Introduction to Process Technology 4th edition Thomas Solutions Manual

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CHAPTER 2:
INTRODUCTION TO PROCESS TECHNOLOGY

OBJECTIVES

- Describe the process technology curriculum and Associate of Applied Science degree plan.
- List the key principles of safety, health, and environment
- Explain the principles of instrumentation and modern process control.
- Identify the different types of process equipment and the technology associated with operating them.
- Solve math and science problems associated with the chemical processing industry.
- List the basic principles of quality control.
- Describe how the principles of chemistry and physics are applied in the chemical processing industry.
- Describe the various systems found in the chemical processing industry.
- Explain how process operations is used to prepare a student for employment in the CPI.
- Solve simple process technology troubleshooting scenarios.

REVIEW QUESTIONS

1. List the basic concepts of statistical quality control.
   Study of the background and application of quality concepts. Topics include team skills, quality tools, statistics, economics and continuous improvement. The focus of the course is on the application of statistics, statistical process control, math, and quality tools to process systems and operations
2. List the basic concepts taught in safety, health, and environment.
   Knowledge and skills to reinforce the attitudes and behaviors required for safe and environmentally sound work habits. Emphasis on safety, health, and environmental issues in the performance of all job tasks and regulatory compliance issues.
3. List three basic systems found in the chemical processing industry.
   Pump and compressor systems, heat exchangers and cooling tower systems, boilers and furnace systems, distillation systems, reaction systems, utility system, separation systems, plastics systems, instrument systems, water treatment, and extraction systems.

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4. List the basic concepts taught in process operations.

   PT-3 Operations combines process systems into operational processes with emphasis on operations under various conditions. Topics include typical duties off an operator. Instruction in the principles of modern manufacturing technology and process equipment. Emphasis on scale-up from laboratory bench to pilot unit. Describe unit operation concepts; solve elementary chemical mass/energy balance; interpret analytical data; and apply distillation and fluid flow principles. The purpose for this class is to provide an adult learner with the opportunity to work in a self-directed work team, operate a complex operational system, collect and analyze data, start-stop process equipment, follow and write operational procedures. The course is advanced and requires the learner to apply classroom skills to real life operational activities. Students will be required to qualify and operate a process unit.

5. List the basic concepts taught in process instrumentation.

   Study of the instruments and instrument systems used in the chemical processing industry including terminology, primary variables, symbology, control loops, and basic troubleshooting. The class discusses basic instrumentation, and modern process control used in the chemical processing industry.

6. List the basic concepts taught in process troubleshooting.

   Instruction in the different types of troubleshooting techniques, methods, and models used to solve process problems. Topics include: application of data collection and analysis, cause-effect relationships, and reasoning. Emphasis on application of troubleshooting methods to scale-up from laboratory bench to pilot unit. Describe unit operation concepts; solve elementary chemical mass/energy balance; interpret analytical data; and apply distillation and fluid flow principles.

7. Describe how science and chemistry are related to the other process classes.

   Governmental guidelines require process technicians to understand the science and chemistry of the processes they are operating, a solid foundation is required in applied math, physics, and chemistry. Calculating product transfers, mixing raw materials to form new products, and dealing with compositional, analytical, pressure, level, flow, and temperature problems are all common areas to which the math/science foundation is applied.

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8. Explain why a good mathematical foundation is important to a process technician.

College mathematics for process technicians typically focuses on applied operations that are commonly performed on-the-job. Variations on basic math, algebra, trigonometry, physics, chemistry and statistics are woven into the daily technician routines.

9. List the basic concepts taught in introduction to process technology.

Introduction to Process Technology is a survey of all the courses found in the process technology curriculum.

10. List the basic concepts taught in the process equipment course.

Process training for operators includes an in-depth study of the basic equipment found in the chemical processing industry. Equipment training focuses on five basic skills: (1) familiarity with the equipment and basic components, (2) understanding the operation of the device (scientific principles and technology), (3) equipment relationships within a system, (4) preventive maintenance and troubleshooting, and (5) operating the equipment. PT-1 Equipment is a foundational course that covers the following types of equipment:

- Valves, piping, and vessels
- Pumps, compressors, fans, and blowers
- Steam turbines, gas turbines and motors
- Heat exchangers and cooling towers
- Boilers and furnaces
- Reactors and distillation columns
- Instrumentation
- Basic hand tools
- Lubrication, bearings, and seals
- Flares, mixers, and steam traps

11. Describe the process technology curriculum and Associate of Applied Science degree plan at your school._

See your college catalog.

