CREATE A MOTION

Purpose

Demonstrate your understanding of motion graphs by creating real-world motion(s) that match a graph(s) you've been given.

Materials

Motion Detector, Interface, Dynamics Cart, Dynamics Track

Procedure

1. Obtain the graph you are going to match from your instructor. Note that the match will be in terms of shape of graph rather than matching specific numerical values.

2. Make a prediction of what kind of motion would be necessary to produce a graph of the shape you've been given. Then determine how you could set up the cart and track to produce that specific graph.

3. Set up your dynamics cart and track as you've determined. Practice giving the cart any required starting motion and coordinate your group to collect data.

4. Plug the Motion Detector into your interface and launch the data collection program. Set any variables you need such as length of data collection, collection rate, etc.

5. Collect data for one run. Compare it to the graph you were given. Make changes as needed until you get the desired results. Save your "unsuccessful" runs to include in your final report.

6. Save the file and/or print the final graph as instructed. Explain how you ultimately obtained the correct results. Relate the motion of your cart to the graph you produced.

Extensions

1. This could be a quantitative lab where values are determined for the graph in advance. Then students would be graded based on how close they came to matching the exact graph they were given. Suggest this only for an honors or AP class.

2. The first extension could be used as a "practicum". The graph would be given to the class and then they would work in groups to determine how to set up the equipment. The class would elect representatives to set up their solution and then everyone would receive points based on how closely the final graph matched the one given.

3. Rather than using a dynamics cart and track, students could use their own body motion to create the graphs. Some samples that could be used are attached. This would be particularly effective in a one-computer classroom.

Teacher Suggestions

1. Depending on the level of the class, some of the graphs you could produce may be too easy or too difficult. Some adjustment of the specific graphs you give the students to duplicate may be needed.

2. In some higher level classes, AP for example, you may wish to include matching of specific numerical values as well as general shape. This would lead to setting the track at an angle that was calculated to produce the specific acceleration, for example.

3. One way to distribute the different graphs to students would be to make up "flash cards" with the graphs on them. A representative from the group would then pick a card, not knowing what is on the other side.

4. This activity could be included as part of a lab practical, a hands-on demonstration that students have learned the concepts. In addition to perhaps answering some specific general questions, they would have to carry out this activity as part of their evaluation.

5. In a reversal of this approach, the teacher sets the track on the demonstration desk. He/she describes what is going to be done to the cart. The students then predict what the graph(s) is(are) going to look like. Upon their predictions becoming set, the teacher then runs the experiment and produces the graphs. Points would be earned based on how accurately the students predict the resulting graph shape.

