Make problems with the help of REASoN and SiQuENC

I. REASoN

Relationships

Governing relationships often involve sums of quantities of the same type associated with distinct entities within or acting on a system

Constitutive relationships often relate quantities of various types to the quantities summed or netted in governing relationships.

Equal

Indicate quantities that are the same, constant, or matched.

Altered

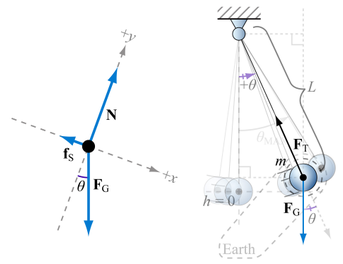
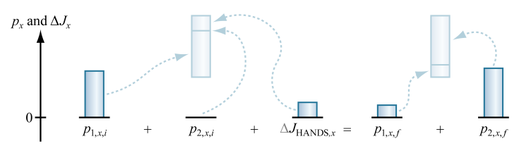
Indicate quantities that are changed, different, or mismatched.

So what?

Indicate conclusions.

Next?

Indicate further conclusions made possible by previous conclusions.

	N2L, N2L for rotational motion	(Angular) impulse-(angular) momentum Generalized work-energy princniple
Governing relationships often involve summing/netting quantities of a given type. Graphically represent such **quantities** (or their inputs).	Force diagrams  without AOR with AOR and depicted lever arm(s)	Bar charts 
Governing relationships can often be represented using **equations** with repeated generic forms.	$\left(\begin{matrix}\text{IROC of IROC}\\ \text{of system}\\ \text{coordinate}\end{matrix}\right) = \dfrac{\sum\left(\begin{matrix}\text{Push or turn}\\ \text{on system}\end{matrix}\right)}{\left(\begin{matrix}\text{Inertial}\\ \text{quantity}\\ \text{of system}\end{matrix}\right)}$	$\sum\left(\begin{matrix}\text{Quantity}\\ \text{of state}\\ \text{of system}\end{matrix}\right)_i + \left(\begin{matrix}\text{Accrued}\\ \text{influence}\\ \text{on system}\end{matrix}\right) = \sum\left(\begin{matrix}\text{Quantity}\\ \text{of state}\\ \text{of system}\end{matrix}\right)_f$

Constitutive relationships can be written as formulas in a table of quantities that allow for changes or absences of changes in quantities from snapshot to snapshot to be **analyzed**.

Involves objects (#s)	Defined & postulated quantities	Snapshots and intervals				
		t_1		t_2		
	m	m	$=$	m		
	v	v	$\times 2$	v		
	$K = \frac{1}{2}mv^2$	K	$\times 4$	K		
	m	m	$=$	m		
	g	g	$=$	g		
	h	h	$\downarrow$	h		
	$U_G = mgh$	U_G	$\downarrow$	U_G		
	ΔW		0			

Inferences made using a table of quantities and snapshots can be **communicated** in natural language using common structures such as, “According to ___. The ___ of the ___ ___, but the ___ of the ___ ___, so the ___ of the ___ ___.” For detailed examples, see the handout “Example written explanations of qualitative reasoning.”

II. Render situation(s)

Entitie(s)

#	Object name	Belongs to system 1	system 2	…
1				
2				

Figure(s) indicating snapshot(s), system(s), and axes.

Label individual features with reference numbers.

Declare features in fragments of natural language.

Feature	Statement, declaration, instantiation
1	
2	

III. Fill in question stems

Qualitative analysis:

(a) Request analysis based on a single simple formula (e.g. constitutive relationship):
“Is the ___ of the ___ greater than, less than, or equal to the ___ of the ___?
___ Greater ___ Less ___ Equal
Briefly explain your reasoning.” (like ConcepTest)

(b) Request analysis that involves multiple relationships (e.g. governing relationship fed into by multiple instances of a constitutive relationship, multiple constitutive relationships, etc.):
“If the …, will the ___ of the ___ increase, decrease, or remain unchanged?
___ Increase ___ Decrease ___ Remain unchanged
Explain your reasoning.”

“Explain why, as [description of 3 or more snapshots in a process], ___.”

QQT:

(a) “Without algebraically manipulating equations, determine whether …
___ Option 1 ___ Option 2 ___ Option 3
Briefly explain your reasoning.”

(b) “Mathematically derive an expression for …”

(c) “Explain how (a) not-final-result step(s) in your work in part (b) represent(s) your reasoning in part (a).”

Critique/debate:

Feature	Correct argument	Incorrect argument
Relationship		
Equal		
Altered		
So what?		

(a)
i. “Identify one aspect of the student’s reasoning that is correct and why it is correct.”
ii. “Identify one aspect of the student’s reasoning that is incorrect and why it is incorrect.”

(b) “Mathematically derive an expression for …”

(c)
i. “Identify a feature of your work in part (b) that represents the correct aspect of the student’s reasoning you identified in part (a)i.”
ii. “Identify a feature of your work in part (b) that corrects the incorrect aspect of the student’s reasoning you identified in part (a)ii.”

Sentences can be made difficult to read by daisy-chaining prepositional phrases. Exact wording of scenario descriptions and questions can be adjusted to make ontological shifts easier or more difficult to perform. To investigate ontological shifts in more detail, see the handout, “Sketch production rules before designing, categorizing, solving, and grading problems.”