EngrD 2190 – Lecture 19

Concept: Process Analysis - Graphical Modeling

Context: Thermodynamic Maps for Binary Mixtures -
The Lever Rule and Tie Lines

Defining Questions:

What is the descriptive term for the border between the ‘all vapor’ and ‘liquid+vapor’ regions on a map for binary mixtures?

What is the descriptive term for the border between the ‘all liquid’ and ‘liquid+vapor’ regions on a map for binary mixtures?

Bring a Straightedge or Ruler to Lecture 20.

EngrD 2190 - Second Team Assignments - Fall 2025

Team 1	NetID
Gabby Alvarado	gaa68
Valerie Ruiz	vr336

Team 2	NetID
Ward Dobeck	wed47
Chuck Fang	cf544
Cullen Mccarthy	cpm227

Team 3	NetID
Maame Amanpene	ma2399
Em Vincent	ekv24
Sophia Zheng	sz683

Team 4	NetID
Evan Brezicki	ejb323
Andy Glesmann	arg292
Bradley Reiff	bjr235

Team 5	NetID
Greg Demos	gd332
Kanat Schoeberlein	kts59

Team 6	NetID
Minwoo Chung	emc358
Bill Nguyen	nn347
Wilson Zhang	wtz5

Team 7	NetID
Nicolas Banks	onb6
Andreas Custelcean	aec327
Jude Thomas	jct268

Team 8	NetID
Noor Dewood	nnd26
Sofia Romero	scr226
Shivani Parmar	ssp238

Team 9	NetID
Luke Aengenheyster	lma226
Connor Lucente	cbl64
Wilman Vlach	wlv23

Team 10	NetID
Sally Mallin	sam595
Kenzie Vasbinder	mrv49
Evelyn Ziaee	ez253

Team 11	NetID
Isabelle Bennie	ikb25
Steffanie Jones	scj56
Anna Voronova	asv44

Team 12	NetID
Youyou Xie	yx645
Hank Xue	zx344
Xinchi Zhang	xz985

Team 13	NetID
Gavin Chaing	gac233
Syon Khatter	sk3297
Vanshikha Sabbi	ls2242

Team 14	NetID
Sumama Haque	smh442
Daniel Herzenstein	dh762
Trevor Williams	tew63

Team 15	NetID
Eliza Gifford-Powell	eg659
Elizabeth Kline	elk92
Eva Yang	ey282

Team 16	NetID
Rhiannon Donovan	rd627
Anika Mahadeshwar	ajm546
Giorgia Santore	gs752

Team 17	NetID
Charlene Chan	cc2878
Minjin Kim	mk2597
Tomou Takahashi	ktt37

Team 18	NetID
Amber Belk	adb329
Dolly Hritz	drh258
Audrey Fu	af643

Team 19	NetID
Julianna Cross	jjc454
Nadia Diaz	nld46
Keira Kim	khk56

Team 20	NetID
Matt Hirsch	mh2623
Noah Reckhart	nar85
Santiago Rodriguez D'Ercole	sar356

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Simeon Hur	sh2659
Eleanor Reid	egr58
Sofia Ziegler	srz25

Team 22	NetID
Areebah Junaid	aj633
Aaron Legg	all288
Parth Vaidyanath	prv24

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Shannon Hitscherich	srh254
Aaron Salit	ams876

Team 24	NetID
Alice Burke	amb625
Mary Kanak	mck236
Noah Parfrey	ncp49

Team 25	NetID
Izabela Grigorov	ig295
Lauren Hsu	lkh58
Evelyn Sangree	ehs95

Team 26	NetID
Alex Cheng	ac2968
Patrick Donahue	pnd25

Team 27	NetID
Anwesha Ghosh	ag2662
Malvika Rao	msr298
Besi Santana	bs862

Team 28	NetID
Ellie Fredine	eaf247
Jasmine Hwee	jh2875
Maddie Li	ml2825

Team 29	NetID
Lila Chami	lc2259
Lila Kaman	lk567
Lizeth Montemayor	lm945

Team 30	NetID
Tanbeer Islam	ti232
Josh Lennon	jsl379
Ayush Tripathi	at969

Homework

- Practice Exercises (not to be handed in):
  Process Economics **3.96** and **3.97**. Solutions are posted.

- Homework 6 due Friday 10/24.
  4.4 and **4.8** graphical energy balances.
  4.15 graphical analysis of flash drums
  Download blank graphs and phase data from EngrD 2190 homepage:
  Textbook→ Textbook Graphs and Figures →
  Graphs for Chapter 4 Exercises.
  Homework is your chief means of assessing your command of the material.

- New Homework Team Assignments
  For New Teams: ***Last*** person listed is Team Coordinator for Homework 6.

- Process Economics Analysis with a Spreadsheet
  Optimize a chemical process with respect to ROI.
  Your *Process Plan* – equipment purchases and operating parameters –
  is due Monday 10/20 at 5 p.m.
  You must also submit your spreadsheet.