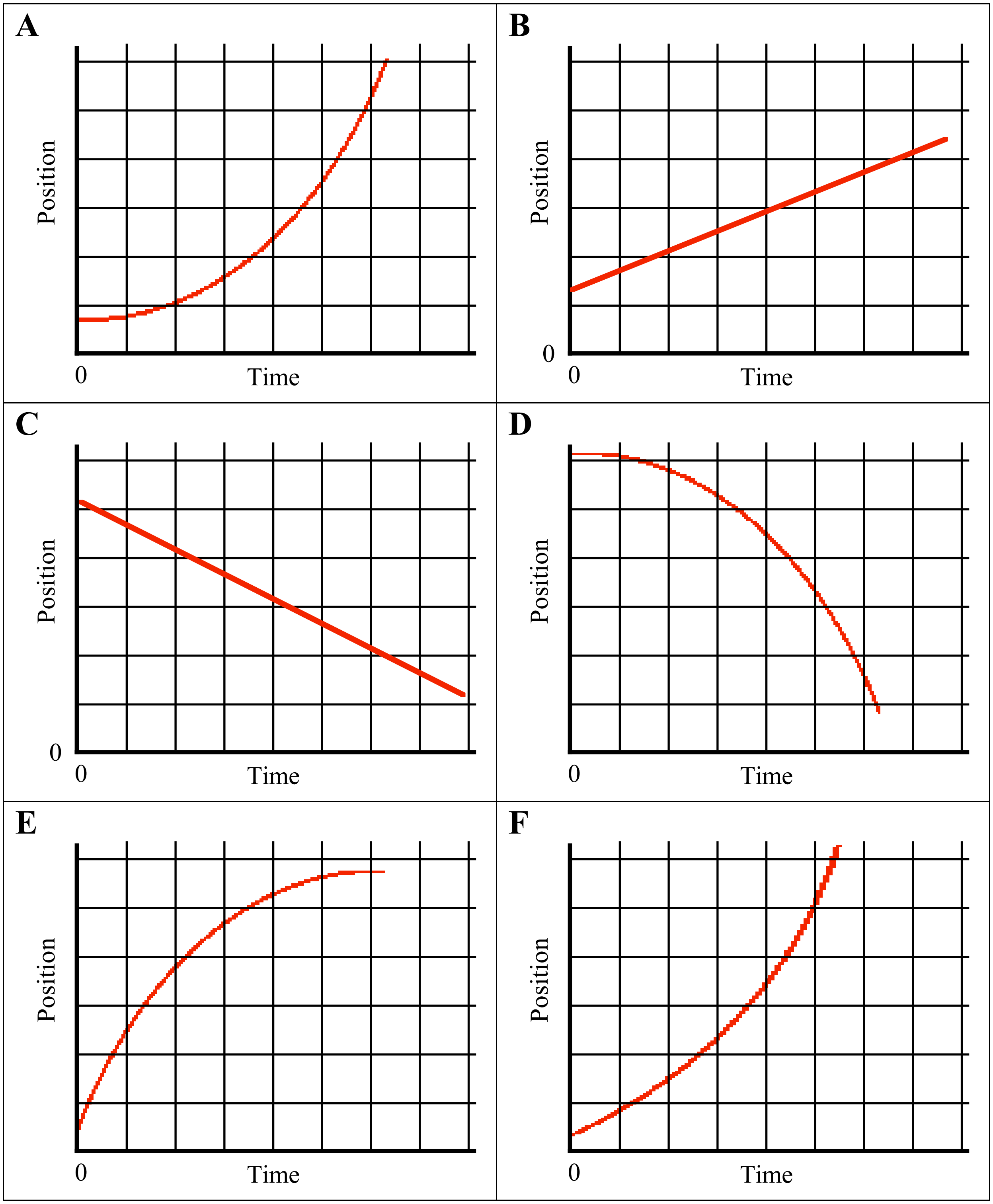
6. Another option would be to have students come to the front of the room, pick a flash card with a graph on it, then get in front of the Motion Detector and try to produce the graph on the card. This could be used for review or for real-time assessment of students. And/or the teacher could give the individual the graph they wish the student to match then the level of difficulty could be metered.

7. Consider also the possibility that this would be a good wrap-up activity for students before a test.

8. Another approach might be to have a student come to the front of the classroom. He/she would choose a card with a graph on it. With the projector blocked off, the student would attempt to re-create the graph they were given. In the meantime, the class would sketch the graph that they thought the student was trying to create. Afterwards, the graph would be shown and the students in the class would compare their responses to what actually occurred.

9. The following section includes some possible graphs for matching and a key to those graphs. Many more graphs could be produced based on the time available and the understanding level of the students.

