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How Can Motion Be Explained?

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CMST SCOLLARCITY Lesson Plan Template-Lesson Plan using **TI, and Interactive Physics Technologies**

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Grade level(s)/Subject taught: Grade 7 math and 7 grade general science
Objectives: • Explain how mass and force affects acceleration. • Collect data, model data using Interactive Physics and the STAT graphing tool on the TI calculator. • Understand that concepts are modeled in several different ways and mean the same thing. **Essential Question** "How can motion be explained?"

Math and Science standards:

MST Standards 3 and 4:
Science intermediate – **Key idea 5.1d**. Force is directly related to an object's mass and acceleration. The greater the force, the greater the change in motion. Mathematics intermediate – Student use mathematical modeling/multiple representation to provide a means of presenting, interpreting, communicating, and connecting mathematical information and relationships. Students are shown the concept of rate as unit verses unit. The IP program models concept of a force moving an object across the x-path. The acceleration is shown as a scalar data from an output object. The acceleration is always the dependent data. The force is held constant as mass is varied. Data is collected by students on a given work sheets. A second table is produced by holding the mass constant and varying the force. The students exercise their data collecting skills with the IP program. The TI models the data as a graph. The TI data is taken from the table students produce. Three sets of data is input to the TI. 4 functions are used to enter and graph the data on the TI. The STAT, Y=, Graph, and Window menu buttons.

Lesson Plan

Note to teacher: Students should have basic knowledge on using the TI calculator to graph and enter data into lists.

Engagement and Assessment of Prior Knowledge:
APK: **10min**
The instructor uses a ping-pong ball and a golf ball as prop. The balls are rolled down an incline to a target marked with a taped finish line.
Students are asked to predict which ball will reach the finish line first.

Discussion will follow:

The following question are asked:

What causes objects to move?
What causes objects to stop?
Why do objects fall down and not up?
What is different between the 2 balls?

Mini Lesson: 10-15

- Newton Second law says force is the product of mass and acceleration or F = m * a. Solve for acceleration, if the force is 50N and the mass is 5kg.

State the essential question: How can motion be explained?
Teacher will introduce Newton's second law and relate it to the demonstration. Students are advised that the following lesson shows how motion of objects are explained by using models and other representations.
The instructor will show students step by step how to gather and record data in their science journals. On the overhead, a blank data chart is shown so students copy the chart into their science/math journal. Teacher explains that the first set the force is kept constant at 100, and on the second trial the mass is kept constant at 10.

The students are then placed in groups of 2 and positioned in front of the computer program Interactive physics model. The teacher models how to use the program.
See Figure 1

Work Time: 40 min
Sample of students data: See figure 1
Enter the values for each RUN of the IP acceleration/force/mass program.
Force is always 100N

Trial	Constant	X	Y
	Force	Mass	Acceleration
1	100	5	20
2	100	20	5
3	100	35	2.9
4	100	45	2.2
5	100	65	1.5
6	100	75	1.3
7	100	90	1.1
8	100	100	1

Mass is always 10 kg.

Trial	Constant	X	Y
	Mass	Force	Acceleration
1	10	5	.5
2	10	15	1.5
3	10	35	3.5
4	10	45	4.5
5	10	50	5.5
6	10	75	7.5
7	10	80	8
8	10	100	10

After data is collected students are asked to follow the worksheet with directions on how to enter data into a stat list and graph using the TI Calculator and answer conclusion questions on worksheet. **See Figure 2**

Closure and Assessment 15 min:
Consensus to the essential question: Write a journal entry discussing the essential question and how force, acceleration and mass are related.

Typical journal entry includes and discusses the following concepts in detail:

Motion is described in 3 differ ways. Mathematical equation, where acceleration is force divided by mass or a= F / m. The force, mass and acceleration data is graphed to show relationship between them. Computer models, such as IP, are used to simulate real life motion of objects.

Scientific laws as Newton’s Second Law are used to explain how matter moves.

The following rubric will be used to keep students on task and working together.

CATEGORY	4	3	2	1
Time-management	Routinely uses time well throughout the project to ensure things get done on time. Group does not have to adjust deadlines or work responsibilities because of this person's procrastination.	Usually uses time well throughout the project, but may have procrastinated on one thing. Group does not have to adjust deadlines or work responsibilities because of this person's procrastination.	Tends to procrastinate, but always gets things done by the deadlines. Group does not have to adjust deadlines or work responsibilities because of this person's procrastination.	Rarely gets things done by the deadlines AND group has to adjust deadlines or work responsibilities because of this person's inadequate time management.
Working with Others	Almost always listens to, shares with, and supports the efforts of others. Tries to keep people working well together.	Usually listens to, shares, with, and supports the efforts of others. Does not cause "waves" in the group.	Often listens to, shares with, and supports the efforts of others, but sometimes is not a good team member.	Rarely listens to, shares with, and supports the efforts of others. Often is not a good team player.
Focus on the task	Consistently stays focused on the task and what needs to be done. Very self-directed.	Focuses on the task and what needs to be done most of the time. Other group members can count on this person.	Focuses on the task and what needs to be done some of the time. Other group members must sometimes nag, prod, and remind to keep this person on-task.	Rarely focuses on the task and what needs to be done. Lets others do the work.
Quality of Work	Provides work of the highest quality.	Provides high quality work.	Provides work that occasionally needs to be checked/redone by other group members to ensure quality.	Provides work that usually needs to be checked/redone by others to ensure quality.

Figure 1
Example of Interactive Physics program in action.

