EXAM # 1

INSTRUCTIONS

1. This is a closed book examination. You are provided with an equation sheet and all needed property tables are provided.
2. Do not hesitate to ask the instructor if you do not understand a problem statement.
3. Start each problem on the same page as the problem statement. Write on only one side of the page. Materials on the back side of the page will not be graded. There are blank pages following each of the second and third problems for your work.
4. Put only one problem on a page. A second problem on the same page will not be graded.
5. Label your system and list relevant assumptions for problems 2 and 3.
6. If you give multiple solutions, you will receive only a partial credit although one of the solutions is correct. Delete the solutions you do not want.
7. For your own benefit, please write clearly and legibly. Maximum credit for each problem is indicated below.
8. After you have completed the exam, at your seat, put your papers in order. This may mean that you have to remove the staple and re-staple. Do not turn in loose pages.
9. Once time is called you will have three minutes to turn in your exam. Points will be subtracted for exams turned in after these three minutes.

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<th>Problem</th>
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Problem 1. (40 points) Place your answers in the boxes. Show all work to receive credit.

a) A 70-kg woman wishes to walk on snow, but the snow cannot withstand pressures greater than 0.5 kPa. Determine the minimum size of the snowshoes needed (imprint area per shoe in m²) to enable her to walk on the snow without sinking. (6 points)

b) The barometer of a mountain hiker’s watch reads 930 mbars at the beginning of a hike and 780 mbars at the end. Neglecting the effect of altitude on local gravitational acceleration, determine the vertical distance climbed (m). Assume an average air density of 1.20 kg/m³. (7 points)

c) Determine the minimum energy required (kJ) to accelerate a 1300-kg car from 10 to 60 km/h on an uphill road with a vertical rise of 40 m. Neglect any frictional effects. (7 points)
d) Determine the work required (kJ) to deflect a linear spring with a spring constant of 70 kN/m by 20 cm from its rest. (6 points)

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e) At winter design conditions, a house is projected to lose heat at a rate of 60,000 Btu/h. The internal heat gain from people, lights, and appliances is estimated to be 6000 Btu/h. If this house is to be heated by electric resistance heaters, determine the required rated power of these heaters in Btu/h to maintain the house at constant temperature. (7 points)

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f) A pan on a stove with a lid initially contains boiling water (no air) within a room at 20°C and 100 kPa. The stove is turned off and the pan cools to the surrounding air temperature. If the lid is rigid and provides a perfect seal, then estimate the force required (kN) to remove the lid. Assume negligible friction and the lid weighs 1 kg with an area of 0.04 m². (7 points)

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Problem 2. (35 points) A used refill container for an automotive air conditioner is left out in the sun such that temperature and pressure of the refrigerant are 120°F and 180 psia. The container is made of steel and has an internal volume of 30 in³. The owner brings the container into the house and the contents cool down to 70°F. Do the following:

a) Determine the mass (lbm) of R134a within the container.
b) Determine the final pressure (psia) of the R134a at the final temperature.
c) Depict the process for the R134a on a P-v diagram with respect to saturation lines.
d) Determine the work done (Btu) by the R134a.
e) Determine the heat transfer (Btu) to the R134a.

Identify your system, list assumptions, and start with basic equations.
First Name ___________________ Last Name ____________________
Problem 3. (25 points) A piston-cylinder device initially contains 0.5 m$^3$ of helium gas at 150 kPa. The helium is compressed to 400 kPa during a process where $PV = k$ and where $k$ is a constant. Estimate the work associated with the process in kJ.

Identify your system, list assumptions, and start with basic equations.