12. Describe the primary purpose of the process instrumentation course.

The purpose of the process instrumentation course varies greatly from a traditional instrumentation course. Process technicians are required to safely operate and troubleshoot a vast array of pipes, pumps, valves, compressors, heat exchangers, cooling

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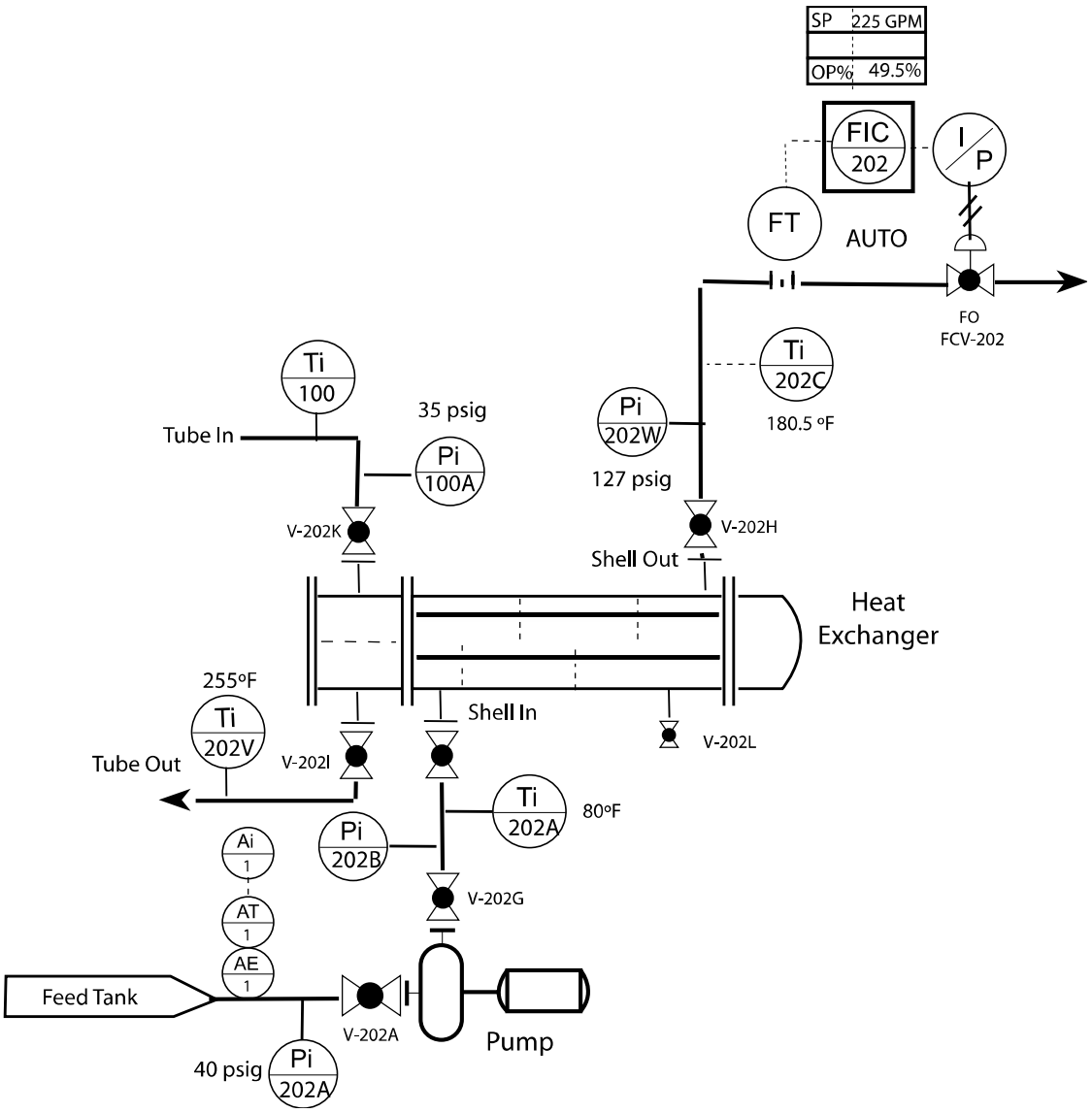
towers, industrial drivers, boilers, furnaces, reactors, strippers, distillation columns, plastics plant equipment, instruments, and control systems. The design of each process system includes simple process flow diagrams (PFD's) and complex piping and instrumentation drawings (P&ID's). The dictionary of equipment, control instrumentation, and piping symbols associated with these processes are foundational in the initial training of process technicians. Operators spend many hours tracing lines and locating specific equipment. A process instrumentation class is designed to prepare students to pick up existing drawings and quickly assimilate the information while learning how to operate their process units. The purpose of a process instrumentation course is to: (1) qualify students on a wide variety of process symbols and diagrams, (2) draw process flow diagrams, (3)study the process variables and instruments used to control; temperature, flow, level, pressure, analytical or composition, time, speed, etc., (4) draw the control loops used to control these variables including cascaded control, and (5) draw a piping and instrumentation drawing (P&ID) that includes all of the above mentioned items. In advanced courses technicians connect the concepts associated with drawing a P & ID's to operational set-points and conditions that exist with the equipment, like tank levels, flow rates, temperatures, etc. Connecting the dots is a critical part of the training process for any process technician.

