

Chemical Engineering Course Packages

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Download the CDF player

(<http://demonstrations.wolfram.com/download-cdf-player.html>)

Open OneNote 2016 (not the OneNote App)

Open www.LearnChemE.com

When you were an undergraduate, how many courses used active learning?

- A. 0
- B. 1
- C. 3
- D. 5 or greater

When you are an undergraduate, how many used clickers?

- A. 0
- B. 1
- C. 3
- D. 5 or greater

When you are a graduate student how many courses used active learning or clickers?

- A. 0
- B. 1
- C. 3 or greater

Is there a way to teach that is more effective than lecturing?

How do you implement this approach?

How do students respond?



"Why do outstanding scientists who demand rigorous proof for scientific assertions in their research continue to use and, indeed, defend on the basis of their intuition alone, teaching methods that are not the most effective?"

Handelsman et al. *Science* 304, p521 (2004)

225 studies were analyzed

compared active learning and traditional lecturing in STEM courses

active learning: students' performance on exams and the concept inventory increased by 0.47 standard deviation (STD)

traditional lecture: students were 1.5 times more likely to fail

Freeman et al., *Proc. Nat. Acad. Sci.* **111**, 8410 (2014)

What routinely goes on in most college classes is not teaching and learning, but stenography

Rich Felder

Goals:

Demonstrate active-learning resources in course packages

Demonstrate how to use OneNote and course packages

Save significant time in course preparation.

Try course packages, www.LearnChemE.com, screencasts, interactive simulations, ConcepTests

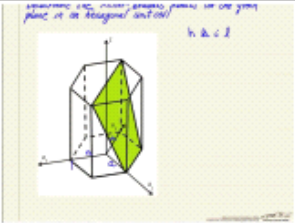
Open the LearnChemE site on your computer

<http://www.learncheme.com/home>

**LearnChemE**
Educational Resources for Chemical Engineering
University of Colorado Boulder


Department of
Chemical &
Biological
Engineering

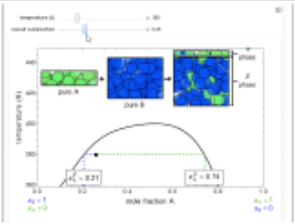
[Home](#) [Screencasts](#) [Interactive Simulations](#) [Student Resources](#) [Instructor Resources](#) [About/Contact Us](#) [Follow Us](#)



Screencasts

Screencasts are short screen captures, usually of a tablet PC, with instructor narration. They are solutions to example problems, explanations of concepts, software tutorials, introduction to topics, descriptions of diagrams, and reviews of material. Screencasts supplement textbooks, classes, and office hours and allow students to learn at their own pace. Many of the screencasts are organized by textbook table of contents found on each topic page. We have over 1,400 screencasts.

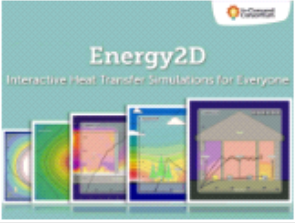
Interactive screencasts present a multiple choice question where the viewer chooses an answer within the video. The video response guides the user to the correct answer and explanation. For more information, see our interactive screencasts on our YouTube channel.



Interactive Simulations

Wolfram *Mathematica*-based simulations (Wolfram Demonstrations) are available for a number of chemical engineering topics. These simulations allow the user to determine how system behavior changes when variables are changed using sliders. The simulations can be accessed using free Wolfram based browser plug-ins or using the free [Wolfram CDF](#) player that enables the simulation to be loaded offline; a *Mathematica* software license is not required. For more information about the simulations and their use, go to [Wolfram Demonstrations](#). We have over 115 interactive simulations.

All simulations are copyrighted © 2013 Wolfram Demonstrations Project & Contributors. Visit Wolfram Demonstrations Project [Terms of Use](#) for more details.

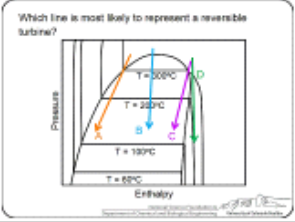


Student Resources

This section contains other resources for chemical engineering education. Screencasts using POLYMATH software to solve chemical engineering problems are organized by topic. The POLYMATH software files are available to download.

More resources are in the process of being added.

Students: let us know which resources you like to use. Email us at LearnChemE@gmail.com.



