Expanding Online Homework Systems with Student Generated Graphs and Diagrams

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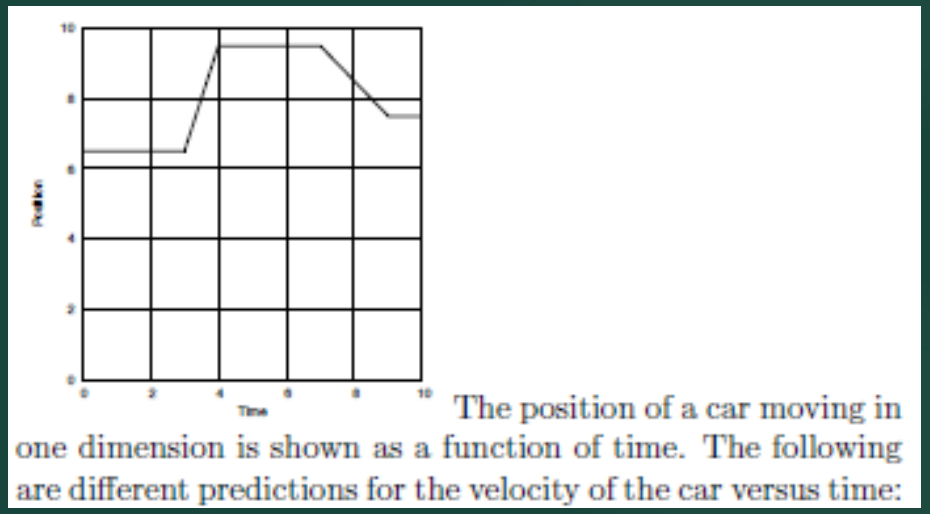
Graphs

- The ability to work with graphs is a necessary skill in all of the sciences, physics included.
- Allow larger trends to be more easily found while keeping smaller details visible
- Unfortunately, students often have difficulties translating between graphs and the real world

LON-CAPA

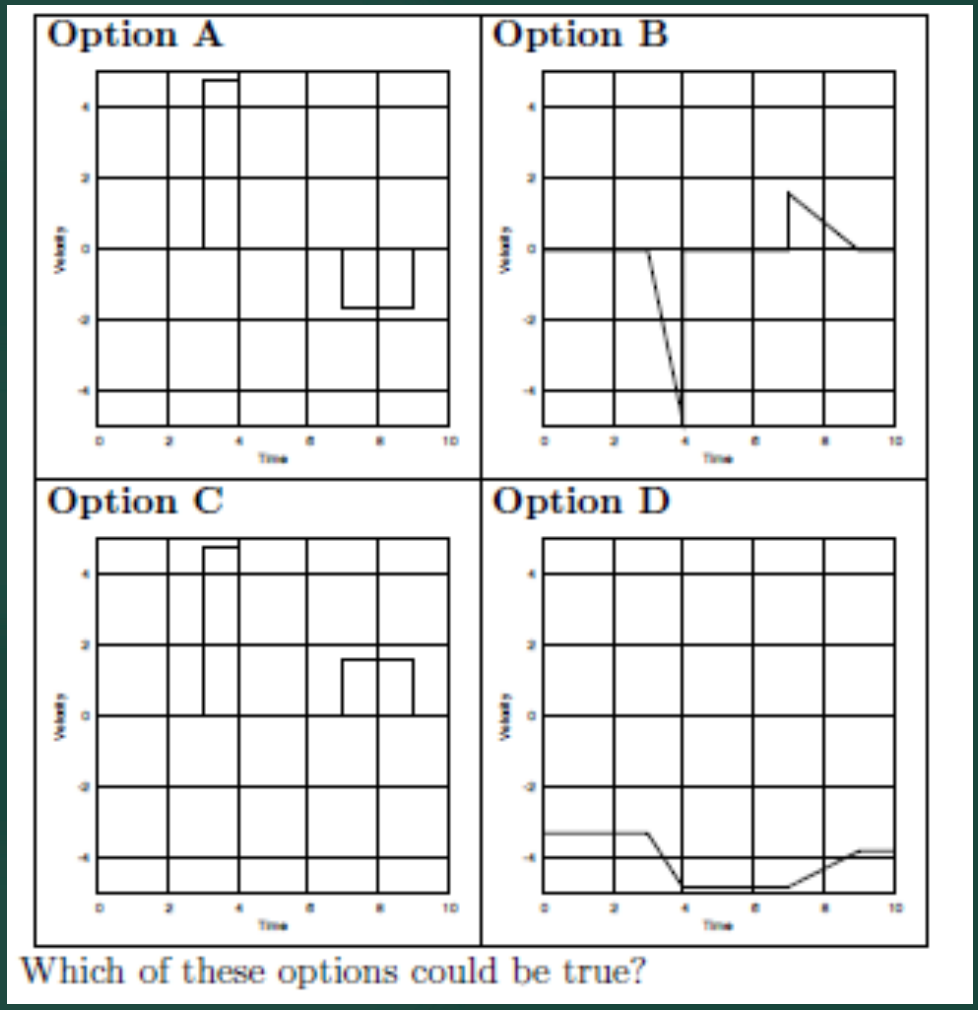
- Learning Online Network – Computer Assisted Personalized Approach
- Course management system primarily developed at MSU
- Open source (read: Free!)
- Currently used at over 160 institutions (about half college and half secondary)
- Used for courses in Accounting, Biology, Chemistry, Mathematics, Physics, Statistics, etc.

