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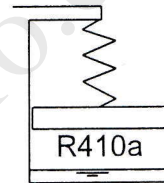
MCG2130 - THERMODYNAMICS I

Midterm Examination
24 October 2014
Prof. W. Hallett

Time: 75 minutes
Page 1 of 2
Version c

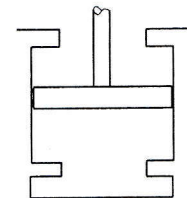
Closed book. Put your name on this question paper and hand it in with your exam booklet. **If you do not hand in the question paper your exam will not be marked.** In each problem, state any assumptions you need to make. Properties data are given on the reverse side of the paper.

1. (16 marks total) Refrigerant R410a is contained in a cylinder with a leakproof frictionless piston. A linear spring acts on the piston, such that when the pressure is 100 kPa the volume is 0.01 m^3 , and when the pressure is 1.0 MPa the volume is 0.035 m^3 . The cylinder initially contains 0.02 m^3 of saturated R410a at -30°C , of which 1% by volume is saturated liquid. The R410a is then heated to a final pressure of 600 kPa.



- (a) (2 marks) Draw this process on a P-v diagram, showing lines of constant temperature at the initial and final state. Also show on this diagram the critical point, the superheated vapour region, and the compressed liquid region.
- (b) (3 marks) Calculate the final volume in the cylinder.
- (c) (3 marks) Calculate the work done in kJ.
- (d) (8 marks) Calculate the heat transfer in kJ and the final temperature.

2. (8 marks total) Air is contained in a cylinder with a leakproof frictionless piston at an initial state of $T_1 = 20^\circ\text{C}$, $P_1 = 150 \text{ kPa}$, and $V_1 = 0.015 \text{ m}^3$. The air is heated until a final temperature of 300°C is reached. The piston maintains a constant pressure until it reaches the end of the cylinder, at which point the volume reaches a maximum value of 0.02 m^3 .



- (a) (1 mark) Sketch this process on a T-v diagram, showing lines of constant pressure at the initial and final pressure.
- (b) (3 marks) Determine whether the piston reaches the end of the cylinder or not and determine the final pressure.
- (c) (4 marks) Calculate the work done and the heat transfer.

Total marks for this paper: 24

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