ASEE's 123rd Annual • Conference & Exposition • New Orleans, LA • June 26-29, 2016

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Paper ID #14850

Teaching an Accelerated Course via Team Activities: Assessment and Peer Rating of the Team Impact

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Abstract

Engineering physics courses are the key opening courses in engineering. Most engineering students take one year of engineering physics courses. Teaching Physics is always fun, but teaching the same course content in little less than half the time in is hard for the instructors, while learning the concepts and solving problems in an accelerated pace is challenging for students. To reverse this trend, and to make learning as interesting as possible, I restructured the course with weekly in class team activities and a final team project to work outside the class. One of the objectives of this approach is to help students develop the habit of helping others to understand the basic engineering physics concepts in a give and take manner.

This restructuring was tested in a small class environment and for a summer accelerated course. In this report we will present detailed information about the team's weekly in class activities; team structure, assignment samples, time constraints, outcome and student feedback via assessment. In brief, a survey was done at the end of the semester to see how much the team's weekly project helped students to learn course materials and help each other to make learning environment more enjoyable. The class had forty-three students of which twenty two were females and the rest were males. About fifty percent of the students were engineering majors and the rest were in other science areas. About forty students participated in the survey. The data was analyzed using a spreadsheet and the outcome will be reported in this paper. The study will benefit other educators who are looking for impactful teaching methods.

Introduction

Group project/activity based teaching is an interesting concept and is in practice at several institutions[1-5]. How much these activities influence learning has been controversial[6-9]. As in other colleges, at our institution most of the engineering students take Engineering Physics 1 and 2. As part of Engineering Physics course requirement, weekly group projects and a final group project were assigned. In order to do the weekly in class group activity, we assigned 5 members to a team and gave them a problem to work on as a team within a given time. At the end of the allocated time, the group had to submit a solution package with the names of the team members. During the course of the project, students were allowed to have a round table discussion with each other. The problem solving approach based on weekly project activities helped students to learn several important concepts in physics 1, such as, vectors, 1D and 2D motions, Newton's laws, work and energy, momentum, fluid mechanics, and oscillations. It also helped them to see how their peers come up with various approaches to solve problems. This mutually beneficial approach has the potential to change the educational approach in a positive manner in the future. In addition, the final out-of-the-class group activity given to students to work as a team for about two weeks was also helpful to study for the final exam as a group.

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Teaching Approach

The accelerated course was structured as follows; each week consisted of four one hundred minute lectures, and a lab, which was taught as a separate course. Syllabus for the course was provided at the beginning of the semester. Students were expected to read the concepts of the chapters before it was discussed in class. Mastering Physics[10] online tool was used to assign weekly homework based on the text book[11] which included video demonstrations and tutorials to help students to self-learn basic concepts in physics. These problems were slightly less complex than traditional end of chapter homework problems. The number of problems varied from assignment to assignment and was based on the contents of the chapters.

During the problem discussion time, about one hundred minutes per week for this accelerated course, students were grouped as five member teams. Each team sat around a table. Then a hour long group activity based on that week concepts was given to the team. During this time team members helped each other to learn that idea and techniques to solve the problem, and master the basic concepts. At the end of the allowed activity time, each team was required to return a solution package with the team members' names on it for group project evaluation. Following the group activity, twenty five-minute weekly quizzes were given based on this activity and chapter concepts. Better understanding of the group activity and the course materials of the week aided the students to do well in the quizzes.

Data Analysis

The survey was done at the end of the semester, so the students had a clear view of the activities and were able to answer questions regarding the impact of the group activities (see a sample project in appendix D). Seven survey questions were asked (see appendix A). About forty students took part in the survey. In addition, students were asked to rate other groups' projects (see appendix B). The data obtained for each question and peer rating were analyzed using a basic excel spread sheet. The following survey questions (q) were analyzed for this report.

q1. Rate the weekly group/team activities from very interesting (5) to uninteresting (1).
q2. Rate how much you helped other group/team members to learn physics concepts during the weekly group activity, 5 (high) to 1 (low).
q3. Rate how much you learned from the other group/team members during the weekly Group project, 5 (high) to 1 (low)
q4. Rate, how much the Final Poster Team project helped you to better understand physics concepts? 5 (high) to 1 (low)
q5. Do you think that the weekly group projects helped you to better understand physics Concepts? (Circle one)
q6**.** Do you like group/team based learning of Physics Concepts? (Circle one)
q7. What could be done to improve the Team based Group Activity (Brief Comments)?

