Problem 14.3: Calculate the adiabatic flame temperature of methane in 20% excess air at 1 bar. Both methane and air are initially at 25 °C, 1 bar.
Additional data. Assume that the reaction is complete and that products are carbon dioxide and water.
The ideal-gas C_P's (in J/mol K) of the reactants and products as a function of temperature are given below (T must be in K):

$$C_P^{\text{ig}} = a + bT$$

	a (J/mol K)	b (J/mol K^2)
Methane	44.2539	0.02273
CO_2	44.3191	0.00730
Oxygen	30.5041	0.00349
Nitrogen	29.2313	0.00307
Water	32.4766	0.00832

Note: First calculate the temperature assuming the C_p's to be constant and equal to their value at 25 °C; then repeat using the temperature-dependent heat capacities given above.

Problem 14.4: a) Calculate the standard heat of reaction for the complete combustion of methane at 800 °C.
b) Calculate the amount of heat that is released in a furnace that burns methane in 20% excess air, if the furnace temperature is 800 °C and the pressure is 2 bar. Assume that the inlet gases are already at 800 °C as they enter the furnace.
c) Repeat part b, but this time the inlet gases are at 40 °C, 2 bar.
Additional data. Assume that the reaction is complete and that products are carbon dioxide and water.
The heat capacities of the gases are given in Problem 14.3.

Problem 14.5: a) Determine the heat of vaporization of benzene at 25 °C using tabulated heats of formation.
b) Determine Henry's law constant of ammonia in water at 25 °C from the tabulated (g) and (aq) Gibbs energies of formation.
c) Generate an entry for the Gibbs energy of formation of CO based on the standard state for aqueous solutes (aq).
d) N_2O gas is bubbled through water at 12 bar, 10 °C. Calculate the activity of N_2O (aq) and of water (l) in the liquid based on the indicated standard states.

Problem 14.6: The standard enthalpy of formation of water in the gas standard state is $H^\circ_{298}(g) = -241,818$ J/mol/K. Use this value and information from the steam tables to obtain the enthalpy of formation in the liquid standard state and compare with the tabulated value $H^\circ_{298}(l) = -285,830$ J/mol~~/K~~.

units should be J/mol