13. List the key elements found in the definition of process technology.

Process technology, as defined in the regionally accredited process curriculum, is a field of study offered at community colleges or universities that prepares students to take entry-level positions as technicians in the chemical processing industry. The curriculum can be categorized as the study and application of the scientific principles (math, physics, and chemistry) associated with the operation and maintenance (safety, quality, instruments, equipment, systems, operations, unit operations, troubleshooting) of the chemical processing industry. The term process technology was first created in the community college environment to describe a new program being designed to train process technicians.

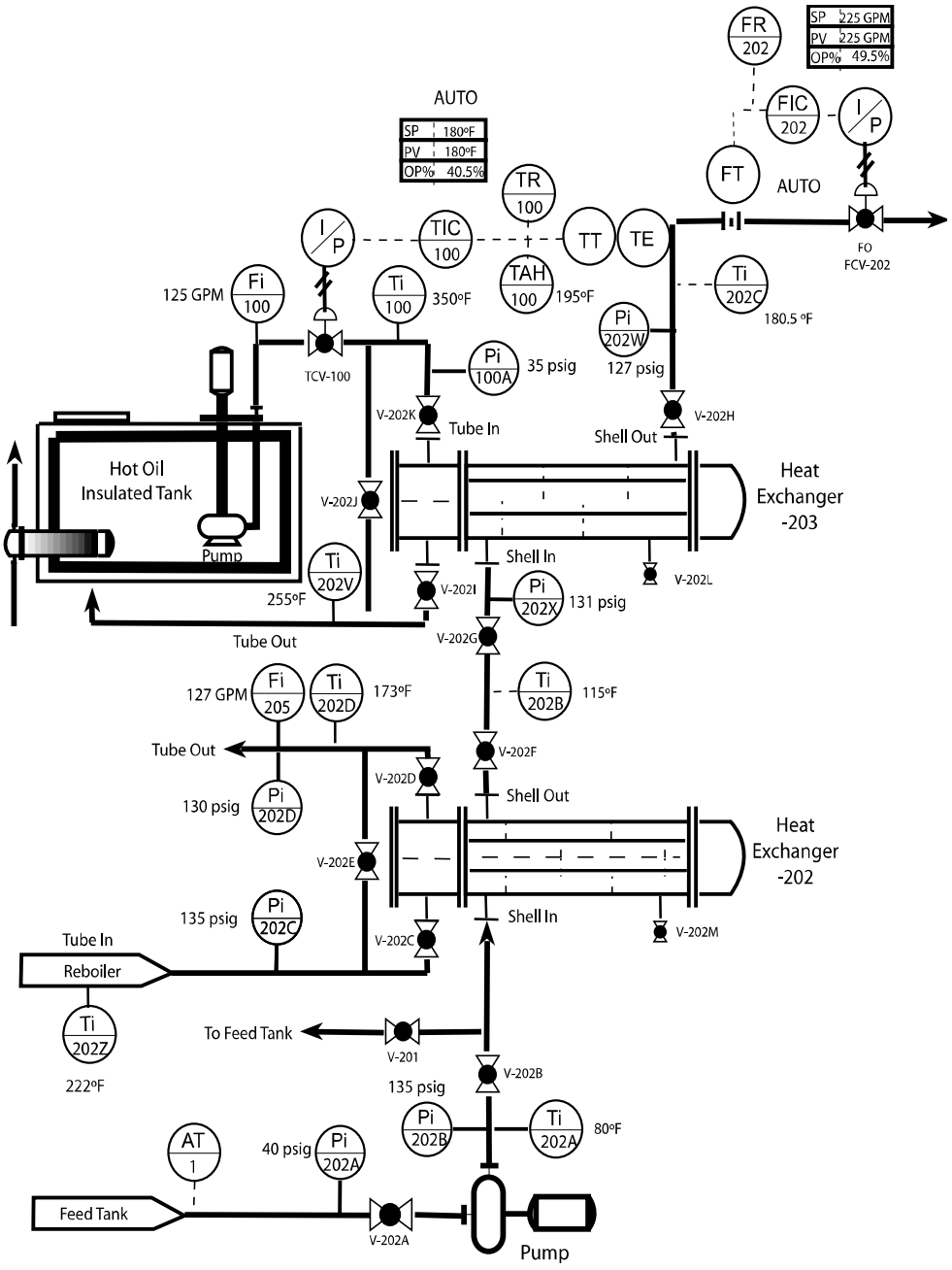
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14. Draw a flow control loop.



