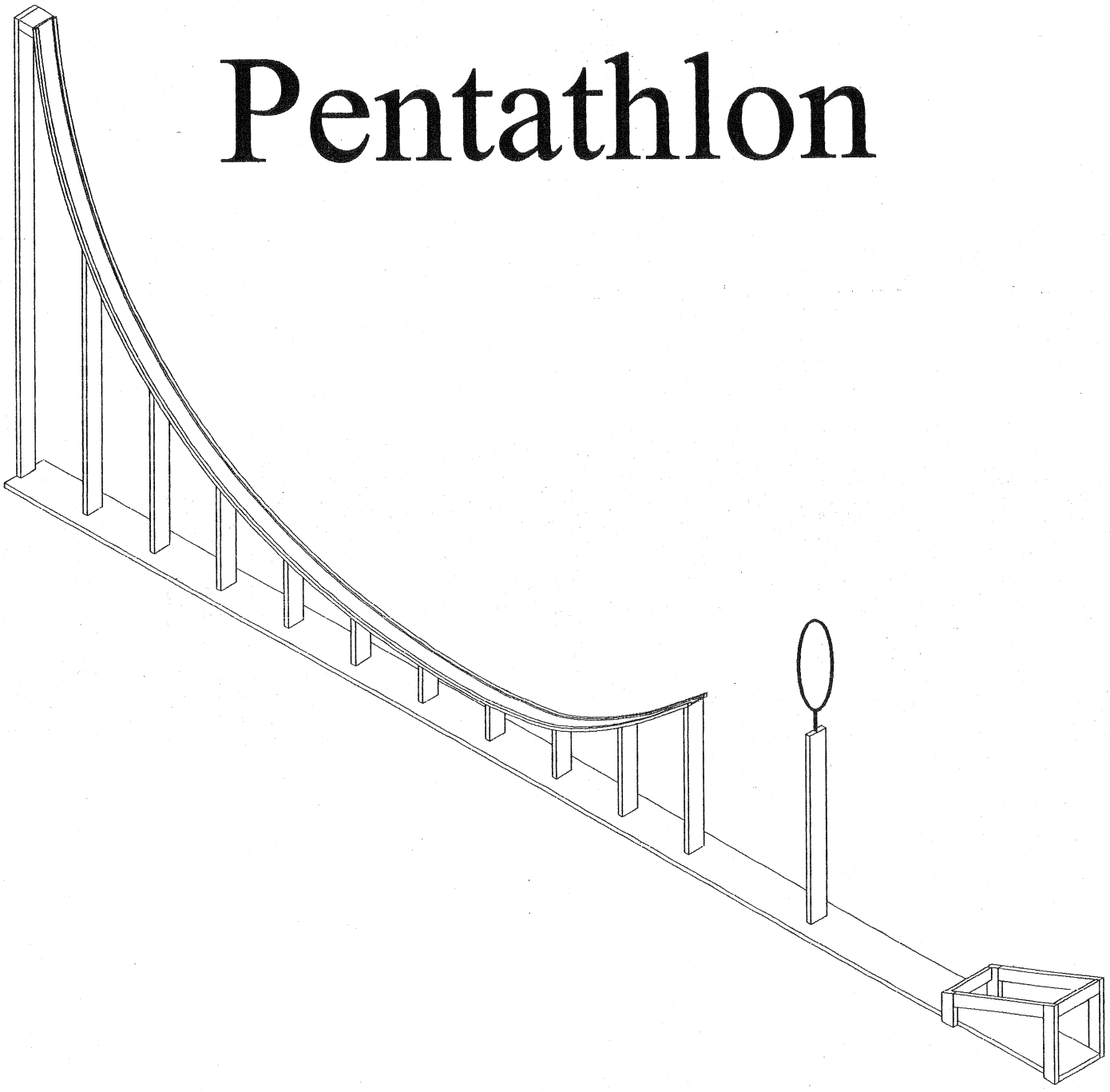
The Grand Pentathlon



Introduction

The grand pentathlon was designed as a U.W. research project involving math and technology classes using enhanced anchored instruction. The project consisted of two major activities: (1) Kim's Komet published by Learning Technology Center at Vanderbilt University, and (2) the "Ramp" with attachable events. Participants in the research project included:

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The following is part of an article written by Brian and Mary and published in Remedial and Special Education, Volume 22, Number 5, September/October 2001. This may help explain the intent of this project.

Instructional Materials

Enhanced Anchors. One video-based anchor from *Kim's Komet* was used in the EAI groups. *Kim's Komet* is in videodisc format, which allows students to quickly search locations in the video where relevant information for solving the problems is located. The procedures for solving the problems are not explicit, and thus they require students to formulate and test several hypotheses before arriving at a plausible solution.

Kim's Komet presents a problem in which two girls, Kim and Darlene, compete in a model car soapbox derby. The challenge for students is to help Kim construct a "smart tool," or graph, to predict where on the derby ramp she should release her car to negotiate several stunts at the end of a straightaway such as a loop, a banked curve, and a long jump. Students learn how to construct graphs from tables of information related to distance, rate, and time. The main objective of the video is to help students learn, in an informal way, concepts such as linear function, line of best fit, variables, rate of change (slope), reliability and measurement error, and acceleration.

