APPROVED SOLUTION

CADET _____ SECTION _____TIME OF DEPARTURE _____

DEPARTMENT OF CHEMICAL & BIOLOGICAL SCIENCE AND ENGINEERING

CH402, AY2025-2026
WRITTEN PARTIAL REVIEW I
55 Minutes, B-Hour
9 February 2026

TEXT: Peters, Timmerhaus & West
SCOPE: CHAPTERS: 12, 14

References Permitted: Open note and open book; Mathematica; Excel; CHEMCAD.

INSTRUCTIONS

1. You have 55 minutes for the exam.
2. Do not mark the exam or open it until "begin work" is given.
3. There are 3 problems on 3 pages in the exam (not including the cover page).
4. Write your name on the top of each sheet.
5. Solve the problems in CHEMCAD
6. Report all answers in the tables provided.
7. Upload your CHEMCAD file to CANVAS.

(TOTAL WEIGHT: 200 POINTS)

DO NOT WRITE IN THIS SPACE

PROBLEM	VALUE	CUT
A	80	
B	60	
C	60	
TOTAL CUT		
GRADE	200	

Cadet: APPROVED SOLUTION

Problem:	Weight:
A	80

A TEMA-R type AEL carbon steel shell-and-tube heat exchanger is being considered for a process in which a stream of benzene at 405.3 kPa must be heated from 20°C to 100°C. A hot stream of 1.5 kg/s of nitrogen at 380°C and 1020 kPa is available for the process and will enter the exchanger on the shell side and emerge at 200°C.

- The exchanger is constructed from ½-inch Sch 40 tubes.
- The outside diameter of the tubes is 0.0213 m with a wall thickness of 0.00277 m.
- The tube pitch of 0.0267 m
- The tubesheet thickness equal to the tube outside diameter.
- Assume the fouling factors are zero.
- All other design constraints and geometric details are the CHEMCAD defaults.
- SRK should be used for K-value and enthalpy models.

Under these conditions, determine the flow rate of the benzene, the length and number of tubes, the inside diameter of the shell, and the purchased cost of the exchanger in February 2026. Are vibrations detected in this heat exchanger?

SOLUTION:

Benzene flow rate, kg/s	2.0874 //ANS
Tube length, m	3.05 //ANS
Number of tubes	35 //ANS
Shell inside diameter, m	0.20 //ANS
Purchased Cost in February 2026, $	$7,454 //ANS
Vibrations detected? (Y/N)	Yes //ANS

Problem is solved in CHEMCAD.

Problem:	Weight:
B	60

Assuming the benzene leaves the exchanger in Problem A at a flow rate of 2.1 kg/s, a pressure of 402 kPa, and a temperature of 101°C, determine the purchased cost of a centrifugal pump in February 2026 that will pressurize the benzene to 430.27 kPa. The pump is centrifugal, one stage, 3550 rpm, VSC, cast iron, with an open drip-proof 3600 RPM motor, and is running at 90% efficiency.

SOLUTION:

Purchased Cost in February 2026, $	$8,474 //ANS

Problem is solved in CHEMCAD.

Problem:	Weight:
C	60

Assuming the nitrogen leaves the exchanger in Problem A at a flow rate of 1.5 kg/s, a pressure of 982 kPa, and a temperature of 199°C, determine the purchased cost of a compressor in February 2026 that will pressurize the nitrogen back to 1020 kPa. The compressor is centrifugal with a belt-drive coupling, has an open drip-proof 3600 RPM motor, and is running at 60% efficiency.

SOLUTION:

Purchased Cost in February 2026, $	$160,006 //ANS

Problem is solved in CHEMCAD.

APPROVED SOLUTION

CADET _____ SECTION _____TIME OF DEPARTURE _____

DEPARTMENT OF CHEMICAL & BIOLOGICAL SCIENCE AND ENGINEERING

CH402, AY2025-2026
WRITTEN PARTIAL REVIEW I
55 Minutes, D-Hour
9 February 2026

TEXT: Peters, Timmerhaus & West
SCOPE: CHAPTERS: 12, 14

References Permitted: Open note and open book; Mathematica; Excel; CHEMCAD.

INSTRUCTIONS

1. You have 55 minutes for the exam.
2. Do not mark this exam or open it until "begin work" is given.
3. There are 3 problems on 3 pages in the exam (not including the cover page).
4. Write your name on the top of each sheet.
5. Solve the problems in CHEMCAD.
6. Report all answers in the tables provided.
7. Upload CHEMCAD file to CANVAS.

(TOTAL WEIGHT: 200 POINTS)

DO NOT WRITE IN THIS SPACE

PROBLEM	VALUE	CUT
A	80	
B	60	
C	60	
TOTAL CUT		
GRADE	200	

Cadet: APPROVED SOLUTION

Problem:	Weight:
A	80

A TEMA-R type AEL carbon steel shell-and-tube heat exchanger is being considered for a process in which a stream of toluene at 303.98 kPa must be heated from 20°C to 100°C. A hot stream of 4.0 kg/s of n-hexane at 250°C and 202.65 kPa is available for the process and will enter the exchanger on the shell side and emerge at 100°C.

- The exchanger is constructed from ½-inch Sch 40 tubes.
- The outside diameter of the tubes is 0.0213 m with a wall thickness of 0.00277 m.
- The tube pitch of 0.0267 m
- The tubesheet thickness equal to the tube outside diameter.
- Assume the fouling factors are zero.
- All other design constraints and geometric details are the CHEMCAD defaults.
- SRK should be used for K-value and enthalpy models.

