

Last Name: _____ **First Name:** _____ **Thermo no.** _____

**ME 200 Thermodynamics 1
Fall 2017 – Exam 1**

Circle your instructor's last name

Division 1: Naik

Division 2: Sojka

Division 3: Wassgren

Division 4: Goldenstein

Division 6: Braun

Division 7: Buckius

Division 8: Meyer

DISCLAIMER

This practice exam is only for practice. The actual exam may not have a format similar to the problems included in this practice exam.

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1. [20 points] Circle all (and only all) correct answers.

(a) Consider a lightbulb powered by electricity. Assume positive sign for heat transfer into the system and for work output from the system. Which of the following is true considering lightbulb as the system?

$$W > 0, Q > 0$$

$$W > 0, Q < 0$$

$$W < 0, Q > 0$$

$$W < 0, Q < 0$$

(b) Which of the following is (are) true for a fixed state containing only vapor?

$$T < T_{\text{sat}}$$

$$P < P_{\text{sat}}$$

$$T > T_{\text{sat}}$$

$$P > P_{\text{sat}}$$

(c) What is the quality for a saturated liquid-vapor mixture?

Ratio of volume occupied by vapor phase to total volume of the mixture

Ratio of volume occupied by liquid phase to total volume of the mixture

Ratio of mass occupied by vapor phase to total mass of the mixture

Ratio of mass occupied by liquid phase to total mass of the mixture

(d) A steel ball at 300°C is initially held stationary 100 m above the ground. The ball is then released, and the ball accelerates and cools during its fall to the ground. Assume air friction to be negligible. When is the total energy of the ball highest?

The instant it is released

Just before it hits the ground

Just after it hits the ground

The energy remains constant

(e) Which of the following is (are) not true for change in specific internal energy during a process with initial and final states having only liquid?

$$\Delta u = u_2(P_2, T_2) - u_1(P_1, T_1)$$

$$\Delta u = u_f(P_2) - u_f(P_1)$$

$$\Delta u = C(T_2 - T_1)$$

$$\Delta u = u_f(T_2) - u_f(T_1)$$

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2. [40 points] A piston-cylinder device contains a gas (which remains a gas throughout) undergoing a cycle with the following three processes:

Process 1-2: Constant pressure expansion at 10 bar absolute pressure

Process 2-3: Constant volume cooling

Process 3-1: Linear pressure increase from 5 bar absolute pressure (State 3) back to 10 bar absolute pressure at State 1

The data at various states in the cycle is provided in table below.

State	P, bar	V, m ³	U, kJ
1	10	0.5	200
2	10	1	400
3	5	1	200

(a) Sketch the three processes on a P-V diagram. Label the axes and all three states and indicate the process directions with arrows.

(b) Calculate the boundary work (kJ) for the gas during each process.

(c) Determine the heat transfer (kJ) for the gas during each process.

(d) Is this a power cycle or a refrigeration cycle? Justify your answer with appropriate calculation.

(e) Calculate thermal efficiency or coefficient of performance for the cycle.

Do not solve (d) and (e) as practice for Exam-1 Spring-2023.

Identify the system, show mass/energy interactions (EFD), list any assumptions and basic equations, and provide your solution. There is no need to re-write the given and find.

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3. [40 points] A closed, rigid tank with a volume of 0.25 m^3 initially contains refrigerant R-134a at an absolute pressure of 6 bar and temperature of 60°C (State 1). The refrigerant is stirred with a paddle wheel device and the tank is cooled at the same time. The paddle wheel performs 10 kJ of work on the refrigerant. The refrigerant temperature drops to 12°C (State 2) due to the given energy interactions.

- (a) Determine the mass (kg) of R-134a in the tank.
- (b) What is the final pressure (bar) of R-134a in the tank?
- (c) Find the heat transfer (kJ) for R-134a during the process.
- (d) Show the process on P-v diagram relative to the vapor dome and the lines of constant temperature for the two states. Label the axes and two states and indicate the process direction with arrow.

Identify the system, show mass/energy interactions (EFD), list any assumptions and basic equations, and provide your solution. There is no need to re-write the given and find.

Selected answers are on the next page. Complete solutions will be not provided. You may check your solutions either with instructors or with teaching assistants during office hours.

Selected Answers

1(a) $W < 0, Q < 0$

1(b) $T > T_{\text{sat}}, P < P_{\text{sat}}$

1(d) The instant it is released

2(b) $W_{12} = +500 \text{ kJ}, W_{23} = 0, W_{31} = -375 \text{ kJ}$

2(c) $Q_{12} = +700 \text{ kJ}, Q_{23} = -200 \text{ kJ}, Q_{31} = -375 \text{ kJ}$

3(a) $m = 6.04 \text{ kg}$

3(c) $Q_{12} = -353 \text{ kJ}$