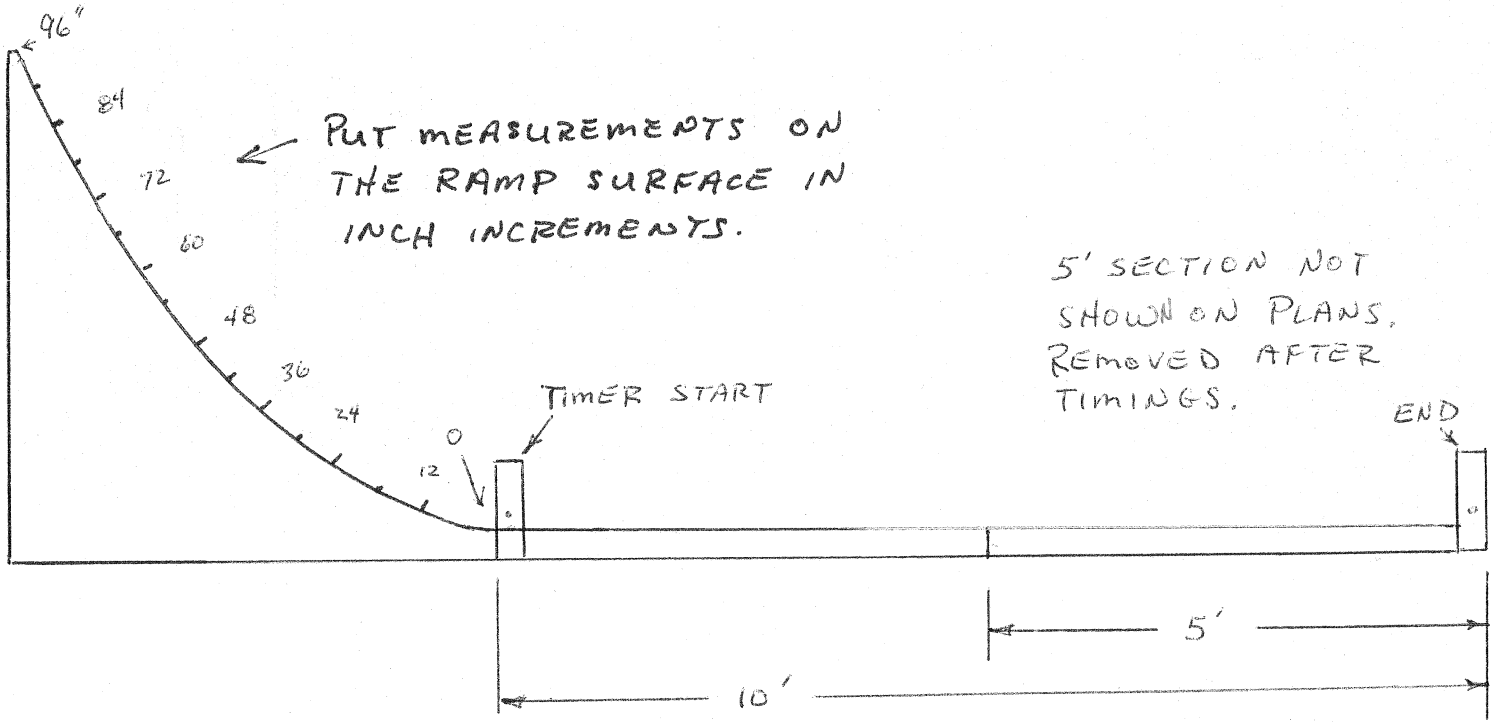
The first challenge in the video asks students to find the three fastest qualifiers in three regional races in which times and distances are known. The video shows the results of time trials in three regions in seconds (e.g., 0.9 seconds, 1.7 seconds) displayed on a tote board. The times across the regions are not readily comparable because the straightaway lengths are 18 feet in the western region, 15 feet in the eastern region, and 20 feet in the central region. Students must first calculate the speeds of the cars in each region and then find a way of comparing the speeds of the cars across regions. For example, students should be able to explain whether a car that travels 15 feet in 0.9 seconds is faster or slower than a car that travels 20 feet in 1.3 seconds.

The second challenge in the video required students to construct a graph to predict the speed of Kim's car at the end of a straightaway when it is released from any height on the soapbox derby ramp (Figure 1). To meet this challenge, students had to decide where they should start their stopwatches—from the release point on the ramp or at the beginning of the straightaway. The video gives students the opportunity to clock the speed of Kim's car from several heights on the ramp. Eventually students realize that they should begin timing her car on the straightaway, where the car's speed is relatively constant, rather than on the ramp, where the car is accelerating. The video also helps students understand the concept of reliability of measurement because students have the opportunity to measure the speed several times at each height on the ramp.

An applied problem in the technology education classroom gave students the opportunity to make, test, and predict the release points on the ramp of cars they made for the derby. The technology education teacher built the ramp, straightaway track, and stunts shown in the video. At the beginning and end of the straightaway, the teacher rigged an infrared detector to measure the time, in thousandths of a second, for the cars to travel from one end of the straightaway to the other. Using these times, students made graphs showing the speeds of their cars for each release point on the ramp. Their graphs helped them predict where on the ramp to release their cars to achieve the speeds necessary to successfully navigate the stunts at the end of the straightaway.