Instructor Resources

ConcepTests challenge students with qualitative questions that are not answered by memorization. Used in tandem with peer instruction, ConcepTests can dramatically improve functional understanding while allowing instructors to gauge students understanding immediately and tailor their instruction accordingly.

Course packages provide digital OneNote based resources containing class notes, ConcepTests, reading assignments, screencast recommendations, homework problems and exam questions. They are available for Thermodynamics and Materials & Energy Balances.

Instructors: [Check out the resources](#) to request access to our 1800+ ConcepTest inventory or course packages.

What is a course package?

Comprehensive set of teaching resources in Microsoft OneNote

Complete set of in-class materials for a semester class

Links to screencasts for a flipped class

Links to interactive simulations

Multiple years of assignments and exams (with solutions)

- Reading quizzes
- Learning objectives/exam study guides
- Organization materials (syllabi, schedules)
- Information on how to use the packages

Open OneNote 2016 on your computer

Open a course package (access from email not website)

Sign in to download notebook (use email address that granted access).

edit in Microsoft OneNote

- Thermodynamics

- Kinetics

- Material and energy balances

Use course package on USB drive or OneDrive
or open from LearnChemE (need access?)

Why OneNote and Tablet PC?

- Easy to use in class

- Well suited for tablet PC and writing on screen (taskbar on left)

- Easy to modify

- Easy to learn

- Save time- everything in one place for course

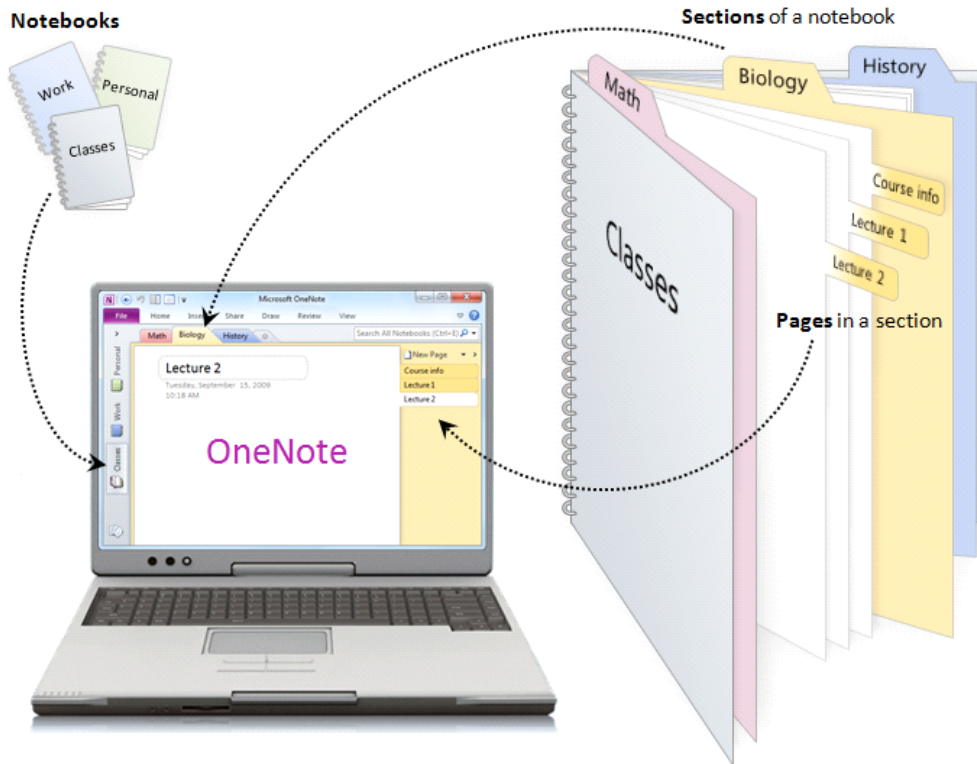
- Multiple other uses

- Part of Microsoft Office

How are OneNote pages different?

Type anywhere on the page.

What are the tabs?