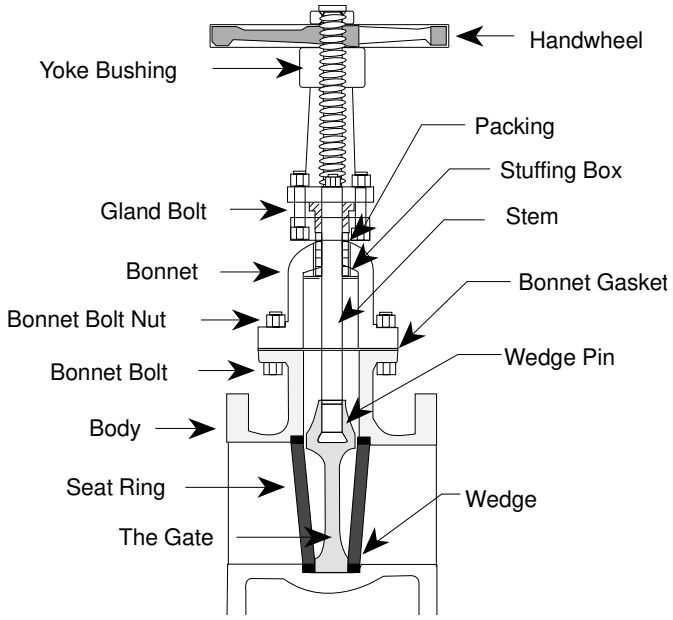
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15. Draw a simple sketch of a shell and tube exchanger. Show all flows: tube-in, tube-out, shell in, shell out, shell, channel-head, pass partition, tube-sheet, and all associated valves. Explain principles of heat transfer, flow rate, and pressure and illustrate on your drawing how they work.

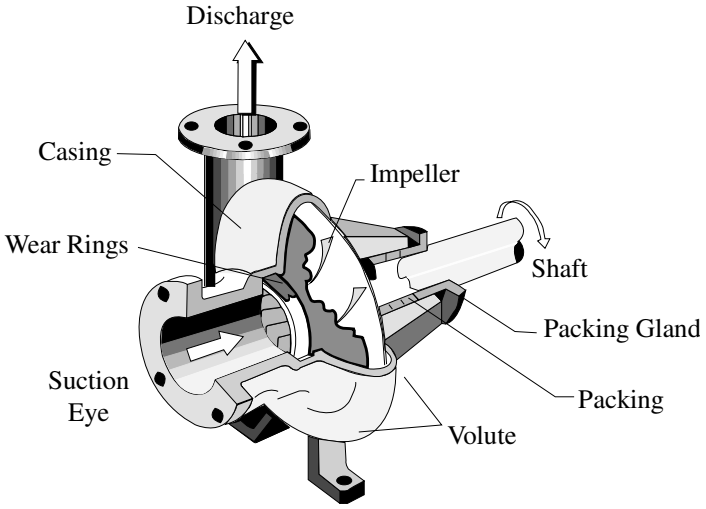


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16. Draw and label a gate valve. LSEP