The Ramp

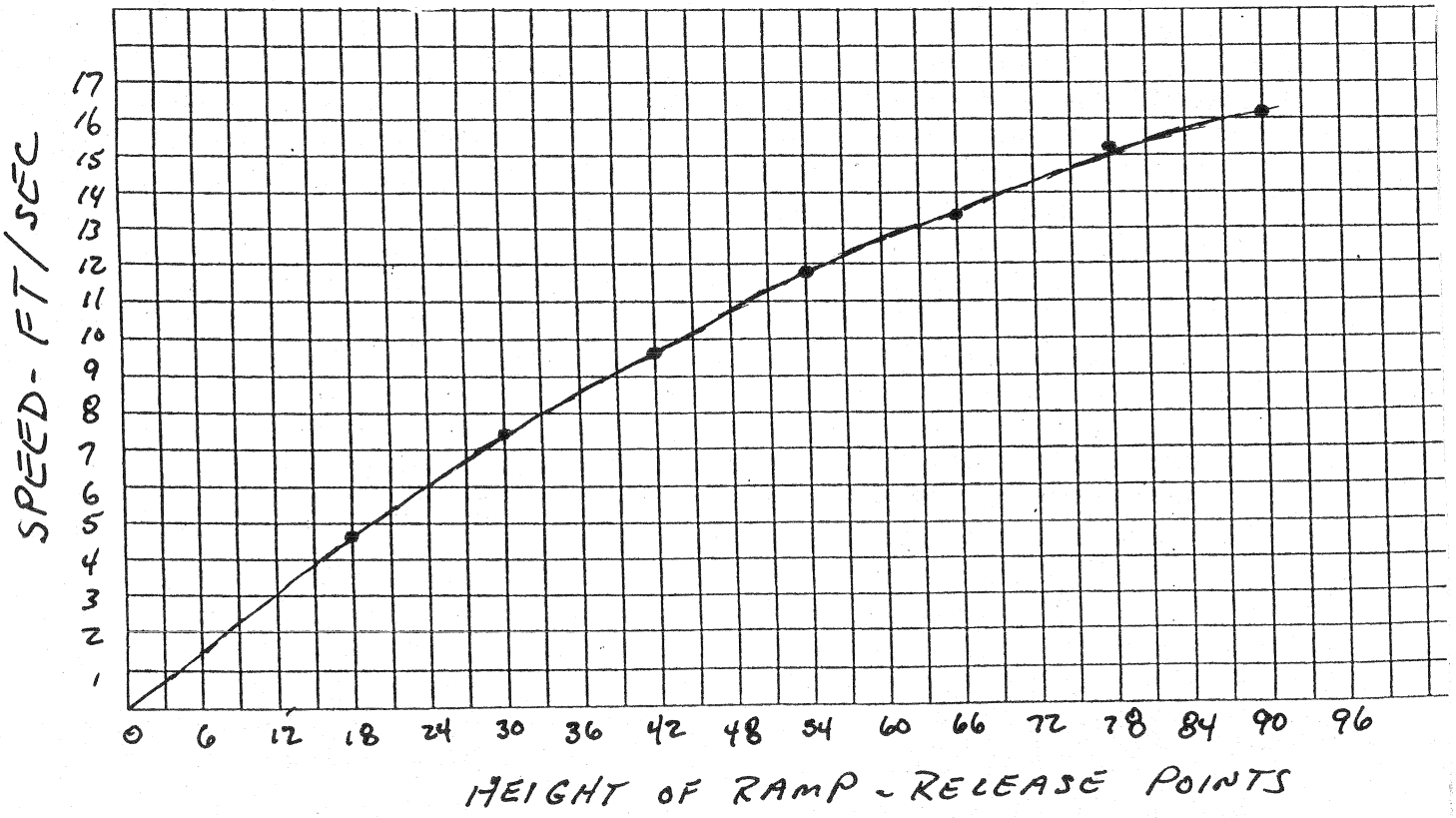
The plans in this packet show the ramp and five of the events that are attached for testing the cars. I made these as economical as possible from pine and hardboard but any design or materials may be used. The ramp consists of a slope, ten foot flat, and timer unit. A Kel-Timer Jr. motion timer was purchased for $195.00 from Kelvin.com of New York and I made two portable stands to hold the sensors. This allows removal of the timer from the ramp when testing cars on the different events. The slope is marked with inch intervals starting on the flat, where the timing starts, working back up the ramp to the maximum height (on this ramp 96"). Students release their cars from various points on the ramp, time it on the flat, and calculate the average speed from that release point. Once they have enough speeds calculated they make a graph as illustrated below. The graph is then used to predict a release point for each of the events attached to the ramp.



SAMPLE TIMINGS

HEIGHT	DISTANCE	TIME	RATE (SPEED)
90	10	.620	16.13 ft/sec
78	10	.659	15.17 ft/sec
66	10	.746	13.4 ft/sec
54	10	.846	11.82 ft/sec
42	10	1.021	9.79 ft/sec
30	10	1.349	7.42 ft/sec
18	10	2.140	4.67 ft/sec

SAMPLE GRAPH



Cars

I have the students design their car blanks on graph paper with a maximum length of 6 ¼ " and a height of 2 ¼" (not including wheels). The cars are made from birch that I glued and machined to a thickness of 1 5/8". The car, with wheels, must be no wider than 2 ¾" to fit the ramp. The best wheels I've found are Kelvin front dragster wheels with end cap. The wheels are very durable for the jumps and can be easily replaced if broken. They come in black or assorted colors for $7.00 – $8.00 per 100 and I use the front axle from the rocket car that is 2 ¼" long. My students bring their cars home to paint and decorate but it is not necessary and isn't part of the grade.

Contest

The contest consists of five events:

(1). Short Jump – the car must clear the bar and land in the basket.
(2). Double Hill – the car must come to rest in the valley between the hills.
(3). Long Jump – the car must go through the hoop and land in the basket.
(4). Loop-the-loop – the car must complete the loop without falling off.
(5). Banked Curve – the car must complete the curve without falling off.

