CE 407 Separations
Happy #1

Instructions: Please read over the entire exam first thing so that you can make a rational decision about how to budget your time. Please think calmly and logically, and work slowly, so that your answers reflect your true knowledge untinged by panic-induced irrationality and careless errors. More than enough data to answer all the questions are supplied on the attached sheets.

1. (60 points) An 80 mol/h saturated vapor feed stream comprising 65 mole percent carbon tetrachloride (CCl_4, light) and 35 mole percent octane (C_8H_{18}, heavy) undergoes continuous distillation at atmospheric pressure in a column fitted with a partial condenser. The top product has CCl_4 mole fraction equal to 0.97 and the bottom product has CCl_4 mole fraction equal to 0.025. The distillation is carried out with reflux ratio $R = 2.23$. Answer the following specific questions.

(a) (25 points) How many stages are required in the column itself if all these stages have Murphree efficiencies η_{M} equal to 0.75?

(b) (10 points) What is the vapor flow rate $\overline{V}$ below the feed stage?

(b) (25 points) Arbitrarily choose reference states such that $H = 0$ for pure liquid CCl_4 at 77 °C and $H = 0$ for pure liquid octane at 77 °C. What is the enthalpy of the vapor leaving the top stage in the column and entering the partial condenser?

Data and assumptions: Data you may need are given on the attached sheets. Use the McCabe-Thiele method, i.e., assume constant molar flow rates in the rectifying and stripping sections of the column.

__2__. (40 points) Methanol is stripped from a 9.0 mol/min contaminated water stream (composition 99.5 mole percent water, 0.5 mole percent methanol) by countercurrent contact with air at 25 °C in a stripping tower purchased from Elroy Hutch Heavy Machine Industries™. Air enters the tower pure. Pressure is atmospheric. Answer the following specific questions.

(a) (20 points) If stripping is carried out using 18.0 mol/min of entering air, what is the smallest achievable methanol mole fraction in the exiting liquid, corresponding to an effectively infinite number of stages?

(b) (20 points) If stripping is carried out using 36.0 mol/min of entering air, how many ideal stages are required in order for the exiting liquid to have methanol mole fraction equal to 0.0001?

Data and assumptions: Data you may need are given on the attached sheet. Make the "usual approximations," i.e., neglect evaporation of water as well as dissolution of air in the liquid. Given the diluteness of the solutions involved, you may assume validity of Henry's law for methanol dissolved in water. Also given the diluteness of the solutions involved, you may use the Kremser equation in any counting of stages.

Data

C_P of liquid CCl_4 is 150 J / mol K

C_P of liquid octane is 270 J / mol K

C_P of vapor CCl_4 is 90 J / mol K

C_P of vapor octane is 260 J / mol K

ΔH^{vap} of CCl_4 at its normal boiling point is 29,300 J / mol

ΔH^{vap} of octane at its normal boiling point is 33,800 J / mol

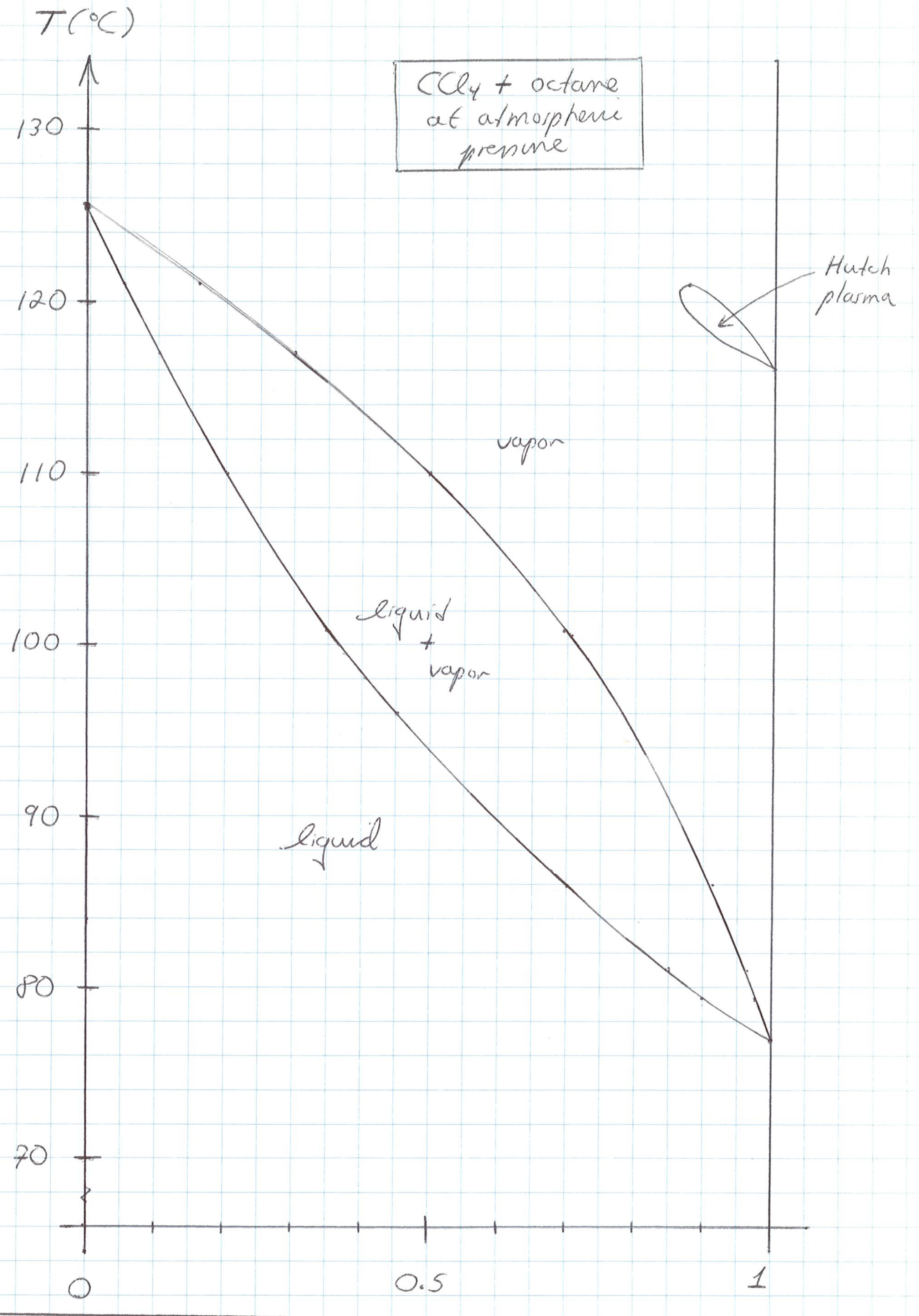
Henry's law constant for methanol in water at 25 °C is 282 mm Hg

