Notes with gaps: An approach to active lectures

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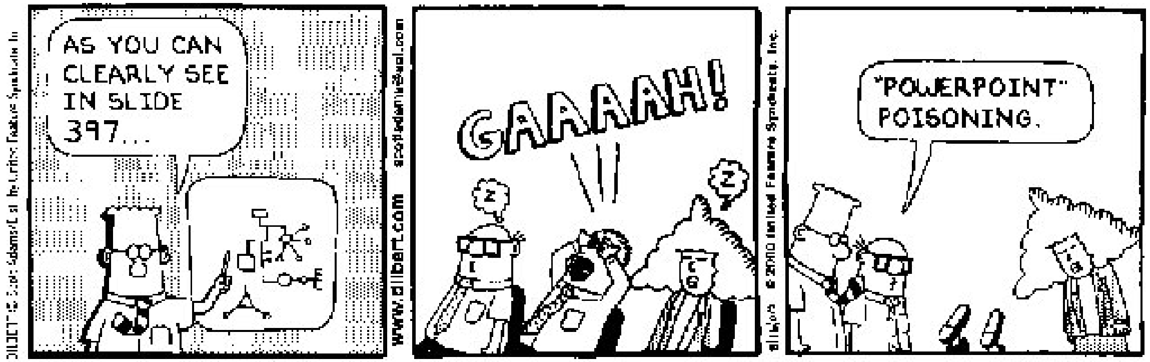
Why notes with gaps?

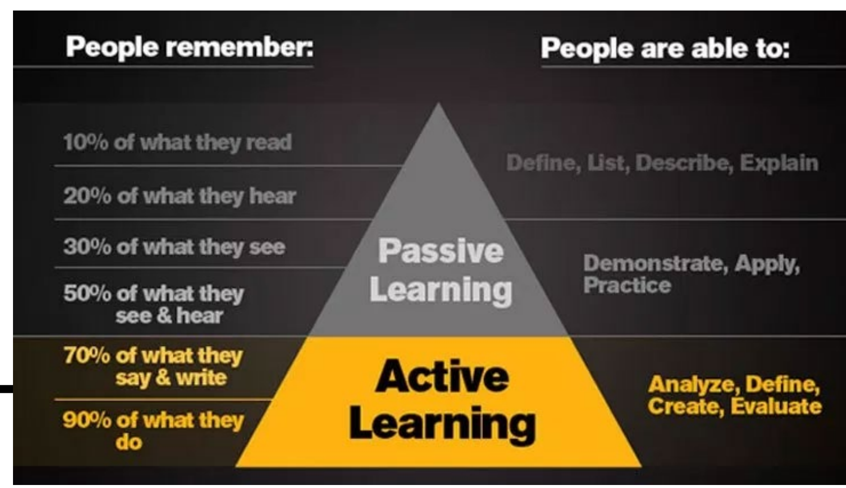
An active lecture format that balances content coverage and the addition of active learning.

Helps alleviate the problems of students “checking out” during lecture and poor handwriting (by the instructor and students).



"You've gotta help me! I can't read my own writing!"

“Does this pen come in another font?”



Setting the gaps

- Lecture notes as handouts
- Write out straightforward stuff
  - Definitions, facts, equations
- Leave gaps - blank space - for students to fill in more challenging information
  - Examples, diagrams, solutions

Section 6: F&R, Ch. 8 (Energy Balances – II)

Calculating $\Delta\hat{U}$ and $\Delta\hat{H}$ for Process Types 1 and 2

<u>Process Type 1: Change *P* at constant T and phase</u>. (Section 8.2)

$\Delta\hat{U} = 0$ (Exact for ideal gas, approximate for solids and liquids)
$\Delta\hat{H} = 0$ (Ideal gas)
$= \hat{V}\Delta P$ (Solid or liquid - $\hat{V}$ is constant)

Find $\hat{V}$ for solids and liquids from specific gravity in Table B.1 (convert to density, $\hat{V} = 1/\rho$).