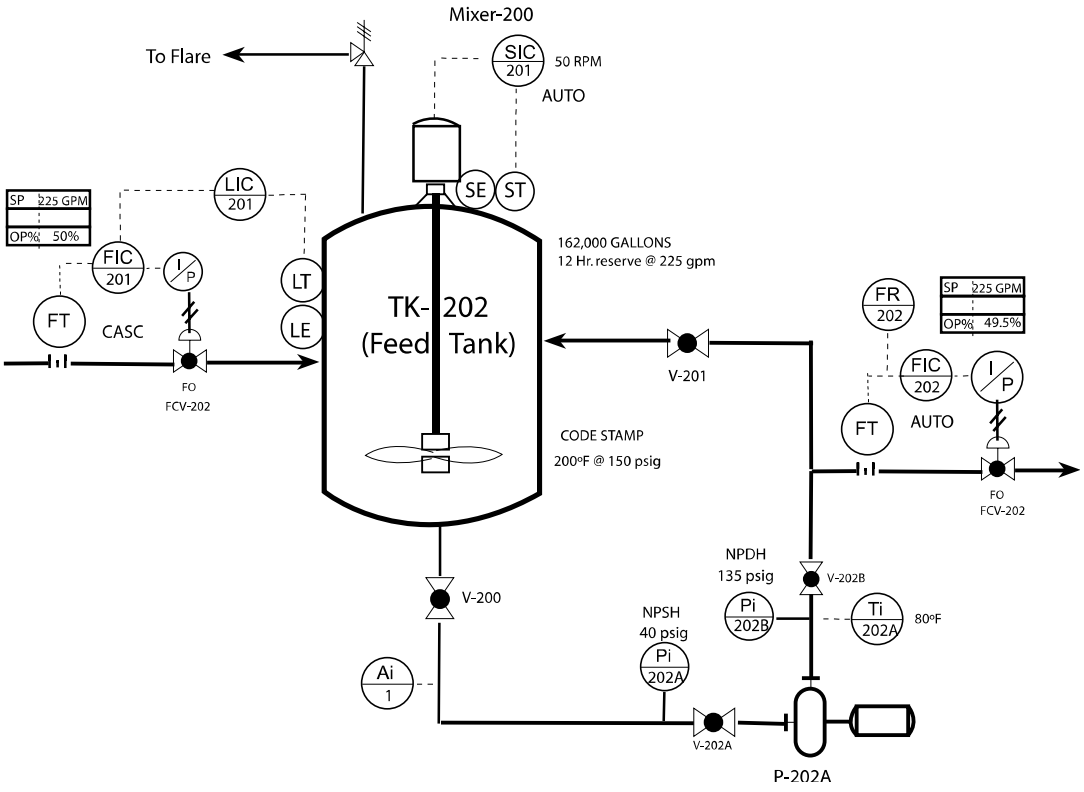


17. Draw and label a centrifugal pump. Explain how it operates and the associated scientific principles. A centrifugal pump is designed use centrifugal force to accelerate fluid flow and move liquids from one place to another. Liquid flows freely into the suction eye and is picked up by the spinning impeller that accelerates the liquid into the volute at high velocity. The volute gradually increases in size until it discharges into the discharge pipe causing the liquid to slow, building pressure. The pump is connected to a motor by the shaft that extends through the casing and into the pumping cavity where it connects to the impeller. A series of external seals and internal bearings allow smooth operation.



