RIT

Aiming High

Using higher-level thinking early to achieve more fundamental course goals

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CTL Active Learning Summer Institute

May 18, 2023

Welcome!

CTL Active Learning Summer Institute 2023:
Aiming High*

About me:

- Taught classes with ~4 students to 300+ students
- Physics, all levels
- Current focus on ~40 person workshop-style intro physics

CTL Active Learning Summer Institute 2023:
Aiming High*

Today's Workshop:

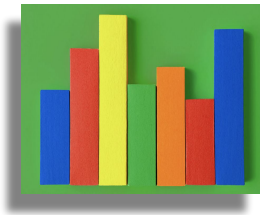
1. Discuss **What and Why** (~15 minutes)
2. Full Active Engagement **Example 1:** Statics (20 minutes)
3. Brief Overview of **More Examples**: (20 minutes)
4. Follow-up **Discussion** (~15 minutes)

*Footnote

- My whole class time isn't like this.
- 2 hour workshop with activities (10 - 20 minutes each) and time for "homework" problems at the end.
- Fully flipped with video notes due each class.

Example of Typical Class Plan:

Class Activity



Clickers

Daily Check

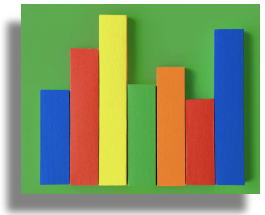
- 10 minutes Individual (submission 1)
- Group (submission 2)

Group Work:

- Hands-on Vector Guided Example (pg 11)
- Module 1 problem set

Example of Typical Class Plan:

Class Activity ~20 minutes



Clickers ~15 minutes

Daily Check
- 10 minutes Individual (submission 1) ~10 minutes
- Group (submission 2)

Group Work:
- Hands-on Vector Guided Example (pg 11)
- Module 1 problem set

~1 hour
"controlled chaos"

CTL Active Learning Summer Institute 2023:
Aiming High*

Today's Workshop:

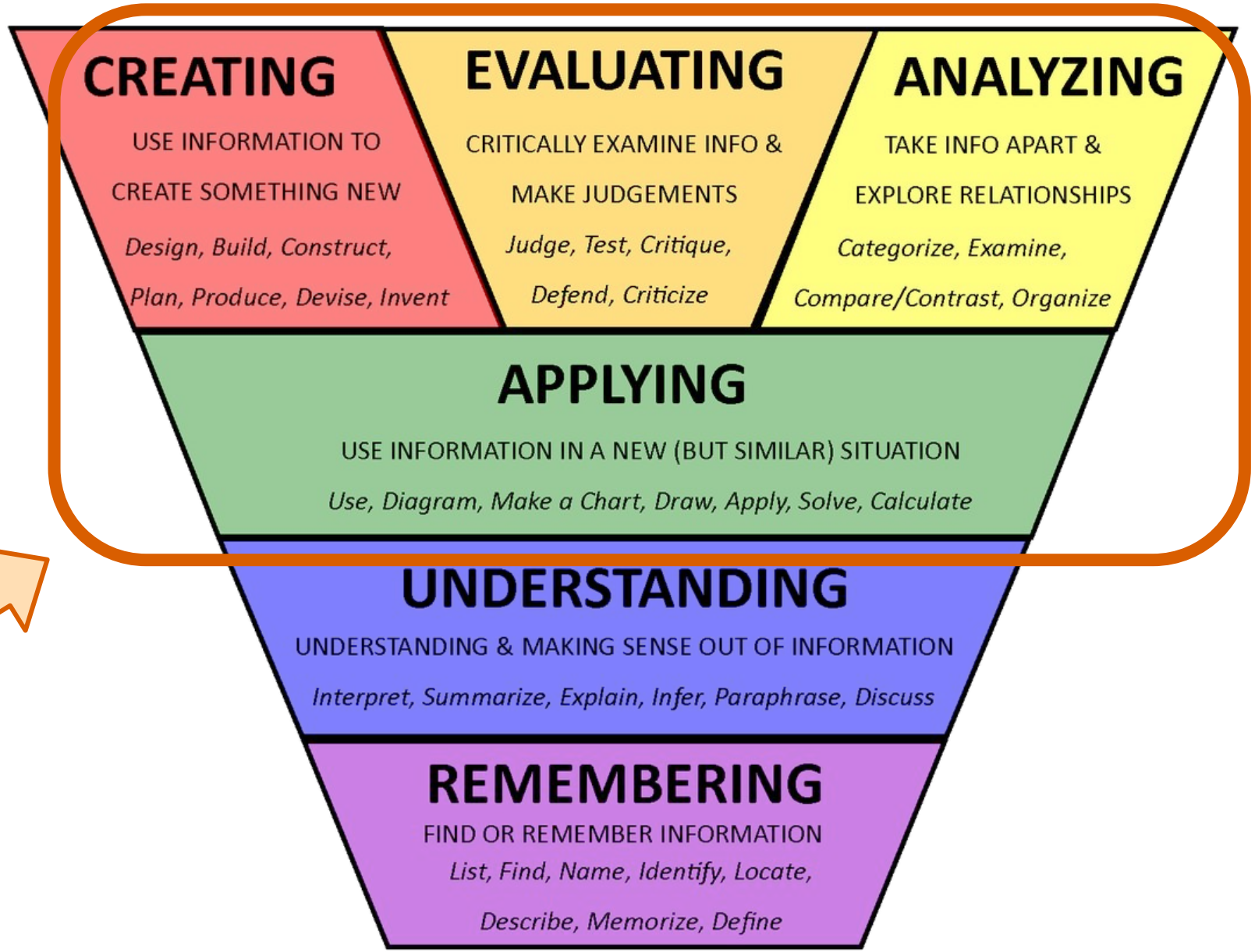
1. Discuss **What and Why** (~10 minutes)
2. Full Active Engagement **Example 1:** Statics (20 minutes)
3. Brief Overview of **More Examples**: (20 minutes)
4. Follow-up **Discussion** (~15 minutes)

What:


Shoot for the moon.
Even if you miss, you'll
land among the stars.
NORMAN VINCENT PEALE

What:

Use Bloom's Taxonomy to force students to **use deeper learning early**, while still developing understanding.



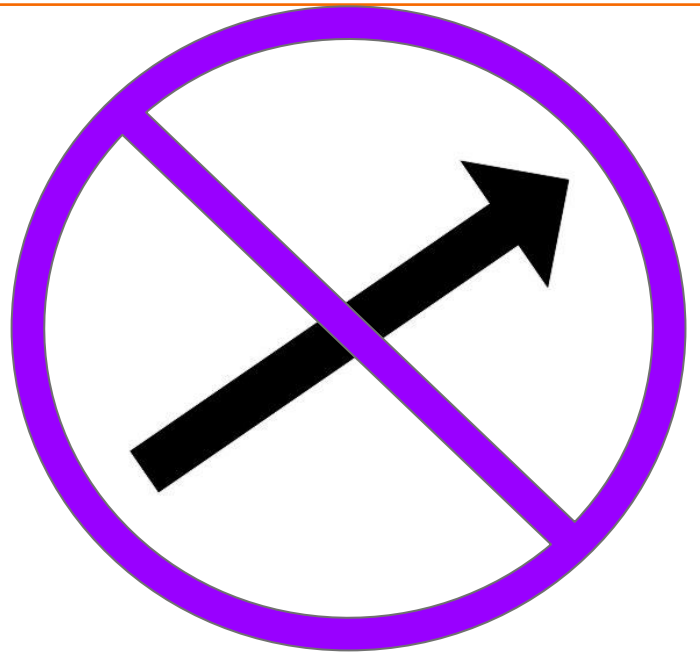
Why? (Reason 1)

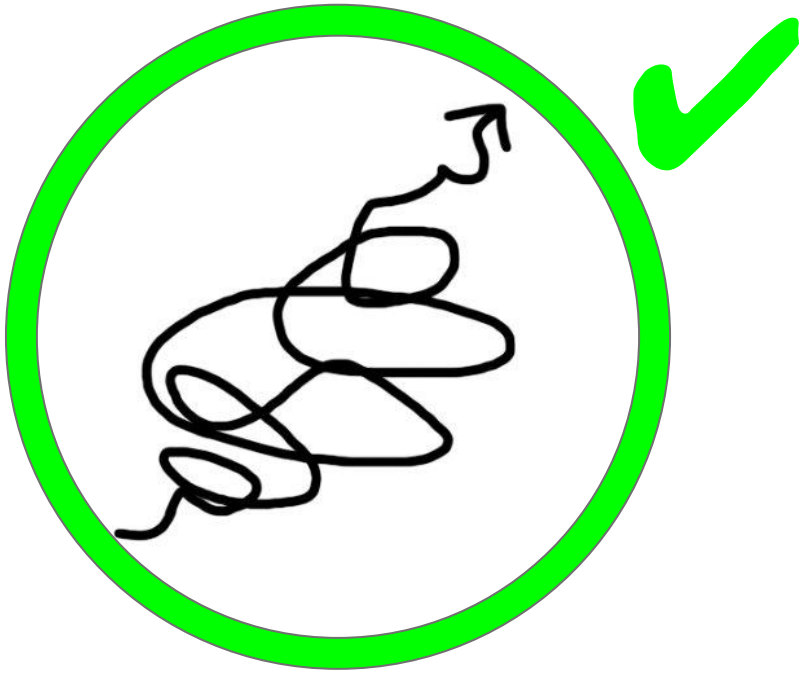
It was always meant to be this way.

Bloom's presents a hierarchy of thinking levels

- BUT -

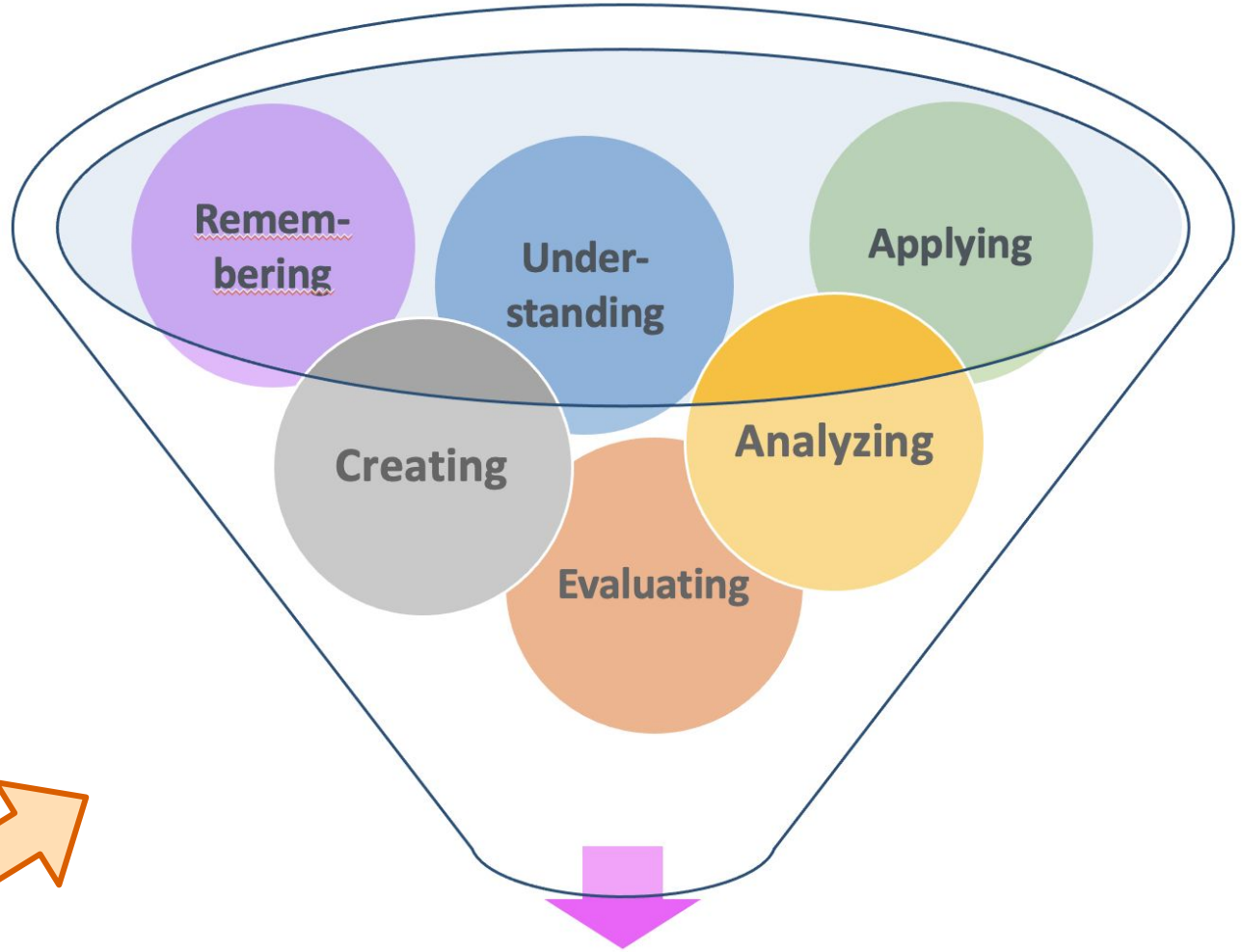
Effective learning is not a linear process.