Graph Interpretation Problems



The position of a car moving in one dimension is shown as a function of time. The following are different predictions for the velocity of the car versus time:

- Two basic types:
  - Choose the right graph (shown)
  - Identify a feature(not shown)



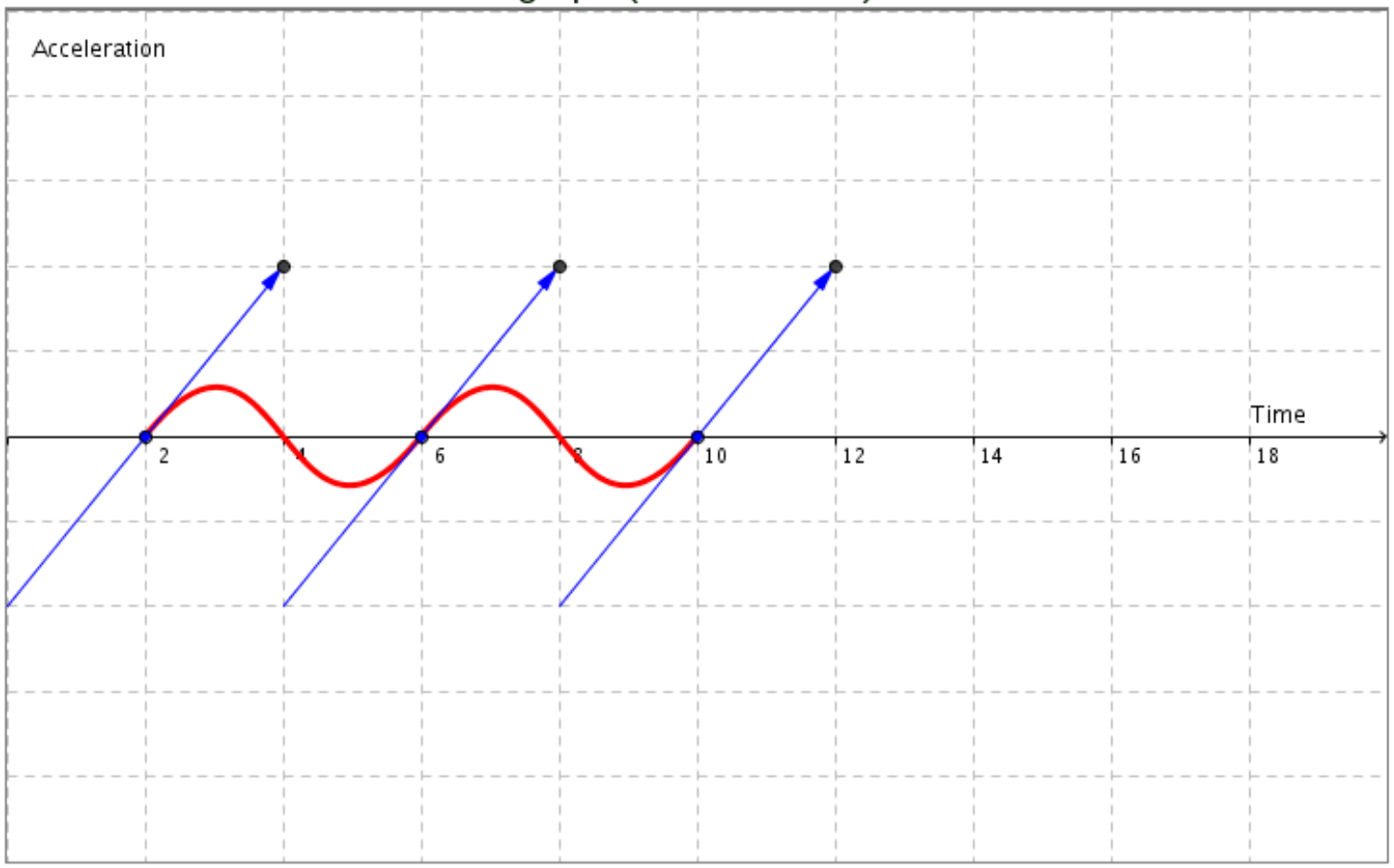
Which of these options could be true?