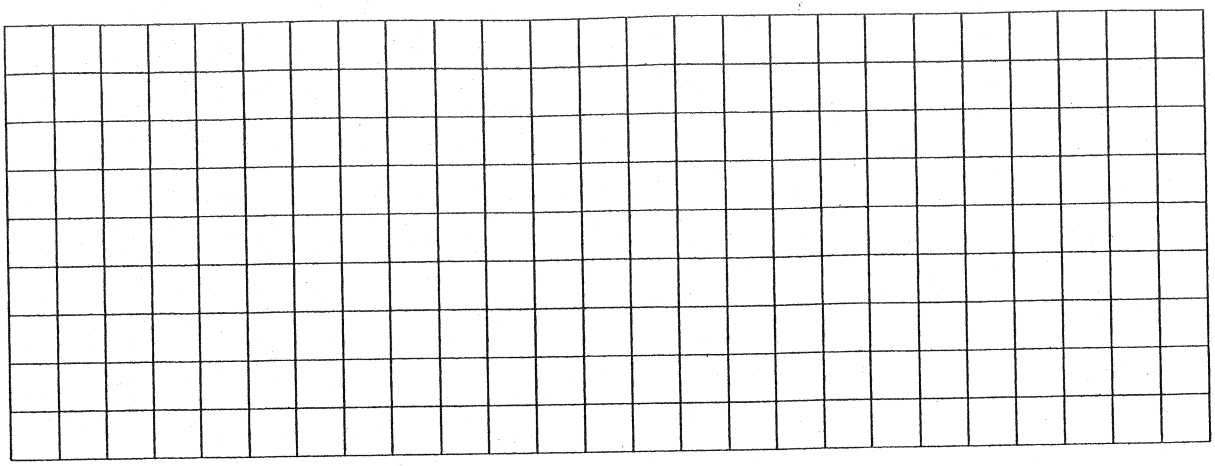
A five-foot section of straightaway is removed from the ramp and the event being tested is attached. Each event has a safe speed range to successfully complete that event. Before competing in an event the range is listed on the board. The students use their graphs to predict a release point and record this on a scorecard. The instructor collects the scorecard before any cars are tested. Points are assigned for each event and bonus points are obtained by subtracting the release point from a predetermined number (I use 110). The lower they can release their car to successfully complete each event, the more bonus points (see sample scorecard). The more accurate the speed calculations and graph, the closer they can release at the minimum speed range. The following chart is the range of speeds for my ramp. Yours may vary.

Grand Pentathlon Championship

Ranges of Speed for Events

Event	Points	Minimum Speed	Maximum Speed
Short Jump	50	12.5 ft/sec	14.8 ft/sec
Double Hill	50	7.9 ft/sec	9.5 ft/sec
Long Jump	75	15 ft/sec	16.5 ft/sec
Loop-the-Loop	75	13.9 ft/sec	None
Banked Curve	100	9.7 ft/sec	Varies