Graph Suggestions



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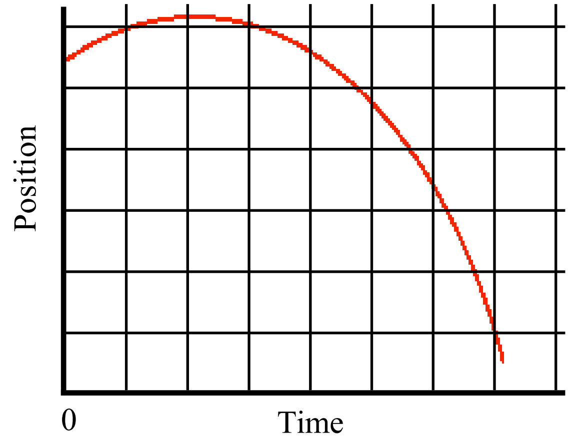
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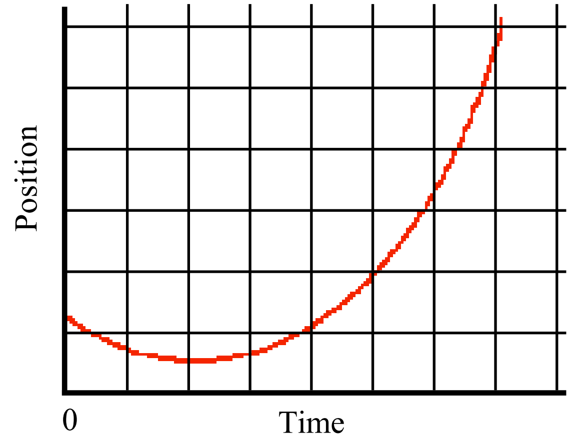
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