New Problem Type

- Function Plot Response (FPR)
- Allows students to create a graph or free body diagram themselves
- The LON-CAPA server is then able to decide whether or not the problem is correct based on a set of rules, written by the author
- No Hand Grading!

Graph – First Look

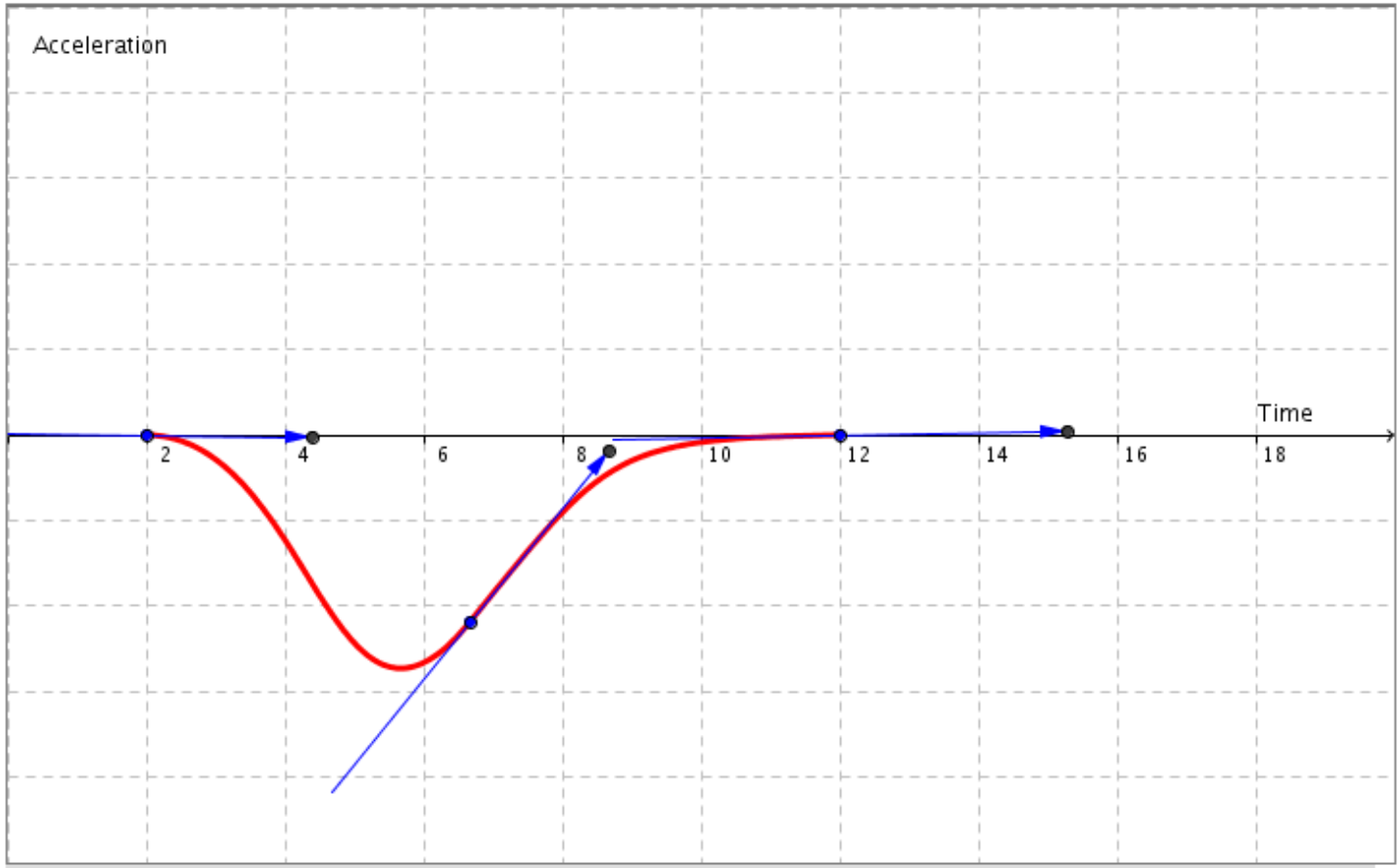
At t=0, a car is sitting at a stop sign. The car then smoothly accelerates forward, until it reaches a constant velocity.
Draw an acceleration vs. time graph (the red curve) for this situation.



Submit Answer Tries 0

Graph – Incorrect Submission

At t=0, a car is sitting at a stop sign. The car then smoothly accelerates forward, until it reaches a constant velocity.
Draw an acceleration vs. time graph (the red curve) for this situation.