CAR DESIGN



MAXIMUM LENGTH - $6\frac{1}{4}$

MAXIMUM WIDTH - $1\frac{5}{8}$

MAXIMUM HEIGHT - $2\frac{1}{4}$

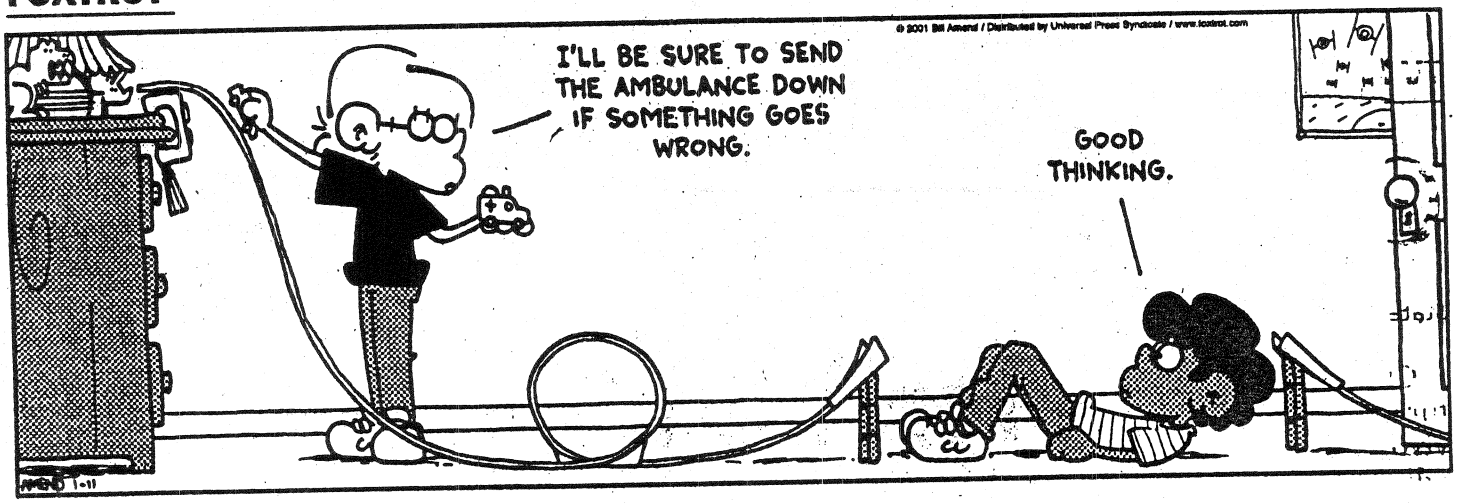
WIDTH WITH WHEELS - $2\frac{3}{4}$

Scorecard for Lodi's Pentathlon

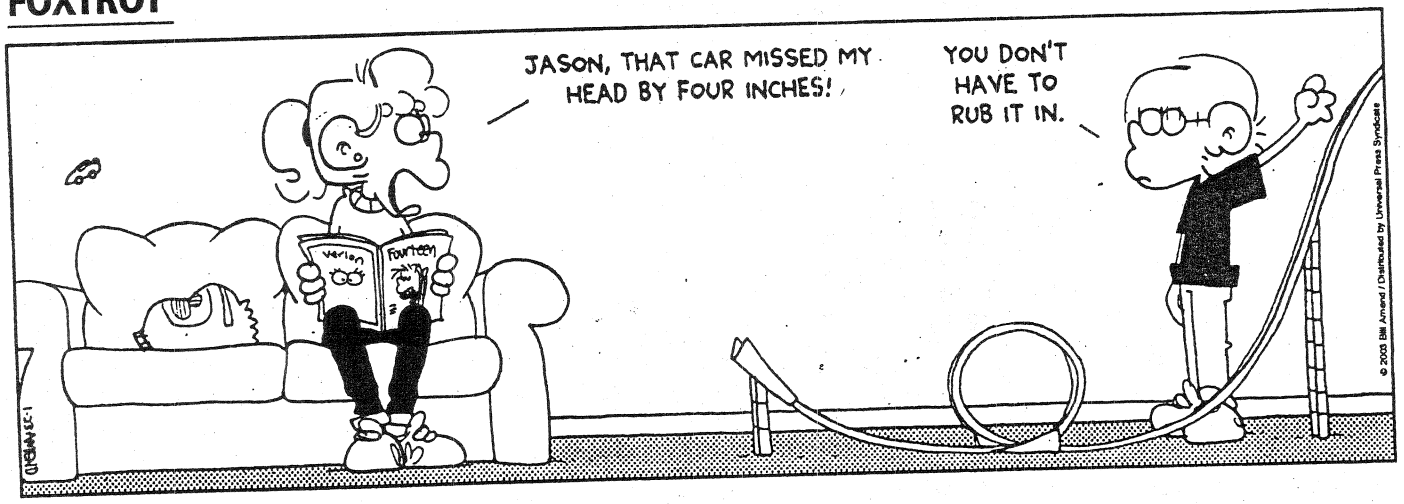
Name _____

Event	Height on Ramp	Event Points	Bonus Points	Total Points

FOXTROT



FOXTROT



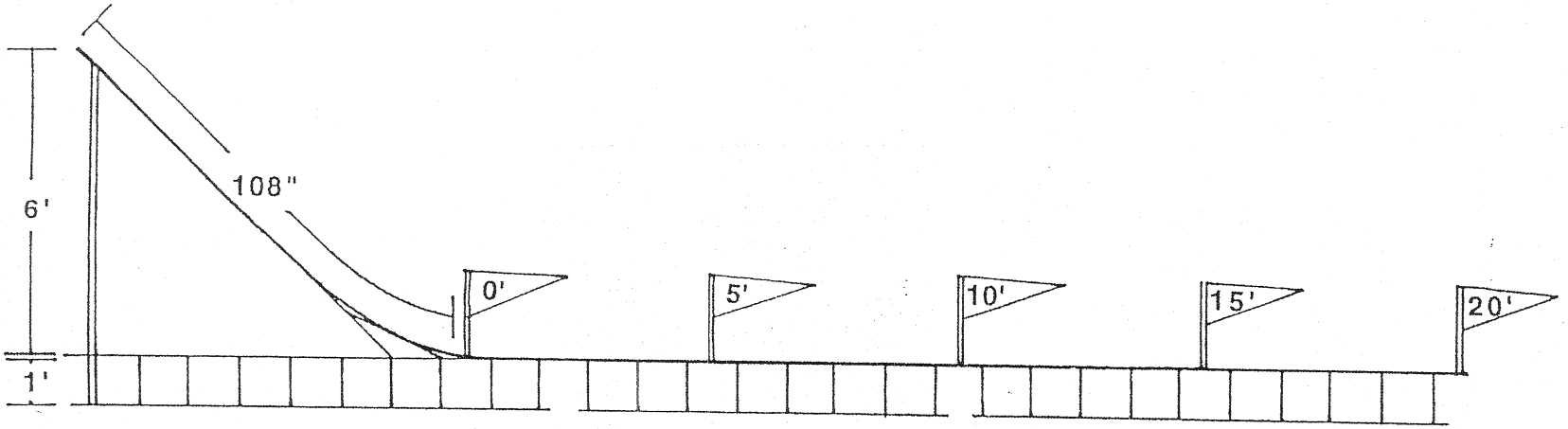
TRANSPARENCY MATERIAL

Grand Pentathlon – Rubric

		Points Possible	Points Obtained
Kim's Komet - Chart		5	_____
- Graph		5	_____
- Scorecard		5	_____
Regional Speeds		12	_____
Warm-up – event points		10	_____
Warm-up – speeds		10	_____
Car Design and Construction		5	_____
Chart with at least 10 heights, times, and speeds calculated		10	_____
Graph – points plotted, line of best fit		10	_____
Scorecard with events, bonus, event totals and grand total calculated		15	_____
Total of all events	600 points	25	_____
	500 points	24	
	400 points	21	
	300 points	19	
	200 points	17	
	100 points	15	
	No car	0	
Total for project		112	_____

A FEW OF THE ITEMS WE GRADE DURING THE UNIT.

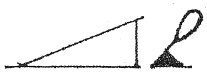
The Grand Pentathlon



Double Hump

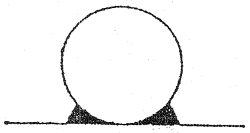
Points: 50

Short Jump



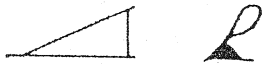
Points: 50

Loop-the-Loop



Points: 100

Long Jump



Points: 75

Banked Curve

Points: 25

- Tricks placed 10' from bottom of Ramp.

- Bonus Points: Subtract Height on Ramp from 120.

THIS IS FROM Kim's Komet. STUDENTS USE THIS TO HELP DETERMINE WHERE TO TIME THE CARS

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WELCOME GRAND PENTATHLON QUALIFIERS!!!

REGIONAL TIME TRIAL RESULTS – FASTEST TIMES
(All cars dropped from same height)

Eastern Region

RACER	STRAIGHT-AWAY LENGTH IN:	TIME
Darlene's Dagger	15 feet	0.9 sec.
Blue Thunder	15 feet	1.0 sec.
Moonshot	15 feet	1.2 sec.
Warp 9.9	15 feet	1.4 sec.