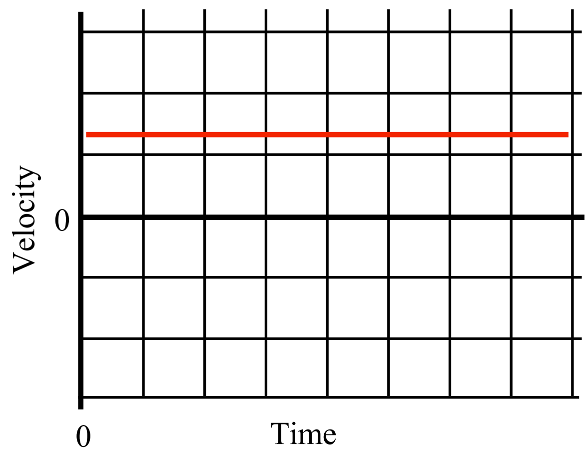
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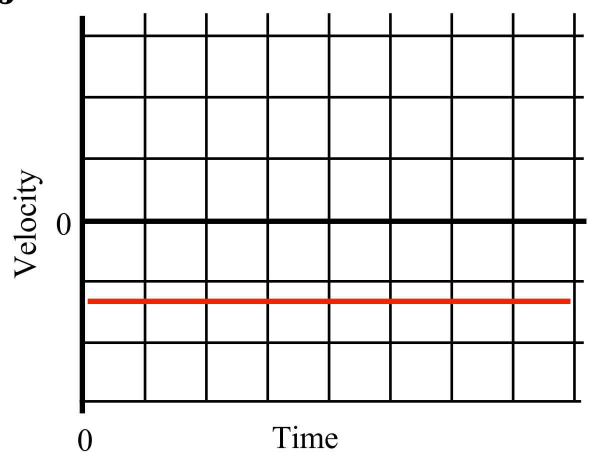
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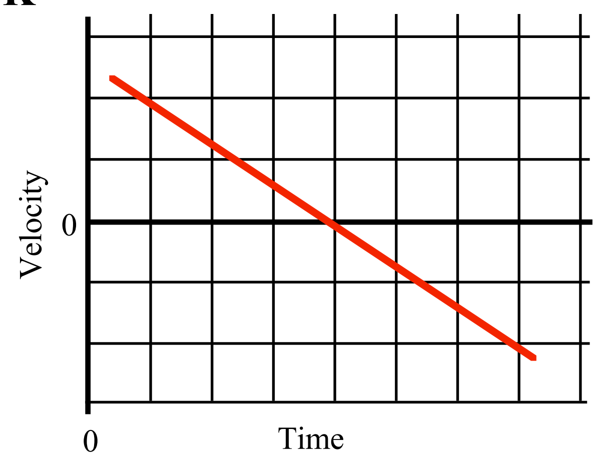