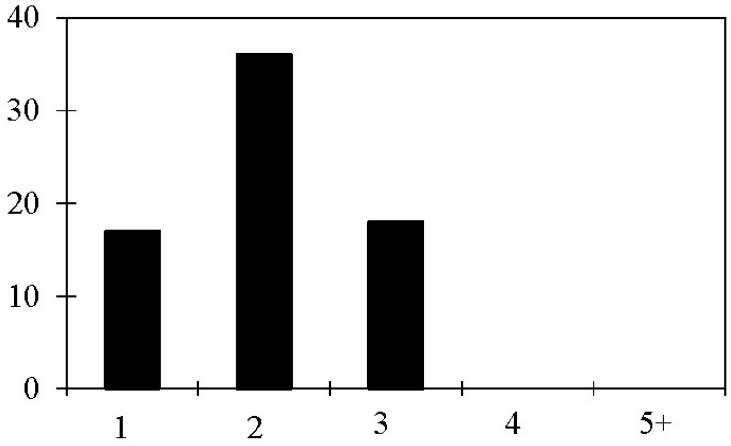
Mid-Semester Survey - 2025

EngrD 2190 - Chemical Process Design & Analysis - Fall 2025

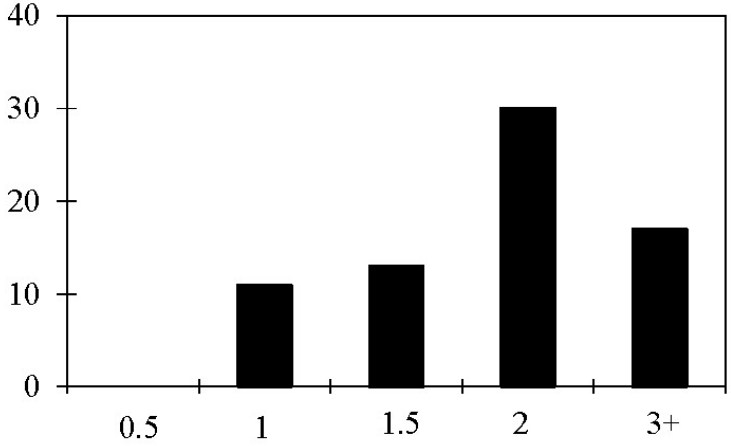
86 enrolled, 72 responses

Team Homework

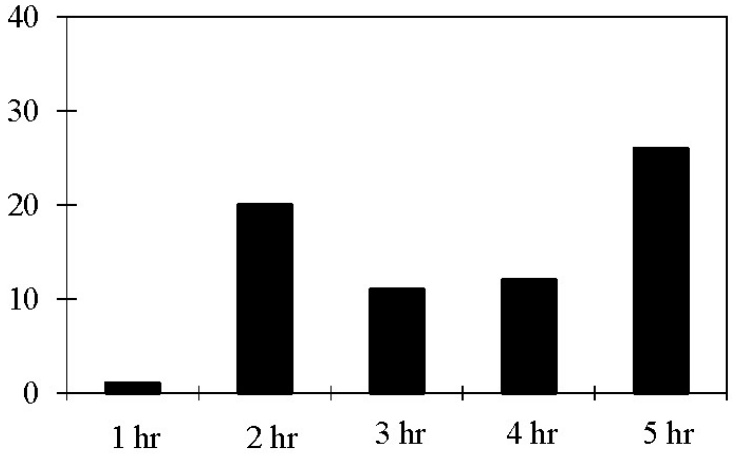
How many times does your team meet to complete a homework assignment?



What is the duration of a typical team meeting (in hours)?



Total time in meetings weekly?



Mid-Semester Survey - 2025

EngrD 2190 - Chemical Process Design & Analysis - Fall 2025
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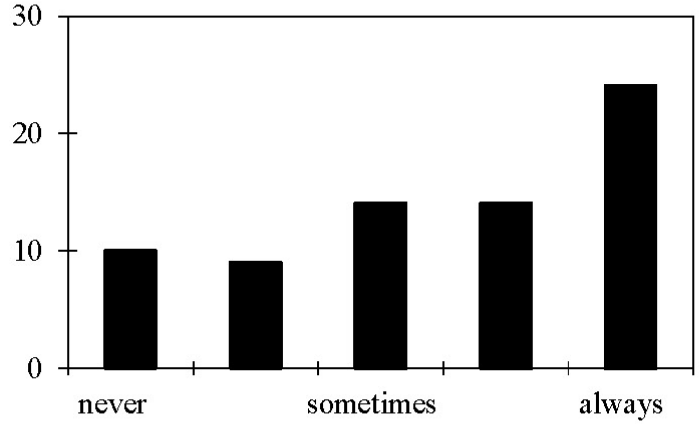
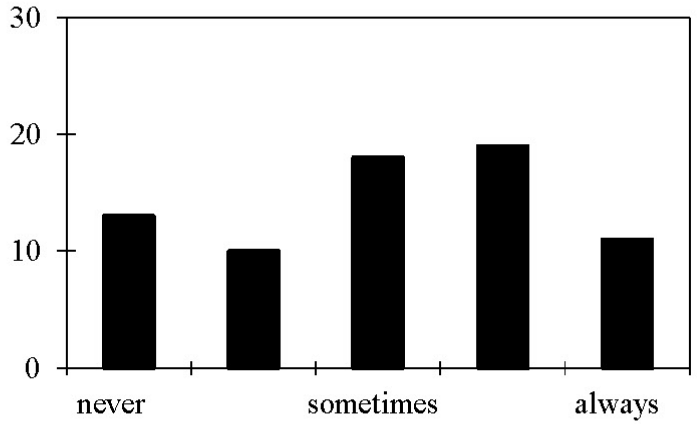
Team Homework, continued

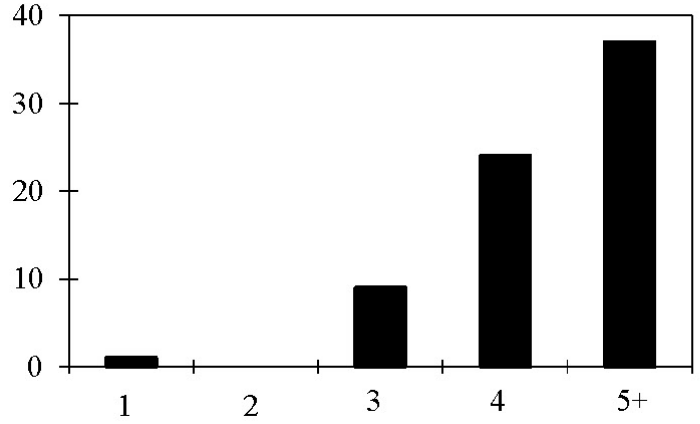
Do you work the homework exercises before your team's first meeting?



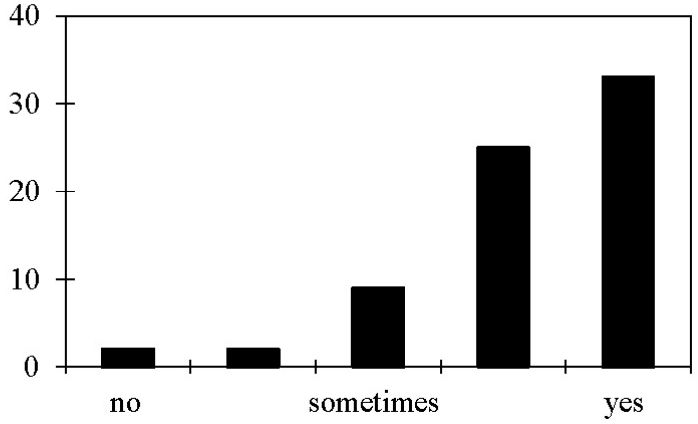
Do your teammates work the exercises before your team's first meeting?



What is your total time spent on a typical homework assignment (hours)?



Is your homework team effective for learning the course material?



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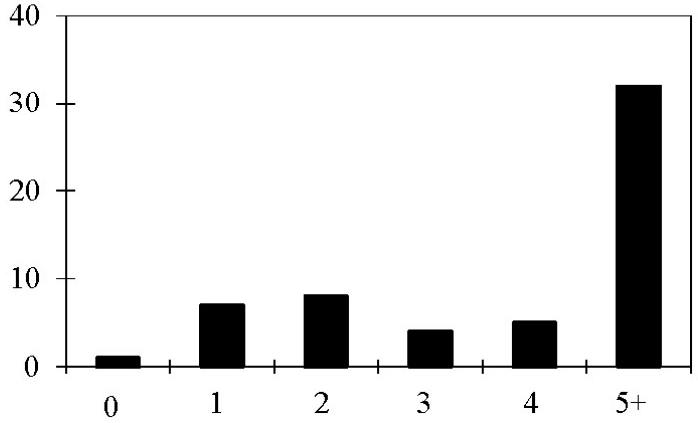
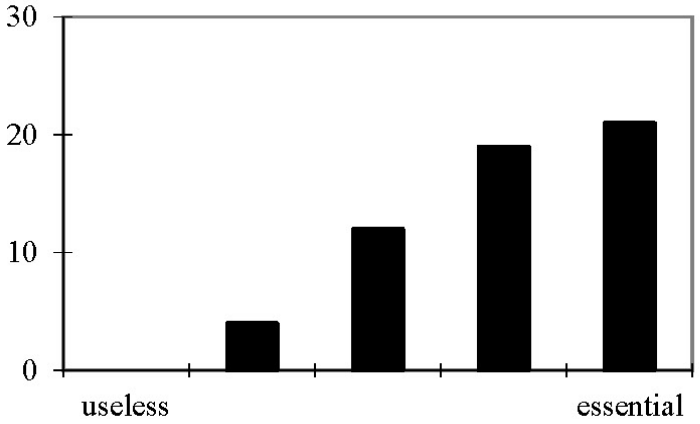
TA Office Hours