Scale given by students for each question was added and the average was obtained by dividing the total by the number of students participating in answering that particular question (except for questions 5 to 7; questions 5 and 6 are simply yes or no questions, and question 7 requests student comments about group activities). Responses to questions 1 to 6 were graphed using excel. The responses to questions 1 and 4 are shown in Figures 1 and 2, to questions 5 and 6 are shown in Figure 3, and the peer rating of the final group project based on appendix B is shown in Figure 3.

Figure 1, shows points in 1 (low) to 5 (high) scale given by students for questions 1 to 4. Bar/color for each question demonstrates the number of students' responses to a particular question.

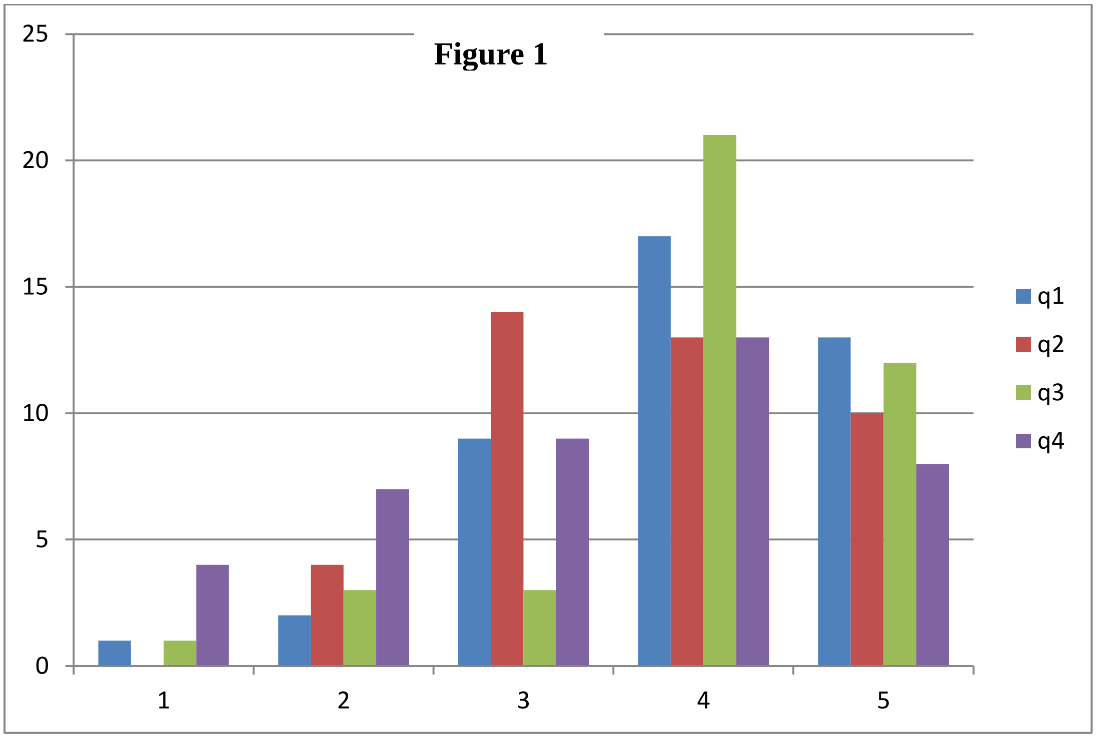


Figure 2, obtained based on Figure 1: Total points and the number of students' responses. It shows the average points for each question.