Calculations for real gases are complex (topic in later thermodynamics class)

<u>Process Type 2: Change *T* at constant P and phase</u>. (Section 8.3)

Sensible heat: heat transferred to raise or lower the temperature depends strongly on *T* (molecules move faster at higher temperatures), and therefore so does

$\hat{H}(=\hat{U} + P\hat{V})$.

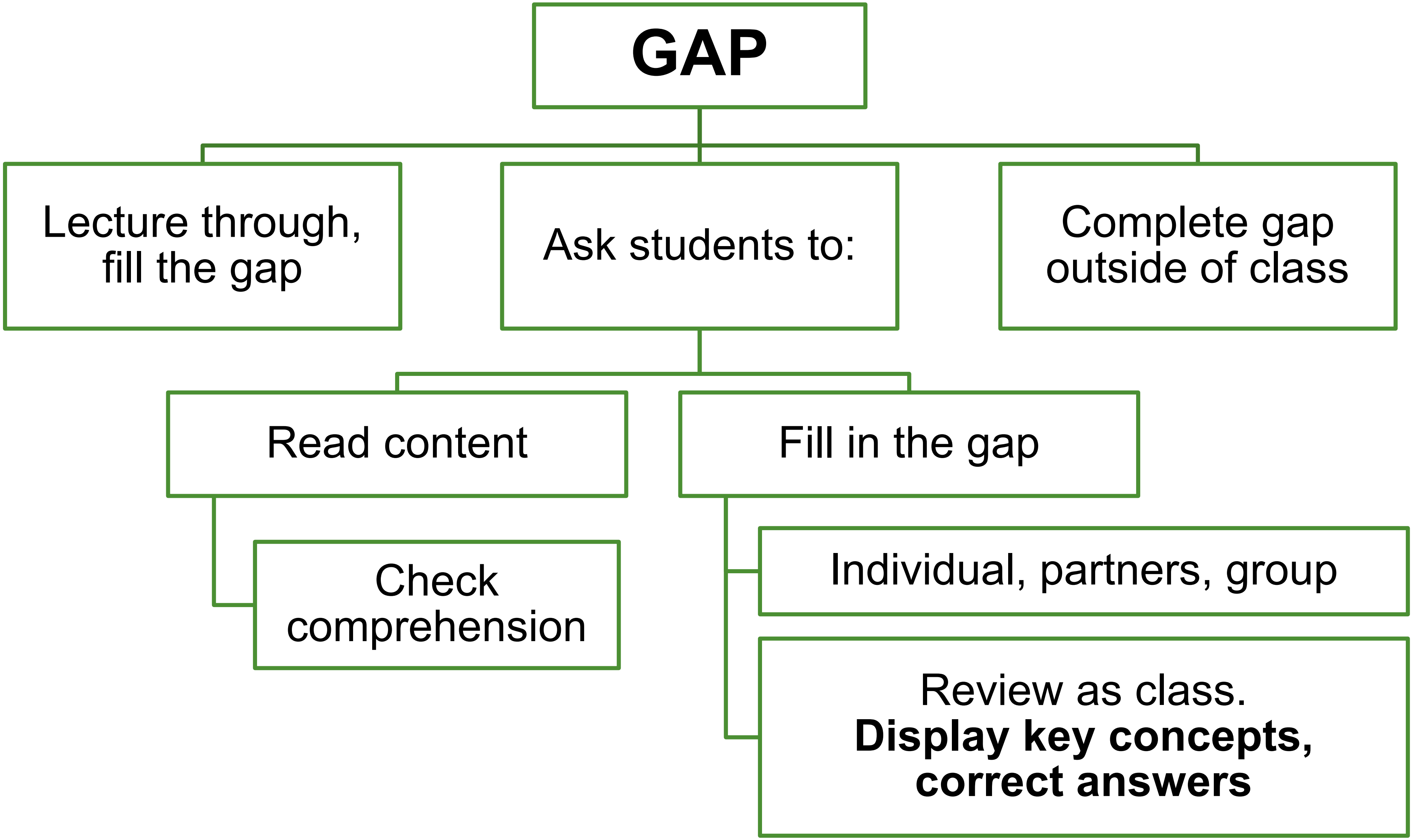
Define $C_p(T)\left(\frac{\text{kJ}}{\text{mol}\cdot^\circ\text{C}}\right) = \frac{d\hat{H}}{dT} = \left(\frac{\partial\hat{H}}{\partial T}\right)_P$ <u>Constant pressure heat capacity</u>