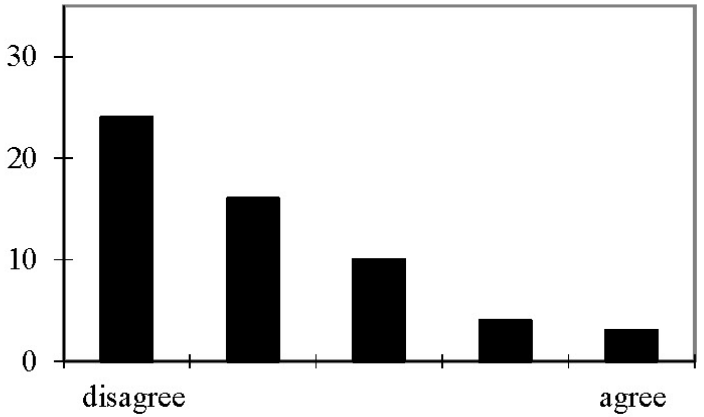
How many times have you visited TA office hours?



If you have consulted the TAs during office hours, please rate the usefulness.

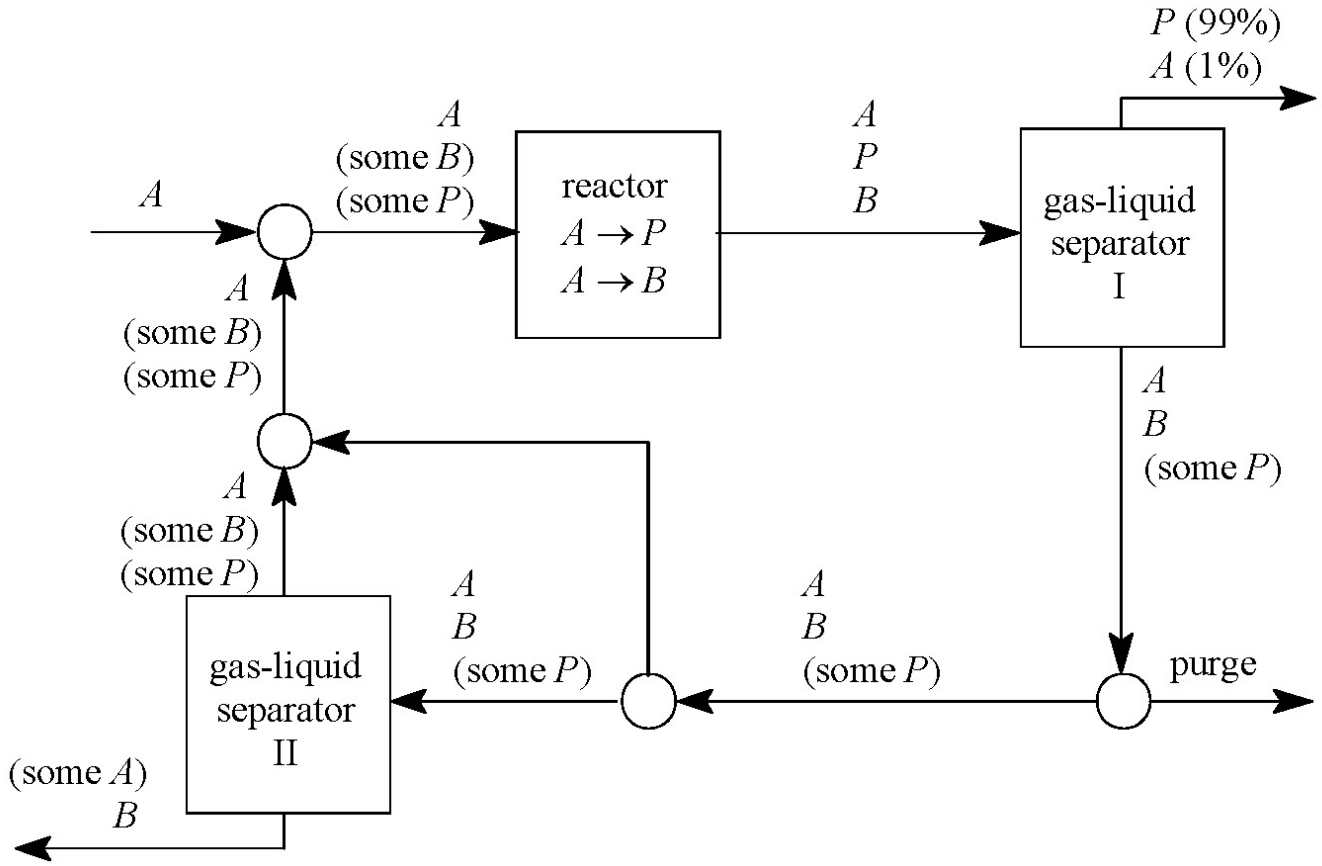


Two TAs are sufficient to cover the demand in TA office hours.



Process Economic Analysis with Spreadsheets - 2025

Optimize a chemical process with respect to ROI.



Annual Plans due Monday 10/20 ~~at noon.~~ at 5 p.m

Process Design:

Equipment Capacities?

Process Operation:

Feed flow rate? Purge fraction? Recycle to Reactor?

Recycle through 2nd Separator?

Process Economic Analysis with Spreadsheets - 2025

Process Design & Operation Plan - 2025

Name _____ NetID _____

Equipment Purc

Reactor:

Separato

Separator II: Type: (1 or 2)

day)

Operating Paramet

Rea

Frac

Fraction of Separator I liquid bottoms to recycle*: _____

Due Monday October 20 ~~at noon~~ at 5 p.m

All eight configurations
can be optimized to a ROI > 0.

The maximum ROI is 36%/year.

The minimum ROI is 18%/year.

You should be able to attain
a ROI of at least 18%/year.

You should be skeptical if you attain
a ROI greater than 36%/year.