Why?

What I think using Bloom's should look like:

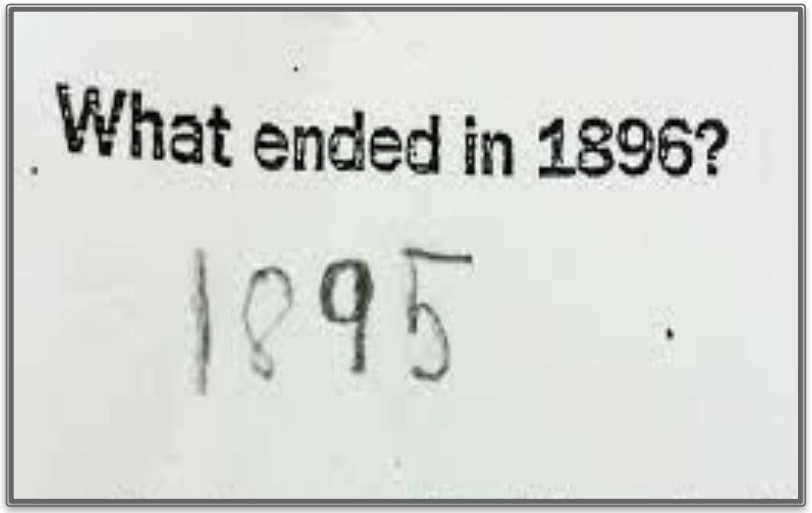


Learning Goals

Why? (Reason 2)

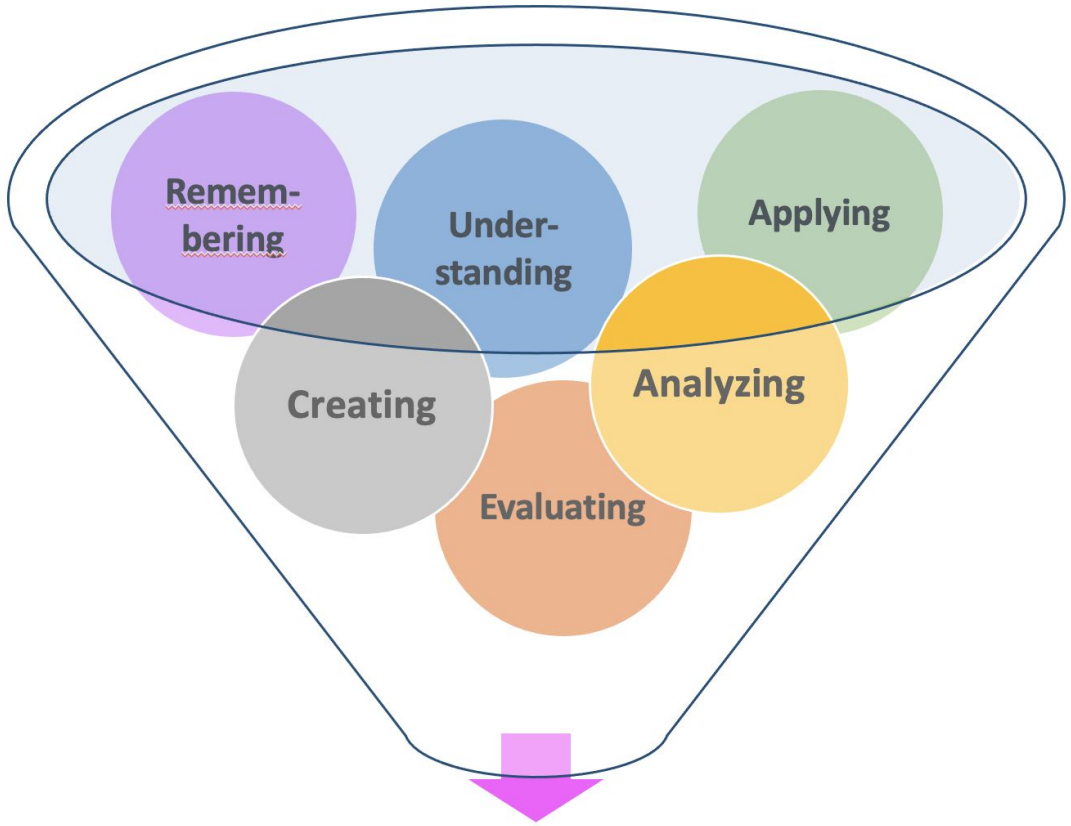
We **assess** students
at the higher levels.

So we might as well expose
students to them,
often and early.



Challenges:

- It can be hard to think about higher level thinking in complex fields with **a lot of information**/remembering.
- **Time** consuming to prepare.
- Harder to **assess** in depth.
- Group work/class dynamics.



An Example from my Classroom

An Example from my Classroom

But first…

An Example from my Classroom

Workshop

My ~~Class~~ Motto: Physics. Is. Awesome!

(I hope I can convince you!)

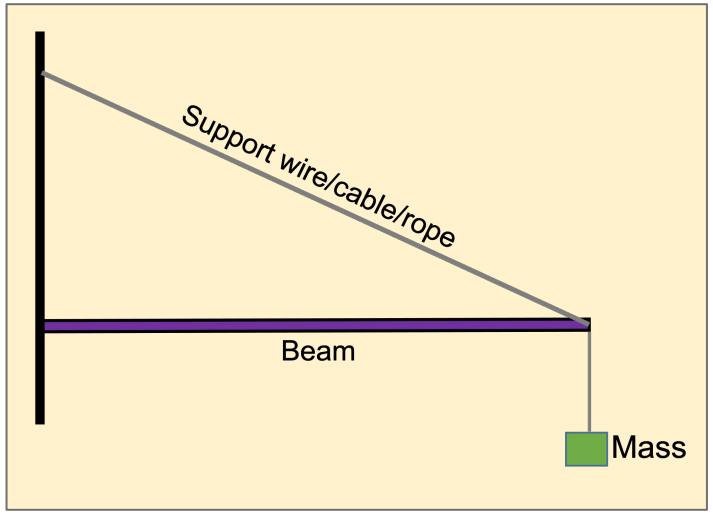
Example:
Static Equilibrium

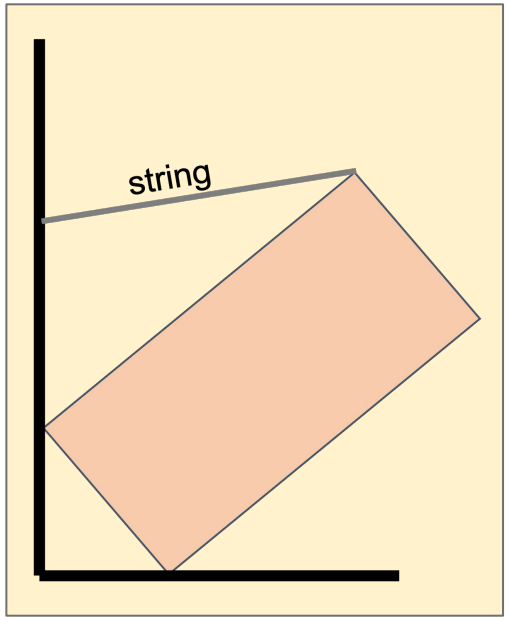
(AKA: Things that aren't moving)

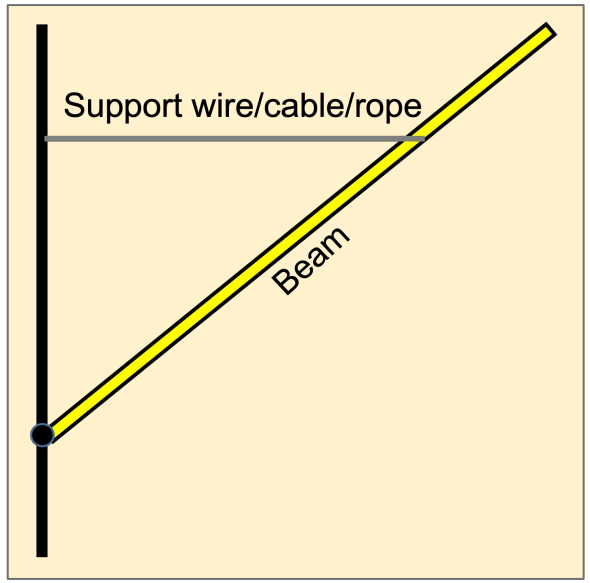
https://www.achrnews.com/articles/128845-work-at-height-worst-practice-revealed-as-idiots-on-ladders-crowned

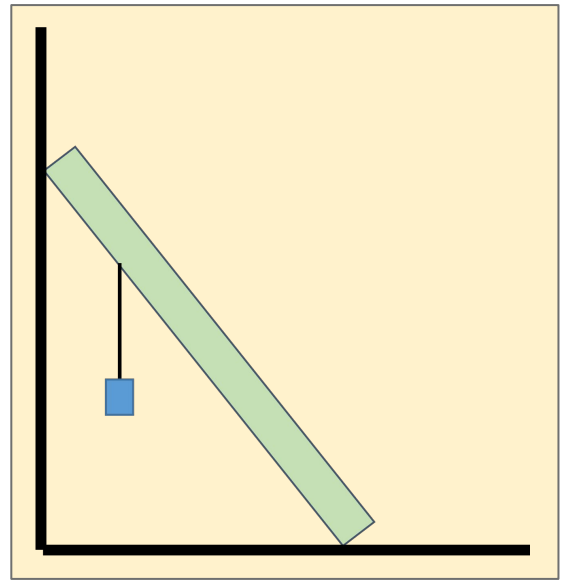
Groups of 2 - 4: Brainstorm Activity (5 minutes)

Below are diagrams from static equilibrium problems in intro physics.









Groups of 2 - 4: Part 1

To Do:

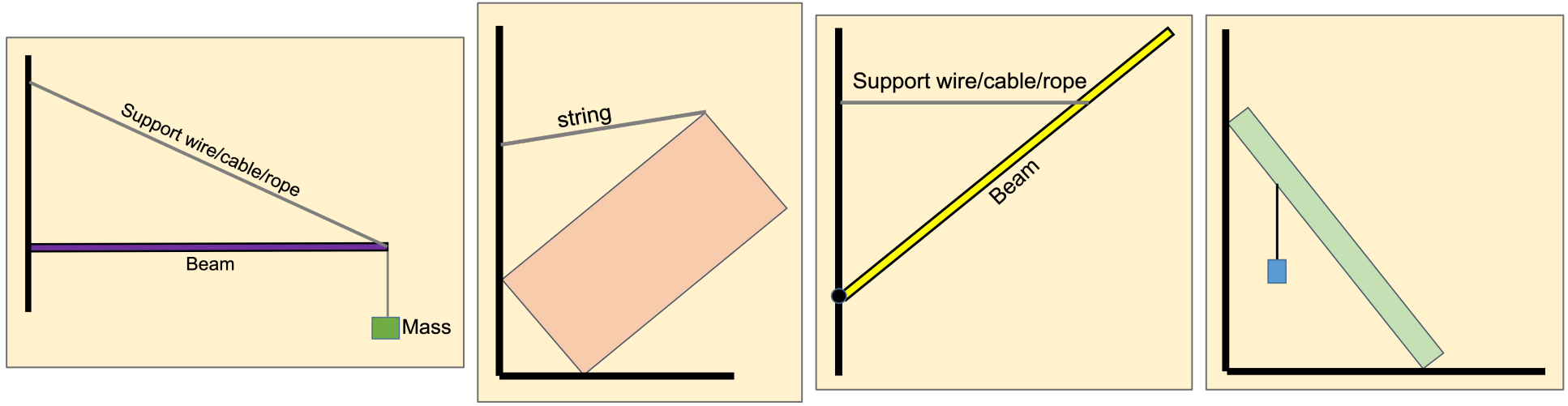
Brainstorm **examples of objects** in static equilibrium **in the real world**.