- In Figure 2, question 1 bar illustrates that most of the students who took part in the activity enjoyed learning the concepts via weekly team activity.
- In Figure 2, bars representing questions 2 and 3 show that students helped each other within the group, to learn physics concepts. This is indeed a positive outcome for this new effort.
- In Figure 2, the results of question 4 indicate student response to the final group activity. This rating was lower than for other questions, and students were less enthusiastic about a lengthy group activity close to the end of the semester, especially for this accelerated course.

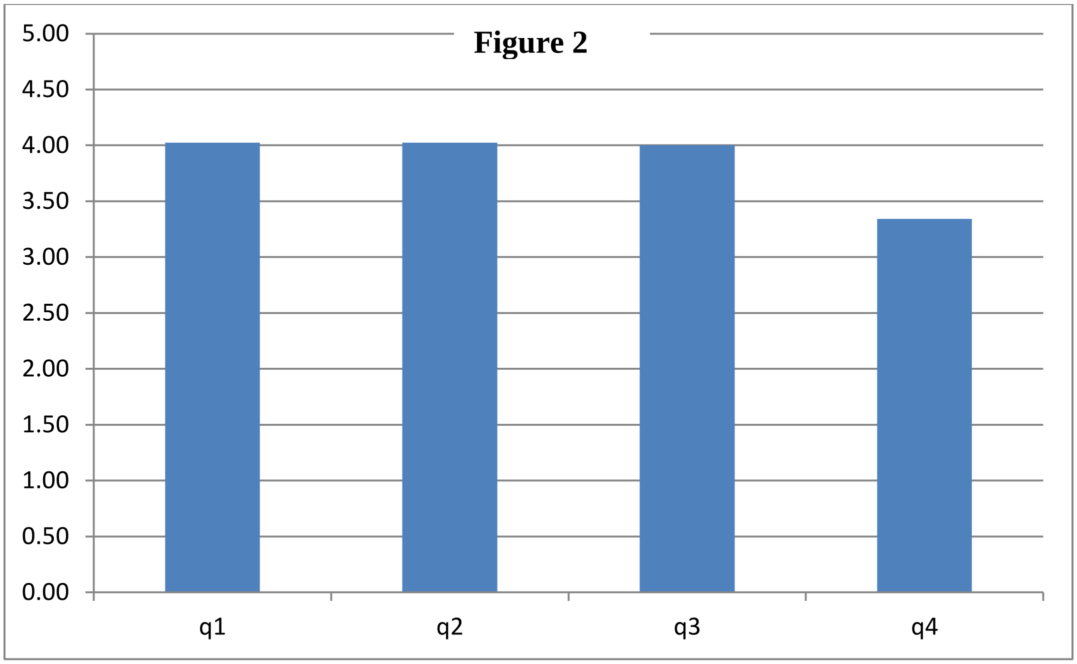


Figure 3, response to questions 5 and 6:

- In Figure 3, question 5 reflects the students' view regarding the important questions of this study and survey of whether "Do you think that the weekly group projects helped you to better understand physics Concepts". The majority of the students, over 90%, felt that weekly group activities helped them to learn physics concepts.
- In Figure 3, question 6 echoes the result of question 5. That is, the students' view regarding their like/dislike of "group/team based learning of Physics Concepts".