Western Region

RACER	STRAIGHT-AWAY LENGTH IN:	TIME
MC Squared	18 feet	1.2 sec.
Blink & U Missit	18 feet	1.3 sec.
We're #1	18 feet	1.5 sec.
Indiana Smith	18 feet	1.6 sec.

Central Region

RACER	STRAIGHT-AWAY LENGTH IN:	TIME
Kim's Komet	20 feet	1.3 sec.
Speedo Lite	20 feet	1.4 sec.
Midnite Special	20 feet	1.6 sec.
X-15	20 feet	1.7 sec.

THIS IS SHOWN AT THE BEGINNING OF KIM'S KOMET. I HAVE THE STUDENTS CALCULATE THE SPEED OF EACH CAR.

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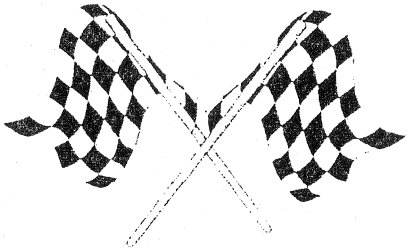
SAMPLE WARMUP FOR START OF CLASS

Warmup



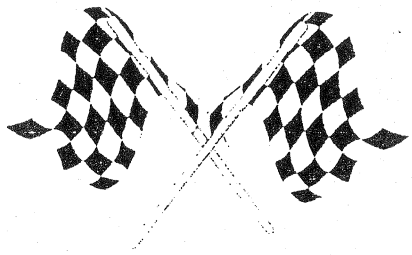
Name_____

1. Fill in the chart.

Name	Distance	Time	Speed
Jacob	26'	3sec	
Anna	21'	2.4sec	
Ryland	23'	2.5sec	
Dennis	24'	2.7sec	
Robin	22'	2.5sec	

2. Who is the fastest?_____

3. Where did you time Kim's car? Why?



Warmup

Name_____

1. Fill in the chart.

Name	Distance	Time	Speed
Joe	14 ft	3 sec	
Sarah	16 ft	3.3 sec	
Harry	19 ft	4.2 sec	
Isabel	15 ft	3 sec	
Walter	17 ft	3.5 sec	

2. Who is the fastest?_____

3. What are the two ways to earn points in the derby?

Name _____

Complete each of the following tables.

Table #1

Time	Distance
0	
1	
2	
3	
4	
5	
6	

Ben's car goes 14 miles per hour.

Table #2

Time	Distance
0	
1	
2	
3	
4	
5	
6	

Mary's car goes 32 miles per hour.

Table #3

Time	Distance
0	
1	
2	
3	
4	
5	
6	

Chad's car goes 43 miles per hour.

Write a rule or equation for each table. Graph all three on the same coordinate graph. The graph must be complete with labels, key, and title.

Scorecard for Kim's Komet

WARM UP

Group Robin's

Event	Height on Ramp	Points	Total
Short Jump	64"	50+ ____	
Double Hump	34"	50+ ____	
Loop the Loop	66"	75+ ____	
Long Jump	86"	75+ ____	
Banked Curve	42"	100+ ____	

