Problem 3.19: a) 200 kJ of heat is added under constant pressure to 1 kg of steam initially at 30 bar, 400 °C. What is the final temperature?
b) What is the change in internal energy during this process?

Problem 3.20: Steam at 200 °C and 10 bar is cooled under constant pressure until it becomes saturated liquid.
a) What is the final temperature?
b) How much heat is removed from the steam?
c) Calculate the work involved in this process, if any.

Problem 3.21: a) Water at 1 bar, 20 °C is heated at const P to produce steam with quality 95%. What is the amount of heat?
b) What is the final state if the amount of heat is 2100 kJ/kg?

Problem 3.22: 1 mol of liquid octane is heated in a closed system at constant pressure of 1.1 bar from 8 °C until it becomes saturated liquid ($T^{\text{sat}} = 240$ °C). Calculate:
a) The amount of heat.
b) The amount of work.
c) The enthalpy at the initial state.
d) The internal energy at the initial state.
Additional data: The enthalpy of the saturated liquid at 1.1 bar is 38.592 kJ/mol. The heat capacity of the liquid is

$$C_P/R = 27.0423 - 0.0224477\,T + 0.000115337\,T^2$$

with T in kelvin. For the liquid volume, use the Rackett equation. You may assume that the liquid is incompressible.

Problem 3.23: Steam is heated in closed system from 20 bar, 300 °C to 450 °C. Determine the amount of heat and work in the following cases:
a) Heating is conducted at constant pressure.
b) Heating is conducted at constant volume. What is the final pressure?
c) Use these results to estimate the C_P and C_V of steam.
The process may be assumed to be mechanically reversible.

Problem 3.24: Wet steam at 200 °C with 80% moisture is ~~heated~~ cooled by removing 600 kJ/kg of heat.
a) Determine the final state (pressure and temperature and quality, if a two-phase system) if cooling is at constant pressure.
b) Determine the final state if cooling is at constant volume.