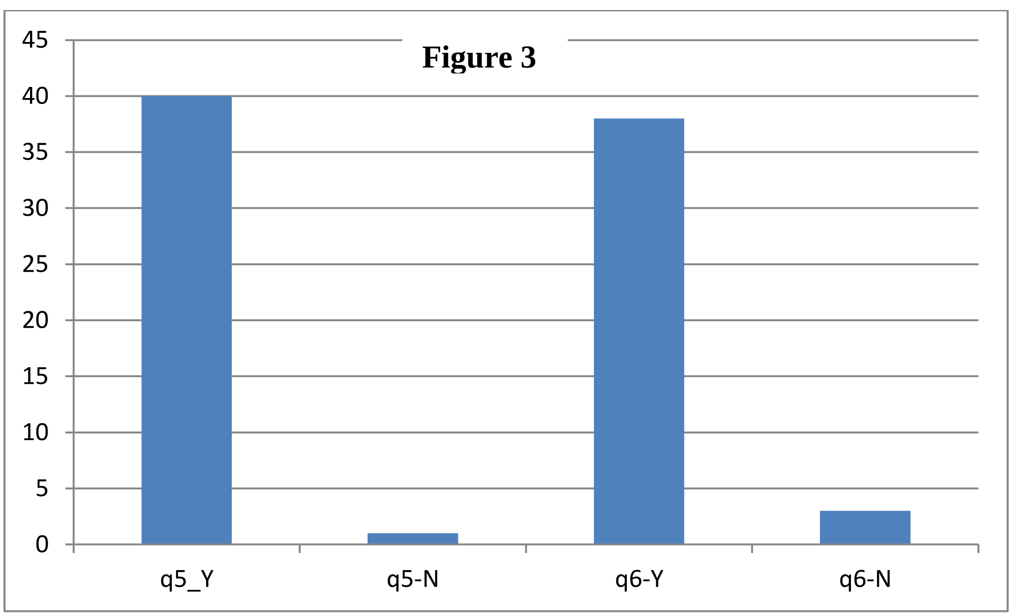
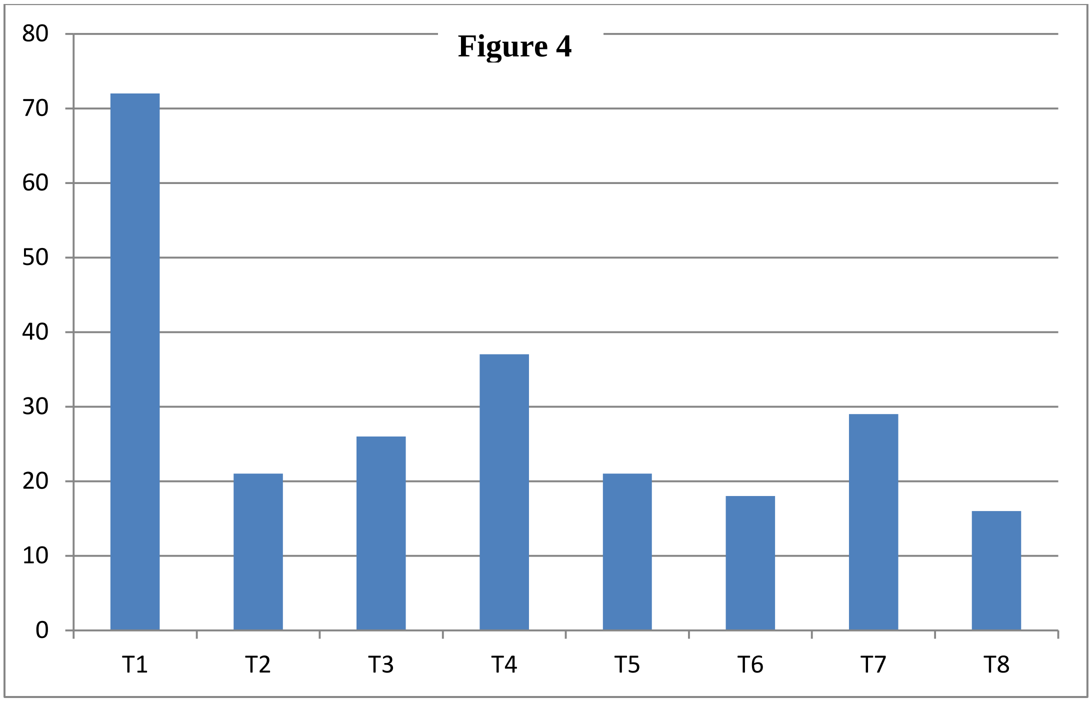


Figure 4 is the peer rating results based on the data showed in appendix B.

- Appendix C shows the scores of eight separate final group projects.
- In appendix C, T1 to T8 represent team IDs, and P1 to P8 represent project IDs. For example, team 1 (T1) was assigned project 1 (P1), …etc.
- Figure 4 represents the total points received by each group/project in bar graph format. In this, students rated other groups' projects, excluding their own.
- One-third of the project grade was based on peer rating.