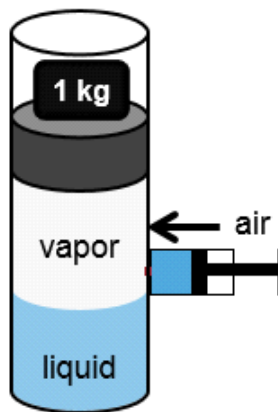


Major part of class notes in OneNote: ConceptTests

A piston-cylinder only contains water, which is in vapor-liquid equilibrium at 1.2 bar. When 5 cm^3 of air is injected into the system at constant pressure and temperature, _____ of the water

_____.

- A. all, vapor condenses
- B. some, vapor condenses
- C. all, liquid vaporizes
- D. some, liquid vaporizes



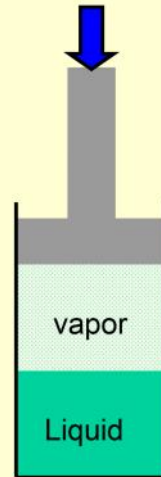
$$P_{\text{H}_2\text{O}}^{\text{sat}} = 1.2 \text{ atm}$$

$$P = P_{\text{H}_2\text{O}} + P_{\text{air}}$$

$$1.2 \text{ atm} = 1.15 \text{ atm} + 0.05 \text{ atm}$$

$$P_{\text{H}_2\text{O}} < P_{\text{H}_2\text{O}}^{\text{sat}}$$

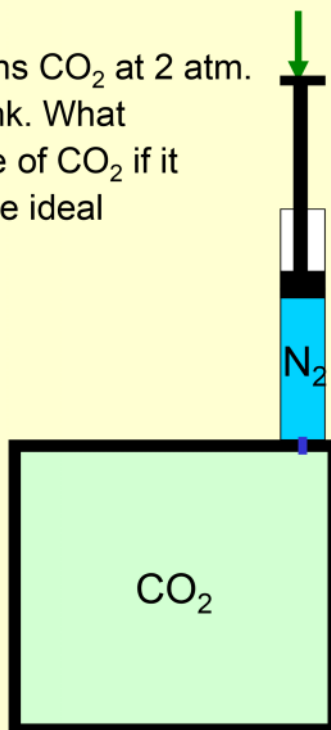
All the water vaporizes



If you gave this problem to your class, what answer do you think they would select?

A constant-volume tank contains CO_2 at 2 atm. Nitrogen is injected into the tank. What happens to the partial pressure of CO_2 if it all remains in the tank? Assume ideal gases.

- A. Decreases
- B. Increases
- C. Stays the same



A constant-volume tank contains CO_2 at 2 atm. Nitrogen is injected into the tank. What happens to the partial pressure of CO_2 if it all remains in the tank? Assume ideal gases.

- 13 A. Decreases
- 32 B. Increases
- 6 C. Stays the same (chance is 17)

Liquid water is in equilibrium with air at 50°C in a piston/cylinder system at 1 atm pressure. The pressure is raised to 2 atm by pushing on the piston. Temperature is constant. At equilibrium, the partial pressure of the water:

- A. Decreased
- B. Increased
- C. Remained the same

Not answered by memorizing answer



Liquid water is in equilibrium with air at 50°C in a piston/cylinder system at 1 atm pressure. The pressure is raised to 2 atm by pushing on the piston. Temperature is constant. At equilibrium, the partial pressure of the water

Answers at beginning of semester

22 A. Decreased

15 B. Increased

14 C. Remained the same (chance is 17 of 51 students)

ConcepTests

- not too easy
- not calculations
- not memorization
- don't contain non-essential information
- emphasize important concepts
- good wrong answers

- challenge students with qualitative questions

Student feedback on ConcepTests

- “I cannot describe how much the active learning helps. I don’t think I have ever taken a class where I feel like I fully understand the information as well as I do in this one.”
- “Something you are doing that helps me learn are concept questions. They make me think about the problem and clear up concepts. A lot of times I think I will understand something but I don’t really understand it and the concept questions help show me that.”
- “The clicker concept questions are great because they are interactive, which makes it easier to pay attention, and they are indicative of what you know and what you don’t know.”
- “I love the way you use clicker questions throughout the entire class rather than lecturing.”
- “The way I learn best is by making mistakes, so when I don’t know how to do the clicker questions, I end up learning much more than I would have if you ran the class in a lecture style format”
- “I would have to say that the format of your thermodynamics class was the most enjoyable and beneficial to my learning as a student. For the first two years... I became accustomed to the traditional lecture format that most professors utilize. **It is very hard to pay attention and stay motivated in these type of class settings where we just sit for an hour and take notes while the professor rambles on about subjects we know little about.**”
- “The interactive learning (clickers, etc.) is super helpful. It really helps me keep my attention in class.”