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18. Draw a simple pump-around system. Include a tank, piping, valves, instrumentation, pump, and control loop. L SEP



19. Explain how having a solid foundation in the principles of chemistry and physics is important to a technician. L SEP

Process technicians need to have a solid understanding of chemistry of the processes they operate. A large number of safety items are attached to this statement. Technicians also need a good grasp of the physics associated with the operations they are assigned to. The physics of mechanical devices like pumps, compressors, hydraulic systems, heat exchangers and cooling towers, and refrigeration systems are covered carefully in apprentice training programs. The chemistry of these same devices and gas laws, chemical reactions and distillation theory, operation, and troubleshooting helps process technicians better understand their equipment and systems.

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20. List the types of jobs available to a person with a process technology degree.

Degrees open doors that are presently closed to those who do not have them. The process technology degree is a very flexible piece of parchment. Technicians can find a variety of jobs as; (1) process technicians, (2) research technicians, and (3) laboratory technicians. Jobs may be found onshore or offshore, in power generation, food processing, pharmaceuticals, paper and pulp, water treatment, gas processing, petrochemicals, or refinery. The Houston Gulf-coast area is frequently referred to as the Silicon Valley for Process Technicians. Over 600 major/minor employers can be found from Texas to Florida. See Chapter 20 for additional information.

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CHAPTER 2 TEST

INTRODUCTION TO PROCESS TECHNOLOGY

1. A system is best described as:
   a. a collection of equipment designed to perform a specific function.
   b. a collection of equipment systems that work together to produce products.
   c. a collection of math, science, equipment and technology.
   d. a collection of feed stocks fed into a process reactor.
2. Process instrumentation is primarily described as the study of:
   a. the structure, components, and science of control loops
   b. symbols and diagrams, process flow diagrams, and drawing piping & instrument drawings.
   c. the instruments and instrument systems used in the chemical processing industry.
   d. all the above
3. List the five elements of a control loop:
   a.
   b.
   c.
   d.
   e.
4. Process technicians _____, organize, and _____ data.
   a. record & respond to
   b. read & flag
   c. compare & contrast
   d. collect & analyze
5. A basic principle of quality states:
   a. change attitudes and behaviors required to implement kaizan systems.
   b. each process has “natural variation” or a range that it naturally moves through.
   c. training is fundamental to the grass roots acceptance of the principles of quality.
   d. equipment is designed to perform a specific function.

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6. Process technology is best described as:
   a. completion of college courses required to be a process technician.
   b. study of modern process control, design, and application of manufacturing engineering principles.
   c. study and application of the scientific principles associated with the operation and maintenance of the CPI.
   d. All the above.
7. Process technology programs prepare students for careers in: (Name 5)
   a.
   b.
   c.
   d.
   e.
8. Process Technology programs are:
   a. Regionally accredited & taught at community colleges & universities
   b. State approved & transferable between institutions
   c. Non-transferable from one institution to another
   d. Continuing education programs for non-credit.
   e. a & b
9. List three critical elements associated with success in college and "Self-directed study habits."
   a.
   b.
   c.
10. List three topics on the course outline for Safety, Health, and Environment."
   a.
   b.
   c.

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11. Name three safety incidents that have changed the chemical processing industry.

    a.

    b.

    c.

12. The primary purpose of process safety is:

    a. prevent injuries and fatalities

    b. prevent fires and explosions

    c. prevent unexpected releases of hazardous materials.

    d. all the above

13. A process safety analysis is primarily designed to:

    a. reduce potential for fire and explosions

    b. protect equipment and physical facilities

    c. establish safe operating parameters

    d. complete assigned government documentation

14. OSHA and the EPA believe that the key to preventing catastrophic emergencies in the CPI is:

    a. adequate employee training

    b. a Hazardous Safety Analysis

    c. support from all levels of management

    d. government support and funding

15. List two quality gurus who changed what we know about the principles of quality.

    a.

    b.

16. List three topics on the course outline for “The Principles of Quality.”

    a.

    b.

    c.

17. List three topics on the course outline for “Process Instrumentation.”

    a.

    b.

    c.

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18. List three topics on the course outline for “Process Equipment.”

    a.

    b.

    c.

19. Process Operations is an advanced course that provides an adult learner with _____ ____ experience.

20. List three topics on the course outline for “Process Operations.”

    a.

    b.

    c.

21. List three process models discussed in the “Process Troubleshooting” class.

    a.

    b.

    c.

22. List the four troubleshooting methods described in the process troubleshooting course.

    a.

    b.

    c.

    d.