Some sample results to question Q7, that is the students' comments regarding the group activity based learning, are given in appendix C.

Conclusion

The study was done for an accelerated course. Absorbing key concepts in a short period of time is a challenging task for students. The weekly group activities and the final group project helped students to learn the physics concepts. Students spent considerable amount of time in class to work on weekly activities and out of class for the final team project. This is in addition to the regular homework assignments using Mastering Physics.

The weekly group activity based learning approach aids students to work as a team and to integrate their problem solving skills and conceptual understanding of physics. It also helped them to recall several physics concepts while solving team activity problems. Simply, this team-based weekly activity guided them to think outside the box. The traditional teaching methods are essential for learning, but integrating it with group-based learning like this makes the classes interesting and help students to learn from each other, mainly for an accelerated course like this one. This approach builds their self-confidence while helping others, and also will help them to face new and demanding tasks later in higher level classes.

The results of questions 2 and 3 in figure 2, clearly illustrate that the majority of the students help others to learn and also learned from other team members while solving team based group project. Based on this particular study and figure 3, the answer to the title "Do you think that weekly group projects helped you to better understand physics Concepts?" is evidently answered: it indeed helped students to learn the key concepts of the accelerated course. Figure 3 shows that students not only learned the fundamentals of physics but also liked weekly group work and considered this as an interesting activity. There was no major grade variation between engineering students versus the others who took this course. There was also no significant difference in grade distribution compared to the summer courses of the previous year. This approach improved peer learning. Additional studies are needed to reach firm conclusions regarding the effect of weekly group project-based learning of engineering physics courses.

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APPENDIX A: Survey Questions

Survey topic: Group Projects/Team Activities

Respond to questions below by using the given rating on the questions:

1. Rate the weekly group/team activities from very interesting (5) to uninteresting (1).

5	**4**	**3**	**2**	**1**

2. Rate how much you helped other group/team members to learn physics concepts during the weekly group activity, 5 (high) to 1 (low).

5	**4**	**3**	**2**	**1**

3. Rate how much you learned from other group/team members during the weekly Group project, 5 (high) to 1 (low)

5	**4**	**3**	**2**	**1**

4. Rate, how much the Final Poster Team project helps you to better understand the physics concepts? 5 (high) to 1 (low).

5	**4**	**3**	**2**	**1**

5. Do you think that the weekly group projects helped you to better understand physics Concepts? (Circle one)

Yes	**No**

6. Do you like group/team based learning of Physics Concepts? (Circle one)

Yes	**No**

7. What could be done to improve the Team based Group Activity (Brief Comments)?

APPENDIX B: Peer Rating Chart

Poster Project - Peer Rating								
	P1	P2	P3	P4	P5	P6	P7	p8
T1					3	2		1
			1	2				3
		1			2	3		
			2	1		3		
		3		2				1
				2			3	1
T2	2						3	1
			3	2		1		
	3		1	2				
	3			2	1			
T3	3	2					1	
	3			2			1	
	1	3		2				
	1	3		2				
		2		1			3	
T4	3				1		2	
			1		2		3	
	3					2	1	
	3					1	2	
	3				2			1
T5	2		1				3	
	3	1					2	
	3	2		1				
	1					2		3
	3		1			2		
T6	3			2	1			
	1		3		2			
	2		3					1
			3				1	2
				1			3	2
T7	3	2		1				
	3		1		2			
	3	1			2			
	3			1	2			
	3		2	1				
T8	2			3	1			
	1			3		2		
	2	1		3				
	3		2				1	
	3		2	1				
Tot	72	21	26	37	21	18	29	16

APPENDIX C: Students Comments

Switch group members each week so students can study from more people.

Have it more often & more problems for us to solve.

Have several questions with different difficulties. for each lesson

Professor [redacted] came up with a great way to interact with other students and learn physics in a new way.

Having students describe the physics of their phenomena in summary with more focus on concepts

I think we should emphasize problem solving & do some on the board so we understand how to do them because summer semesters move fast. Prof [redacted] was great.