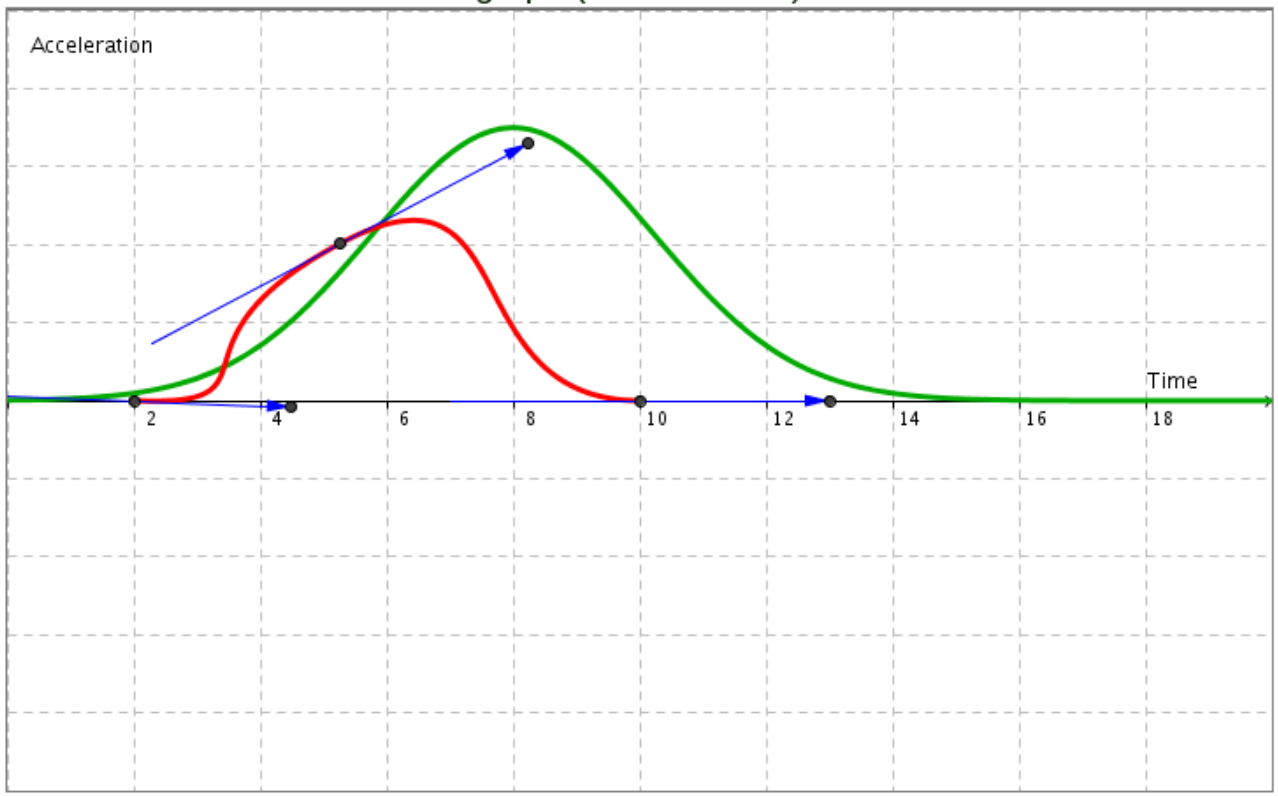


The car is accelerating forward. Should the acceleration be positive or negative?

Submit Answer Incorrect. Tries 1 Previous Tries

Graph – Correct Answer

At t=0, a car is sitting at a stop sign. The car then smoothly accelerates forward, until it reaches a constant velocity.
Draw an acceleration vs. time graph (the red curve) for this situation.



Note: The computer's answer is just one of many possible answers. It is possible your answer does not match up with it.