C_p is the rate of increase of specific enthalpy with temperature for a constant pressure process. Graphically, it is the slope of the tangent to the plot of $\hat{H}$ vs. T. To find the change in enthalpy from C_p:

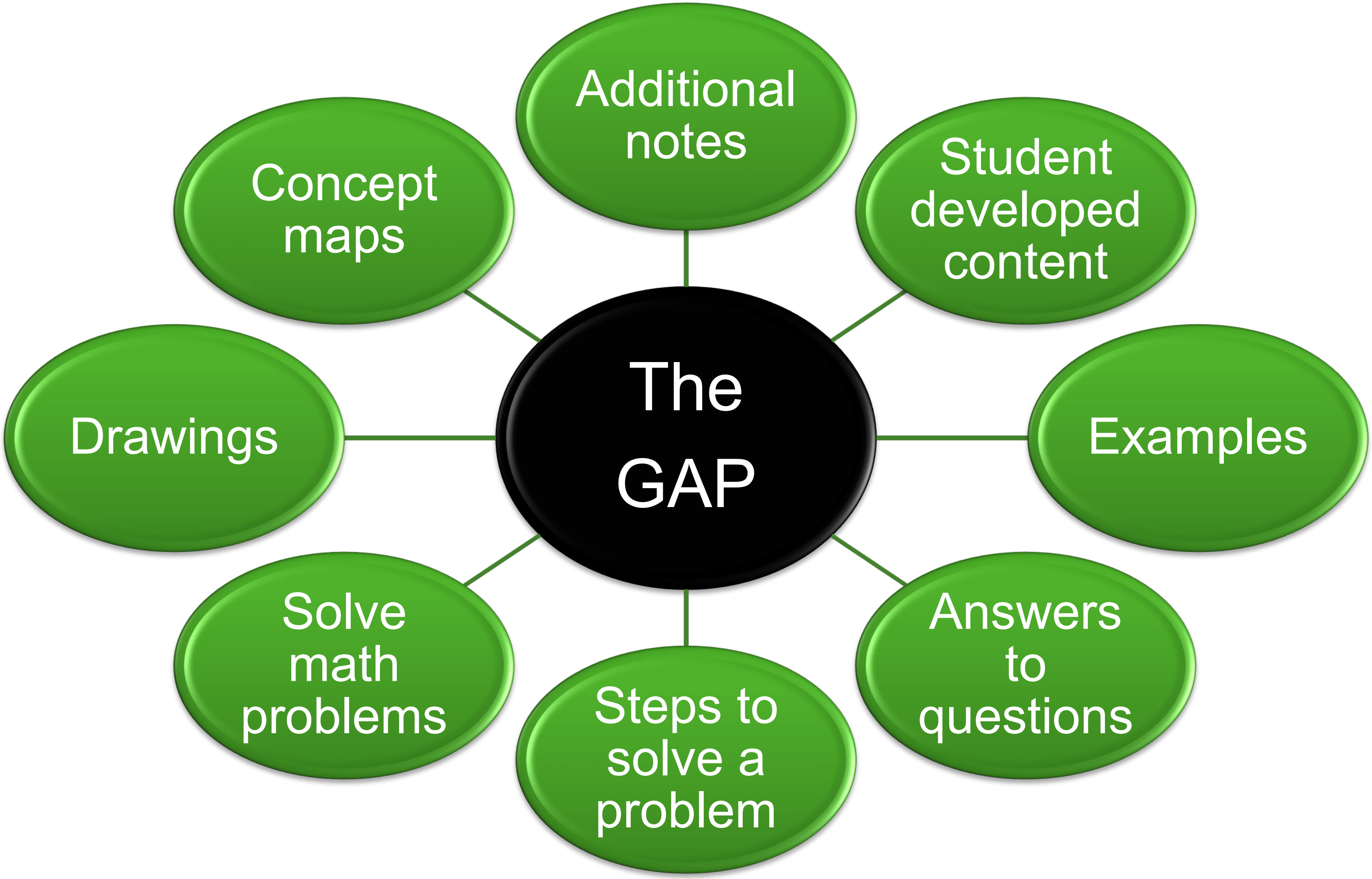
$$\Delta\hat{H} = \int_{T_1}^{T_2} C_p(T)\,dT$$