Bonus Points = 110 - height on Ramp total ____

Scorecard for Kim's Komet

SCORECARD FOR VIDEO

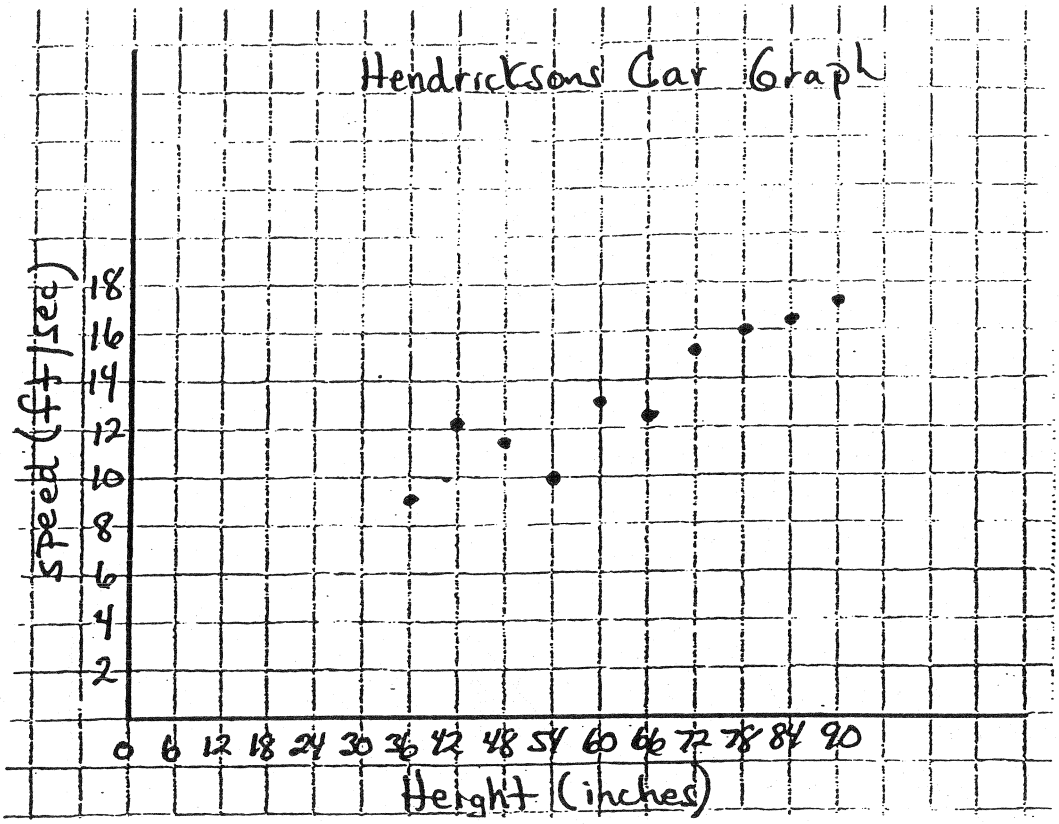
Group ____

Event	Height on Ramp	Points	Total

SAMPLE Quiz

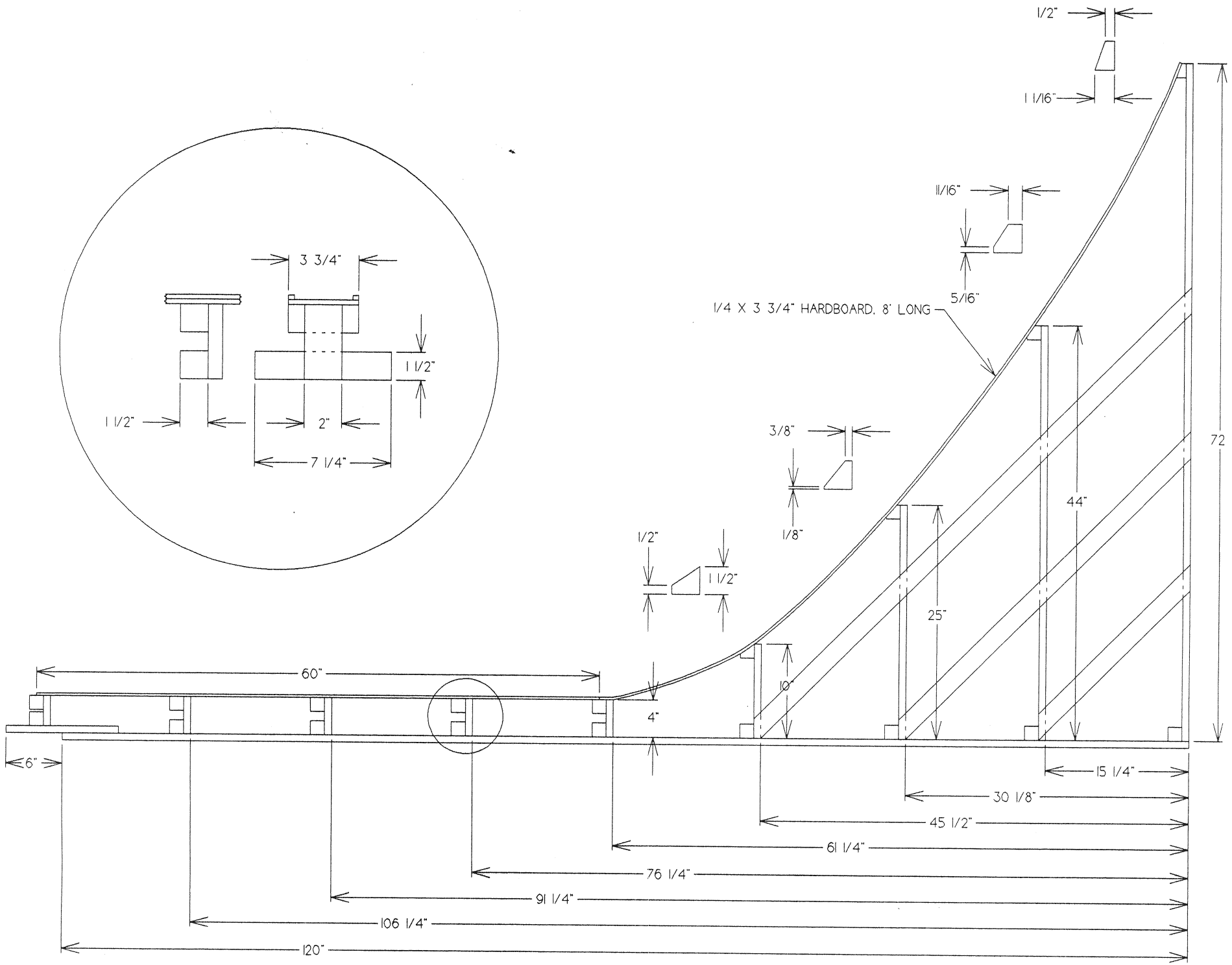
Kim's Komet Quiz Name_____

1. Draw the "line of best fit" for my graph.

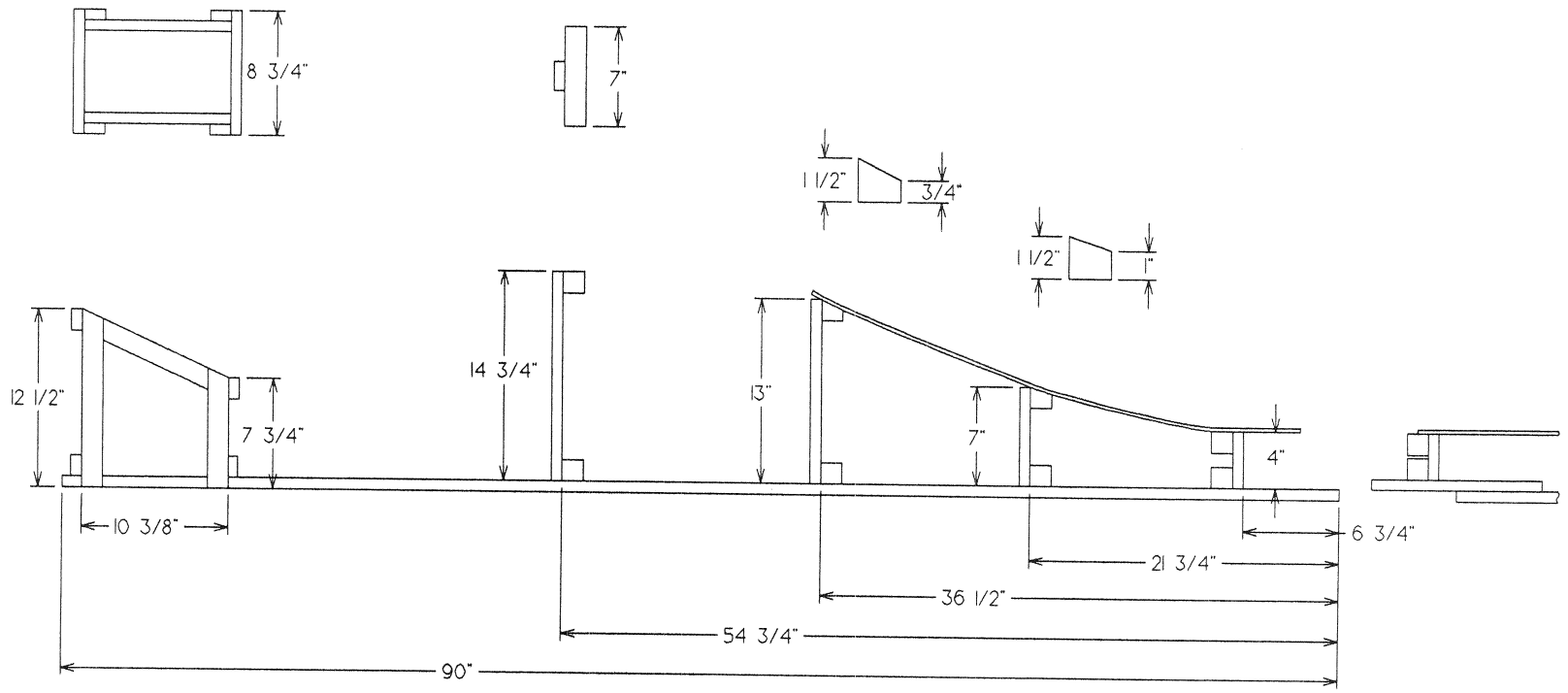


2. Fill out the following table using the graph.