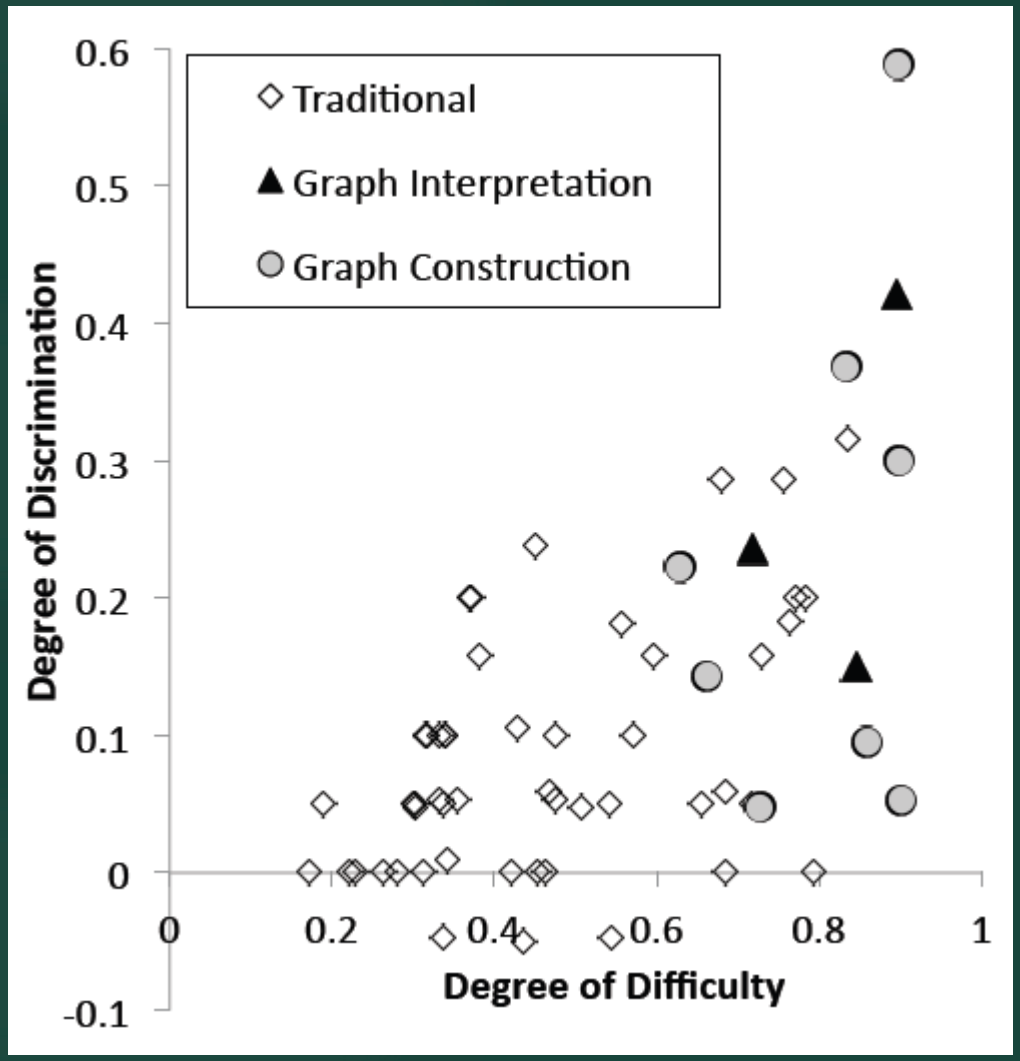
You are correct. Previous Tries

Graph Creation Problems

- Rules
  - Can check the value (or non-value) of each of these over any given (or even unspecified) domain
    - Function value
    - First derivative
    - Second derivative
    - Integral
  - Also can define minimum & maximum lengths for domains and the level of accuracy required for credit