Types dictated by your NetID

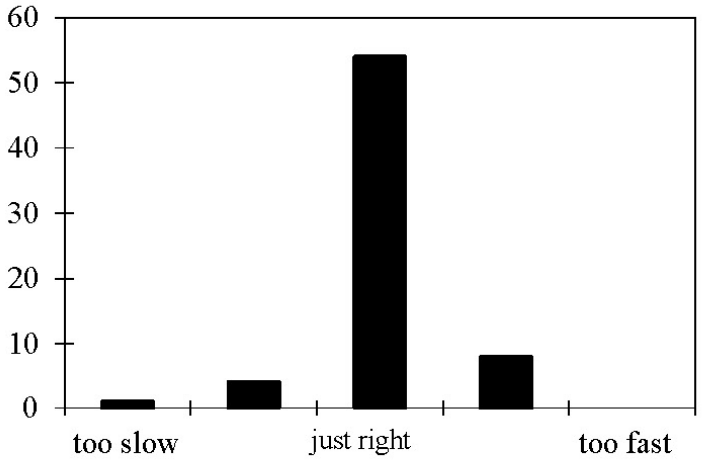
Download this form from the EngrD 2190 website

Mid-Semester Survey - 2025

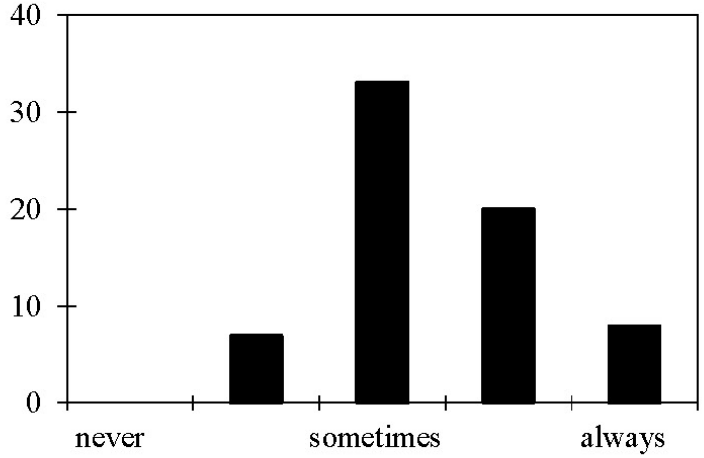
EngrD 2190 - Chemical Process Design & Analysis - Fall 2025
86 enrolled, 72 responses

Lectures

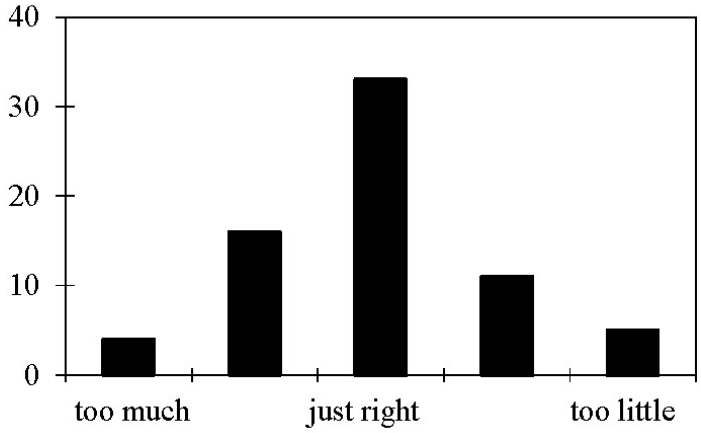
Pace of the lectures?



Read the textbook before the lecture?



Overlap between the lectures and the textbook?



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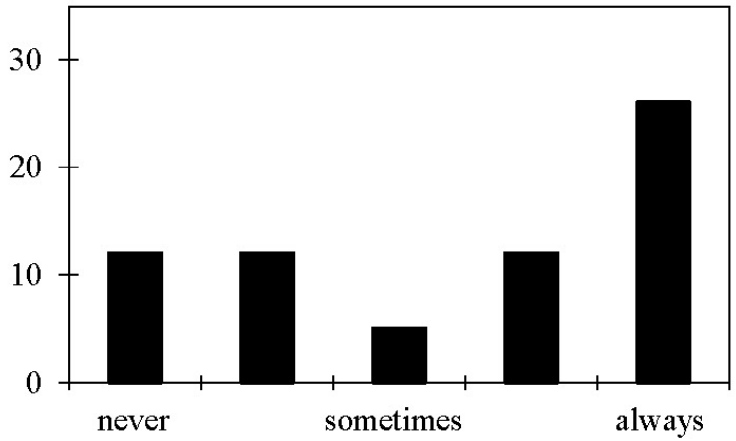
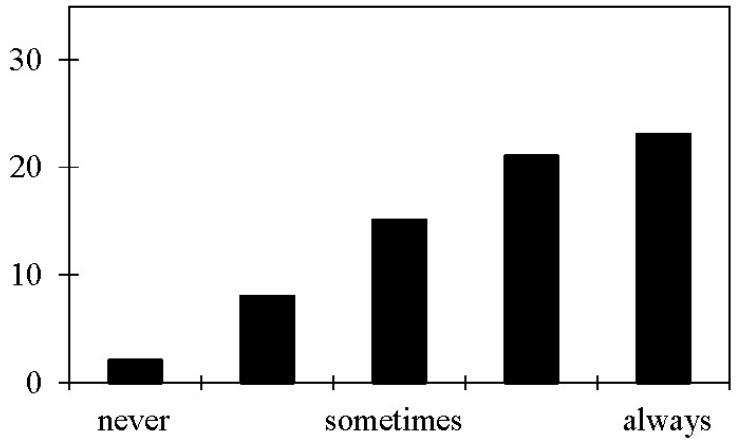
Lectures