Under these conditions, determine the flow rate of the toluene, the length and number of tubes, the inside diameter of the shell, and the purchased cost of the exchanger in February 2026. Are vibrations detected in this heat exchanger?

SOLUTION:

Toluene flow rate, kg/s	9.8675 //ANS
Tube length, m	4.88 //ANS
Number of tubes	154 //ANS
Shell inside diameter, m	0.39 //ANS
Purchased Cost in February 2026, $	$21,918 //ANS
Vibrations detected (Y/N)	Yes //ANS

Problem is solved in CHEMCAD.

Problem:	Weight:
B	60

Assuming the toluene leaves the exchanger in Problem A at a flow rate of 9.9 kg/s, at a pressure of 297 kPa, and a temperature of 102°C, determine the purchased cost of a centrifugal pump in February 2026 that will pressurize the toluene to 346.15 kPa. The pump is centrifugal, one stage, 3550 rpm, VSC, cast iron, with an open drip-proof 3600 RPM motor, running at 70% efficiency.

SOLUTION:

Purchased Cost in February 2026, $	$8,406 //ANS

Problem is solved in CHEMCAD.

Problem:	Weight:
C	60

Assuming the n-hexane leaves the exchanger in Problem A at a flow rate of 4.0 kg/s, a pressure of 163 kPa, and a temperature of 93°C, determine the purchased cost of a compressor in February 2026 that will pressurize the n-hexane back to 202.65 kPa. The compressor is centrifugal with a belt-drive coupling, has an open drip-proof 3600 RPM motor, and is running at 75% efficiency.

SOLUTION:

Purchased Cost in February 2026, $	$311,802 //ANS

Problem is solved in CHEMCAD.

APPROVED SOLUTION

CADET _____ SECTION _____TIME OF DEPARTURE _____

DEPARTMENT OF CHEMICAL & BIOLOGICAL SCIENCE AND ENGINEERING

CH402, AY2025-2026
WRITTEN PARTIAL REVIEW I
55 Minutes, Makeup
11 February 2026

TEXT: Peters, Timmerhaus & West
SCOPE: CHAPTERS: 12, 14

References Permitted: Open note and open book; Mathematica; Excel; CHEMCAD.

INSTRUCTIONS

1. You have 55 minutes for the exam.
2. Do not mark this exam or open it until "begin work" is given.
3. There are 3 problems on 3 pages in the exam (not including the cover page).
4. Write your name on the top of each sheet.
5. Solve the problems in CHEMCAD.
6. This exam contains fillable tables.
7. Report all answers in the tables provided.
8. Upload your completed exam and your CHEMCAD file to CANVAS.

(TOTAL WEIGHT: 200 POINTS)

DO NOT WRITE IN THIS SPACE

PROBLEM	VALUE	CUT
A	80	
B	60	
C	60	
TOTAL CUT		
GRADE	200	

Cadet: APPROVED SOLUTION

Problem:	Weight:
A	80

A TEMA-R type AEL carbon steel countercurrent shell-and-tube heat exchanger is being considered for a process in which a stream of toluene at 405.3 kPa must be heated from 20°C to 100°C. A hot stream of 15.0 kg/s of Dowtherm G at 200°C and 202.65 kPa is available for the process, entering the exchanger on the shell side and emerging at 100°C.

- The exchanger is constructed from ½-inch Sch 40 tubes.
- The outside diameter of the tubes is 0.0213 m with a wall thickness of 0.00277 m.
- The tube pitch of 0.0267 m
- The tubesheet thickness equal to the tube outside diameter.
- Assume the fouling factors are zero.
- All other design constraints and geometric details are the CHEMCAD defaults, but you may need to increase the upper limits on the tube length and shell diameter.
- SRK should be used for K-value and enthalpy models.

Under these conditions, determine the flow rate of the toluene, the length and number of tubes, the inside diameter of the shell, and the purchased cost of the exchanger in February 2026. Are vibrations detected in this heat exchanger?

SOLUTION:

Toluene flow rate, kg/s	18.9216 //ANS
Tube length, m	6.10 //ANS
Number of tubes	200 //ANS
Shell inside diameter, m	0.44 //ANS
Cost in February 2026, $	$30,674 //ANS
Vibrations detected? (Y/N)	No //ANS

Problem is solved in CHEMCAD.

Problem:	Weight:
B	60

Assuming the toluene leaves the exchanger in Problem A at a flow rate of 19.0 kg/s, a pressure of 397 kPa, and a temperature of 102°C, determine the purchased cost of a centrifugal pump in January 2026 that will pressurize the toluene to 473.72 kPa. The pump is centrifugal, one stage, 3550 rpm, VSC, cast iron, and with an open drip-proof 3600 RPM motor.

SOLUTION:

Purchased Cost in February 2026, $	$9,607 //ANS

Problem is solved in CHEMCAD.

Problem:	Weight:
C	60

Determine the nominal diameter of a section of carbon (commercial) steel pipe that will connect the outlet of the pump in problem B to a storage tank at 423 kPa. The toluene at the inlet of the pipe is flowing at 19.0 kg/s with a pressure of 473.72 kPa and a temperature of 102°C. The pipe is 150-m carbon (commercial) steel welded Sch 40 with 12 standard 90° elbows and an elevation change of 2 m.

SOLUTION:

Nominal diameter, inches	5 //ANS

Problem is solved in CHEMCAD.