2,000 ConcepTests for 7 courses

AICHE Concept warehouse has more ConcepTests

Use in class, on exams, on HW

Course packages have ConcepTests for given class

plus extras -easy to replace

have 2 copies of OneNote open at the same time

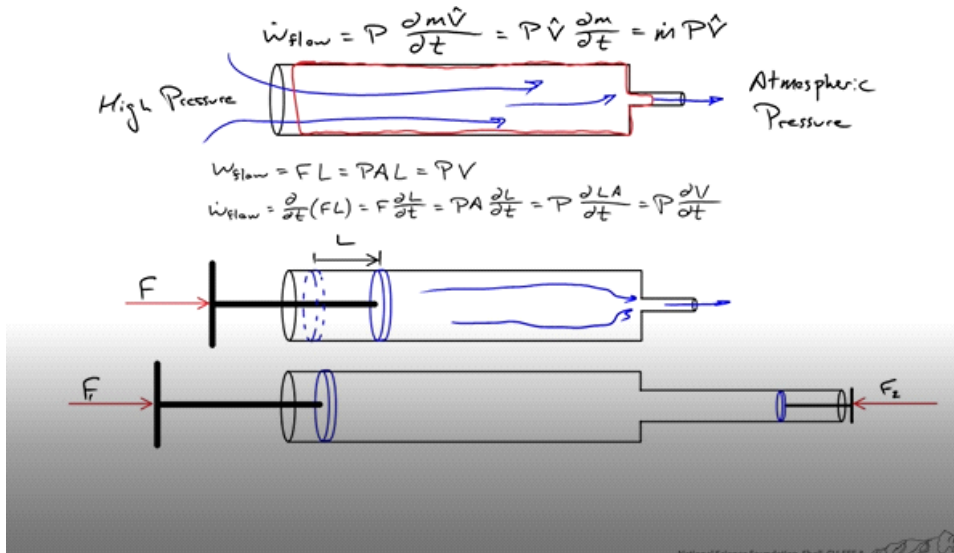
Break: 5 minutes

Screencasts

Introduction to a topic

[Screencast example](#): Flow work

[YouTube](#): Flow work



Example problem

https://www.youtube.com/watch?v=Gag_HoWILnE#t=1m30s

b) irreversible and the work required is 20.% more than required for the reversible process to the same exit pressure

Handwritten solution for the example problem:

Diagram: A circle representing a process from 25°C and 2.0 bar to $T_2 = ?$ and 7.0 bar . The work input is W .

Reversible process equations:

$$\left(\frac{T_2}{T_1}\right) = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$$

where T_1 is absolute.

Specific heat ratio γ calculation:

$$\gamma = \frac{C_p}{C_v}$$
$$C_p = C_v + R$$
$$\gamma = \frac{25 \text{ J/mol} \cdot \text{K}}{25 - 8.314 \text{ J/mol} \cdot \text{K}}$$
$$\gamma = 1.50$$

Temperature T_2 calculation:

$$\frac{T_2}{(273 + 25 \text{ K})} = \left(\frac{7.0 \text{ bar}}{2.0 \text{ bar}}\right)^{\frac{1.5-1}{1.5}}$$
$$T_2 = (298 \text{ K})(3.5)^{2/3} = 452 \text{ K}$$

Software tutorial

<https://www.youtube.com/watch?v=0QFLng0fz68&feature=youtu.be&list=PL4xAk5acInUjMQaDPzjOWCkGQORbYDNl5#t=1m0s>

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW ACROBAT

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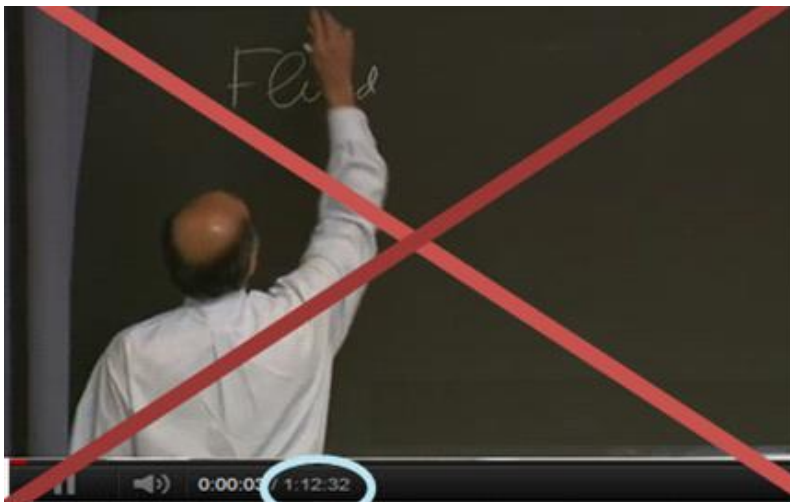
Other types of screencasts