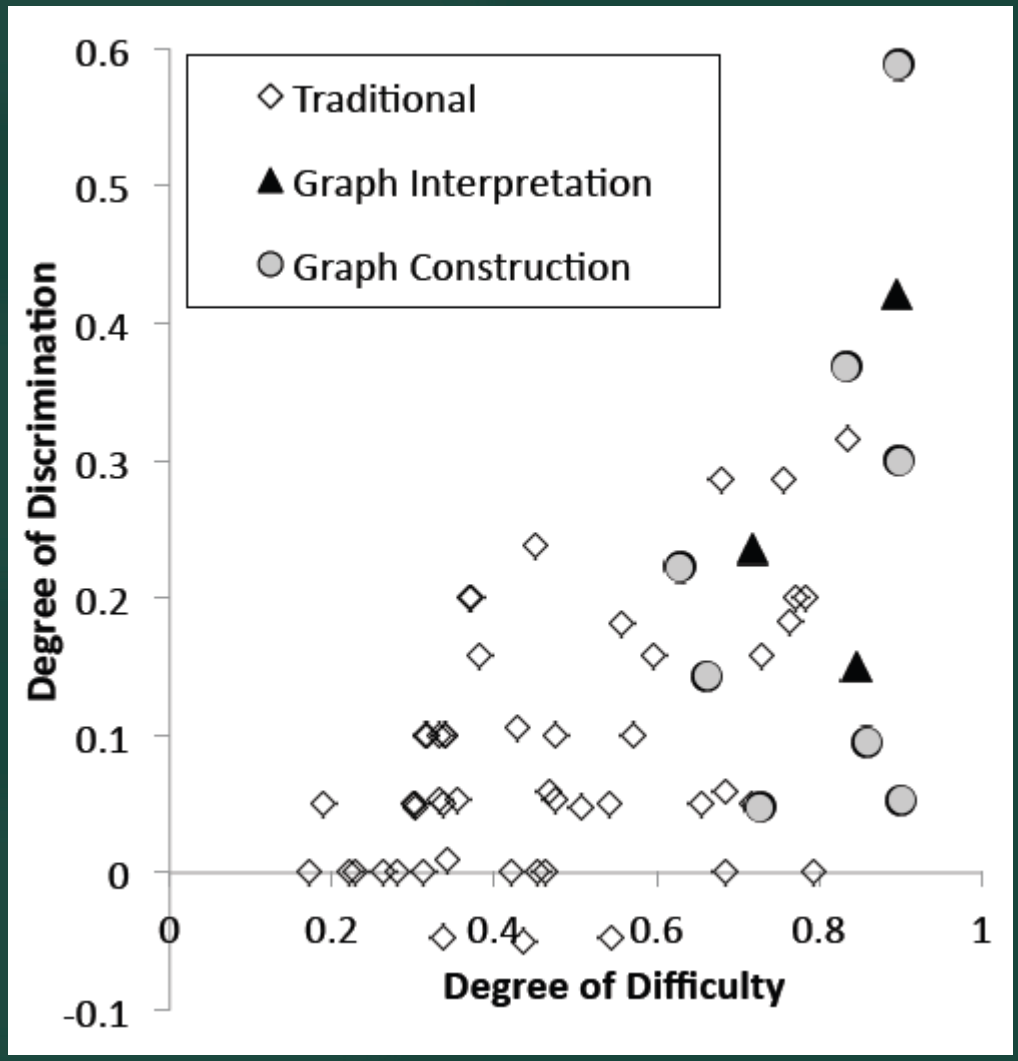
Graph Creation Problems In Class

- DoDisc – (How well the top 25% did) – (the bottom 25%)
- DoDiff: 1- (# correct solutions)/(# submissions)
- 61 questions
  - 8 graph construction
  - 3 graph interpretation



Graph Creation Problems In Class

- Graph problems are generally harder for students (though, 99 tries)
- Also tend to be more discriminating – Students who get these problems, seem to be doing better overall
- Despite increase in difficulty, the problems did not take the students significantly longer than other problems (not shown)



Long Term Graph Problems Study

- Normalized Gain: $$g = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score}.$$

Class	Semester #	Graph Problems	g	gbar
A	1	None	0.178	0.053
A	2	None	0.177	0.111
A	3	Interpretation	0.172	0.042
B	1	Intepretation	0.317	0.303
B	2	Construction	0.485	0.461

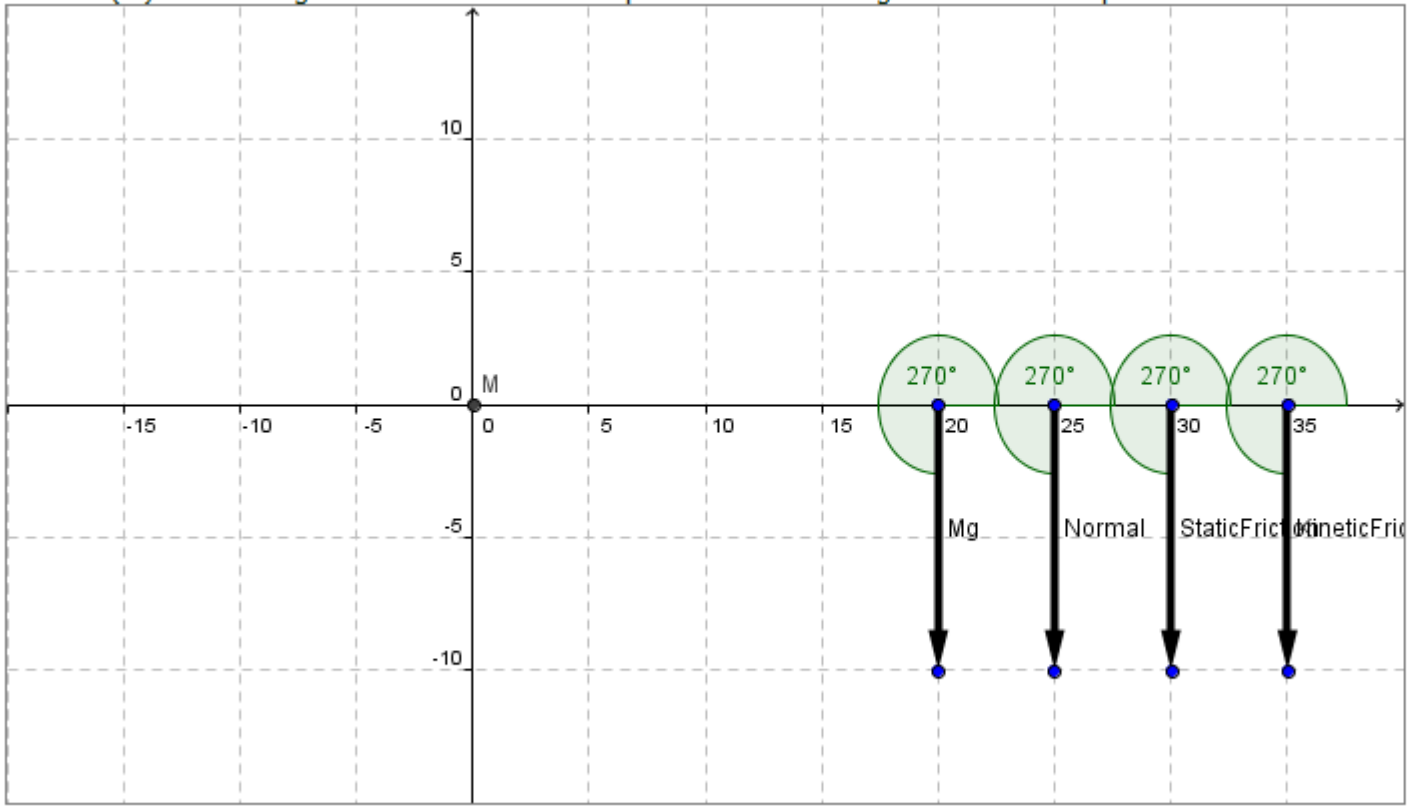
- No difference between no graph problems and graph interpretation problems
- Significant difference between old graph problems and FPR

