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D R E X E L   U N I V E R S I T Y  
Department of Chemical and Biological Engineering  
CHE 230 – Chemical Engineering Thermodynamics I  
Winter 2024-2025 (202425)  
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Midterm Exam – February 11, 2025

S O L U T I O N S

This is an example header named `example_head-38618812.tex`.

1. (15 pts)

This is an example problem named `example_problem_template-38618812.tex`.

Determine the product of 5 and 8.

**SOLUTION**

$$5 \times 8 = 40$$

The serial number is 38618812. This is labeled as question number 1.

2. (16 pts)

This is an example problem named `example_problem2_template-38618812.tex`.

Determine the quotient of 3.1 and 359.0.

**SOLUTION**

$$3.1 \div 359.0 = 0.009$$

The serial number is 38618812. This is labeled as question number 2.

3. (17 pts)

Superheated steam at 3 MPa and 359.0°C is to be converted to saturated steam at 3 MPa in a desuperheater. This desuperheater is supplied with inlet liquid water at 53.0°C. The unit should produce saturated steam at a rate of 44.0 kg s<sup>-1</sup>. Assuming adiabatic operation, and assuming the liquid inlet is saturated, what is the mass flowrate of the inlet water?

The following enthalpies will be useful:

Superheated steam at 359.0°C and 3 MPa:  $\hat{H} = 3,133.95$  kJ/kg;

Saturated liquid water at 53.0°C:  $\hat{H}^L = 221.87$  kJ/kg; and

Saturated water vapor at 3 MPa:  $\hat{H}^V = 2,803.84$  kJ/kg.

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## SOLUTION

Let stream 1 be the liquid water stream, which we assume is saturated liquid, stream 2 be the superheated steam inlet, and stream 3 be the saturated steam outlet. Hence,  $\dot{m}_3 = 15 \text{ kg s}^{-1}$  as given. The mass and energy balance yield the two unknowns  $\dot{m}_1$  and  $\dot{m}_2$ :

$$\begin{aligned}\dot{m}_1 + \dot{m}_2 &= \dot{m}_3 \\ \dot{m}_1 \hat{H}_1 + \dot{m}_2 \hat{H}_2 &= \dot{m}_3 \hat{H}_3\end{aligned}$$

Solving these two simultaneously yields

$$\begin{aligned}\dot{m}_1 &= \dot{m}_3 \left( \frac{\hat{H}_2 - \hat{H}_3}{\hat{H}_2 - \hat{H}_1} \right) \\ &= (15) \left( \frac{3,133.95 - 2,803.84}{3,133.95 - 221.87} \right) = \boxed{4.99 \text{ kg s}^{-1}}.\end{aligned}$$

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This is an example tail named `example_tail.tex`.