Exam problems

Explain diagrams

Interactive ConcepTests

What is a screencast?



Not video of person & board

Not 50 minutes

Not multiple topics

How is a screencast better than a live lecture?

Students watch on their schedule (24/7)

Students control pace: start/stop/replay

Just-in-time use

Short, modular

Students like them

Students use them (> 4.5 million views in 12 months)

Increase student confidence

Improve student learning

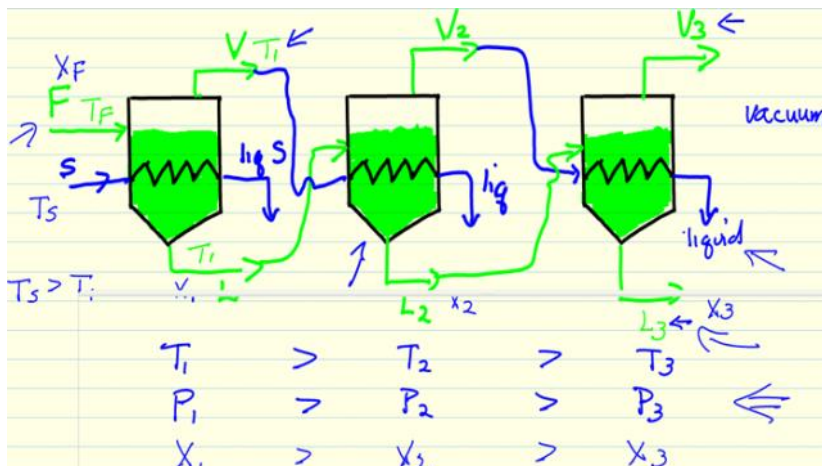
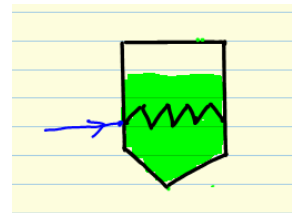
Free class time for active learning

Screencasts minimize cognitive overload

Diagrams and verbal explanation at same time enhance learning
(Clark and Mayer, 2011)

More flexibility than textbook

Material sequenced in time, unlike textbook



Survey 440 students about screencasts

95%: useful or very useful

85%: better than textbook at improving understanding

92%: felt more confident about material

Student feedback

- "Screencasts are fantastic."

- “Screencasts are amazing.”
- “Super, super, super, super useful.”
- “I love screencasts!”
- “I think screencasts are fantastic and incredibly helpful.”
- “As for screencasts, they are REALLY helpful. It's like office hours available 24/7.”
- “I think screencasts are very VERY helpful,”
- “I think that screencasts were unbelievably effective.....”

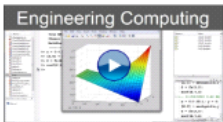
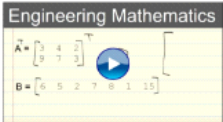
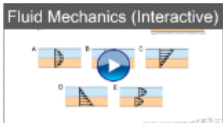
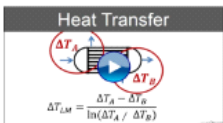
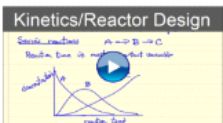
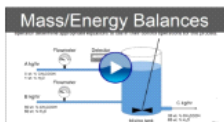
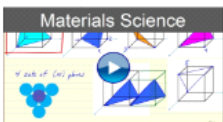
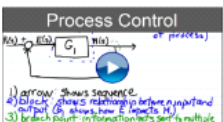
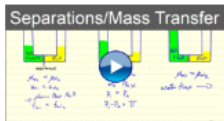
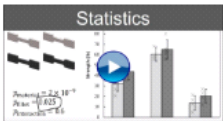
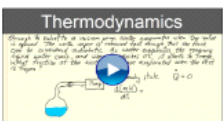
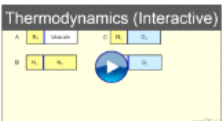
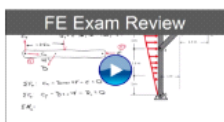
screencasts for 14 courses

