



## HPCL RAJASTHAN REFINERY LIMITED

Joint Venture between Hindustan Petroleum Corporation Limited (HPCL)  
and Government of Rajasthan.

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Tehsil - Pachpadra, Dist. Balotra, Rajasthan, India – 344032

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Jaipur, Rajasthan, India 302005

CIN No.U23201RJ2013GOI043865

Advt. No - HRRL/RECT/02/2025

### **Computer Based Test (CBT) for Engineer – Chemical (Process) : S/G E2**

As per Advt. No - HRRL/RECT/02/2025 clause no. 7 (mentioned in page 51), the syllabus for Engineer – Chemical (Process) : S/G E2 is given as below.

**Duration: 2 hours**

**Total Marks: 100**

All questions of the Computer Based Test (CBT) will be objective and multiple-choice type. Total number of questions in the CBT are 100. Each correct answer carries 1 mark and there is no **negative** marking for wrong answers.

### **Syllabus**

**Part-1: General Aptitude (Graduate – Level)**

**(30 Marks)**

#### **1. Intellectual Potential Test:**

- Distance
- Syllogism
- Logical Operations
- Similarities and dissimilarities
- Verbal Comprehension
- Perpetual Reasoning
- Working Memory
- Processing Speed
- Fluid reasoning

#### **2. Logical Reasoning & Data interpretation**

- Seating arrangements and puzzles
- Series – verbal and number
- Relationships

- Coding-decoding
- Verbal and numerical Analogy
- Binary Logic
- Games and Tournaments
- Arrangements
- Team Formations
- Order and Ranking
- Table, Data Caselets – Reasoning-Based DI, 3. Column Graphs, Bar Graphs, Line Charts, Pie Charts, Routes and Network

### 3. Quantitative Aptitude

The test of QA may cover Number systems including questions on simplification, decimals, fraction, LCM and HCF, square root, divisibility test, Ratio & proportion, Percentage, Average, Profit & loss, Discount, Simple and compound interest, Mensuration, Time & Work, Time and distance, Algebraic identities, Problems on Age, Tables & Graphs etc.

### 4. English Language

Program	Education Level	Course	Subject	Topic	Sub Topic	Concept / Type
General Aptitude	HSC	General Verbal Ability - English	Grammar - English	Question Tags	Negative question tag	Sentence Completion
General Aptitude	HSC	General Verbal Ability - English	Grammar - English	Question Tags	Positive question tag	Sentence Completion
General Aptitude	HSC	General Verbal Ability - English	Grammar - English	Parts of speech	Adjective	Sentence Completion
General Aptitude	HSC	General Verbal Ability - English	Grammar - English	Parts of speech	Adverb	Sentence Completion
General Aptitude	HSC	General Verbal Ability - English	Grammar - English	Parts of speech	Prepositions	Sentence Completion
General Aptitude	HSC	General Verbal Ability	Grammar - English	Parts of speech	Conjunctions	Sentence Completion

		- English				
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Grammar - English	Parts of speech	Verb	Sentence Completion
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Indirect Writing - English	Prose	Syntax and structure	Para Jumbles
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Indirect Writing - English	Sentences	Word Usage and Understanding	One word substitution
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Appropriate Title	Identify the suitable title for the passage
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Central theme of the passage	Identify the central theme of the passage
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Facts	Identify the facts given in the passage
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Inferences drawn	Identify the inferences drawn from the passage
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Structure of the passage	Identify the structure of the passage
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Summary	Select the correct summary for the passage
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Text to World connection	The most appropriate connection to the real-life situations
<b>General Aptitude</b>	HSC	General Verbal Ability	Reading Comprehension	Passage	Tone of the passage	Identify the tone of the

		- English	ension - English			passage
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Vocabulary	Antonyms of the word
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Vocabulary	Correct usage of the word in other examples
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Reading Comprehension – English	Passage	Vocabulary	Synonyms of the word
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Vocabulary	Word meaning
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Vocabulary - English	Idioms and Phrases	Idioms	Word-segment substitution
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Vocabulary - English	Idioms and Phrases	Proverbs	Word-segment substitution
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Vocabulary - English	Semantics	Antonyms	Identification of antonym in a sentence
<b>General Aptitude</b>	HSC	General Verbal Ability - English	Vocabulary - English	Semantics	Synonyms	Word meaning in sentence

**Section 1: Process Calculations and Thermodynamics**

Steady and unsteady state mass and energy balances including multiphase, multi-component, reacting and non-reacting systems. Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis. First and Second laws of thermodynamics. Applications of first law to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: Equation of State and residual properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibrium.