23. Identify the Math and Science requirements in your program.

    a.

    b.

    c.

    d.

24. List three topics on the course outline for “Applied General Chemistry.”

    a.

    b.

    c.

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25. Name the course that first introduces students to; symbols and diagrams, process flow diagrams PFD's, control loops and Piping and Instrumentation Drawings P&ID's.

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ANSWER KEY CHAPTER 2 TEST

1. A
2. D
3. Must be in the following order!
   - Primary element or sensors,
   - transmitter
   - controller
   - transducer or I/P
   - final control element
4. D
5. B
6. C
7. Any order! Select 3
   - Process Technician or operator
   - Laboratory technician
   - Research technician
   - Pharmaceutical technician
   - Power generation
   - Food processing
8. E
9. Any order!
   - Attendance
   - Participation
   - Motivation and attitude
   - Time management
   - Goal setting
   - Reading and study
   - Complete homework
   - Self-directed learner and self-testing
   - Critical thinking and troubleshooting ability

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10. Any Three (3) of the following!
    - Introduction to Process Safety
    - Hazard Classification
    - Routes of Entry & Environmental Effects
    - Gases, Vapors, Particulates & Toxic Metals
    - Hazards of Liquids
    - Hazardous Chemical Identification: HAZCOM, Toxicology, DOT
    - Fire and Explosion
    - Electrical, Noise, Heat, Radiation, Ergonomic and Biological Hazards
    - Operating Hazards: Permits, Emergency Response, HAZWOPER
    - Personal Protective Equipment (PPE)
    - Engineering Controls
    - Administrative Controls
    - Regulatory Overview: OSHA, PSM, EPA
11. a. Bhopal
    b. Exxon Valdez
    c. Texas City BP
    d. ARCO 1990
    e. Phillips 1989
    f. Texas City 1947

    Note: More current issues can also be used.
12. D
13. C
14. A
15. Dr. W. Edward Deming

    Dr. Joseph M. Juran
16. Any Three (3) of the following!
    - The Quality Gurus
    - Total Quality Management (TQM)
    - Quality Tools

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- Statistics
- Statistical Process Control
- Control Charts
- Variation in Processes
- Customer Satisfaction
- The Economics of Quality
- Communication-The Critical Skill
- International Standards Organization (ISO)
- Teamwork & Personal Effectiveness

17. Any Three (3) of the following!
    - Symbols & diagrams
    - Process Flow Diagrams PFD
    - Basic Instrumentation
    - Control Loops
    - Modern Process Control- Application and Console Operations
    - Piping and Instrumentation Drawing
18. Any Three (3) of the following!
    - Valves
    - Piping and Vessels
    - Pumps
    - Compressors
    - Turbines and Motors
    - Heat Exchangers
    - Cooling Towers
    - Boilers
    - Furnaces
    - Reactors
    - Distillation Columns
19. Hands-on

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20. Any Three (3) of the following!

- Orientation & overview of operating unit
- Safety, health, and environment review
- On-the-job training- Drawing Process Flow Diagrams
- Developing and using standard operational procedures
- Work in self-directed teams
- Complete operational assignments
- Collect, organize, and analyze data, and troubleshoot process problems
- Complete qualification process and written exam
- Operate the process unit (Required)

  - start-up and shut down

21. Any Three (3) of the following!

- Distillation model
- Reaction model
- Separation model
- Pump and tank model
- Compressor model
- Heat exchanger model
- Cooling tower model
- Boiler model
- Furnace model
- Multi-variable model

22. Any order!

- Method 1: Educational (Completed in College Program)
- Method 2: Instrumental (Completed in College Program)
- Method 3: Experiential (Completed on-the-job)
- Method 4: Scientific (Requires engineering, process technology, & experience)

23. See college catalog.

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24. Any Three (3) of the following!

- Pressure and characteristics of fluids
- Temperature, heat transfer and math
- Fundamentals of chemistry and Periodic Table
- Chemical reactions, material balance, % by weight, pH
- Fundamental concepts of physics; density, specific gravity, pressure
- Complex and simple machines, electricity, magnetism
- Advanced concepts of chemistry- distillation
- Chemical bonds, fluid flow, gas laws, and heat
- Organic chemistry

25. Process instrumentation

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