

## Exercise 14 (Mock exam questions)

This exercise includes a few mock exam questions. In the solution, we will share with you our grading rubric for your information.

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### Problem 1 [1.5 points]

In a vapor-compression refrigeration system, a valve is used to reduce the refrigerant's pressure. Indicate what conditions must be satisfied to consider an isenthalpic process when the working fluid passes in the valve.

### Problem 2 [0.75 points]

In a closed system, air expands from  $V_1$  to  $V_2 > V_1$  through an isothermal process. Derive the work transfer in the process supposing that air behaves as:

(a) a perfect gas;

(b) an ideal gas;

**Problem 3 [11.75 points]**

A cycle is executed within a closed piston-cylinder system, consisting of these processes:

1-2 Polytropic ( $pv^k = \text{constant}$ ,  $k = c_p/c_v$ ) and adiabatic compression from 100 kPa and 27 °C to 700 kPa;

2-3 Isochoric heating;

3-4 Isothermal expansion until  $v_4 = 10v_3$ ;

4-1 Isobaric heat extraction to the initial state.

Assume a perfect gas with:

$$c_v = 0.718 \text{ kJ}/(\text{kg} \cdot \text{K}), c_p = 1.005 \text{ kJ}/(\text{kg} \cdot \text{K}), R = 0.287 \text{ kJ}/(\text{kg} \cdot \text{K})$$

(a) Sketch the  $p$ - $v$  diagram of the cycle. **[1 point]**

(b) Determine the ratio of the compression work to the expansion work. **[7.5 point]**

(c) Determine the thermal efficiency of the cycle and the heat per unit mass exchanged in every process. **[3.75 point]**