Open some screencasts to get a better idea

<http://www.learncheme.com/screencasts>

Screencasts

Screencasts are short screen captures, usually of a tablet PC, with instructor narration. They supplement textbooks and lectures by featuring solutions to example problems, e. concepts, software tutorials, descriptions of diagrams, and material reviews. They are made and reviewed by faculty. (CC) indicates the entire topic has corrected closed caption over 1,400 screencasts available for the following engineering courses/topics:

 Catalysis 27 videos	 Chemistry 93 videos (CC)	 Engineering Computing 90 videos	 Engineering Mathematics 30 videos
 Fluid Mechanics 185 videos (CC)	 Fluid Mechanics (Interactive) 54 videos	 Heat Transfer 91 videos (CC)	 Kinetics/Reactor Design 308 videos (CC)
 Mass/Energy Balances 165 videos (CC)	 Materials Science 49 videos (CC)	 Process Control 58 videos	 Process Design 69 videos
 Separations/Mass Transfer 76 videos	 Statistics 24 videos	 Thermodynamics 326 videos (CC)	 Thermodynamics (Interactive) 43 videos
 FE Exam Review 178 videos			

Interactive simulations

Mathematica

Wolfram Demonstration Project

<http://demonstrations.wolfram.com/new.html>

CDF files

Download CDF reader

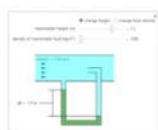
<http://demonstrations.wolfram.com/download-cdf-player.html>)

Open one of the simulations

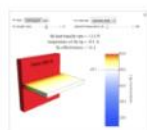
<http://www.learncheme.com/simulations>

Interactive Simulations

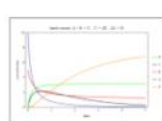
Our interactive *Mathematica* simulations can be viewed below using [Opera](#) and [Mozilla Firefox](#) browsers with the free [Wolfram CDF](#) plug-in. They can be downloaded and used offline with the [Wolfram CDF](#) plug-in. They are also available on the [Wolfram Demonstrations Project](#) website. Most thermodynamics and kinetics/reactor design simulations have an accompanying screencast showing how to use them. We currently have more than 115 simulations, and we are continuously improving and adding new simulations. Please contact us at learncheme@gmail.com if you identify any problems with the simulations or if you have suggestions for simulations we might prepare.



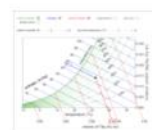
[Fluid Mechanics](#)



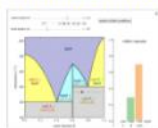
[Heat Transfer](#)



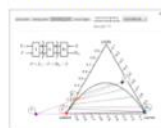
[Kinetics/Reactor Design](#)



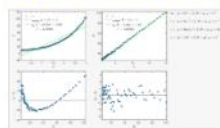
[Mass/Energy Balances](#)



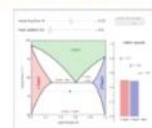
[Materials Science](#)



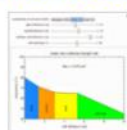
[Separations](#)



[Statistics](#)