For each example you come up with:

1) Name the object of focus, and

2) Make a basic sketch of the situation.

Diagrams from static equilibrium problems in intro physics:



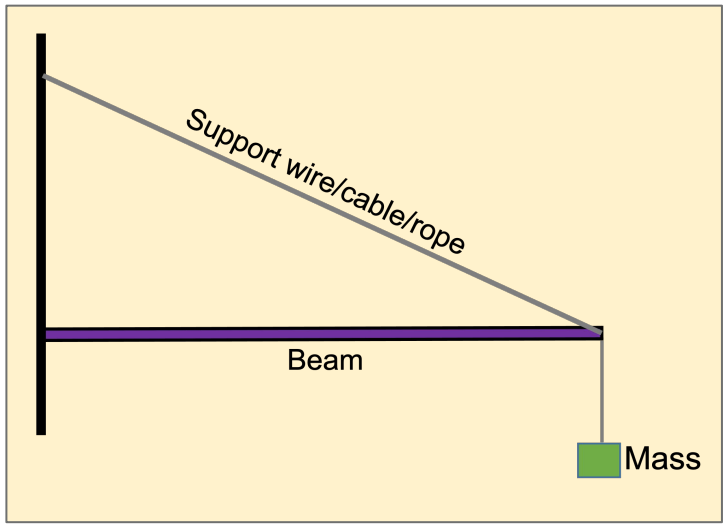
Groups of 2 - 4: Part 1

Example:

Groups of 2 - 4: Part 1

Example:

Which is kind of like this:



Groups of 2 - 4: Part 1

15:00

Brainstorm **examples of objects** in static equilibrium **in the real world**.

For each example you come up with:

1) Name the object of focus, and

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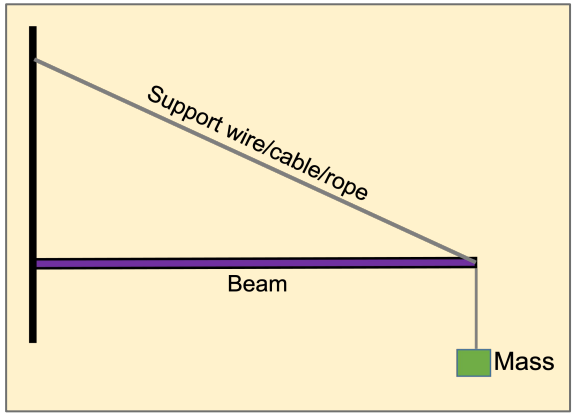
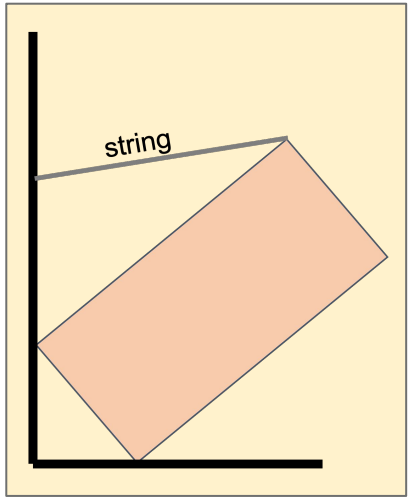
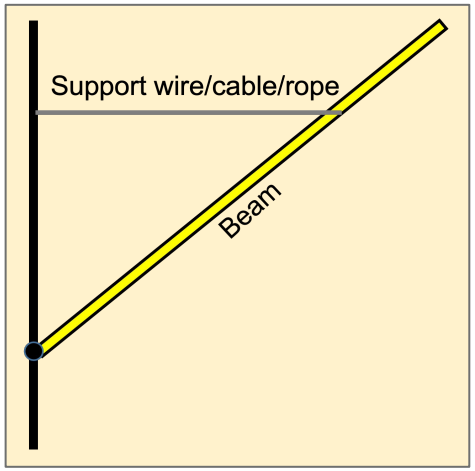
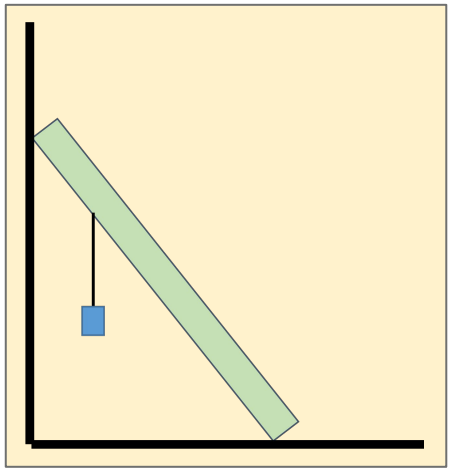
Example:

Diagrams from static equilibrium problems in intro physics:









Groups of 2 - 4: Analysis Activity (5 minutes)

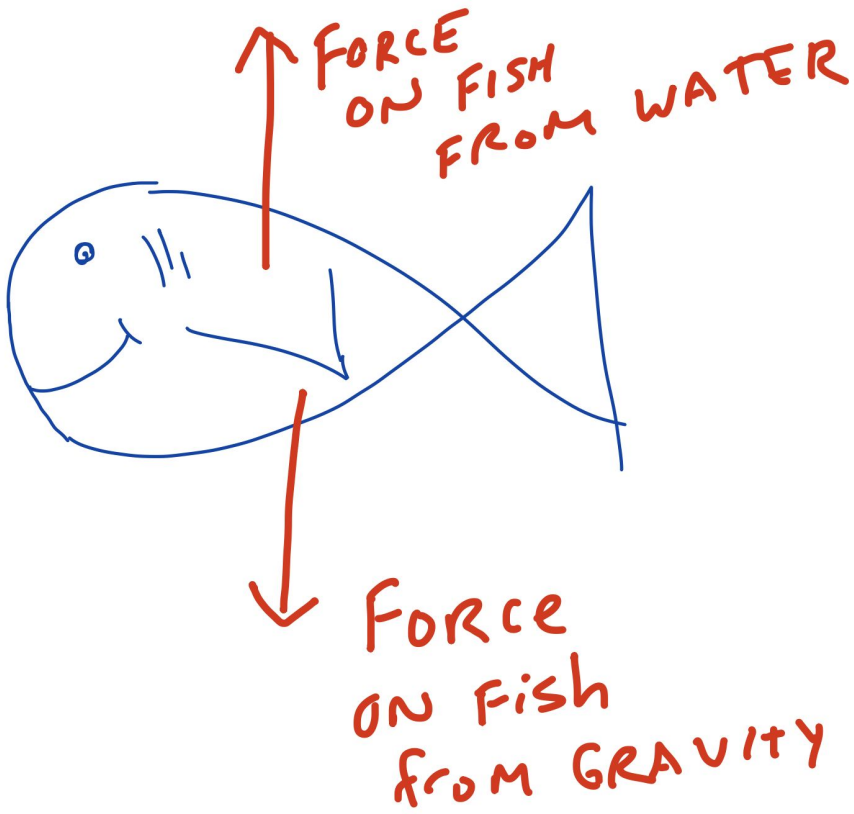
Pick one of your objects, and list the **forces** that might be acting **on that object**, and **where they act**.

Label these on your diagram.
Use arrows to show what direction you think the forces act.

Groups of 2 - 4: Part 2

Pick one of your objects, and list the **forces** that might be acting **on that object**, and **where they act**.

Label these on your diagram.
Use arrows to show what direction you think the forces act.

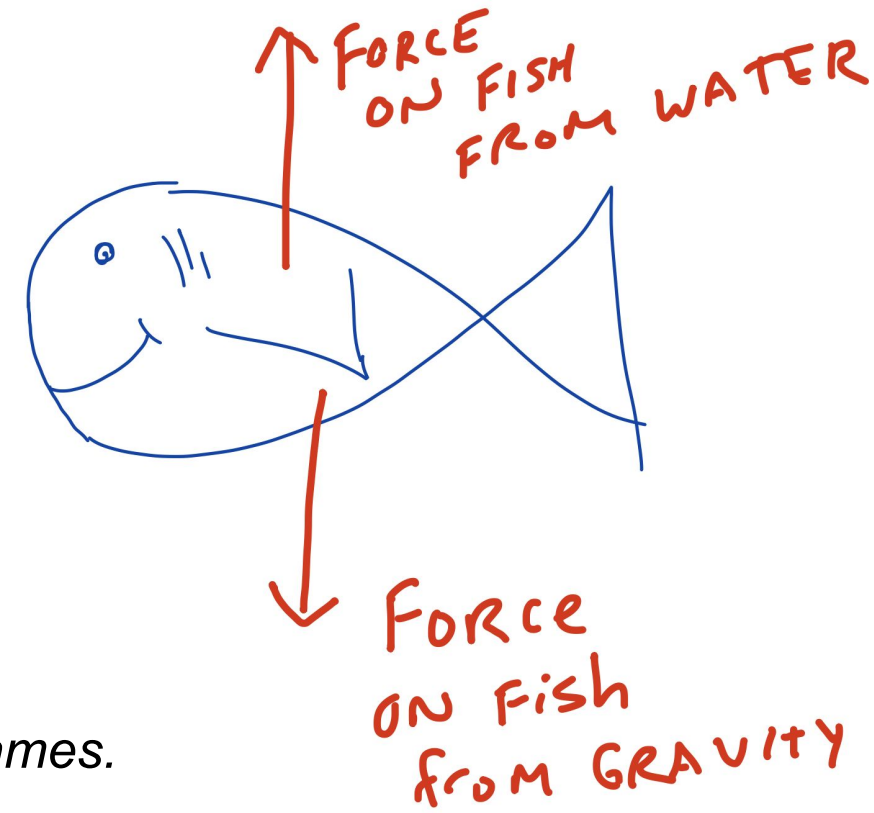


Groups of 2 - 4: Part 2

15:00

Pick one of your objects, and list the **forces** that might be acting **on that object**, and **where they act**.

Label these on your diagram.
Use arrows to show what direction you think the forces act.



Don't try to be fancy or technical with force names.

'Contact force from wall' or 'pulling force from string' are just fine.

Hint: Pretend YOU are the object.
What would be acting on you?

Right now,
you might be thinking:

You might be thinking:

Am I doing this right?

What's happening?

This is easy.

She lied. Physics is NOT awesome. Grrrr.

Lucky for you, there are other people in this room!

Find another group, trade papers, chat, revise.

Finishing it Up:

1. Choose a pivot and write the Rotational N2L Equation of Motion for your object relative to that pivot.

2. Then write the N2L Equation of Motion for the forces in the x and in the y directions.

3. Assume you know the masses and lengths. Do you have enough information to solve for all the forces acting? Why or why not? What would you need to know about this system to solve for everything?

Finishing it Up:

Modified Version (you're welcome)

We are able to write **three equations** relevant to this system.

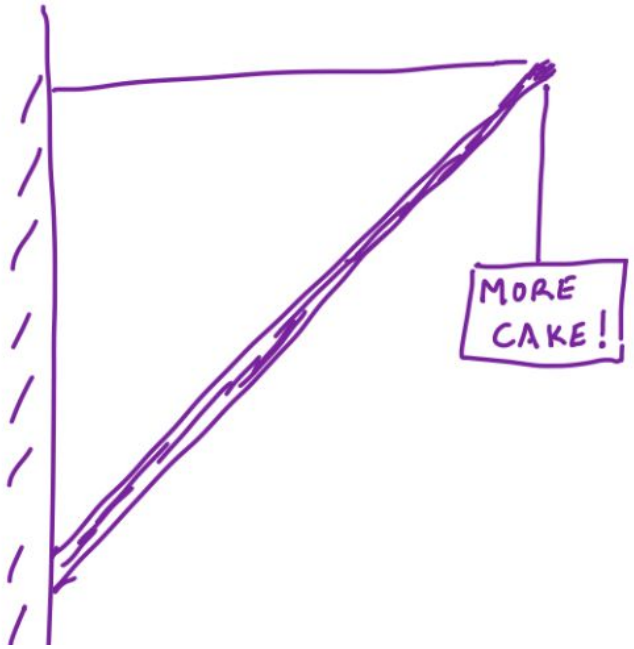
This means we can solve for **three unknowns**.