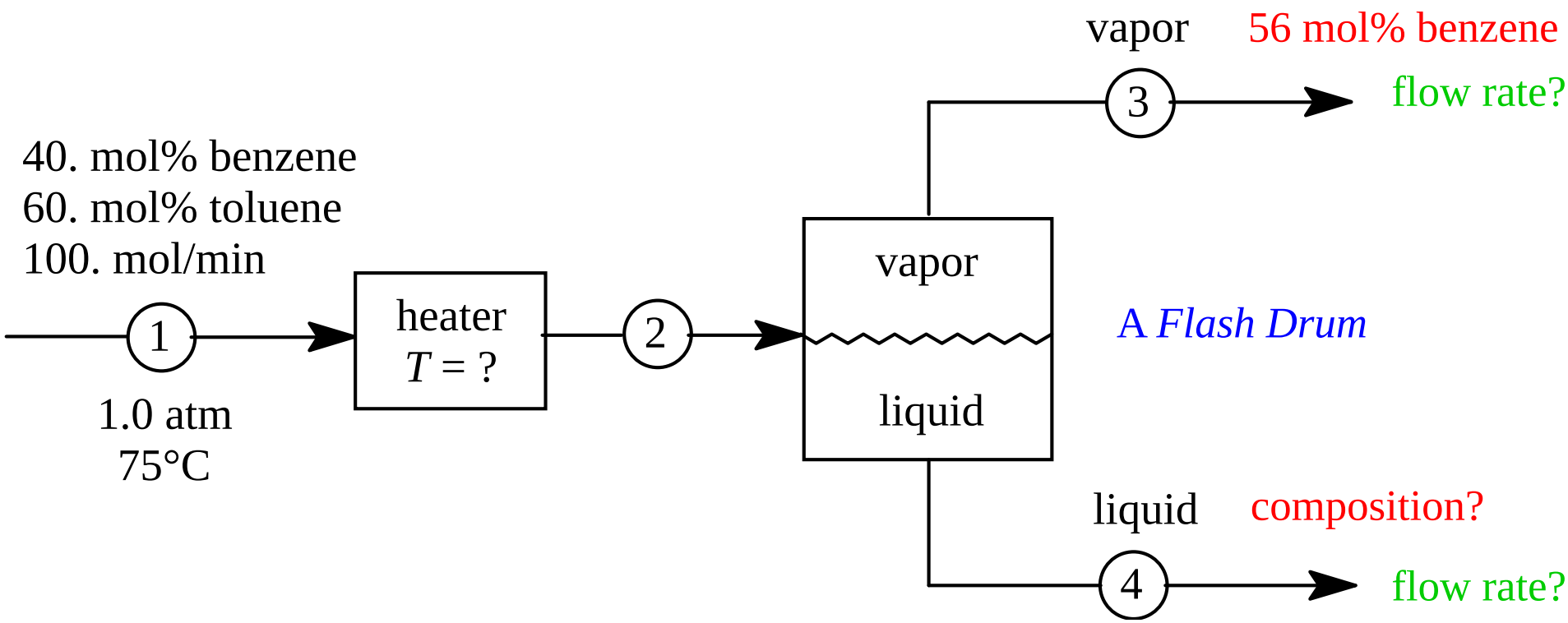
Review the posted powerpoints and pdf's of the lecture ***before or during*** the lecture?



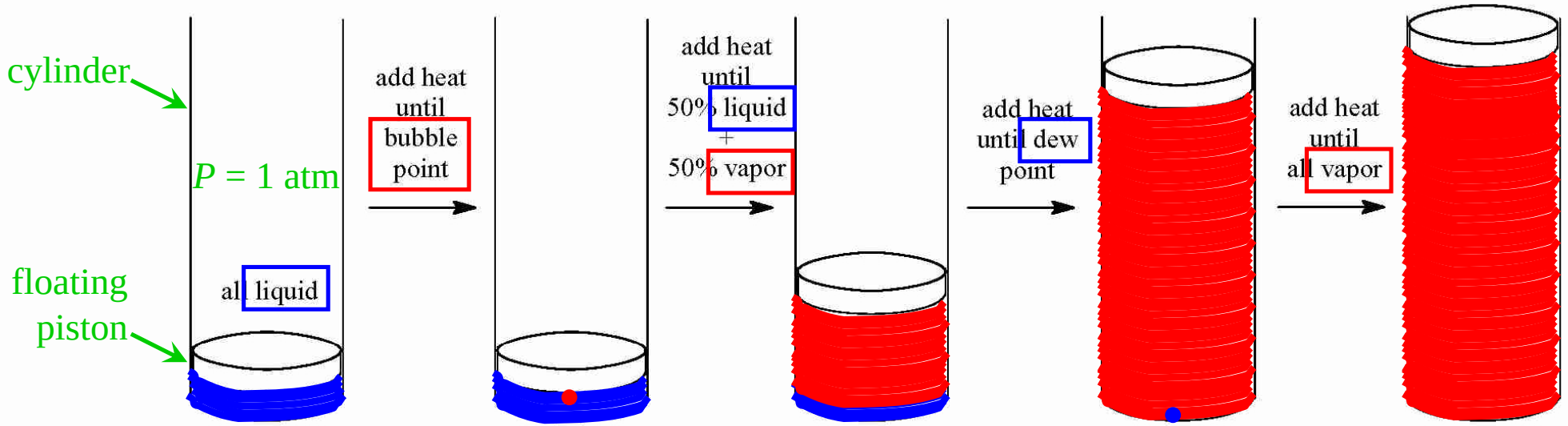
Review the posted powerpoints and pdf's of the lecture ***after*** the lecture?



One L+V Equilbrium Stage



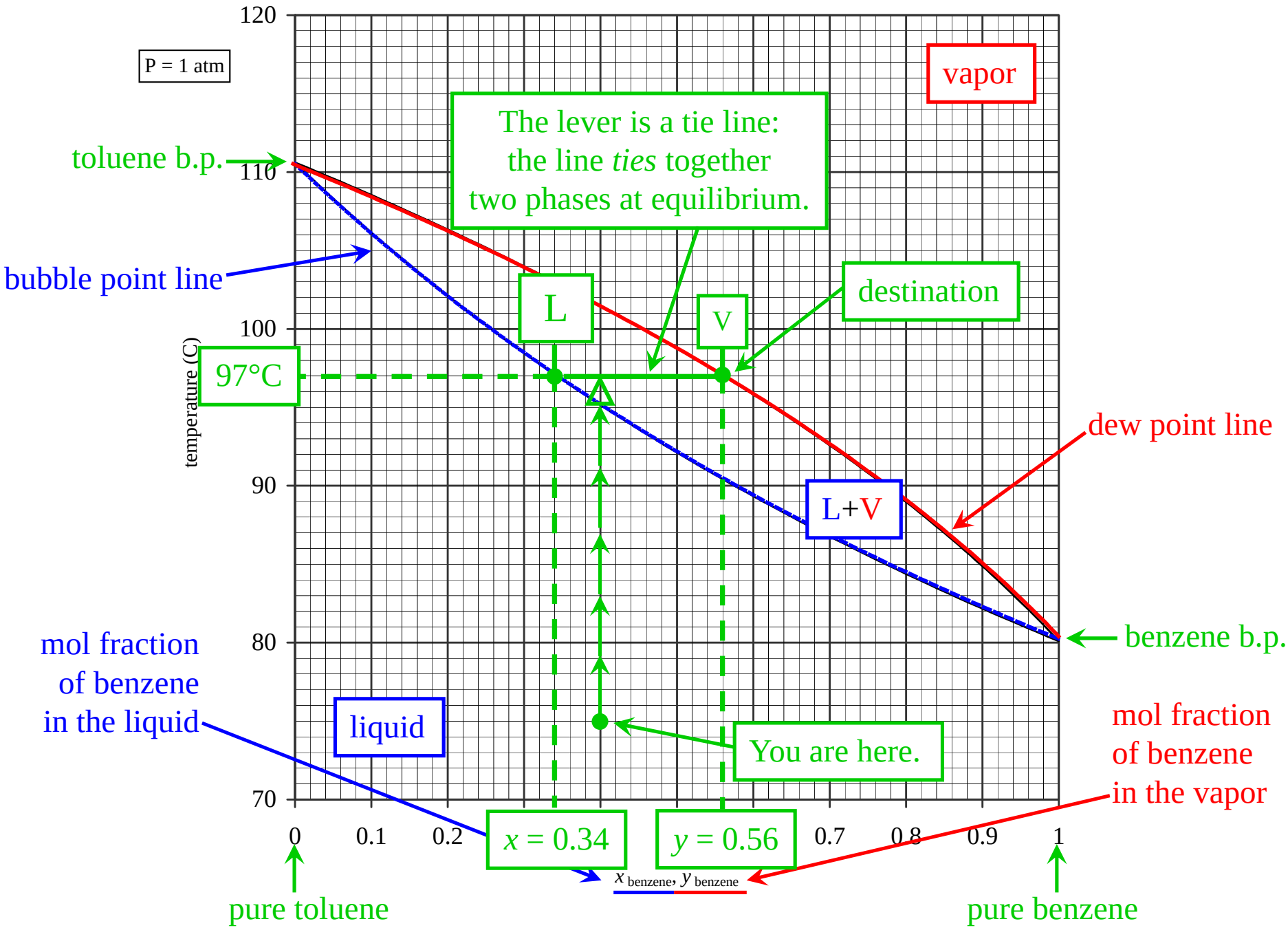
Binary Mixtures: Phase Changes by Increasing *T* at Constant *P*