APPENDIX D: Sample Group Project

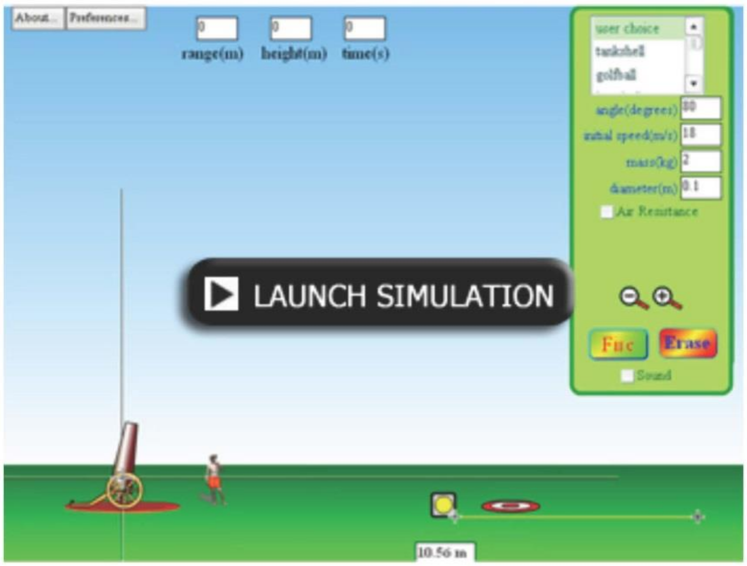
GROUP NUMBER:

PHYS1153 – Physics 1 for Engineers
Group Activity 1 - Summer 2015

INSTRUCTOR:

GROUP MEMBERS:
1)
2)
3)
4)

LEARNING GOAL: To understand how the trajectory of an object depends on its initial velocity, and to understand how air resistance affects the trajectory.
For this problem, use the PhET simulation *Projectile Motion* (http://phet.colorado.edu/en/simulation/projectile-motion).
This simulation allows you to fire an object from a cannon, see its trajectory, and measure its range and hang time (the amount of time in the air).



START THE SIMULATION (http://phet.colorado.edu/en/simulation/projectile-motion) : Press **Fire** to launch an object. You can choose the object by clicking on one of the objects in the scroll-down menu at top right (a cannonball is not among the choices). To adjust the cannon barrel's angle, click and drag on it or type in a numerical value (in degrees). You can also adjust the speed, mass, and diameter of the object by typing in values. Clicking **Air Resistance** displays settings for (1) the drag coefficient and (2) the altitude (which controls the air density). For this tutorial, we will use an altitude of zero (sea level) and let the drag coefficient be automatically set when the object is chosen.

Play around with the simulation. When you are done, click **Erase** and select a baseball prior to beginning Part A. Leave **Air Resistance** unchecked.

Part A

First, you will investigate purely vertical motion. The kinematics equation for vertical motion (ignoring air resistance) is given by

$$y(t)=y_0+v_0t-(1/2)gt^2,$$

where $y_0=0$ is the initial position (which is 1.2 m above the ground due to the wheels of the cannon), v_0 is the initial speed, and g is the acceleration due to gravity.

Shoot the baseball straight upward (at an angle of 90°) with an initial speed of 20 $\mathrm{m/s}$.

How long does it take for the baseball to hit the ground?

Express your answer with the appropriate units.

Part B

When the baseball is shot straight upward with an initial speed of 20 $\mathrm{m/s}$, what is the maximum height above its initial location? (Note that the ball's initial height is denoted by the horizontal white line. It is initially 1.2 m above the ground. The yellow box that is below the target on the grass is measuring tape that should be used for this part.)
Express your answer with appropriate units.

Part C

If the initial speed of the ball is doubled, how does the maximum height change?

1) The maximum height increases by a factor of 1.4 (square root of 2).
2) The maximum height increases by a factor of two.
3) The maximum height increases by a factor of four.