QUESTION: If you had those three equations, would you have enough information to solve for all the unknown forces acting on your object?

Assume you know all relevant weights and lengths.

Why or why not? What would do you think you need to know about this system to solve for all the unknowns?

"Creating" tasks help them avoid cognitive overload:



$$\Sigma \vec{\tau} = T_{cable} L \sin\theta - M_{beam} g \frac{L}{2} \cos\Theta - M_{sign} g L \cos\Theta = 0$$

$$\Sigma \vec{F_x} = \vec{F}_{x,pivot} - T_{cable} = 0$$

$$\Sigma \vec{F_y} = \vec{F}_{y,pivot} - M_{beam} g - M_{sign} g = 0$$

Some modifications I have used for activities like this:

1. **Gallery walk**

Instead of “find a group and trade,” post around the room and walk around.

2. **Trade for good**

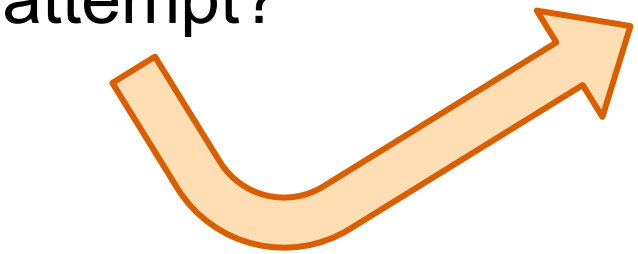
Work with the other group’s example the rest of the time.

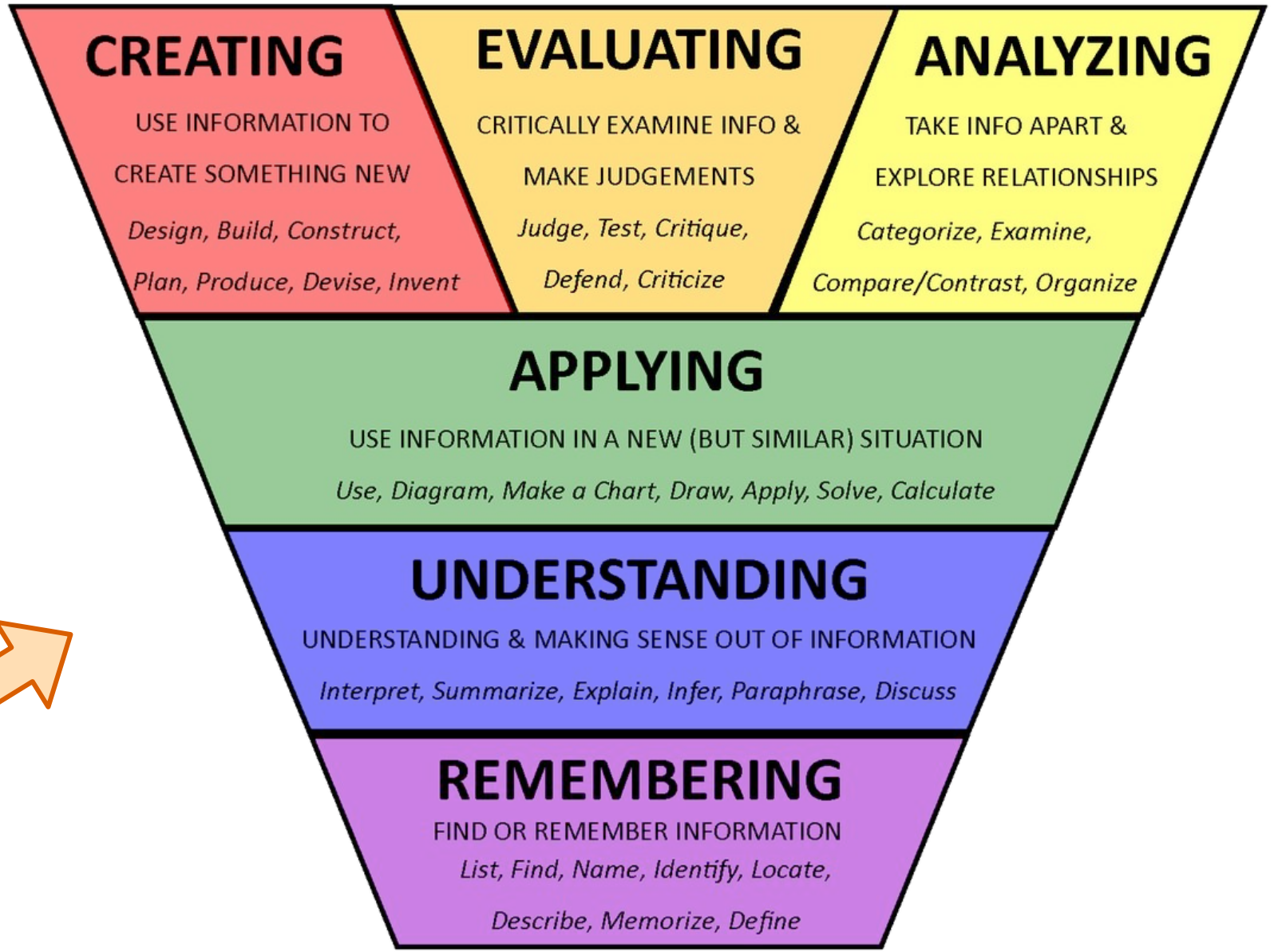
3. **Peer evaluation, correction**

Solve first, then trade and correct.

Reflection:

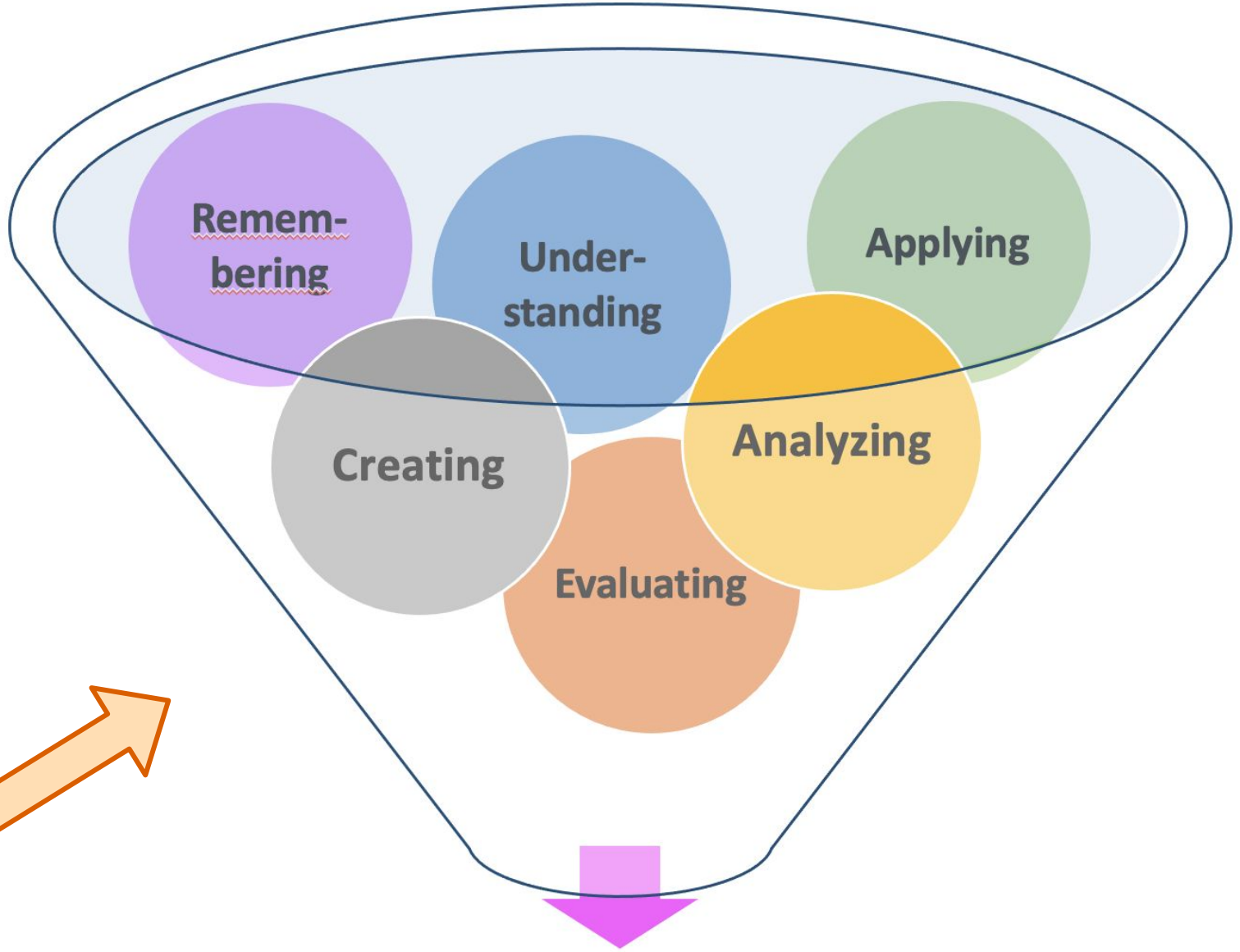
Which part of the Bloom's Taxonomy "levels" do you feel like this activity forced you to attempt?





Recall:

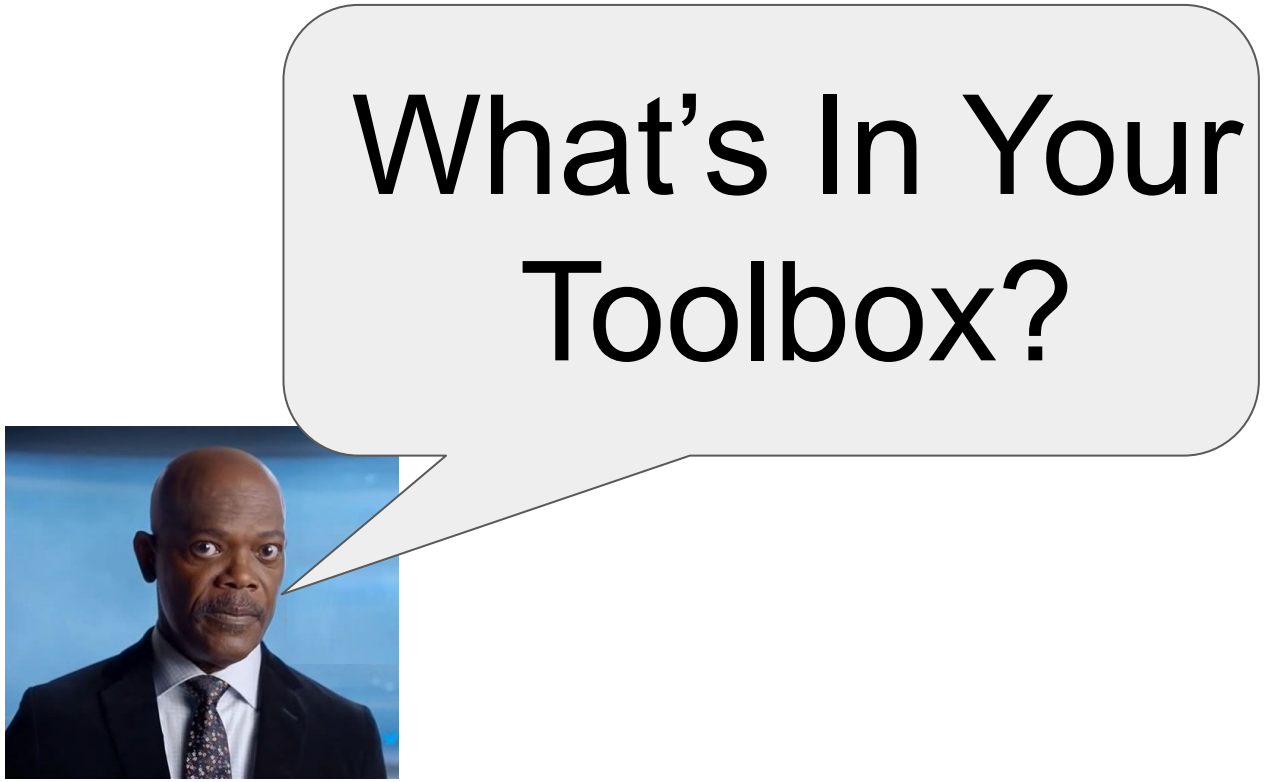
What I think using Bloom's should look like:



Brief Overview of Other Examples

(from my Classroom… and yours!)