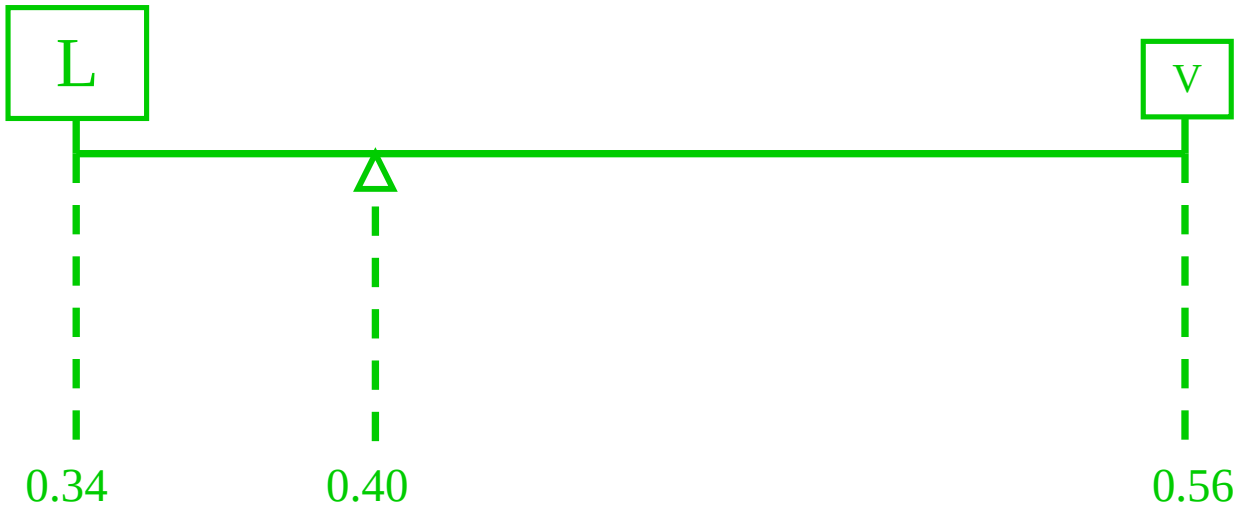
benzene	$T < 80°C$	80°C	80°C	80°C	$T > 80°C$
toluene	$T < 111°C$	111°C	111°C	111°C	$T > 111°C$
50% benzene 50% toluene	$T < 92°C$	92°C L: 50% B V: 70% B	95.5°C L: 38% B V: 62% B	98.5°C L: 30% B V: 50% B	$T > 98.5°C$
75% benzene 25% toluene	$T < 85.5°C$	85.5°C L: 75% B V: 88% B	87.5°C L: 66% B V: 84% B	91°C L: 54% B V: 75% B	$T > 91°C$
25% benzene 75% toluene	$T < 100°C$	100°C L: 25% B V: 45% B	103.5°C L: 17% B V: 33% B	105°C L: 11% B V: 25% B	$T > 105°C$

Example 1.

Benzene+Toluene Mixtures at Equilibrium - A Map



Example 1 - Apply the Lever Rule to the Tie Line



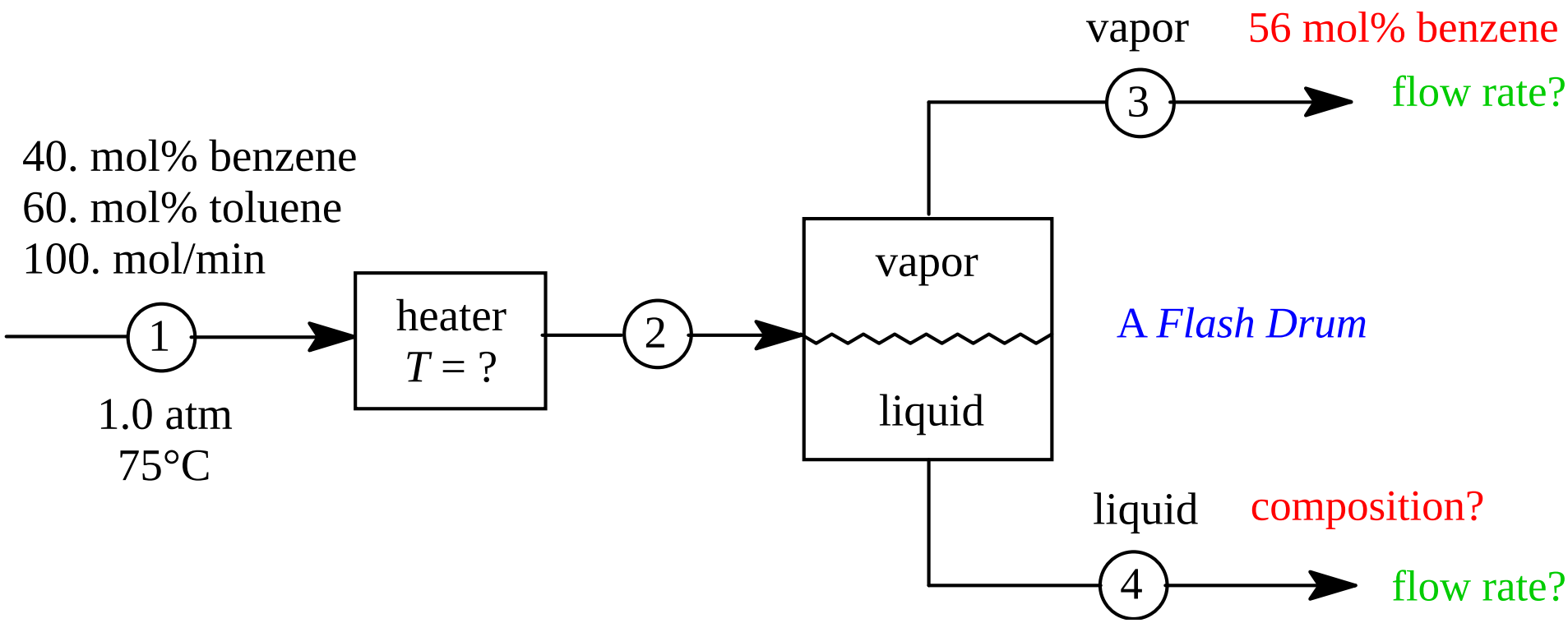
total lever: $0.56 - 0.34 = 0.22$

lever arm to liquid: $0.40 - 0.34 = 0.06$

~~liquid~~ vapor flow rate $= 100 \times 0.06/0.22 = 27$ mol/min. Okay?