Part D

Erase all the trajectories, and fire the ball vertically again with an initial speed of 20 m/s. As you found earlier, the maximum height is roughly 20 m. If the ball isn't fired vertically, but at an angle less than 90°, it can reach the same maximum height if its initial speed is faster. Set the initial speed to 25 m/s, and find the angle such that the maximum height is roughly 20 m. Experiment by firing the ball with many different angles. You can use the measuring tape to determine the maximum height of the trajectory and compare it to 20 m.

What is this angle?

1) 75°
2) 30°
3) 63°
4) 45°
5) 53°

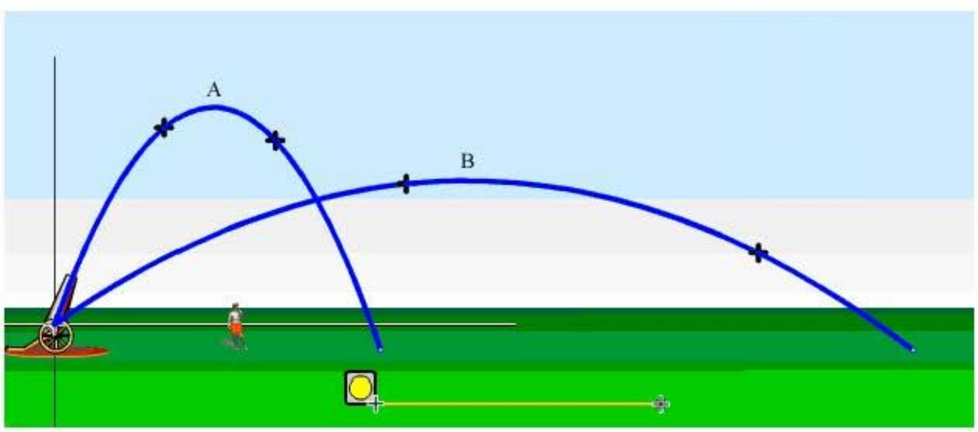
Part E

In the previous part, you found that a ball fired with an initial speed of 25 m/s and an angle of 53° reaches the same height as a ball fired vertically with an initial speed of 20 m/s. Which ball takes longer to land?

1) The ball fired vertically stays in the air longer.
2) Both balls are in the air the same amount of time.
3) The ball fired at an angle of 53° stays in the air longer.

Part F

The figure shows two trajectories, made by two balls launched with different angles and possibly different initial speeds.



Based on the figure, for which trajectory was the ball in the air for the greatest amount of time?

1) It's impossible to tell solely based on the figure.
2) Trajectory B
3) The balls are in the air for the same amount of time.
4) Trajectory A

Part G

The range is the distance from the cannon when the ball hits the ground. This distance is given by the horizontal velocity (which is constant) times the amount of time the ball is in the air (which is determined by the vertical component of the initial velocity, as you just discovered).

Set the initial speed to 20 m/s, and fire the ball several times while varying the angle between the cannon and the horizontal. Notice that the digital display near the top gives the range of the ball.

For which angle is the range a maximum (with the initial speed held constant)?

1) 45°
2) 90°
3) 30°
4) 60°
5) 0°

Part H

How does the range of the object change if its initial velocity is doubled (keeping the angle fixed and less than 90°)?

1) The ball's range is four times as far.
2) The ball's range is eight times as far.
3) The ball's range is twice as far.

Part I

Now, let's see what happens when the cannon is high above the ground. Click on the wheel of the cannon, and drag it upward as far as it goes (about 21 m above the ground). Set the initial velocity to 20 m/s , and fire several balls while varying the angle.

For what angle is the range the greatest?

1) 40°
2) 50°
3) 45°
4) 35°
5) 30°

Problem 2: Canoeing in a river

Two students are canoeing on a river. While heading upstream, they accidentally drop an empty bottle overboard. They then continue paddling for 2.0h , reaching a point 2.4km farther upstream. At this point they realize that the bottle is missing and, driven by ecological awareness, they turn around and head downstream. They catch up with and retrieve the bottle (which has been moving along with the current) 4.9km downstream from the turn-around point.

1) Assuming a constant paddling effort throughout, how fast is the river flowing?

2) What would the canoe speed in a still lake be for the same paddling effort?