23

24

The University of Jordan – Faculty of Engineering and Technology- Mechanical Engineering Department
ME 0904341: Thermodynamics I, sections 1 & 2
Fall, 2013 - Instructor: Dr. Jamil Al Asfar & Dr. Osama Ayadi

FORM B

Midterm Exam (1:45-2:45 pm): November 13th, 2013

الاسم: [redacted] الرقم الجامعي: 0127146 الرقم التسلسلي:

Q1) (10 points) Write the symbol of the correct answer:

10 9

Question	1	2	3	4	5	6	7	8	9	10
Answer	a	d	c	b	b	a	a	c	a	b

1. At the end of a thermodynamic cycle, final and initial states should be
   a. Identical
   b. Not identical
   c. Identical to an adiabatic process
   d. None of the above

2. During an adiabatic process:
   a. The temperature remains constant
   b. The pressure remains constant
   c. The volume remains constant
   d. None of the above

3. In the pressure-volume diagram, the area under the curve of a process represents
   a. The amount of heat exchanged with the surroundings
   b. The amount of increase in pressure.
   c. The amount of work exchanged with the surroundings
   d. None of the above.

4. A pure substance is the substance with a constant:
   a. Mechanical properties.
   b. Chemical properties
   c. Thermodynamic properties.
   d. Chemical Composition.
   e. All of the above.

5. The specific volume change (v_{fg}) of a pure substance:
   a. Increases with temperature.
   b. Decreases with temperature.
   c. Is independent of temperature.
   d. Increases with pressure.
   e. None of the above.

6. The boundary work associated with an isometric process of a closed system is:
(a) Zero b. Positive. c. Negative d. None of the mentioned.

7. When a system undergoes a closed cycle, the net heat exchanged with the surroundings is equal to:
(a) Work done b. Zero c. Enthalpy change d. None of the mentioned

8. An insulated system:
a. Does not exchange work with surroundings
b. Always has a constant temperature.
(c) Does not exchange heat with surroundings
d. None of the above

9. If at a given temperature, the pressure of a system is higher than the saturation pressure, then, which properties are sufficient to determine its state:
(a) Temperature and pressure.
b. Pressure and quality.
c. Temperature and quality.
d. All of the above.
e. non of the above.

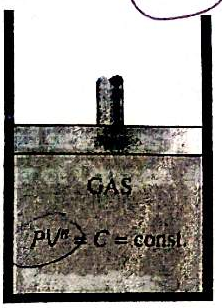
10. A thermodynamic cycle should consist of:
a. One process
(b.) More than one process
c. Two processes
d. None of the above.

4.5

5.5

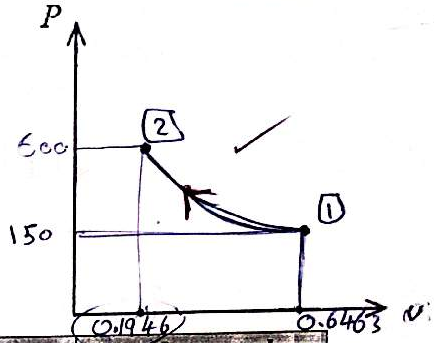
Q2) Three (3) kg of Oxygen gas undergoes a polytropic process from 100° C and 150 kPa to 600 kPa (with $n = 1.2$). **Represent** the process on a P-v diagram, then find the work done and heat transfer during this process, assuming ideal gas behavior of Oxygen. **(6 points)**

3.5



(a) Properties:

State	T [°C]	P [kPa]	v [m³/kg]	V[m³]
1	100	150	0.6463	1.939
2	176.4	600	0.1946	0.5840



(b) Boundary work & heat transfer:

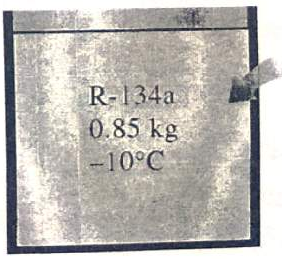
Process	Type of boundary work	Boundary work [kJ]
1→2	Polytropic $W_b = \frac{P_2V_2 - P_1V_1}{1-n}$	-297.75
	Heat transfer	
1→2	$Q - W = \Delta U = m c_v (T_2 - T_1)$	$Q = 0.658(176.4 - 100) - 297.75$ $Q = -247.478$

(c) Is it accepted to assume ideal gas behaviour of O_2 in this process? Justify.

$P_r = \frac{P}{P_{cr}}$, T , α , $Z \geq 1$

T_1

b) **(4 points)** A rigid tank of 41.99 liters volume contains 0.85 kg of rfrigerant R-134a at (-10° C). If heat is added such that the final state of the refrigerant is saturated vapor, then find the initial pressure, and the final temperature and pressure.



State	T [°C]	P [kPa]
1	-10	200.74
2	8	387.88

$1\,m^3 = 1000\,L$

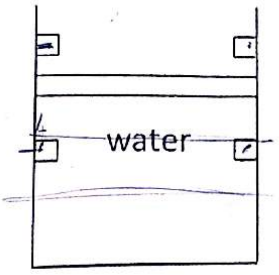
$= 44.99\,L$

$= 0.045\,m^3$

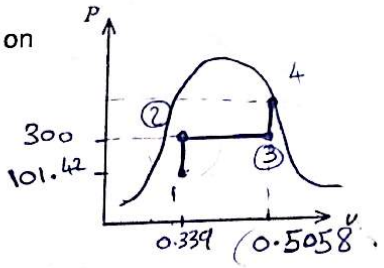
$v = 0.05292$

8.5

Q3) **3.53982 kg** of water initially at 100 °C is contained in a piston/cylinder arrangement as shown. The piston is frictionless and is free to move between two sets of stops. When the piston rests on the lower stops, the enclosed volume is **1.2** m^3, but when the piston reaches the upper stops, the enclosed volume is **1.80** m^3. The piston is massless and the outside pressure is **300 kPa** . If heat is added until water exists as saturated vapor, show the process(es) on a ***P-v*** diagram, then determine the final pressure & temperature in the cylinder, the total work done, and heat transfer during this (these) process(es). **(10 points)**



1) Plot the processes from the initial to the final state on the P-v diagram and determine:
2) The properties at each state of the processes.
3) The boundary work during each process.
4) The total heat transfer during the process(es).



(a) Properties:

State	T [°C]	P [kPa]	v [m^3/kg]	V[m^3]	u [kJ/kg]	x [-]
1	100	101.42	0.339	1.2	841.2	$x \leq 0.2$ saturated mixture
2	133.52	300	0.339	1.2	1668.9	saturated mixture $x = 0.558$
3	133.52	300	1.8	2251.8	$x = 0.835$	sat. mixture
4	139.93	361	0.5058	1.8	2	$x = 1$ saturated vapor

(b) Boundary work:

Process	Type of boundary work	Boundary work [kJ]
1→2	isometric	$\Delta V = 0 \quad W_b = 0$
2→3	iso baric	$W_b = P(V_3 - V_2) = 300(1.8 - 1.2) = 180$ kJ
3→4	isometric	$\Delta V = 0 \rightarrow W_b = 0$
Total work	$W_b = W_{b1\to2} + W_{b2\to3} + W_{b3\to4} = 180 + 0 + 0 = 180$ kJ	

(c) Total Heat transfer

$$Q - W = \Delta U$$

$$Q - 180 = m(u_4 - u_1) = 236.33 \text{ kJ}$$

- Good Luck -