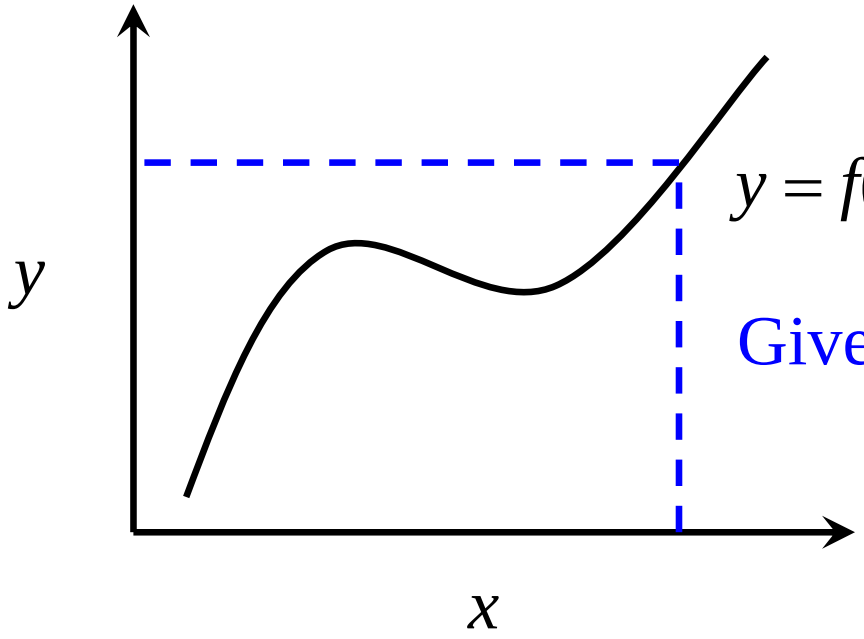
The following five slides
were developed simultaneously
on the second screen.

One L+V Equilbrium Stage



How to plot these Data? A Graph?

A Graph:



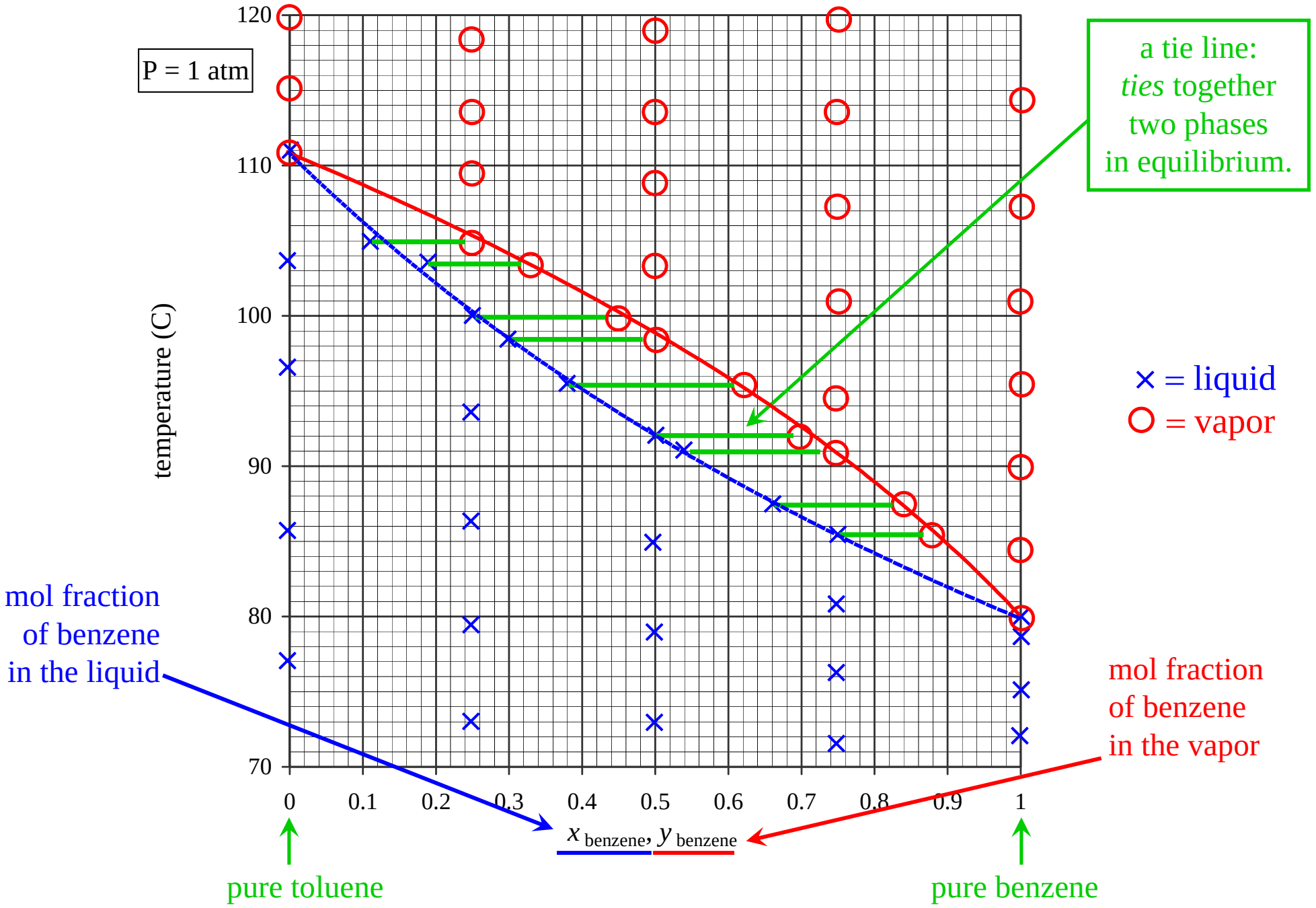
Given *x*, the graph gives *y*.

Our data: given composition *and* temperature,
what is the phase (liquid, vapor, or liquid+vapor)?