Example 1:



Example 1: “What’s in Your Toolbox?”

Groups of 2 or 3

Write brief description of problem on post-it.

Continue until shared with larger group.

Example:

A box slides down a hill, over rough patch, collides with spring

CoE (Conservation of Energy)

General CoE Equation for Linear Motion:

$$K_i + U_{g,i} + U_{el,i} = K_f + U_{g,f} + U_{el,f} + \Delta U_{int}$$

- $U_{el} = \frac{1}{2}kx^2$
- $U_g = mgh$
- $\Delta U_{int} = -(\text{work done by friction}) = +\mu_k nd$

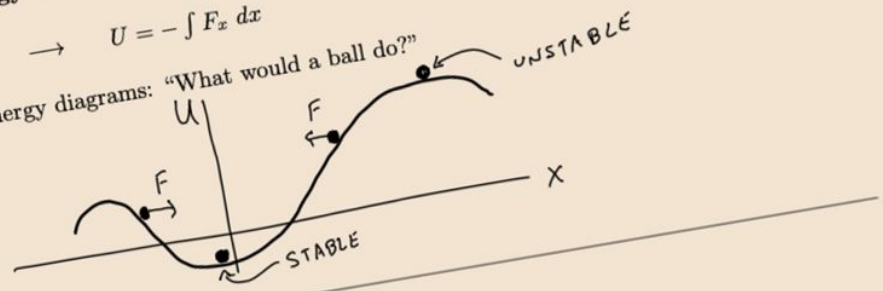
Power:

$$P = \frac{dW}{dt} = \frac{\Delta \text{ energy}}{\Delta \text{ time}}$$

Potential Energy and Force:

$$F_x = -\frac{dU}{dx} \longrightarrow U = -\int F_x \, dx$$

Potential energy diagrams: “What would a ball do?”



Impulse-Momentum Relation

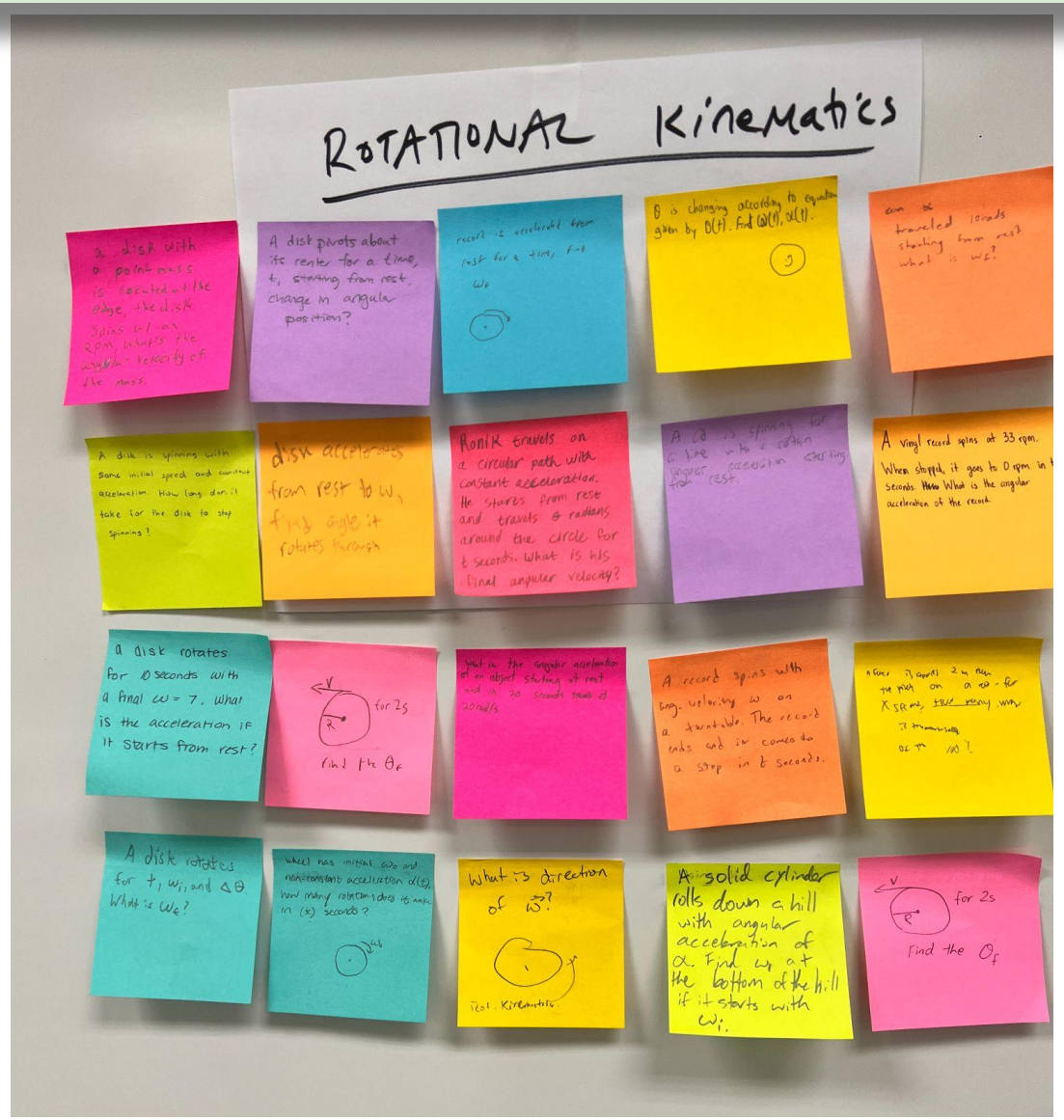
When and How to Use:

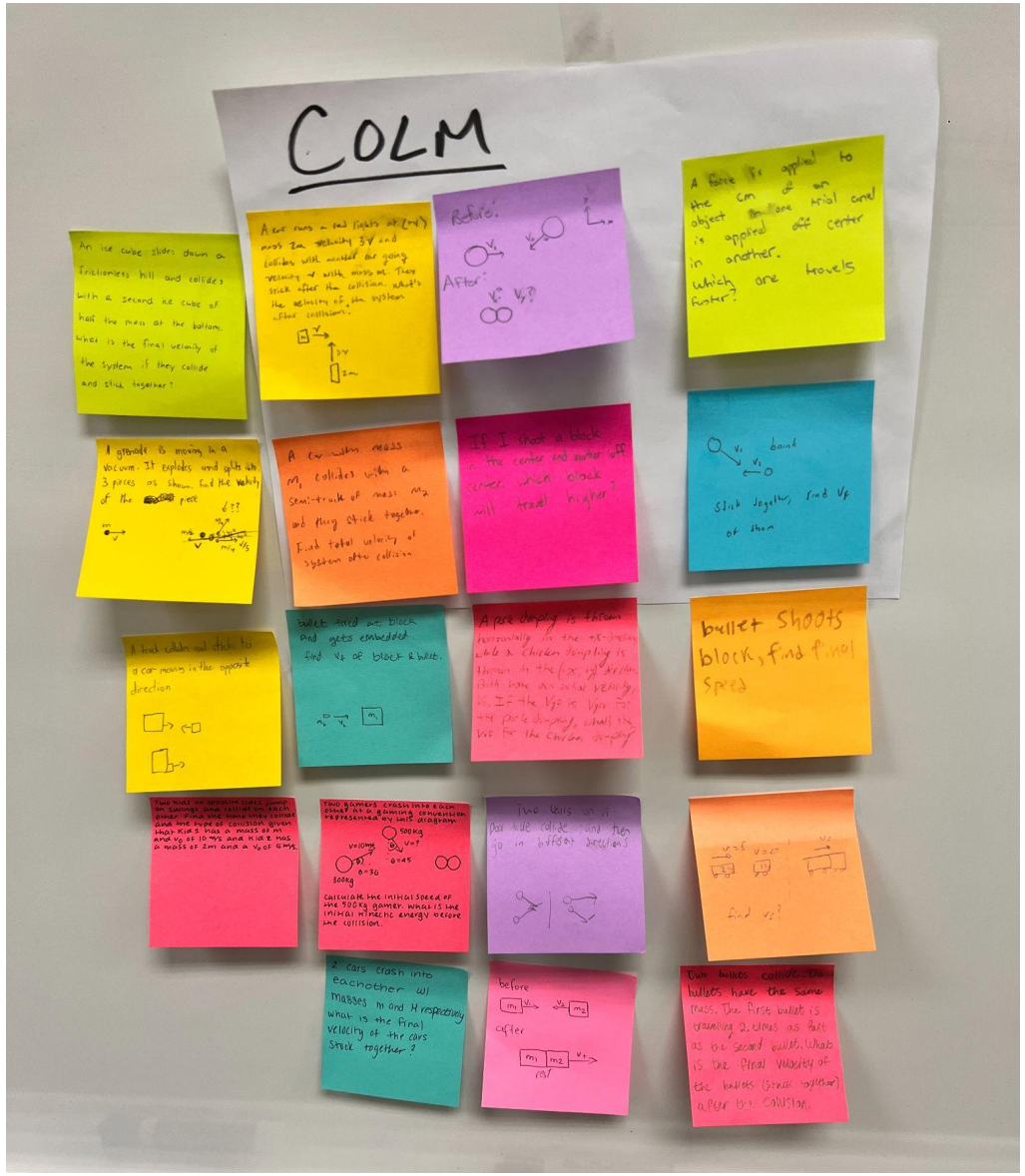
- Have time-varying force and want impulse or speed:

$$\int \vec{F}\,dt = \Delta\vec{p} = m(\vec{v}_f - \vec{v}_i)$$

- want impulse or speed:

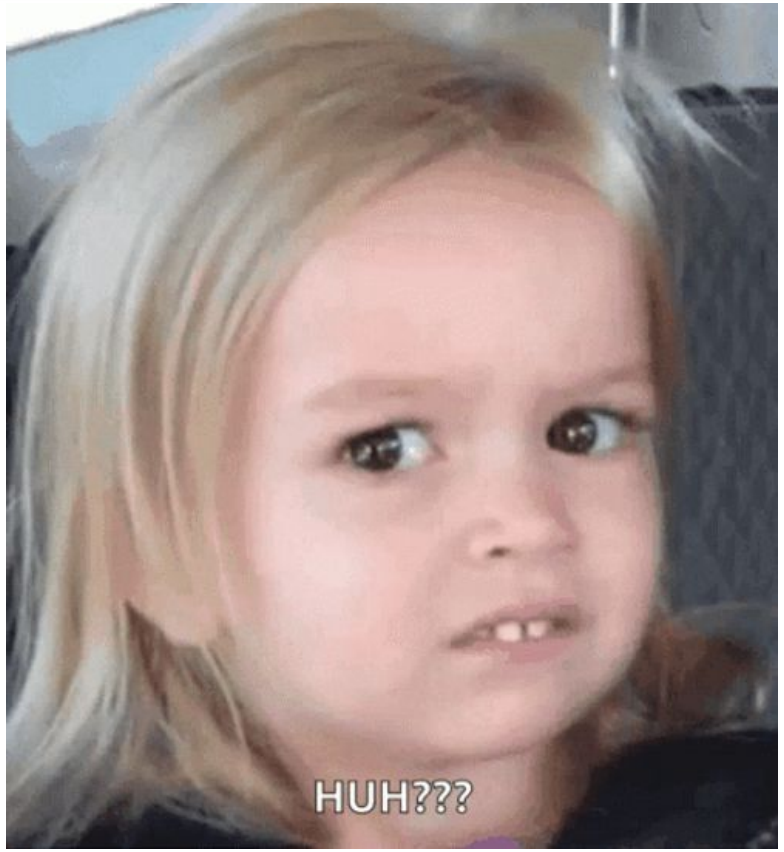
Example 1: “What’s in Your Toolbox?”