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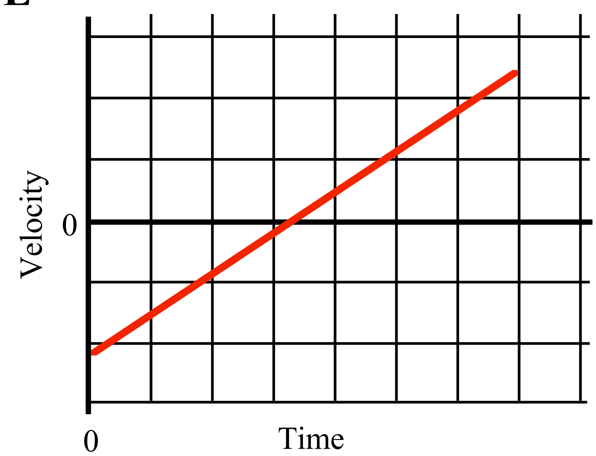
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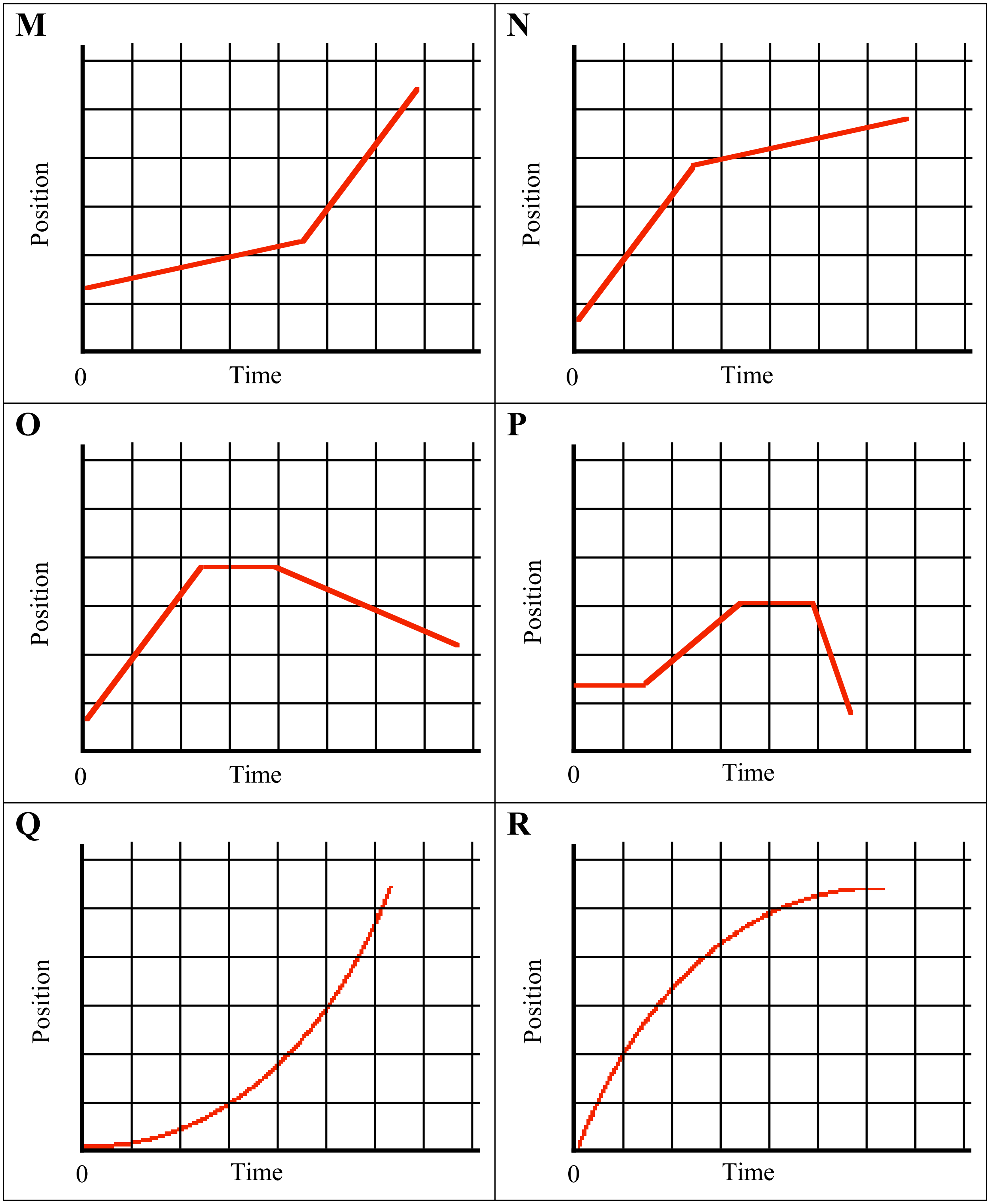
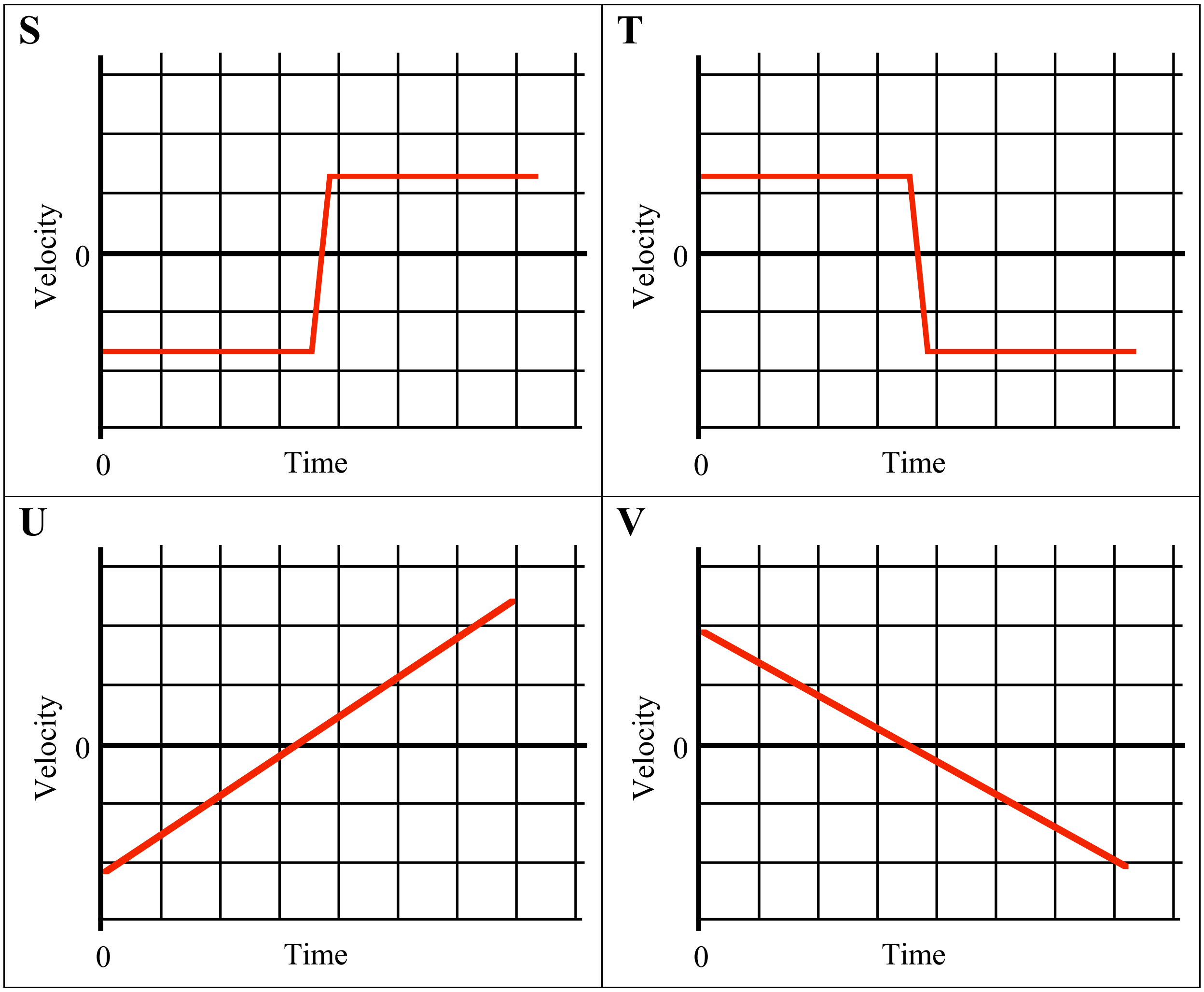
Possible Graphs for Students Moving





