



Major thematic clusters:

1. **Fluid Mechanics & Mechanical Operations (~15 questions)** — Pumps (vane, peristaltic, plunger), conveyors, ball mills/Bond's law, particle settling (Stokes' law, hindered settling), fluid rheology (dilatant, pseudoplastic, Bingham plastic), cyclones, orifice meters, drag coefficient.
2. **Heat Transfer (~10 questions)** — Radiation heat transfer coefficient, Biot number, Nusselt number correlations, baffles in shell-and-tube exchangers, natural convection, dropwise condensation, unidirectional conduction temperature profiles.
3. **Mass Transfer & Separation Processes (~15 questions)** — Distillation (McCabe-Thiele, total reflux, relative volatility), absorption columns, flux/diffusion (equimolar counter-diffusion), surface renewal theory, filtration, water treatment (coagulation/flocculation), NPSH for pumps.
4. **Thermodynamics (~12 questions)** — Entropy change in cyclic processes, Gibbs/Helmholtz free energy, fugacity-Gibbs relation, chemical potential, triple point degrees of freedom, adiabatic flame temperature, COP of refrigerators, dew/bubble point concepts.
5. **Reaction Engineering (~8 questions)** — Reactor types (PFR, CSTR, batch, semi-batch), Peclet number, space velocity, zero-order kinetics, back-mixing, autothermal reactors, series reactor arrangement for nth-order reactions.
6. **Process Control & Instrumentation (~6 questions)** — Laplace transforms, first-order system response, U-tube manometer order, amplitude ratio for sinusoidal input, temperature sensors (pyrometer, thermocouple, RTD).
7. **Process Calculations & Economics (~6 questions)** — Stoichiometry (carbon in CO₂), cost indices, six-tenths rule, payback period, material balance (steady-state accumulation).
8. **Petroleum Refining & Petrochemicals (~12 questions)** — Catalytic



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reforming/cracking, IBP, cetane number, VDU stripping steam, drilling rig components (Kelly, derrick), petroleum fraction boiling points, dewaxing, naphtha reforming, middle distillates.

9. **Inorganic/Fertilizer & Polymer Technology (~8 questions)** — Viscose rayon manufacturing, caustic soda (membrane cell process), superphosphate/SSP manufacture, PVC production, rubber processing (calendaring, mastication), prilling towers, sulfite pulping.
10. **Environmental & Safety Engineering (~5 questions)** — Particulate matter size hazards, electrostatic precipitators, catalytic converters, noise safety, groundwater hardness.

Key observations:

- **Numerical/formula-based questions are prominent** (relative volatility, mass transfer coefficient units, carbon mass calculation, amplitude ratio)
- **Dimensional analysis and units are frequently tested** (mass transfer coefficient units, thermal conductivity SI units, filter resistance units) — a recurring theme rewarding formula fluency.
- Many questions test **conceptual “why” over rote memorization** — e.g., Q75 (activation energy vs. reaction rate), Q88 (extensive vs. intensive properties in Q100), Q94 (relative volatility ordering)