Chemistry 2720 Fall 2002 Test 1

Answer all questions.
Write all answers in the booklets provided.
Aids allowed: $8\frac{1}{2} \times 11$-inch information sheet, calculator.
Time: 75 min
Questions: 4
Marks: 61
Useful data:

$$R = 8.314\,472\,\mathrm{J\,K^{-1}mol^{-1}}$$
$$1\,\mathrm{m}^3 = 1000\,\mathrm{L}$$

To convert degrees Celsius to Kelvin, add 273.15.

Standard Thermodynamic Properties at 25°C and 1 bar		
Species	$\Delta \bar{H}_f^\circ$ (kJ/mol)	$\bar{C}_P$ $\mathrm{J\,K^{-1}mol^{-1}}$
$C_3H_{8(g)}$	-103.85	73.6
$CO_{2(g)}$	-393.51	37.1
$CaCO_{3(s)}$	-1206.9	81.9
$CaO_{(s)}$	-634.92	42.8
$H_2O_{(g)}$	-241.826	33.58
$O_{2(g)}$	0	29.35

1. Calculate the work done on or by the gas when 8 mol of nitrogen is compressed isothermally and reversibly at 300°C from an initial volume of 1 L to a final volume of 30 mL. Assume that nitrogen behaves as an ideal gas. Explain the meaning of the sign of your answer. [9 marks]

2. Calculate the heat produced or absorbed when 18 g of solid calcium oxide (molar mass 56.077 g/mol) is completely converted to calcium carbonate by reaction with carbon dioxide at 25°C in a container of fixed volume. Explain the meaning of the sign of your answer. [12 marks]

3. Does propane (C_3H_8) provide more heat when it burns under constant-pressure conditions at 400°C or at 25°C? To make the comparison fair, assume that water vapor (rather than liquid) is produced in both cases. [14 marks]

4. Dichloroacetic acid (molar mass 128.94 g/mol) melts at 286.5 K and has an enthalpy of fusion of 12.34 kJ/mol. The liquid has a heat capacity of $207 \, \mathrm{J\,K^{-1}mol^{-1}}$ while the solid has a heat capacity of $182.30 \, \mathrm{J\,K^{-1}mol^{-1}}$. Water ice melts at 273.15 K with an enthalpy of fusion of 333.4 J/g. The specific heat capacity of liquid water is $4.184 \, \mathrm{J\,K^{-1}g^{-1}}$. 150 g of liquid dichloroacetic acid initially at 20°C is poured onto a 50 g ice cube at 0°C in an insulated cup. What is the final state of the system? [26 marks]

Note: Your answer to this question will be evaluated for clarity as well as correctness. It may be a good idea to separate rough calculations from explanations of your reasoning by placing them on facing pages of the booklet.