Color of Elroy's blue jumpsuit is blue

Henry's law:

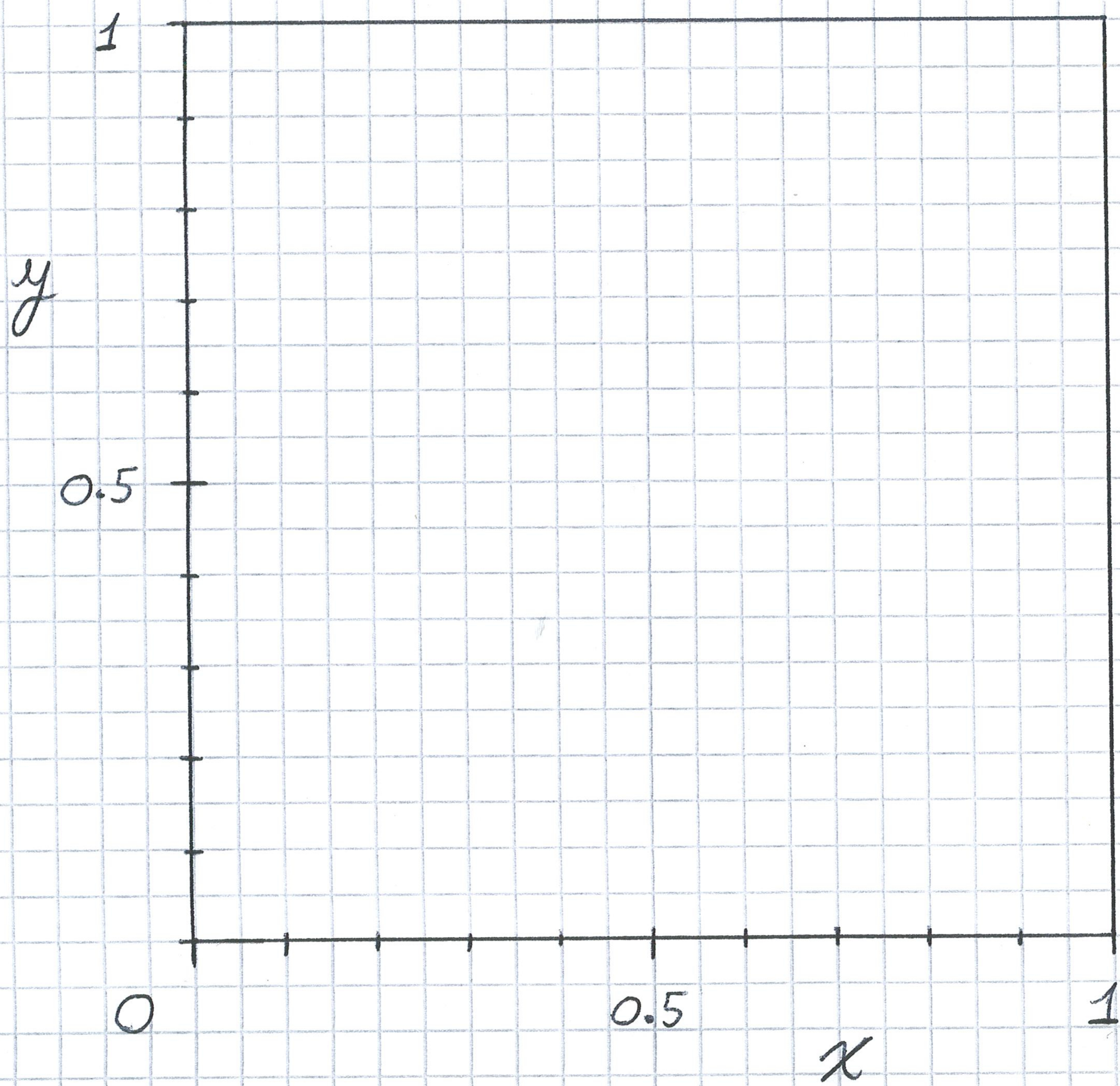
$$y_i P = \underset{\substack{\uparrow \\ \text{Henry's law constant}}}{K_i}\, x_i$$

Elroy-matic™ Data Sheet
No. 1



Elroy-matic™ Data Sheet No. 2

Graph paper for #1



Graph paper for # 1