Free Body Diagrams

- Implemented, but not available until the next release of LON-CAPA
- The same system can also be used to…
  - Show computer programming state changes, etc.
  - Connect concept maps
  - Whatever else you can come up with…

FBDs – First Look

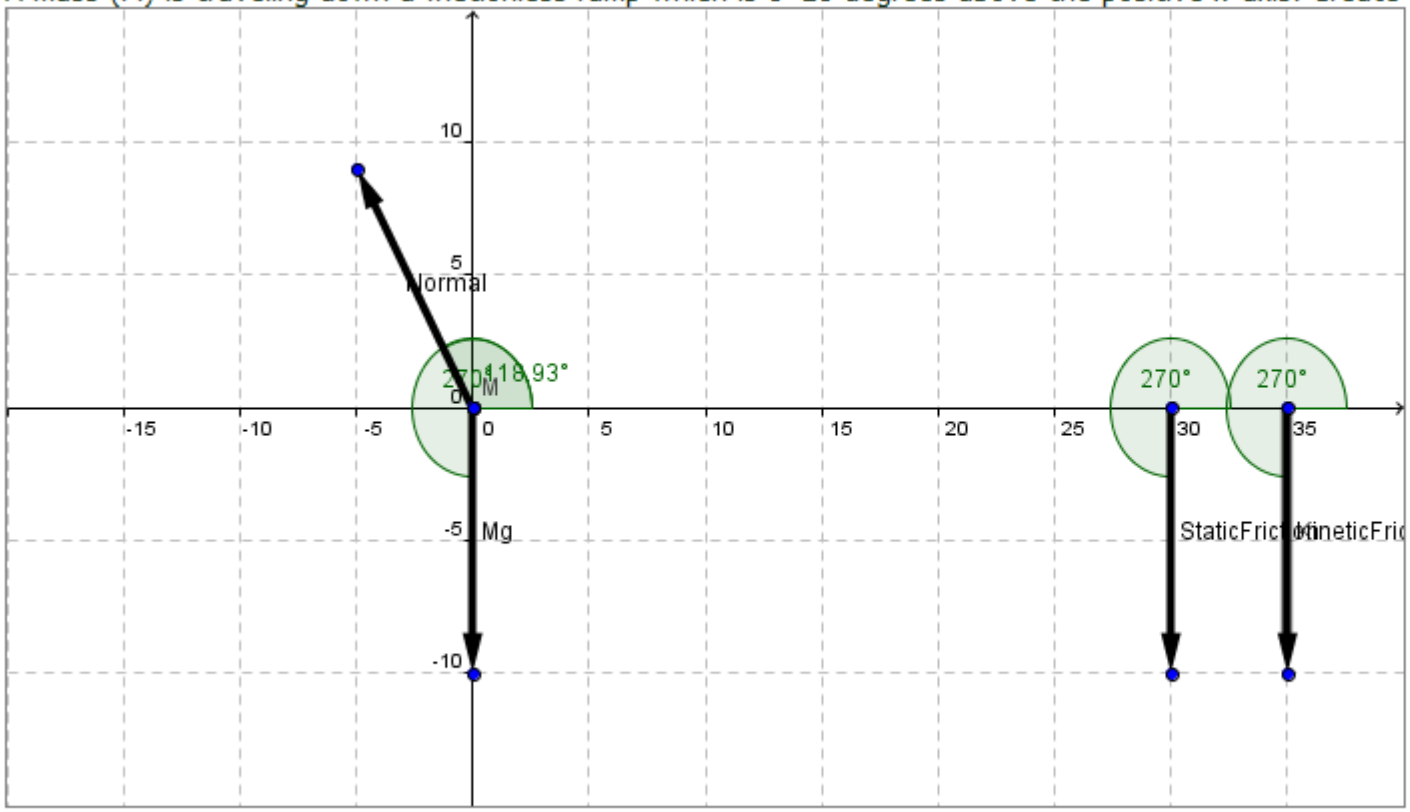
A mass (M) is traveling down a frictionless ramp which is θ=28 degrees above the positive x-axis. Create a free body diagram for this mass.