note: Cp is a function of T, not times T

Filling the gap



Applications and Examples



Ex: Notes

Measurement = quantitative observation

Ex. 440 ft

- REMEMBER UNITS!

Making a measurement:

1. *Record digits that are certain.*
2. *Estimate the next (uncertain) digit.*

   Uncertainty in last digit is ± 1

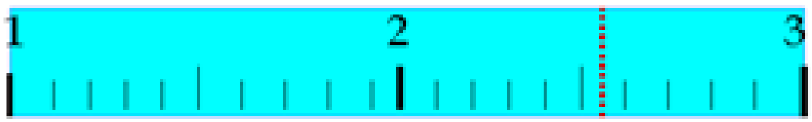
Note: *green text* in this presentation would be handwritten annotations.

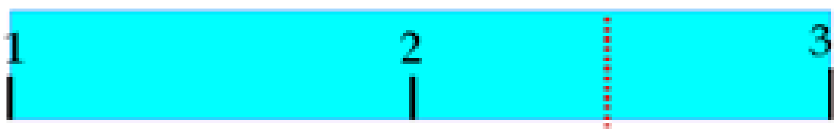
Ex: Examples and practice problems

Making measurements

Instructor leads examples, then students practice.

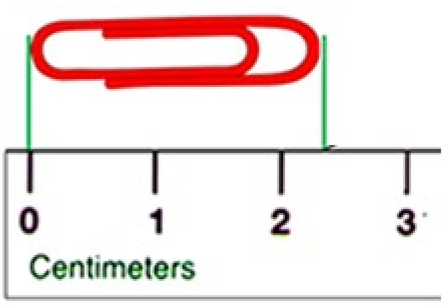
Examples



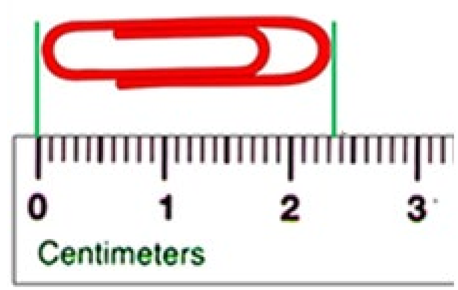


With each ruler, estimate the last place.

Practice



2.3 cm



2.35 cm

Ex: Notes (students fill in) and concept question

SI Units

Note: blue text in this presentation would be animation that appear after students have time to complete the "gap"

	Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Volume	liter	L

- Volume is derived from length:
  - One milliliter (mL) contains 1 cubic centimeter (cm^3)

Is the mass of an object the same as its weight? Are these terms the same?

- Mass = quantity of matter; gram
- Weight = force matter experiences from gravity

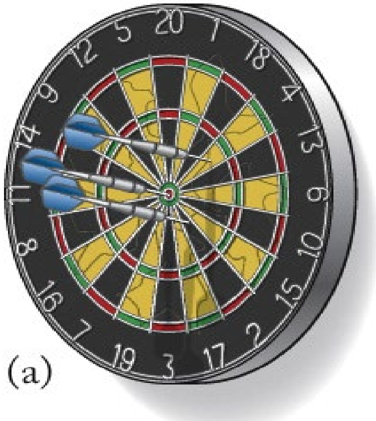
Ex. Drawing

Accuracy and Precision

- **Accuracy:** agreement with accepted value

- **Precision:** agreement among several measurements (reproducibility)

