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Activity: Students find conceptual errors in AI output

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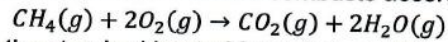
Example 1 Problem Statement and Solution (Thermodynamics):

1. You are an intern at Enterprise Pharmaceuticals, and your team is designing a new refrigeration system for an active ingredient. You are trying to decide between two refrigerants to use at a specific temperature and pressure: R-134a and R-410a.
 - a. (1 pt) Your colleague, Chet Geepeatee¹, says that the state postulate implies that at the same temperature and pressure conditions, both R-134a and R-410a will have identical pressure, temperature, density, and other properties, and therefore, there is no preference for one refrigerant over the other. Are they correct about what the state postulate means? Explain.

No! The state postulate says that the intensive properties (the state) of a pure component are defined when any 2 independent intensive properties are specified. That is, if we set the values of P & T , then ρ , v , etc. will be defined. The state postulate, however, does not say anything about how the properties of two different substances will compare. Both refrigerants' states may be defined by the P & T , but that doesn't mean their other properties are identical.

Example 2 Problem Statement and Solution (Thermodynamics):

1. As part of your internship at Enterprise Pharmaceuticals, you've now been tasked to help design a waste incinerator for methane. Methane combusts according to the following:



You previously calculated the standard heat of formation as $\Delta h^\circ_{\text{rxn}} = -802.31 \text{ kJ/mol}$.

- a. (1.5 pts) Your boss wants you to help assess the adiabatic flame temperature of this reaction, assuming the fuel is air. Your fellow intern Chet Geepeattee¹ chimes in with the following:

"We can use the following equation:

$$\Delta H^\circ = m c_p \Delta T$$

where ΔH° is the enthalpy change, m is the mass of methane combusted, c_p is the heat capacity at constant pressure, and ΔT is the change in temperature. Assuming one mole of methane is combusted and that the combustion is adiabatic, meaning there is no heat exchange with the surroundings ($Q = 0$),

$$0 = (1 \text{ mol})(c_p)(\Delta T)$$

and ΔT must be the adiabatic flame temperature. Therefore, $\Delta T = 0 \text{ K}$. So the adiabatic flame temperature for the combustion of methane is 0 K ."

Briefly, what are three (3) conceptual errors in Chet's explanation/calculations?

- 1) This equation only accounts for sensible heat, not the heat of the reaction
- 2) Chet is using a constant c_p value which wouldn't likely be applicable for the entire mixture of components
- 3) The adiabatic flame temperature could not possibly be absolute zero! That is nonsensical — it should at least be equal or higher than the starting reaction temperature since it represents the "hottest possible" reactor temperature.

ANSWERS WILL VARY — THESE ARE POSSIBLE EXAMPLES

Example 3 Problem Statement and Solution (Chemical Separations):

4. (10 pts) You are interning at Enterprise Pharmaceuticals, and your boss asks you to find the bounding values (R_{min} and N_{min}) for the binary distillation column they are designing. When you go to review what you know about how these values are related, your fellow intern, Chet Geepeatee¹, butts in with the following:

No — there is no analytical relationship between them

The relationship between the minimum reflux ratio (R_{min}) and the minimum number of stages (N_{min}) in distillation can be described by the Fenske equation. The Fenske equation relates the minimum reflux ratio to the minimum number of stages required to achieve a desired separation for a given feed composition, product specifications, and relative volatility of components. It is given by:

$$R_{min} = \frac{N_{min} - 1}{N_{min}}$$

Not the Fenske equation!!

No, it finds N_{min} from x_D, x_B , and α_{AB} . It has nothing to do with R_{min}

The minimum number of stages (N_{min}) represents the minimum number of equilibrium stages required to achieve the desired separation. It is influenced by factors such as the relative volatility of components, feed composition, and desired product specifications.

It is not influenced by feed composition

you're trying to describe the "normal" reflux ratio, not the min. Also, $R = \frac{L_0}{D}$ not $\frac{L_0}{V}$

The minimum reflux ratio (R_{min}) is the ratio of the liquid refluxed back to the column to the vapor leaving the top stage. It is essential to provide sufficient reflux for efficient separation and maintaining the desired product specifications. Overall, as the number of equilibrium stages (N_{min}) increases, the minimum reflux ratio (R_{min}) also increases. This relationship ensures that an adequate amount of liquid is circulated within the column to achieve the desired separation.

No — as $N \uparrow$, $R \downarrow$. They're inversely related

N_{min} not directly related to R_{min}

Underline/circle two (2) **significant** conceptual errors in Chet's explanation above and leave a **brief** annotation next to each explaining why/how he's wrong. **ANSWERS WILL VARY. A FEW ARE SHOWN.**

Example 4 Problem Statement and Solution (Chemical Separations):

6. (8 pts) You are interning at Enterprise Pharmaceuticals, and your boss has asked you to design a batch distillation system. Like any good engineer, you begin by thinking about what assumptions you must make when solving for your design. When you confer with your fellow intern, Chet Geepeatee¹, he explains that the following are common assumptions in batch distillation:

- **Constant molar overflow:** It is assumed that the liquid and vapor leaving the distillation column are in equilibrium with each other.
- **Ideal behavior:** Ideal behavior of the components and phases is assumed, which means there are no azeotropes or deviations from Raoult's law.
- **Negligible pressure drop:** Any pressure changes along the distillation column are assumed to be negligible.
- **Constant vapor and liquid compositions:** It is assumed that the vapor and liquid compositions remain constant throughout the distillation process.
- **No heat loss:** It is assumed that there is no heat loss to the surroundings during the distillation process.
- **Uniform temperature and pressure:** The temperature and pressure within the distillation column are assumed to be uniform at all points.
- **Well-mixed liquid and vapor phases:** It is assumed that there is perfect mixing between the liquid and vapor phases within the distillation column.
- **Instantaneous phase equilibrium:** It is assumed that phase equilibrium between the liquid and vapor phases is immediately reached at each stage.

No!
Column is
coolest at
top & hottest
at bottom

This is not CMO
but the equil. stage
model (ish)
[should be streams leaving
a stage]

No! These
change (decrease)
throughout the
batch dist. process

Underline/circle two (2) **significant** errors in Chet's explanation above and leave a **brief** annotation next to each explaining why/how he's wrong.

¹ Yes, I really did ask ChatGPT to explain this to me, and yes, this is what it told me. Note that it has been somewhat shortened because it's entirely too wordy for my taste.