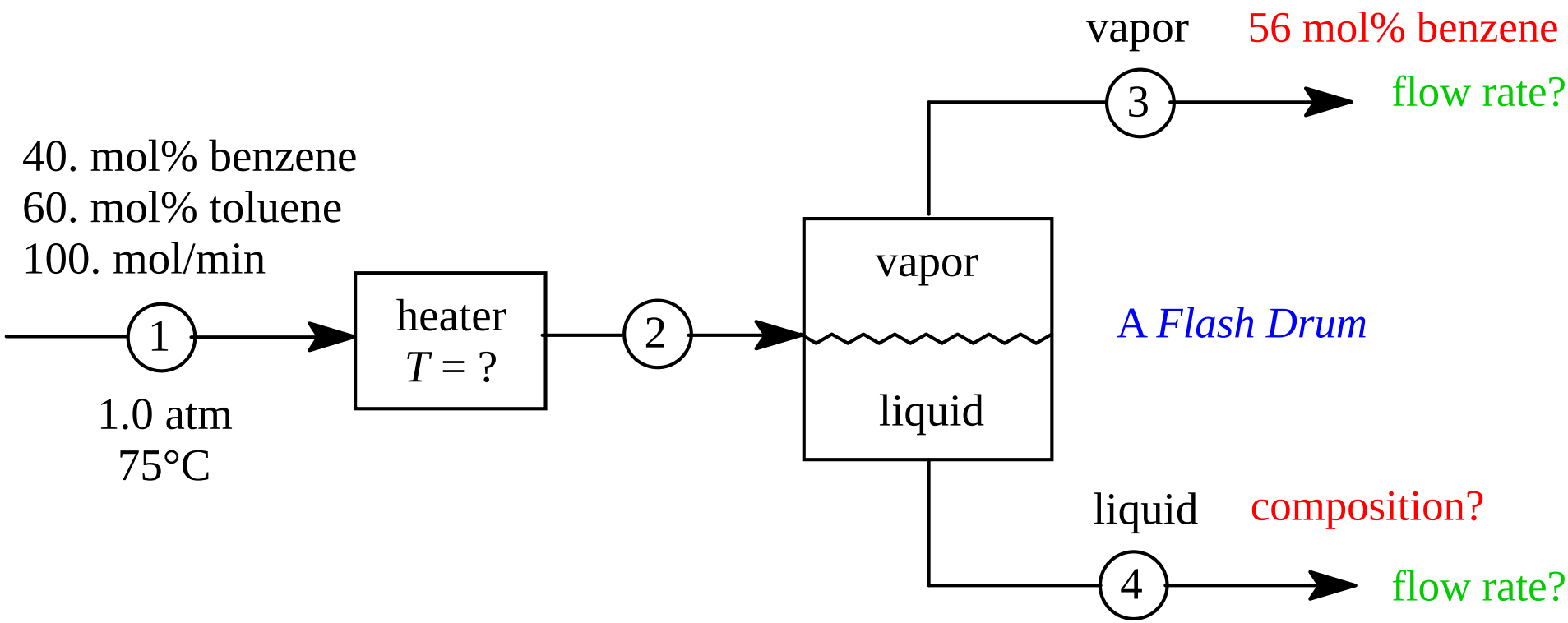
Two independent variables - composition *and* temperature.

We need a *map*.

Benzene+Toluene Mixtures at Equilibrium A Map

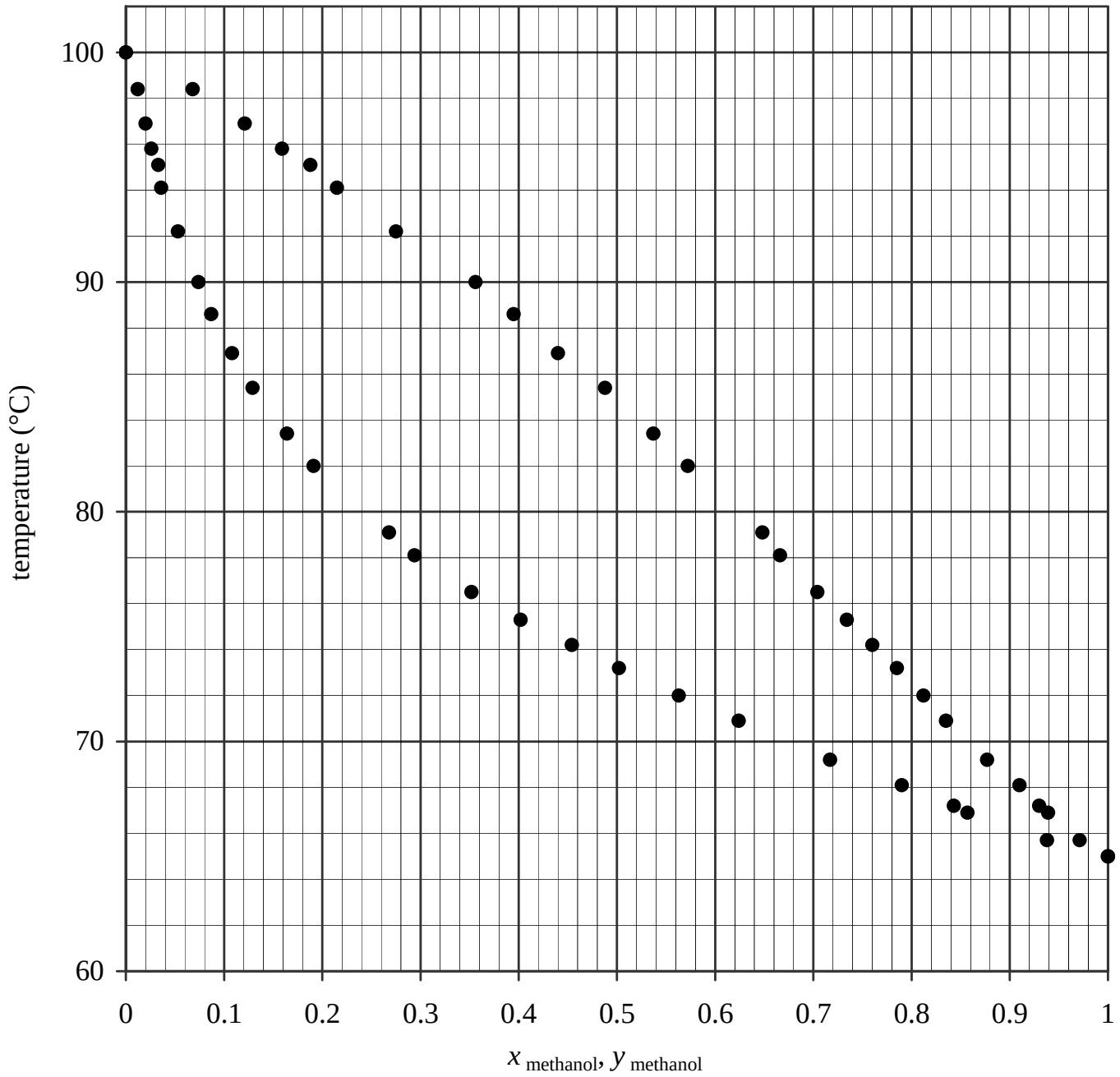


One L+V Equilbrium Stage



The following two slides
were not used Fall 2025.

Vapor-Liquid Phase Map for Methanol + Water at 1 atm - Exercise 4.19



Vapor-Liquid Phase Map for Methanol + Water at 1 atm - Exercise 4.19

Do not
'connect the dots.'

Sketch 'best fit'
lines or use
French curves.