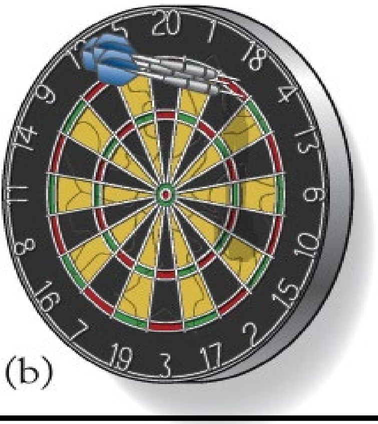
What would it look like to be precise, but not accurate?



(a)

Accurate and precise

Image appears by animation



(b)

Ex: Working a problem

Converting between units: Factor-label method

Use conversion factors to transition from “old” to “new” units

Ex. Convert 10.936 yd = ________ m

Steps

1. Determine calculation path and find conversion factors.
2. Set up conversion, starting with given info.
3. Use conversion factor(s) to cancel units.
4. Do the math and cancel units.
   Units as expected? If not, calc is wrong!
5. Sig Figs and rounding.
6. Check. Answer reasonable?

$$\frac{1\,m}{1.094\,yd} \quad or \quad \frac{1.094\,yd}{1\,m}$$

$$\frac{10.936\,yd}{}\left(\frac{1\,m}{1.094\,yd}\right) = \frac{10.936\,yd \cdot m}{1.094\,yd} = 9.996\,m$$

Ex: Worked example

Problem and work

How many hours are in 2.0 years?

Years → days → hours

1 yr = 365 days

1 day = 24 hours

$$\frac{2.0\ yr}{}\left(\frac{365\ days}{1\ yr}\right)\left(\frac{24\ hours}{1\ day}\right)$$

$$= 18{,}000\ hours$$

Steps

Students decode the steps taken to solve a problem.

Calculation map

Find conversion factors

Set up conversion (Use conversion factors to cancel units.)

Calculate.

Sig figs and rounding

Check.

Ex: Practice problem

Would a car traveling at 65 km/h violate a 45 mi/h speed limit? Note: there are 5280 ft in 1 mile.

$$\frac{65\ km}{h}\left(\frac{1000\ m}{1\ km}\right)\frac{1.094\ yd}{1\ mi}\left(\frac{3\ ft}{1\ yd}\right)\frac{1\ mi}{5280\ ft}$$

$$=\left(\frac{2.133\ x\ 10^{5}\ mi}{5280\ h}\right)=\mathbf{40.4}\,\frac{\boldsymbol{mi}}{\boldsymbol{h}}\rightarrow \mathbf{40.}\,\boldsymbol{mi/h}$$

A. Yes

B. No

C. I'm confused.

Can couple with a student response system or live audience polling.

