Solving Dynamics Problems

"*… then he tried again, to the same end. And a third time.*

It only took that horse two bites to learn better, Des[demona] observed, amused…

…I swear the man doesn't listen to a thing one tells him."

– Penric's Mission

Issue: While many problems can be solved in multiples ways, there are, however, some elements that must be present for the solution to make physical sense. In addition to presenting the fundamental principle and strategy to solve the problem, care should be taken not to confuse or mix vectors quantities with scalars quantities. (Review the "Solution vs Answer" handout.)

Solving Dynamics Problems

The solution to Dynamics or Newton's Laws problems include two stages:

- a **setup** stage, involving the sketching of free-body diagrams (FBD); and
- an **analysis** stage, involving the application of Newton's Laws.

Setup Stage: Refer to Free-Body Diagrams handout.

Analysis Stage: Apply Newton's Laws (i.e. "Read" the free-body diagrams).

▶ **EACH STEP IS GRADED**.

	example:
• **Physics Principle:** write the relevant Newton's Law(s) equation(s) *independently* for each direction (axis). i.e: Newton's 1st Law ($\Sigma \boldsymbol{F} = 0$) or 2nd Law ($\Sigma \boldsymbol{F} = m\boldsymbol{a}$)	$\sum \vec{F}_x = 0$
• **Application:** Write the explicit sum of the vectors or component vectors along that direction. Note: there must be a variable for every force (arrow) in the FBD.	$\vec{F}_{1x} + \vec{F}_{2x} + ... + \vec{F}_{Nx} = 0$
• **Sign Convention:** Separate magnitude and direction. Use +/– signs to represent the direction of the components. Note: the variables are now magnitudes, so no arrow caps; the direction is described by the +/– signs.	$F_{1x} - F_{2x} + ... - F_{Nx} = 0$
• Write the components in terms of the original vector magnitudes and functions of the angles (sin or cos), when applicable. If the angle is not known, you may leave it as a component.	$F_1 \cos\theta_1 - F_2 \sin\theta_2 + ... = 0$
• Identify and solve for the desired quantity.	

Rubric for Solution of Dynamics Problems (Newton's Laws)

Approx. Worth	Criteria	Ratings		
		Excellent	**Fair**	**Poor**
~20%	Problem Setup: Free-Body Diagrams	• Includes complete second free-body diagram with component vectors; • Illustrates angles; • Writes vector components in terms of original vector magnitudes and angles	• Mostly complete second free-body diagram with component vectors; • Misses some angles in the free-body diagrams, *or* does not write vector components in terms of original vector magnitudes and angles	• Omits second free-body diagram; • Does not illustrate angles in the free-body diagrams, *and* does not write vector components in terms of original vector magnitudes and angles
~30%	Analysis Intro	• Starts with fundamental physics principle or equation; • Writes explicit sum of forces *and* specifies the direction/ components; • Clearly distinguishes vector and scalar quantities by using appropriate vector notation	• Includes fundamental principle or equation, *or* includes explicit sum of forces; • Includes mostly correct vector notation to distinguish vector and scalar quantities	• Does not include fundamental physics principle or equation, *and* does not include explicit sum of forces; • Unclear vector notation or vector components
~35%	Analysis Development	• Uses clear sign convention (+/–) for vector direction; • Substitutes vector components in terms of original vector magnitudes and angles; • Includes units in every step; • Boxes important results	• Uses clear sign convention (+/–) for vector direction; • Substitutes most vector components in terms of original vector magnitudes and angles; • Uses units sparingly *or* only boxes some results	• Uses unclear sign convention (+/–) for vector direction; • Does not substitute vector components in terms of original vector magnitudes and angles; • Does not include units *and* does not box important results
~15%	Analysis Conclusion	• Identifies and algebraically solves for desired quantities; • Includes units in final result; • Performs dimensional analysis for consistency of results	• Unclear identification of desired quantities or algebraic steps; • Includes most units in final result *or* performs dimensional analysis for consistency of results	• Unclear identification of desired quantities or algebraic steps; • Fails to include units *and* to perform dimensional analysis for consistency of results