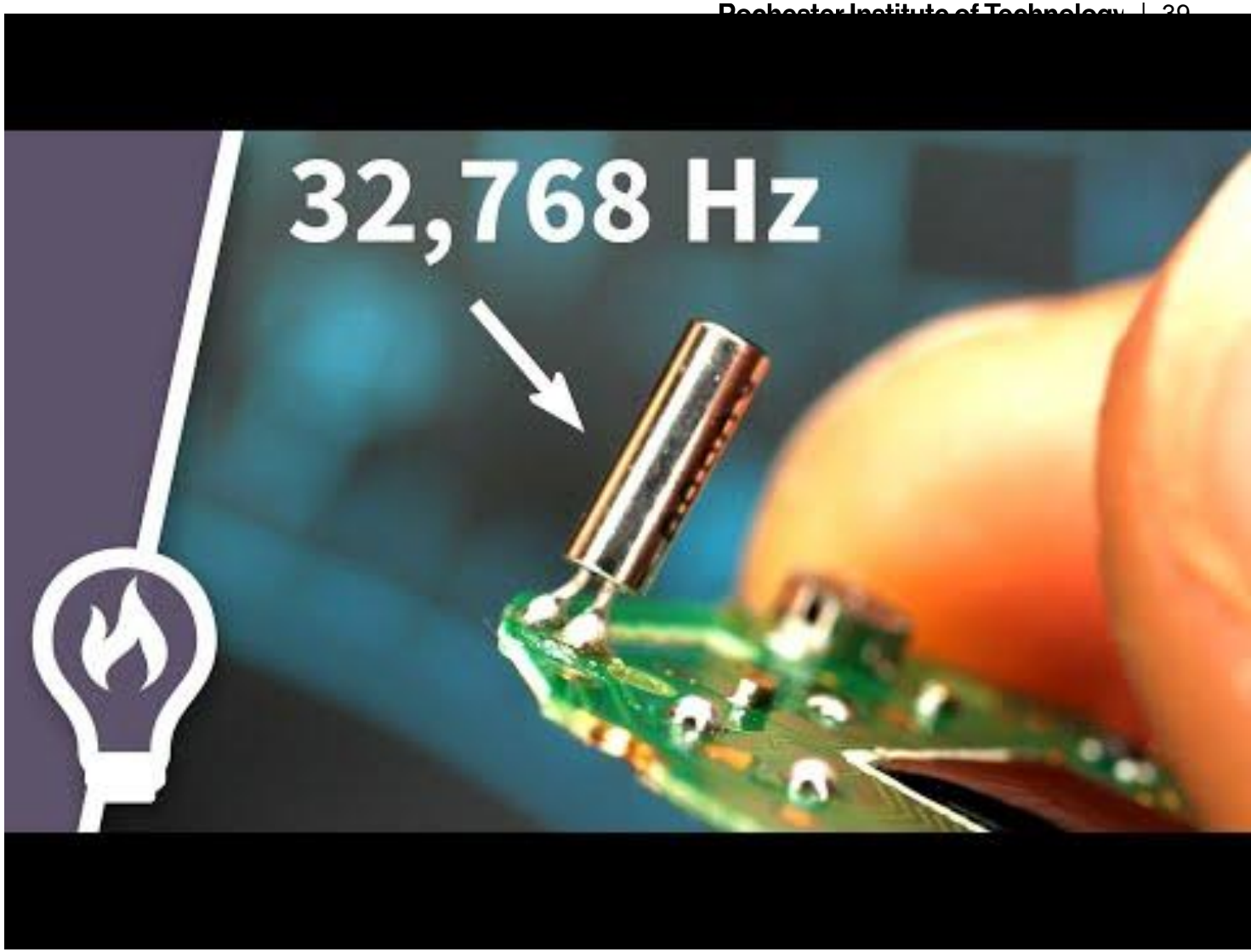
Example 2:

Why this?



Example 2: Why This?

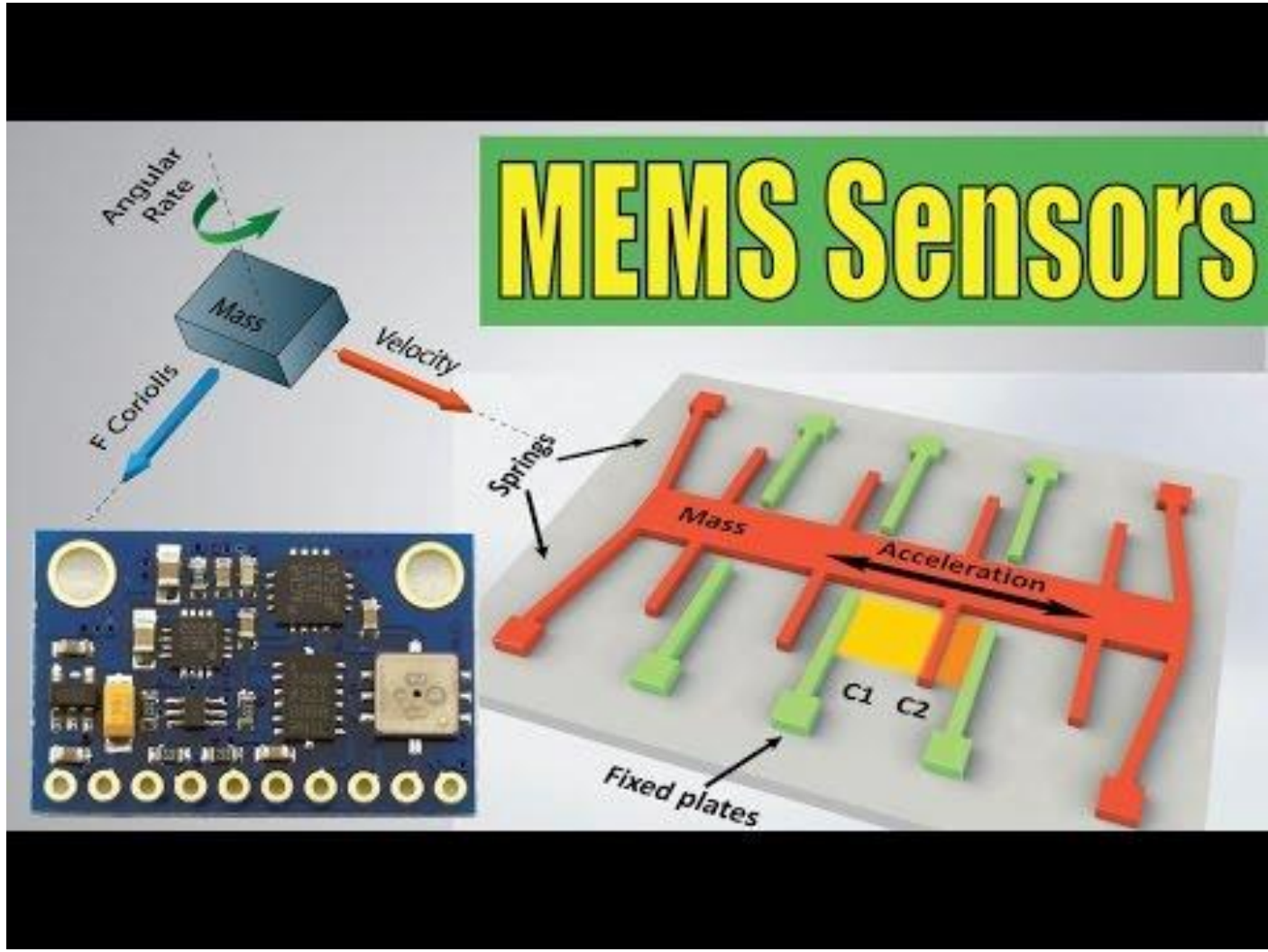
Why am I showing you this video clip?



(There is not sound on this video.)

Example 2: Why This?

Or this one?

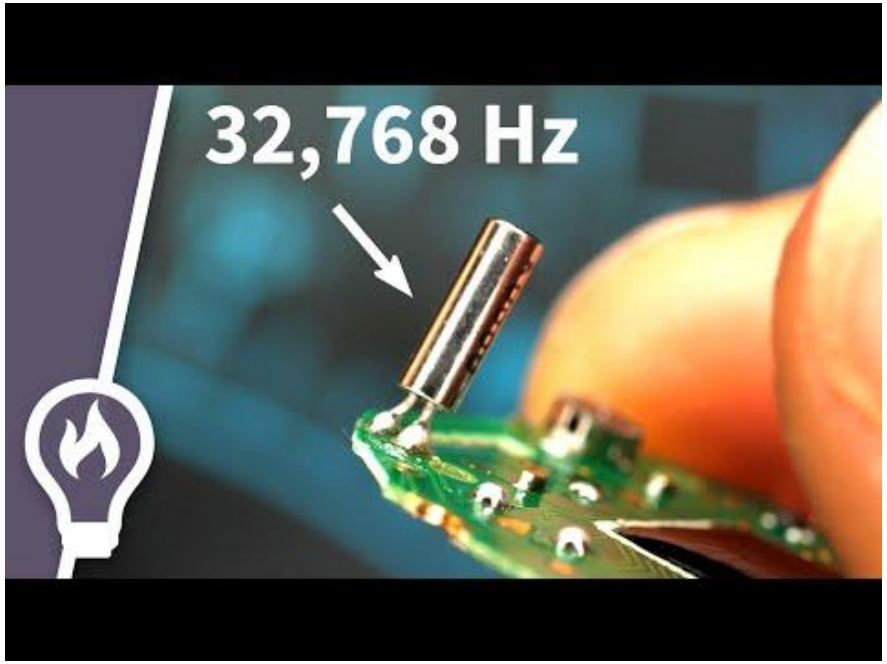


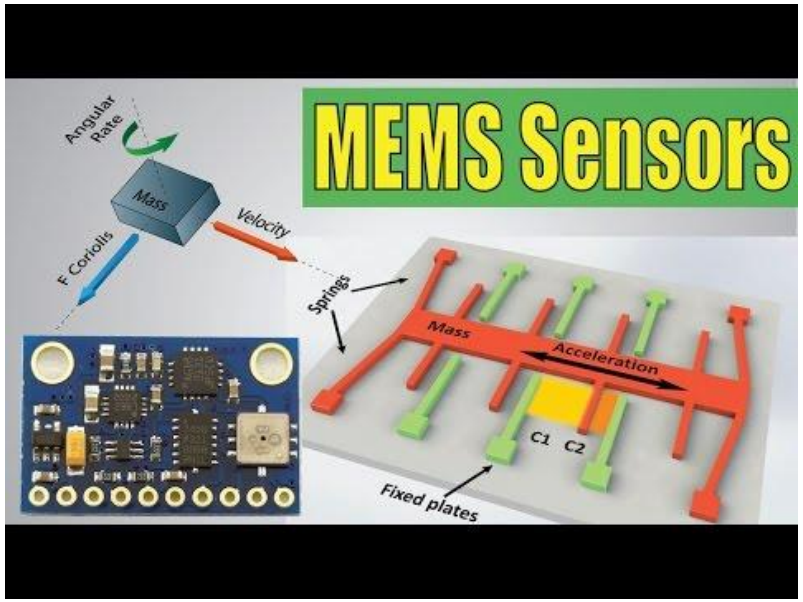
(There is not sound on this video.)

Example 2: Why This?

Why am I showing you these?

As a table:
List all the relevant concepts/keywords from Module 15 that might apply to this video.