Ex. Definitions and examples

Students read definitions and come up with examples

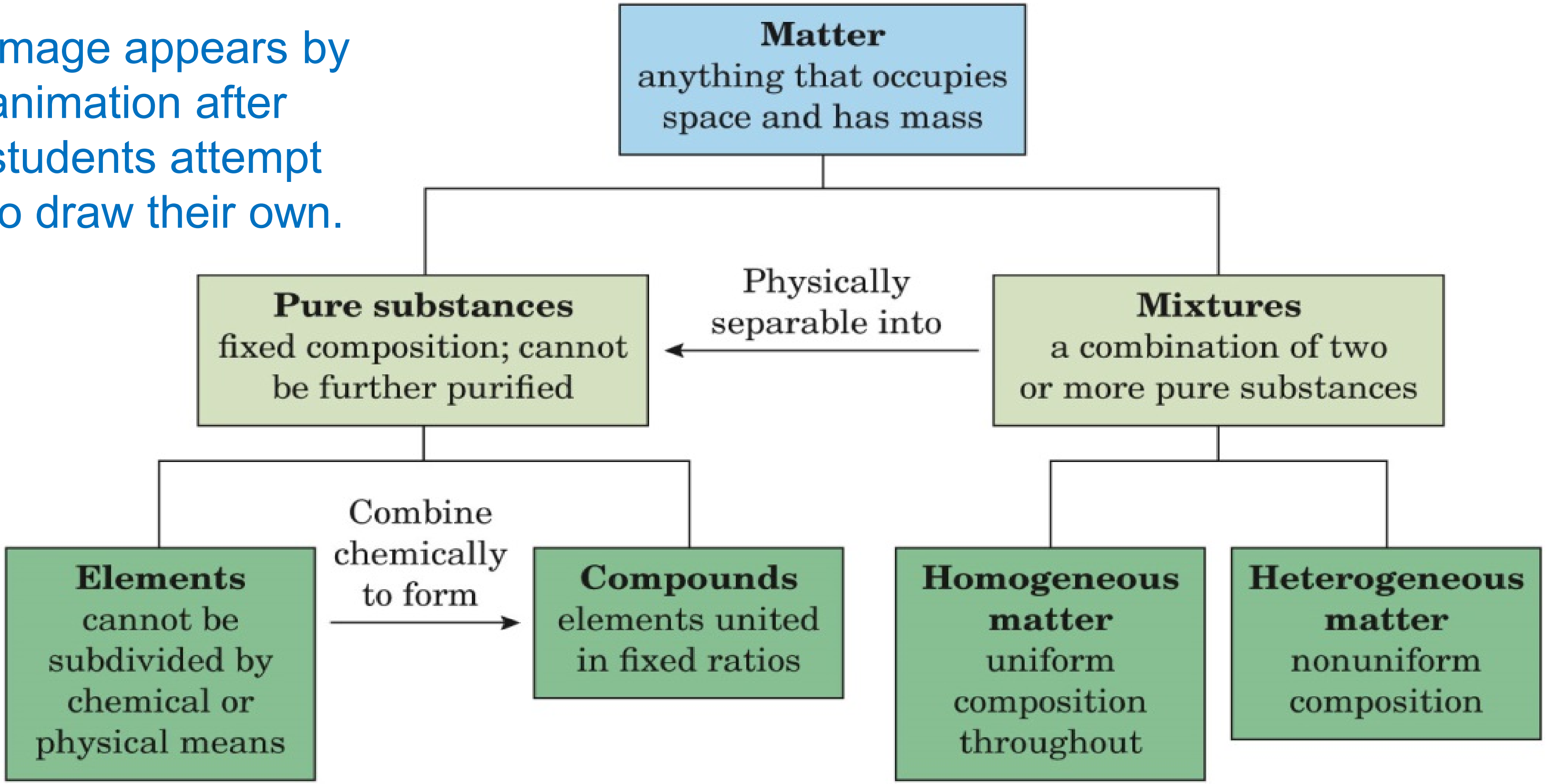
Matter – takes up space and has mass

Definitions for classes of matter:	Example:
Atoms – smallest unit of matter	
Elements – cannot be subdivided by chemical or physical means (made of identical atoms)	Hydrogen, Carbon
Pure substances – fixed composition, can't purify	Water, Gold
Molecules – 2 or more atoms the same or different elements joined (bonded) chemically	Oxygen gas
Compounds – different elements united in fixed ratios	Water, Sucrose
Mixtures – combination of 2 or more pure substances	
Homogeneous matter – uniform composition	Salt water
Heterogeneous mater – non-uniform composition	Chicken noodle soup