Submit Answer Tries 0

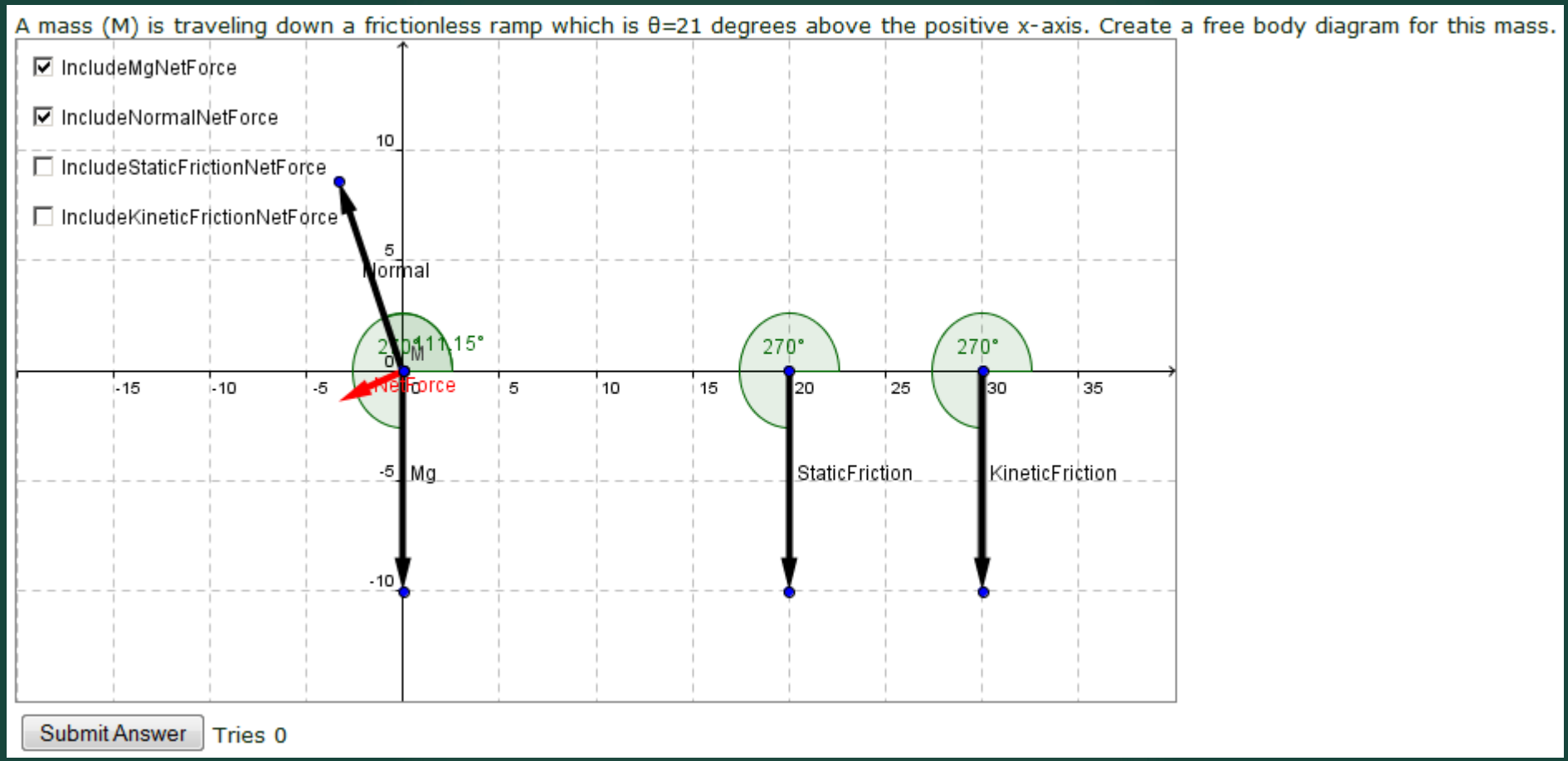
FBDs – Correct Answer

A mass (M) is traveling down a frictionless ramp which is θ=28 degrees above the positive x-axis. Create a free body diagram for this mass.



You are correct. Previous Tries

FBDs – With F_{net} Vector



Thank You

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- www.loncapa.org
- www.geogebra.org
- In LON-CAPA, examples can be found in “msu > LBCPhysLib”