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Example 3:

Free-Body Diagram Telephone

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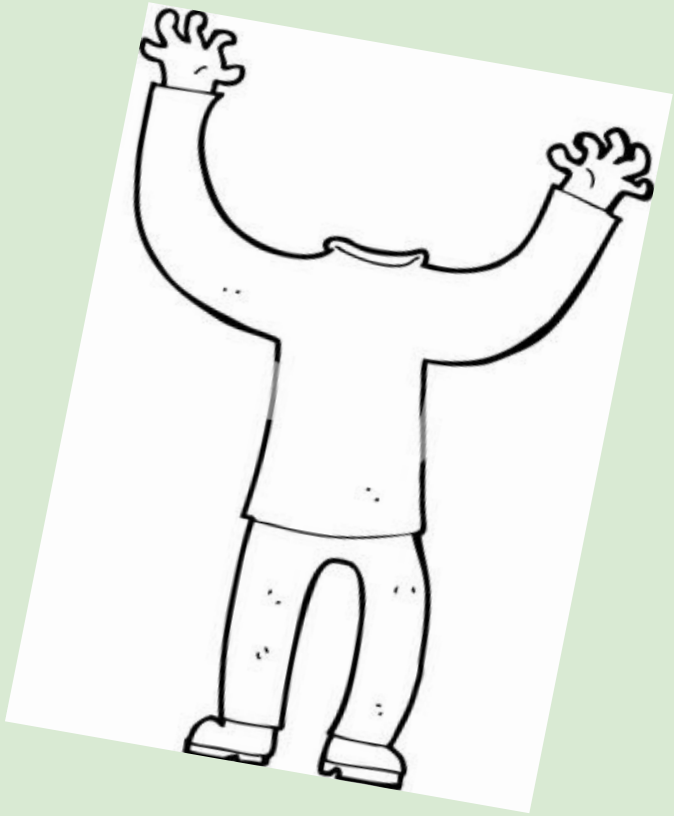
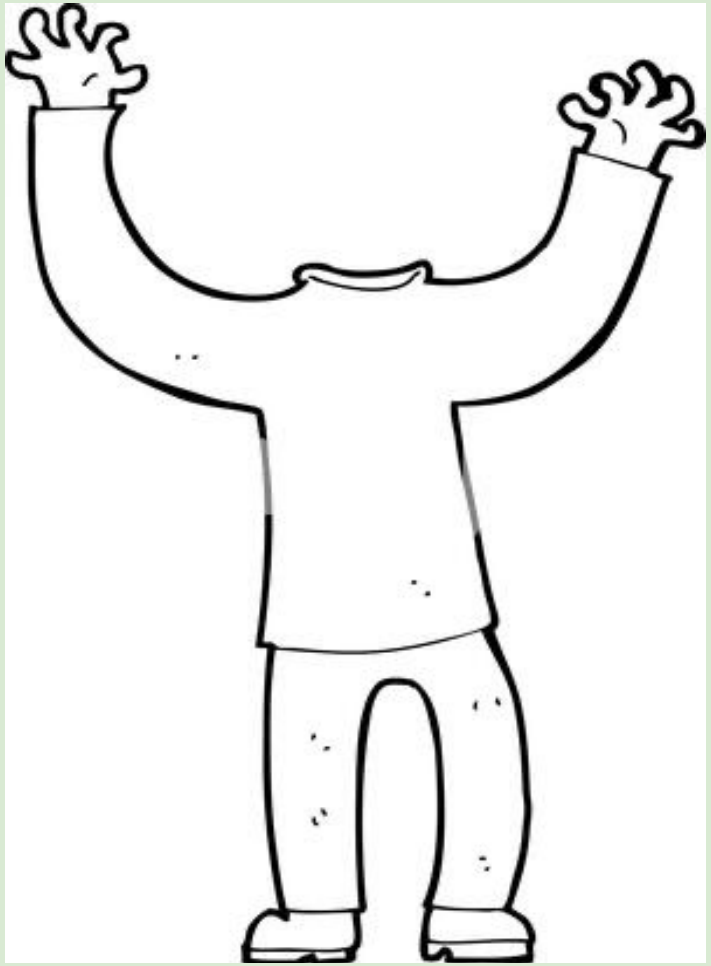
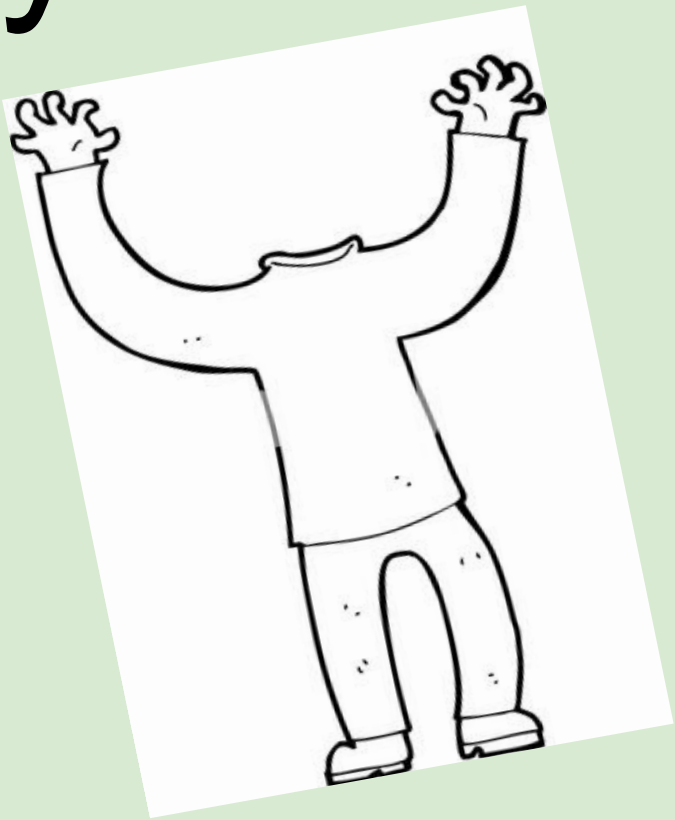
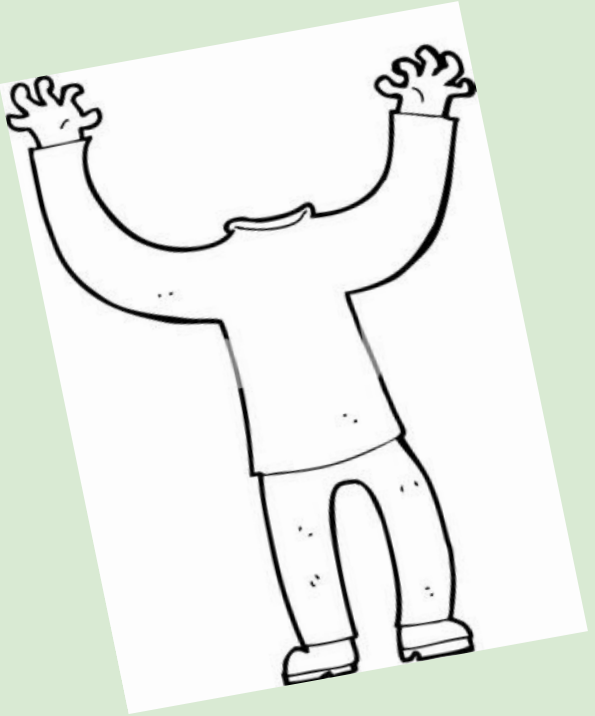
Free That Body!





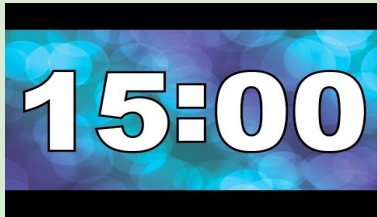


Free That Body!



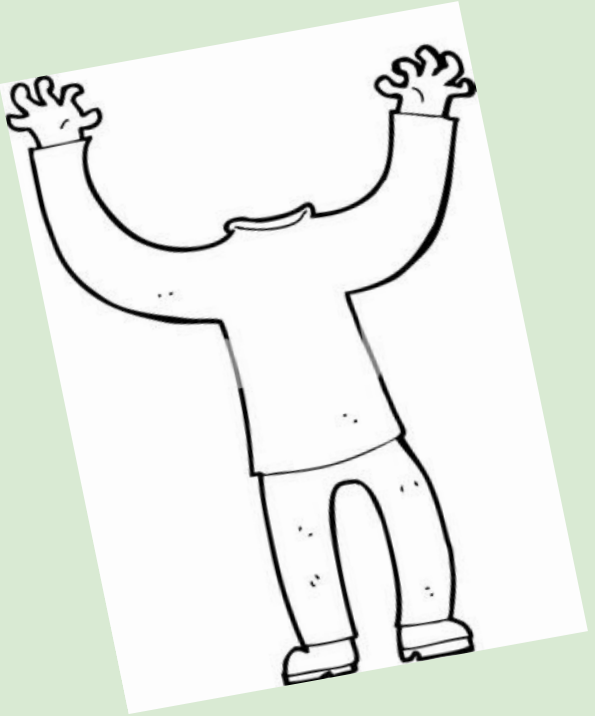
Step 1

1. Groups of 2 or 3
2. On the blank paper provided, draw a free body diagram for the scenario given to your group. (Keep the scenario secret!)
3. Label all forces clearly, and direction of acceleration.
4. Label the paper with the # shown on your scenario.



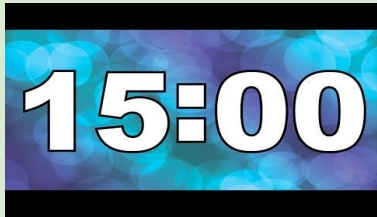
Free That Body!

Step 2



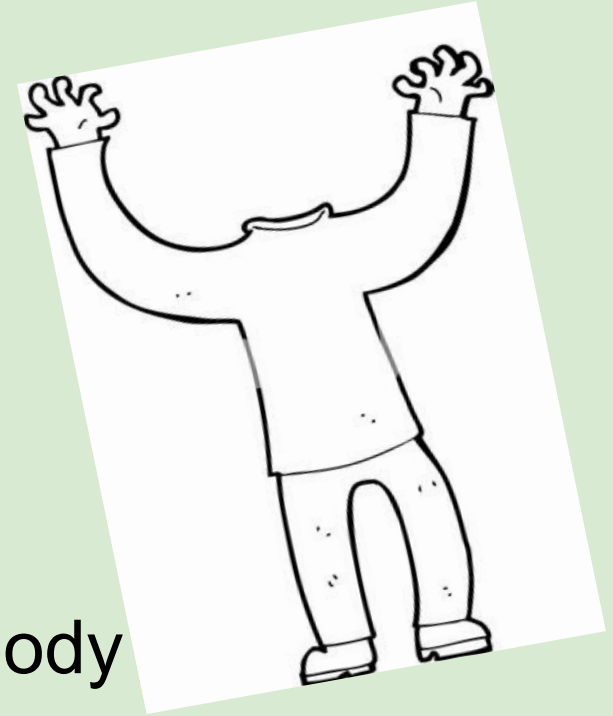
1. Trade according to professor instructions.

2. For the free body diagram you now have, write a scenario that could be happening to this object. Write this on the paper with the free body diagram.



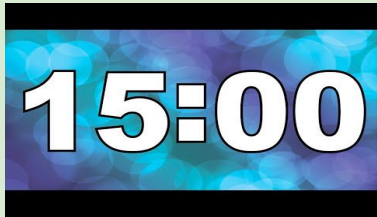
Free That Body!

Step 3

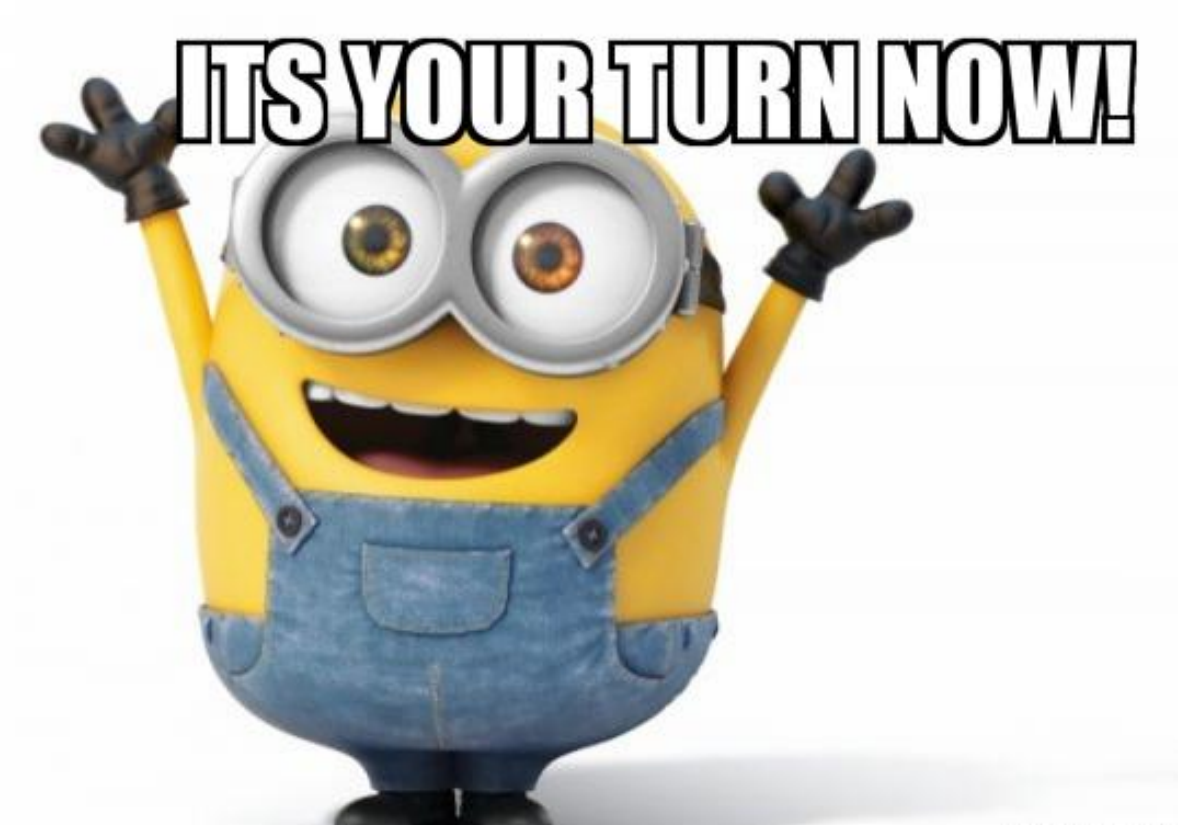


1. Find the group that originally drew the free body diagram that you currently have.

2. Compare scenarios and discuss



Your turn.