Ex: Concept map

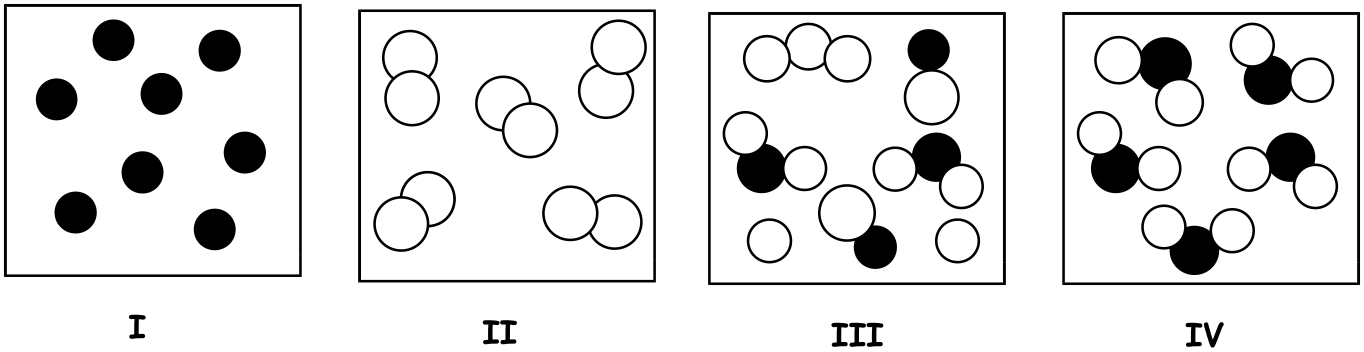
Draw a diagram or flow chart that illustrates the relationships among pure substances, mixtures, elements, compounds, mixtures, homo- and heterogeneous matter.

Image appears by animation after students attempt to draw their own.



Ex: Concept check question

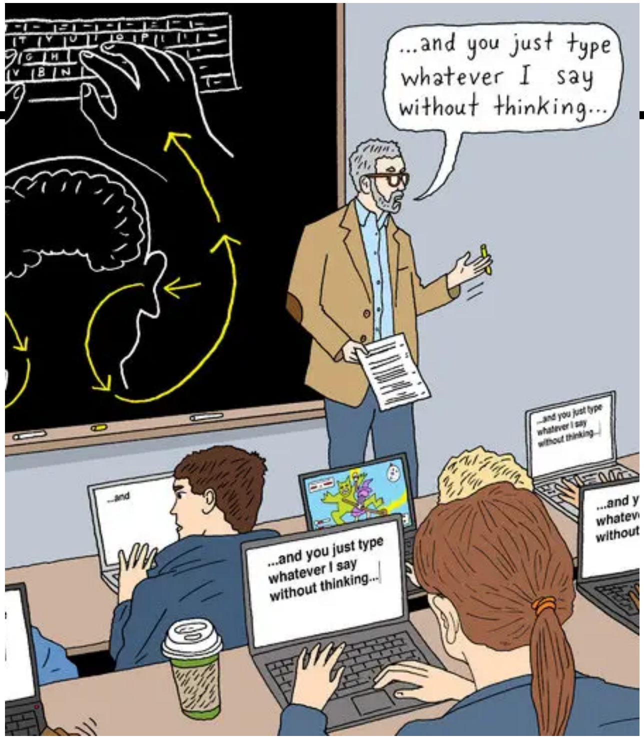
Which of these atomic and/or molecular views represent pure substances?



A. I and III
B. I and IV
C. I, II, and IV
D. II, III, and IV

Use a
student response system
or live audience polling.

Benefits



- Active!
- Facilitates notetaking.
- Increases student engagement and focus.
  - Students "own" the notes. (They develop some content.)
- Increases attendance (maybe).
- Increases student performance.
  - On application questions, not factual/ definition questions.
- **Balance content coverage and active learning.**

Reflect… and Apply?

How could you apply “notes with gaps” in your class?

What are the benefits or limitations of this approach?

References

- Felder, R.M. and Brent, R. (2016) *Teaching and Learning STEM: A Practical Guide.* Chapter 4, section 7 and Chapter 6. San Francisco: Jossey-Bass.
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- Katayama, A.D., and Robinson, D. H. (2000) Getting students "partially" involved in note-taking using graphic organizers. *Journal of Experimental Education,* 68, 119-133.
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