NCEES
advancing licensure for engineers and surveyors

NCEES Principles and Practice of Engineering Examination
CHEMICAL CBT Exam Specifications

Effective beginning January 1, 2018

- The exam topics have not changed since April 2011 when they were originally published.
- The PE Chemical exam is computer-based. It is closed book with an electronic reference.
- Examinees have 9 hours to complete the exam, which contains 80 questions. The 9-hour time includes a tutorial and an optional scheduled break. Examinees work all questions.
- The exam uses both the International System of units (SI) and the U.S. Customary System (USCS).
- The exam is developed with questions that will require a variety of approaches and methodologies, including design, analysis, and application.
- The knowledge areas specified as examples of kinds of knowledge are not exclusive or exhaustive categories.

	Number of Questions
1. Mass/Energy Balances and Thermodynamics	**16–24**
A. Mass Balances	7–10
1. Material balances with no reaction (e.g., phase behavior, mass, volume, density, composition, purge, bypass)	
2. Material balances with reaction (e.g., multiple reactions, incomplete reactions, excess reactant, purge, bypass, recycle, combustion)	
B. Energy Balances and Thermodynamics	9–14
1. Energy balances on non-reactive systems (e.g., sensible heat, latent heat, heat of solution)	
2. Energy balances on reactive systems (e.g., heat of reaction and combinations with sensible heat; latent heat; heat of solution)	
3. Power cycles (e.g., refrigeration, engines, turbines, heat recovery)	
2. Heat Transfer	**11–16**
A. Mechanisms	6–9
1. Heat transfer without phase change (e.g., thermal conductivity, heat capacity, conduction, convection, free/forced heat transfer coefficients/correlations, radiation, combinations thereof)	
2. Heat transfer with phase change (e.g., vaporization and evaporation, condensation, sublimation, crystallization, latent heat)	
B. Applications	5–7
1. Heat exchange equipment design (e.g., overall heat transfer coefficient, fouling factors, LMTD, F-factor, equipment selection, insulation)	
2. Heat exchange equipment analysis [e.g., pressure drop, fouling effects, performance evaluation (NTU), changes in parameters]	

3. Kinetics **8–12**

A. Reaction Parameters 4–6

1. Rate equation (e.g., rate constant, activation energy, order of reaction, mechanisms, catalysis)
2. Chemical equilibria (e.g., temperature and pressure dependence, composition)

B. Reactors 4–6

1. Conversion in single reactors [e.g., batch reactor, continuous stirred tank reactor (CSTR), plug flow reactor (PFR)]
2. Conversion in complex reactors (e.g., reactors in series: CSTR and/or PFR, multiphase reactors, fluidized beds, packed beds, recycle, bioreactors)
3. Yield and selectivity

4. Fluids **11–16**

A. Mechanical-Energy Balance 8–12

1. Flow behavior (e.g., viscosity; velocity; Reynolds number; friction factor; pressure drop in pipes, valves, and fittings; expansion/contraction; porous media; particle dynamics; fluidization; sonic velocity; laminar/turbulent; two-phase flow)
2. Flow applications (e.g., potential and kinetic energy, friction, flow networks, mixing, pumps, NPSH, turbines, compressors, drivers, solids handling)

B. Flow and Pressure Measurement Techniques 3–4

1. Flow measurement application (e.g., mass and volumetric meters) and pressure measurement application (e.g., permanent pressure drop, differential pressure devices)

5. Mass Transfer **10–15**

A. Phase Equilibria 4–6

1. Ideal systems (e.g., Henry's Law, Raoult's Law, Dalton's Law, ideal gas law, vapor pressure)
2. Non-ideal systems (e.g., activity coefficients, fugacity coefficients, azeotropes, immiscible/partially miscible phases, equations of state)
3. Phase equilibrium applications (e.g., bubble point, dew point, flash, critical states)

B. Continuous Vapor-Liquid Contactors 5–7

1. Material and energy balances for trayed units and packed units (e.g., absorption, stripping, distillation)
2. Design parameters for trayed units (e.g., minimum flow rates and reflux, minimum and theoretical stages, feed location, tray selection, capacity/efficiency, flooding, dumping, tray hydraulics)
3. Design parameters for non-trayed units (e.g., minimum flow rates and reflux, minimum stages, theoretical stages/NTU, feed location, packing selection, capacity/efficiency, flooding, pressure drop, mass transfer coefficients/height of transfer units)

C. Miscellaneous Mass Transfer Processes 1–2
   1. Continuous, batch, and semicontinuous (e.g., drying, membranes, extraction, crystallization, filtration, leaching, humidification, diffusion, adsorption, absorption, stripping, distillation)

6. Plant Design and Operation 14–21

A. Economic Considerations 1–2
   1. Cost estimation and project evaluation (e.g., capital costs, depreciation, operating costs, risk evaluation, optimization, return on investment)

B. Design 7–11
   1. Process design (e.g., process flow sheets, P&ID, specifications, procedures, modeling/simulation, scale-up, process or product development, boundary conditions)
   2. Process equipment design (e.g., equipment selection, optimization, design temperature, design pressure)
   3. Siting considerations (e.g., security, ingress, egress, plant layout, utilities, natural disasters, human factors)
   4. Instrumentation and process control (e.g., sensors, controller actions, feedback/feed-forward actions)
   5. Materials of construction (e.g., material properties and selection, corrosion considerations)

C. Operation 3–4
   1. Process and equipment reliability (e.g., testing, preventive maintenance, startup/shutdown procedures, robustness)
   2. Process improvement and troubleshooting (e.g., debottlenecking, experimental design and evaluation, optimization)

D. Safety, Health, and Environment 3–4
   1. Protection systems [e.g., pressure/vacuum relief valves (safety valves), flares, rupture disks, vents, vacuum breakers, inerting, seal legs, discharge location, configuration, fire protection]
   2. Industrial hygiene (e.g., MSDS, exposure limits and control, noise control, ventilation, personal protective equipment)
   3. Hazard identification and management [e.g., flammability/ explosive limits, auto-ignition, reactor stability, process hazard analysis, safety integrity level (SIL), management of change]
   4. Environmental considerations (e.g., emissions evaluation, permitting, pollution prevention, mitigation, waste determination)