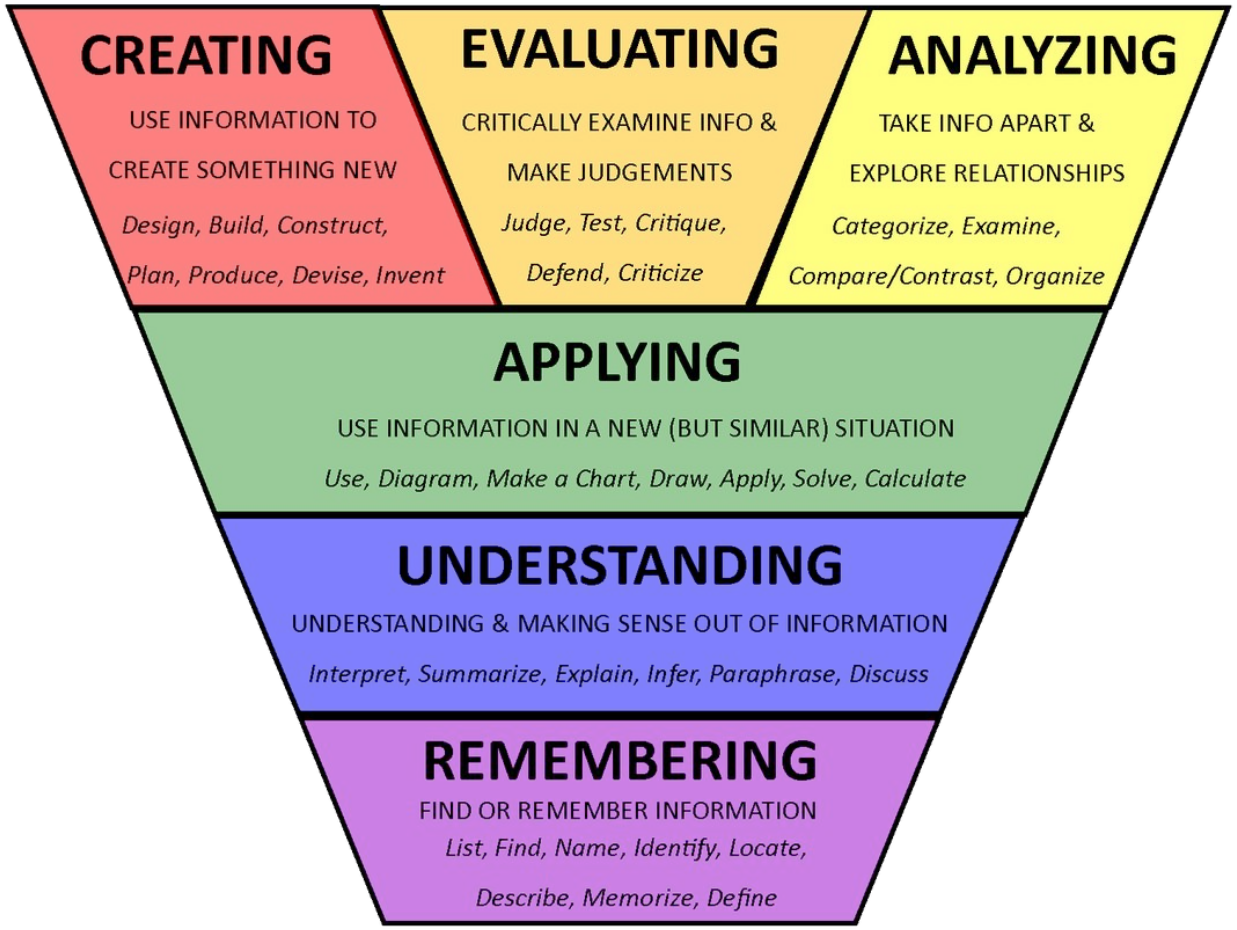


Individually:

Write an activity/assignment you do (or want to do!) that gets students "up the triangle" early on.

RULES:

1. Two-sentence description maximum!
2. Write clearly on index card.
3. When done, raise your hand and I'll collect it.
4. Optional: Put your name and email.



Individually:

Write an activity/assignment you do (or want to do!) that gets students "up the triangle" early on.

RULES:

1. Two-sentence description maximum!
2. Write clearly on index card.
3. When done, raise your hand and I'll collect it.
4. Optional: Put your name and email.

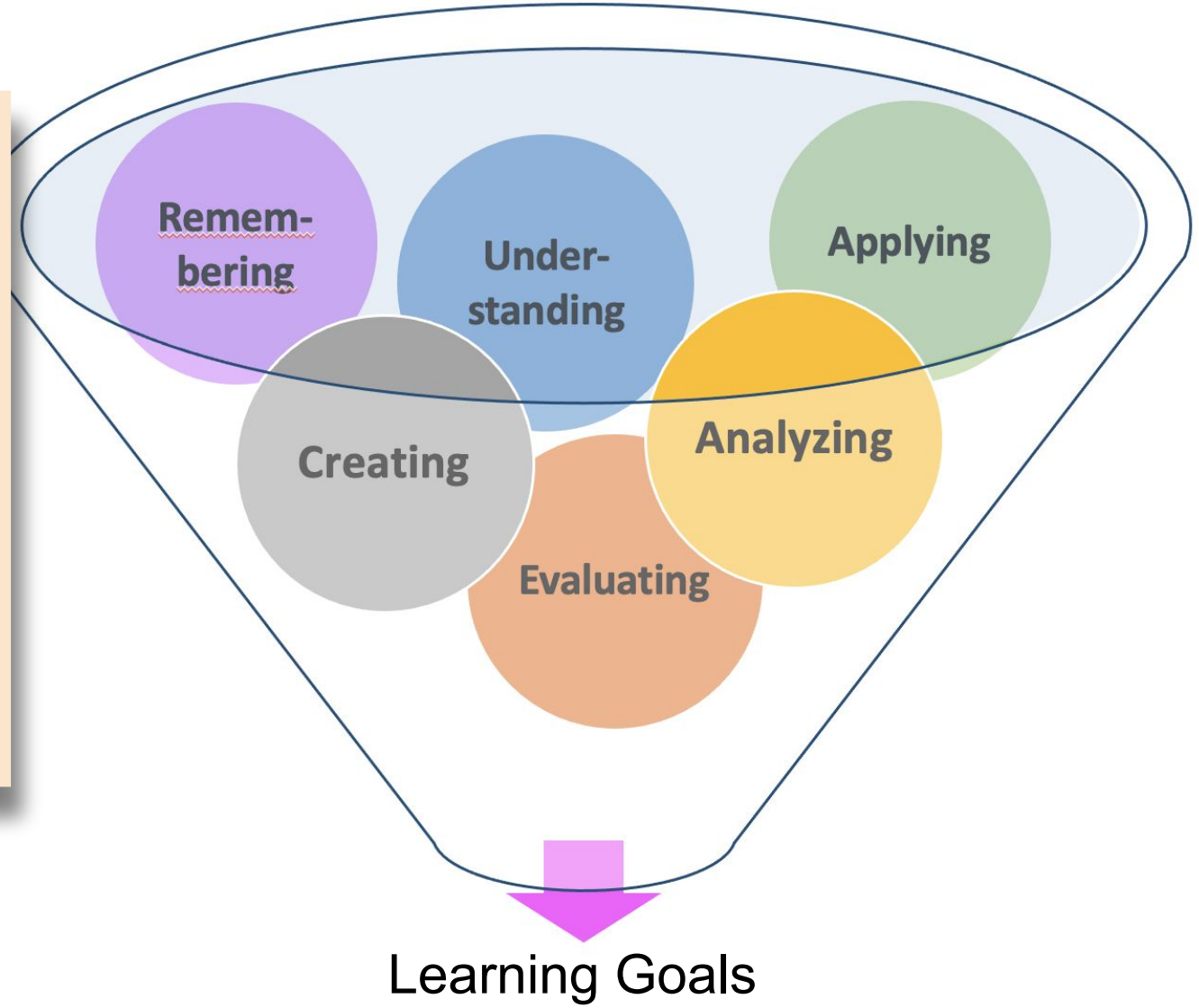
Gallery Walk

NO RULES.

Wander, read, chat, and learn!

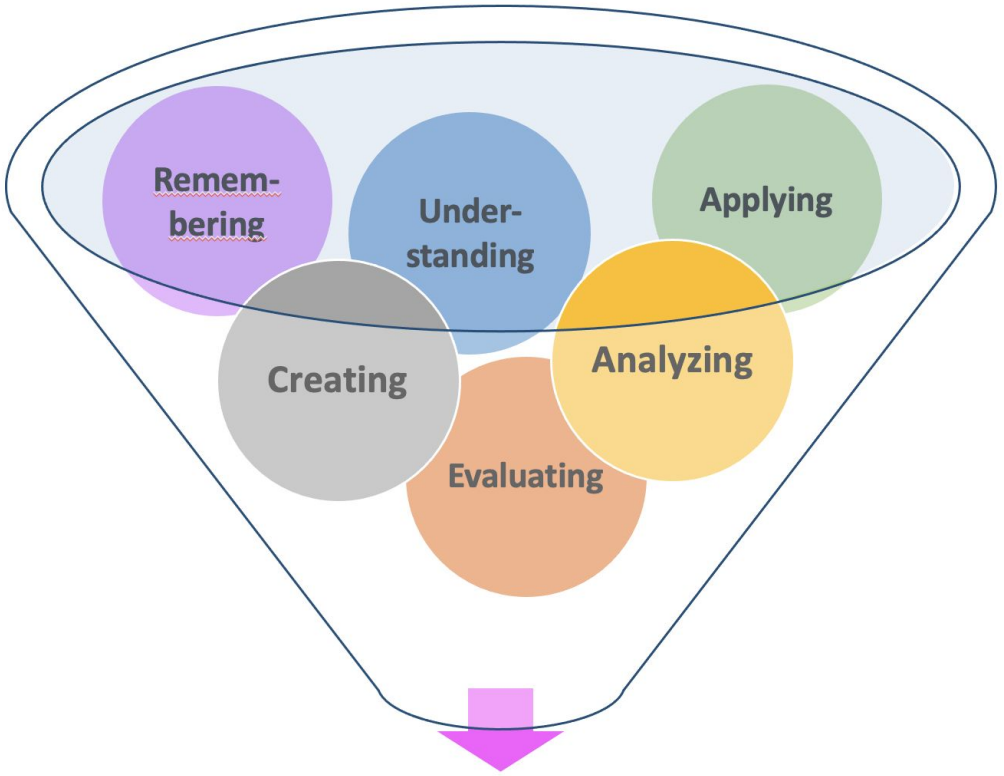
Discussion and Reflection

Questions?
Thoughts?
(Discussion and General Q&A time.)



Recall the Challenges:

- It can be hard to think about higher level thinking in complex fields with **a lot of information**/remembering.
- **Time** consuming to prepare.
- Harder to **assess** in depth.
- Group work/class dynamics.



Questions? Thoughts?

(Discussion and General Q&A time.)

Thank you! Have a great summer!

Contact me to talk further:
mdcsps@rit.edu