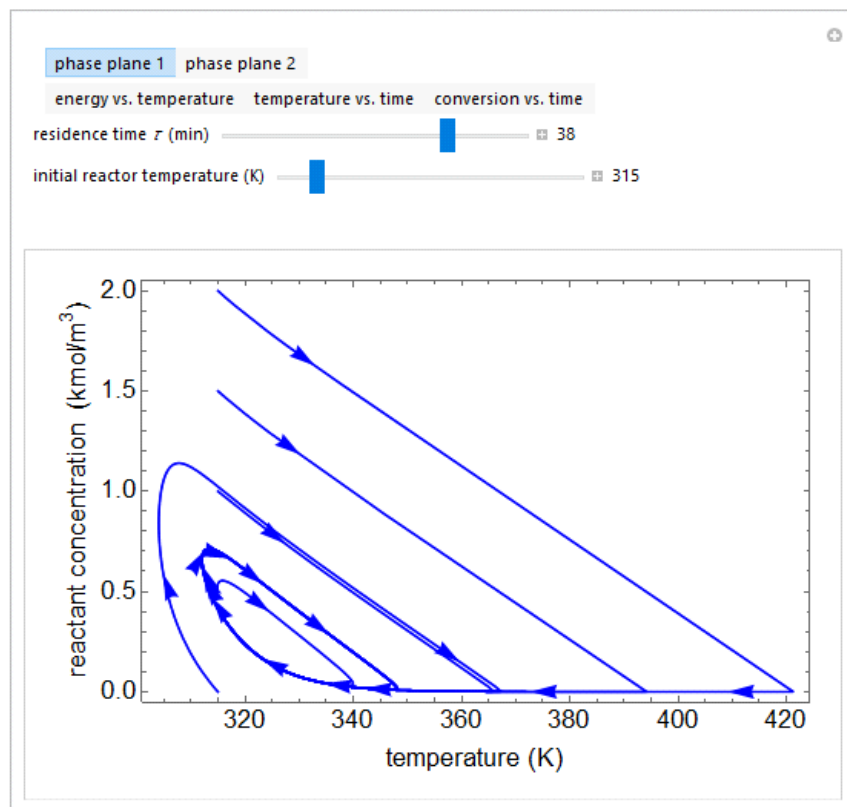
[Thermodynamics](#)



[Other Topics](#)

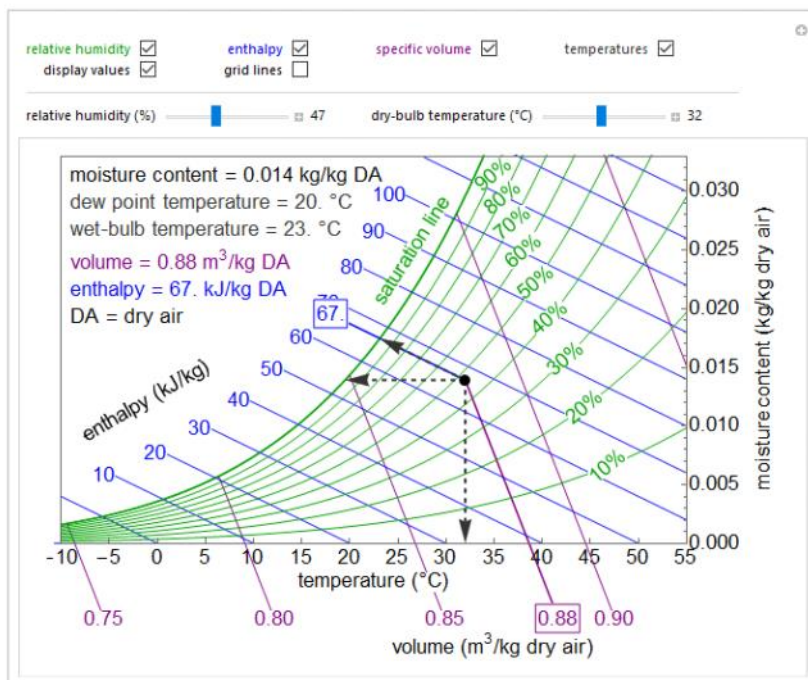
[Multiple steady states in nonisothermal CSTR](#)

Multiple Steady States in a Continuous Stirred-Tank Reactor with Heat Exchange



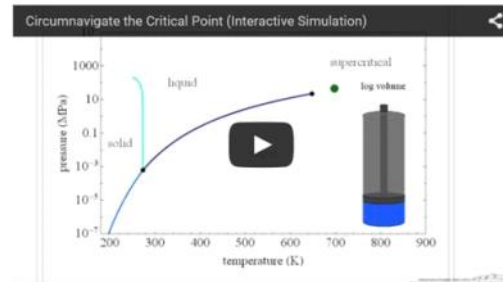
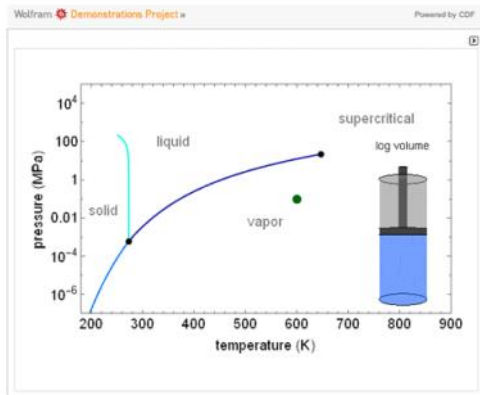
[Reading a Psychrometric Chart](#)

