□□□□□□□□□ □□□□□ □□□□□□□.

□□□□

(□□)

□□) 298 K □□ □□□□□□□□□□ □□□□□□ □□□□□□□□□□ □□□□□ - 3269.5 kJ/mol □□ □□□□□□□ CO2 □□□ □□□□□□□□ □□□□□□□□ □□□□□□□□□□□□ □□□ □□□ □□. □□□□□□□□□□□□ □□□□□□□□ □□□□□□□ □□□□□□□□□ □□□□□□□□□□ □□□□□ -286.04 kJ/mol □□ □□□□ □□□□□□□□□ □□□□□□□

□□□□□□□□□□□□□ -393.78 kJ/mol □□. □□□□□□□□ □□□□□□□□□□ □□□□□□□ □□□□□□□□□□ □□□□□□□ □□□□□□ □□□.

(□□)

□□) □□□□□□□ □□□□□□□□□□□□ □□□□□□□ □□□□□□(II) □□□□□□□□□□ □□□□□□ □□□□□ □□□□□□□□□□□□□□ □□□□□□□□□□ □□□□□□□□□□ □□□□ □□?

$FeO(s) + CO(g) \text{---}> Fe(s) + CO2(g)$ □□□□□□□ □□□□□□□ □□□□:

$3Fe2O3(s) + CO(g) \text{---}> 2Fe3O4(s) + CO2(g)\ \Delta H = -48.26\ kJ$

$Fe2O3(s) + 3CO(g) \text{---}> 2Fe(s) + 3CO2(g)\ \Delta H = -23.44\ kJ$

$Fe3O4(s) + CO(g) \text{---}> 3FeO(s) + CO2(g)\ \Delta H = +21.79\ kJ$

□□□□

(□□)

□□) □□□□□□□ □□□□□□□□□□□□□ □□□□□ $\Delta H°$ □□ □□□□□□□□ □□□□□□ □□□□:

$P4O10(s) + 6PCl5(g) \text{---}> 10Cl3PO(g)$

□□□□□□□ □□□□ □□□□□□□□□□ □□□□□□ □□□□□□:

a) $P4(s) + 6Cl2(g) \text{---}> 4PCl3(g)\ \Delta H° = -1225.6\ kJ$

b) $P4(s) + 5O2(g) \text{---}> P4O10(s)\ \Delta H° = -2967.3\ kJ$

c) $PCl3(g) + Cl2(g) \text{---}> PCl5(g)\ \Delta H° = -84.2\ kJ$

d) $PCl3(g) + 1/2O2(g) \text{---}> Cl3PO(g)\ \Delta H° = -285.7\ kJ$

(□□)

□□) □□□□□□□ □□□□ □□□□□□□□□ □□□□□□□□□□□□□ □□□□□ 300 K □□ □□□□□□□□□□□□□□□□ □□□□□ □□□□ □□□□□□□□□□□□ □□ □□□□□:

$A + 3B \rightarrow C$

A □□□□□□□□□□ mol □□□□ –200 kJ □□. □□□□□□ □□□□□ □□□□□ □□□□ □□□□□ (kJ/mol K) □□ □□□□□□ □□□□□□□ □□□□□□□ □□□□□ □□□□□ □□: : $A = –1.7 * 10 –3 + 3.4* 10 –4\ T$ □□□□□ CP, □□□□□□ T K □□□□□, B □□□□□ $CP = C = 0.1$ □□□□□ 0.03 □□□□ CP. 500 K □□ □□□□ 100 kPa □□ □□□□□ □□ □□□□□□□□□□□□□□□ □□□□□□□ □□□□□□ □□□□.

□□□□□□□.□

(□□)

□) □□□□□□□ □□□□□□□□□ □□□□□□□ □□□□□□.

□□□□

(□□)

□) □□□□□□□□□□ □□□□ □□□□□□□□□□□□□ □□□□□□□□ □□□□□□□.

(□□)

□□) □□□□□□ □□□□□ □□□□□□□ □□□□□□□.

□□□□

(□□)

□□) □□□□□□□□□□□□□□ □□□□□ □□□□□□□ □□□□□□□.

(□□)

□□) □□□□□□□□□□ □□□□□□□□□□ □□□□□□□ □□□□□□

□□□□

(□□)

□□) □□□□□□□□□□ □□□□□□□ □□□□□□.

(□□)

□□) □□□□□□□□□□□□□□ □□□□□□□ □□□□□□.