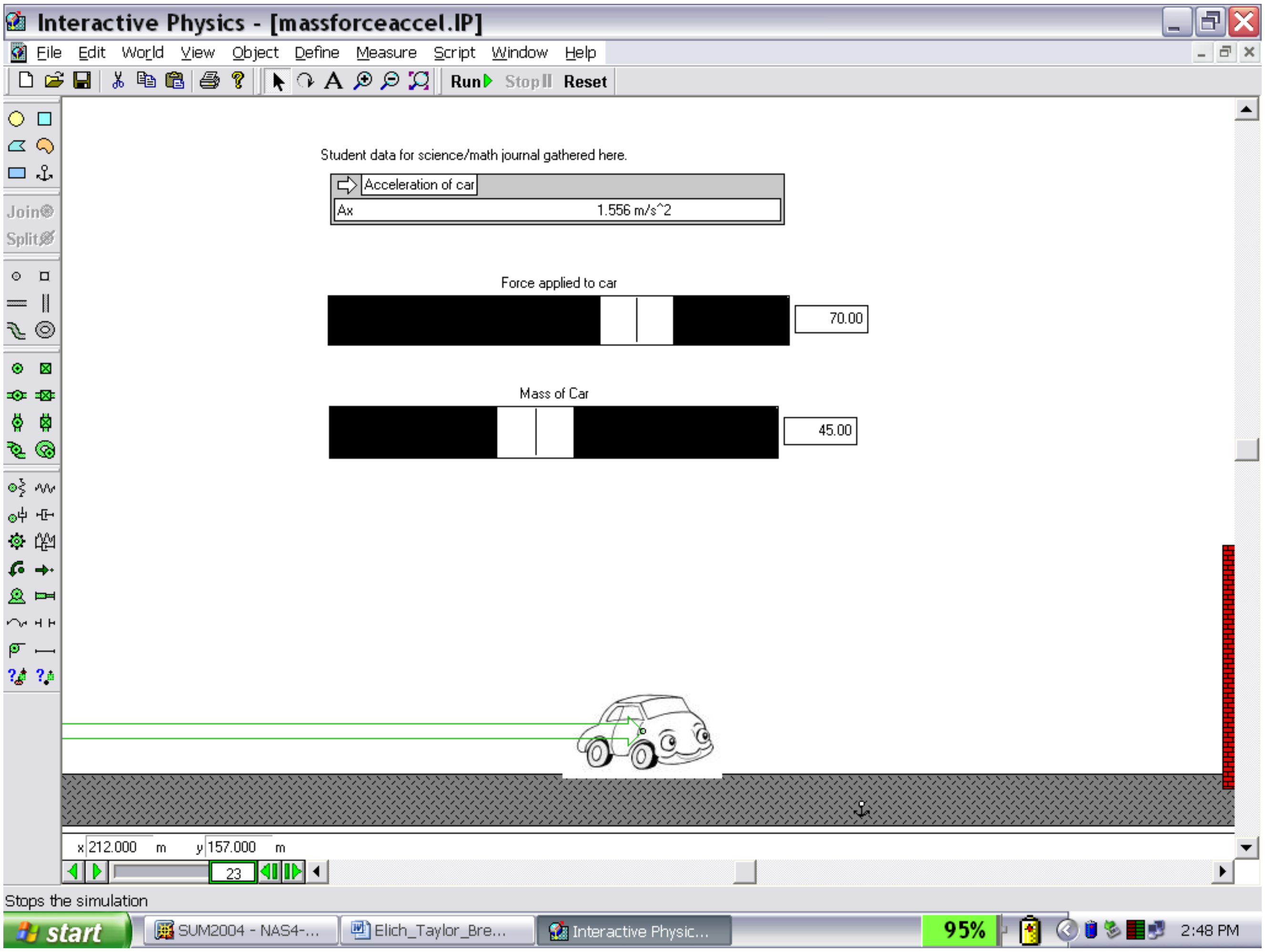


Figure2

Matter in Motion
Graph Instructions

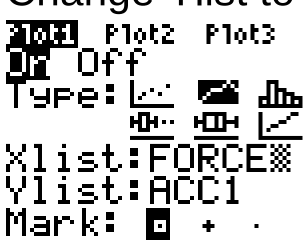
- Finish table
- On TI-84 go to “STAT” and then “EDIT”
- Go to list 6 and press right arrow

MASS	ACC2	1
5	20	
20	5	
35	2.9	
45	2.2	
65	1.5	
75	1.3	
90	1.1	

- Name=
- Type Force into name and enter.
- Press right arrow and Type ACC1 (acceleration) enter.
- Repeat for Mass and ACC2
- Using the tables, enter the information in each of the lists.

FORCE	ACC1	MASS 7
5	.5	5
15	1.5	20
35	3.5	35
45	4.5	45
55	5.5	65
75	7.5	75
80	8	90

- FORCE ={5,15,35,4…
- Go to STAT PLOT (2nd/Y=) Highlight Plot1 enter.
- Change to ON and second graph type. Enter
- Go to Xlist and change to Force (go to Xlist and press 2nd/STAT and scroll down until you highlight force then press ENTER
- Change Ylist to ACC1 (same as with Xlist)



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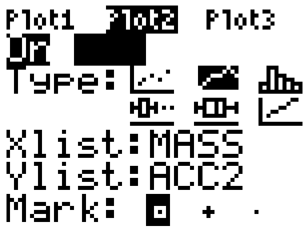
- Go to Plot2, Turn on, change to second graph.
- Change Xlist to Mass and Ylist to ACC2



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- Go to Y= and make sure there is no data in any of those fields.
- Graph
- If graph does not show well press ZOOM button and then go to ZOOMSTAT and enter. Graph.

Questions:

1. Compare the graphs. What are the similarities and differences? ________________________________

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2. Look at the Force line. What would you expect to happen to the acceleration if the force is increased?____

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3. Look at the Mass line. What will happen to the acceleration as the mass is increased? Will it ever be zero?

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