Key to the Graphs

Graphs for Cart moving on Track

A Tip track. Cart and Motion Detector at the top end. Release cart when data collection starts. – *Constant acceleration starting from zero velocity*

B Tip track down just enough to compensate for the amount of friction present. It could be level. Cart and Motion Detector both at higher end if any. Push the cart just before starting data collection. – *Constant speed*

C Tip track down just enough to compensate for the amount of friction present. It could be level. Cart and Motion Detectors at opposite ends of the track. Push the cart just before starting data collection, the cart moving towards the detector. – *Constant speed*

D Tip track. Cart at top and Motion Detector at bottom. Release cart when data collection starts. – *Constant acceleration starting from zero velocity*

E Tip track. Cart and Motion Detector at bottom. Push cart up the slope just as data collection starts. – *Constant deceleration starting from a positive velocity*

F Tip track. Cart and Motion Detector at top. Release cart then start data collection after it has already started moving. – *Constant acceleration starting from positive velocity*

G Tip track. Cart and Motion Detector at bottom. Push cart up the track then start data collection after it has already started moving. Cart will slow to stop then come back down the slope. – *Constant negative acceleration starting from a positive velocity*

H Tip track. Cart at bottom and Motion Detector at top. Push cart up the track then start data collection after it has already started moving. Cart will slow to stop then go back down the slope. – *Constant positive acceleration relative to the motion detector starting from a negative velocity*

I Tip track down just enough to compensate for the amount of friction present. It could be level. Cart and Motion Detector both at higher end if any. Push the cart just before starting data collection. – *Constant speed*

J Tip track down just enough to compensate for the amount of friction present. It could be level. Cart at the higher end, if any, and Motion Detector at lower end. Push the cart just before starting data collection. – *Constant speed in negative direction*

K Tip track. Cart and Motion Detector at bottom. Push cart up the track then start data collection after it has already started moving. Cart will slow to stop then come back down the slope. – *Constant negative acceleration starting from a positive velocity*

L Tip track. Cart at bottom and Motion Detector at top. Push cart up the track then start data collection after it has already started moving. Cart will slow to stop then go back down the slope. – *Constant positive acceleration relative to the motion detector starting from a negative velocity*

Graphs for Students Moving:

M At time=0, student is moving away at a steady speed. They keep this speed for a while, then increase their speed to a new steady speed partway through collection period.

N At time=0, student is moving away at a steady speed. They keep this speed for a while, then decrease their speed to a new steady speed partway through collection period.

O At time=0, student is moving away at a steady speed. They keep this speed for a while then stop for a while, then go back towards the detector but at a slower speed than they went away.

P At time=0, student is stopped. After a bit, they start moving forward with a steady speed. They stop for a while, then go backwards at a greater speed than they had originally.

Q Student starts at rest at time=0. When data collection begins, they start moving, going faster and faster in a steady acceleration.

R At time=0, student is moving away from the detector. Over the course of several seconds, he/she slows down to a stop, displaying deceleration.

S At time=0, student is moving at a steady rate towards the detector. Part way through the collection time, he/she reverses direction and goes away from the detector at a steady rate.

T At time=0, student is moving at a steady rate away from the detector. Part way through the collection time, he/she reverses direction and goes towards the detector at a steady rate.

U At time=0, the student is moving towards the detector. He/she slows down gradually, then quickly reverses direction, speeding up in a direction away from the detector.

V At time=0, the student is moving away from the detector. He/she slows down gradually, then quickly reverses direction, speeding up in a direction toward the detector.

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