Reading a Psychrometric Chart



Simulation and short screencast

Circumnavigating the Critical Point



The pressure-temperature phase diagram for water is used to illustrate the concept of state functions and the possibility of going from the liquid phase to the vapor phase (or the other way) without a phase change (a single phase throughout the process) by circumnavigating the critical point, which is the highest temperature and pressure where two distinct phases exist (647 K, 22.1 MPa for water).

Interactive simulations

- Demonstrate concept or explain diagram
- Easy to use- not too many options
- Studies show simulations improve learning
- Actively engage students
- Observe behavior that hard to observe in real time
- Students like them
- Use with ConcepTests in class (part of course packages)
- Use with assignments

Positive feedback from students

- "These interactive simulations were **amazing!**"
- "Really liked the simulations. You should use more of these"
- "The interactive simulations are **extremely useful.**"
- "The interactive simulations were the **best thing that could even imagine.**"
- "The simulations were very helpful to me. I'm a visual learner, so lectures don't always stick but diagrams always have been very helpful.
- "The interactive simulations are **incredibly useful** in understanding the material, especially vapor-liquid equilibrium and vapor liquid-liquid equilibrium."
- "I **enjoyed using the interactive simulations.** Thought they provided an excellent visual learning tool that added tremendous value to the class."

“The interactive simulations were very useful because **I could test every scenario** on my own rather than just seeing a few general ones.”

How to study/How to learn

Which of these would you suggest your students do?

Click A for yes, B for no

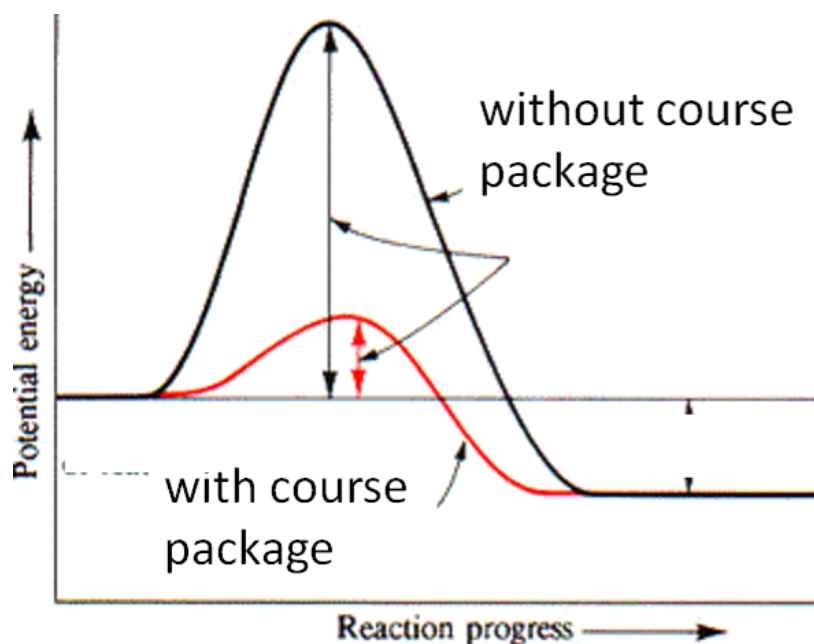
- Re-read textbook
- Underline and highlight textbook
- Review notes before exam
- Reread solutions to HW problems before exam
- Concentrated study on one topic
- Study in the same location
- Study several hours non-stop
- Being persistent: continue trying to solve problem when stuck (e.g., 30 minutes)

Resources on LearnChemE on How to Study

<http://www.learncheme.com/student-resources/how-to-study-resources>

Summary

Course packages



LearnChemE :

3 course packages (will continue to update)

template for other courses

> 1,400 screencasts

> 130 interactive simulations (150 soon) (on USB)

> 2,000 ConcepTests (on USB)

How to Study/How to Learn Resources

Goals:

Demonstrate active-learning resources in course packages

Demonstrate how to use OneNote and course packages

Save significant time in course preparation.

Try course packages, www.LearnChemE.com,
screencasts, interactive simulations, ConcepTests