**Section 2: Fluid Mechanics and Mechanical Operations**

Fluid statics, Newtonian and non-Newtonian fluids, shell-balances including differential form of Bernoulli equation and energy balance, Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, turbulent flow: fluctuating velocity, universal velocity profile and pressure drop. Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids. Principles of Pumps, Compressors and Blowers, Types of Compressors/Pumps and Start/Stop procedures. Flow Measurement devices, Pump performance and characteristics, Pipe flow and pressure loss calculations.

**Section 3: Heat Transfer**

Steady and unsteady heat conduction, convection and radiation, thermal boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators and their process calculations. Design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators. Operation of Fired Heaters, Different types and its significance. Calculation of Heat Balance across Heat Exchanger, Different types of Furnaces and its Operation, Furnace light up procedure, critical parameters for steady operation.

**Section 4: Mass Transfer**

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stage-wise and continuous contacting and stage efficiencies; HTU & NTU concepts; design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption.

Distillation column working practical approach, Critical Operating parameters in a Distillation column/Strippers/Absorbers/Reflux drum, KOD, Surge drum etc., Absorption and Stripping, Extraction, Adsorption, Diffusion-Controlled Processes.

### **Section 5: Chemical Reaction Engineering**

Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time distribution, single parameter model; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis. Reactor Design and types, Plug flow reactor working principle, LHSV, Residence time distribution, Chemical equilibrium and Reaction Thermodynamics, Catalyst role in chemical reactions.

### **Section 6: Instrumentation and Process Control**

Measurement of process variables; sensors, transducers and their dynamics, process modeling and linearization, transfer functions and dynamic responses of various systems, systems with inverse response, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response, controller tuning, cascade and feed forward control.

Types of instrument sensors and their applications, Calibration of instruments, PID controller tuning and optimisations, Distributed Control Systems (DCS), Programmable Logic Controllers (PLC), Troubleshooting and Maintenance of Instrumentation systems, Control loops performance monitoring.

### **Section 7: Plant Design and Economics**

Principles of process economics and cost estimation including depreciation and total annualized cost, cost indices, rate of return, payback period, discounted cash flow, optimization in process design and sizing of chemical engineering equipment's such as compressors, heat exchangers, multistage contactors.

Process Flow Diagram/Piping & Instrumentation Diagram of process plant, knowledge of Plant Layout and equipment design, Material Selection and Corrosion Control, Economic Evaluation Techniques, Risk Analysis and Safety Engineering, Energy Efficiency and Optimization.

### **Section 8: Chemical Technology**

- Natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries (polyethylene, polypropylene, PVC and polyester synthetic fibres).
- Practical approach of natural and synthesized petrochemicals/Polymers, Process Design and Optimization, Catalysis and Reaction Engineering, Separation Techniques, Polymers and Material Science, Nanotechnology in Chemical Engineering

### **Section 9: Net Zero Concepts**

- Industrial Decarbonization, renewable energies, environmental controls and monitoring, Sustainable Supply Chain Management, Carbon Capture, Utilization, and Storage (CCUS).

### **Section 10: Process Safety**

- Key elements of Process Safety Management, Chemical Safety, Hazards and controls for chemical reactions, Fire and Explosion related incidents and mitigation measures, Safe startup and shutdown of process units.
- Hazard Identification and Risk Assessment, Process Safety Management (PSM) Regulations, Operational Safety Procedures, Process Safety Metrics and Performance Monitoring, Emergency Response Planning.

### **Section 11: Introduction to Petrochemicals process**

- Overview of the Petrochemical Industry, Classification of Petrochemicals, Key Raw Materials: Crude Oil, Natural Gas, Naphtha, LPG, Naphtha as a Petrochemical Feedstock, Cracking Processes like Steam Cracking (for Ethylene, Propylene, Butadiene), Pyrolysis Gasoline Hydrogenation Unit (PGHU), Olefin Saturation.
- Types of Catalysts such as, Ziegler-Natta Catalysts, Production of Olefins, Ethylene, Propylene, and Butadiene Production, Naphtha Cracking (NCI – Naphtha Cracking Index), Separation and Purification of Olefins, Applications of Olefins in Polymer Production (e.g., Polyethylene, Polypropylene). Production of Aromatics (BTX), Benzene, Toluene, Xylene Production from Catalytic Reforming, Pyrolysis Gasoline Processing for Aromatics Recovery

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**NOTE: The syllabus/topics mentioned are indicative in nature. Candidates are expected to possess significant knowledge/proficiency pertaining to the relevant subjects and their qualifying degree.**