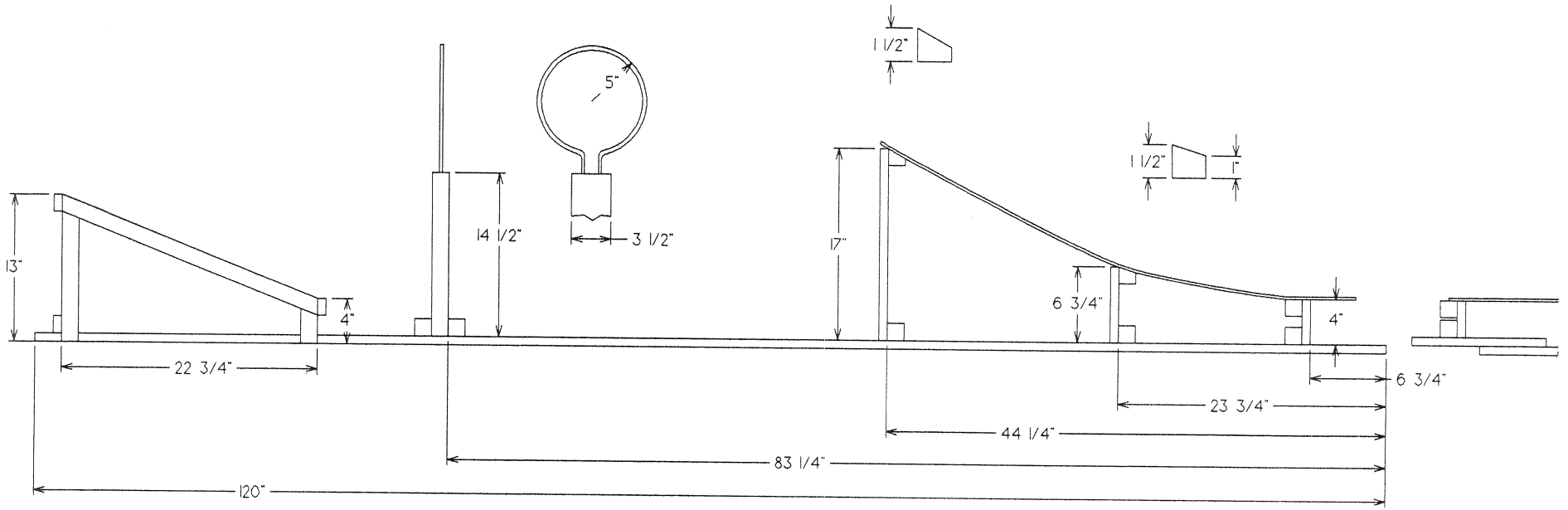
	Event	Required Speed	Height Released
A.	#1	12.5 – 14.0	
B.	#2	15.5 – 16.0	
C.	#3	9.5 – 10.5	
D.	#4	11.5 – 13	
E.	#5	16.0 – 17.5	


1/2"
1 1/16"
11/16"
5/16"
1/4 X 3 3/4" HARDBOARD, 8' LONG
3 3/4"
1 1/2"
1 1/2"
2"
7 1/4"
3/8"
1/8"
1/2"
1 1/2"
72
44"
25"
10"
60"
4"
6"
15 1/4"
30 1/8"
45 1/2"
61 1/4"
76 1/4"
91 1/4"
106 1/4"
120"

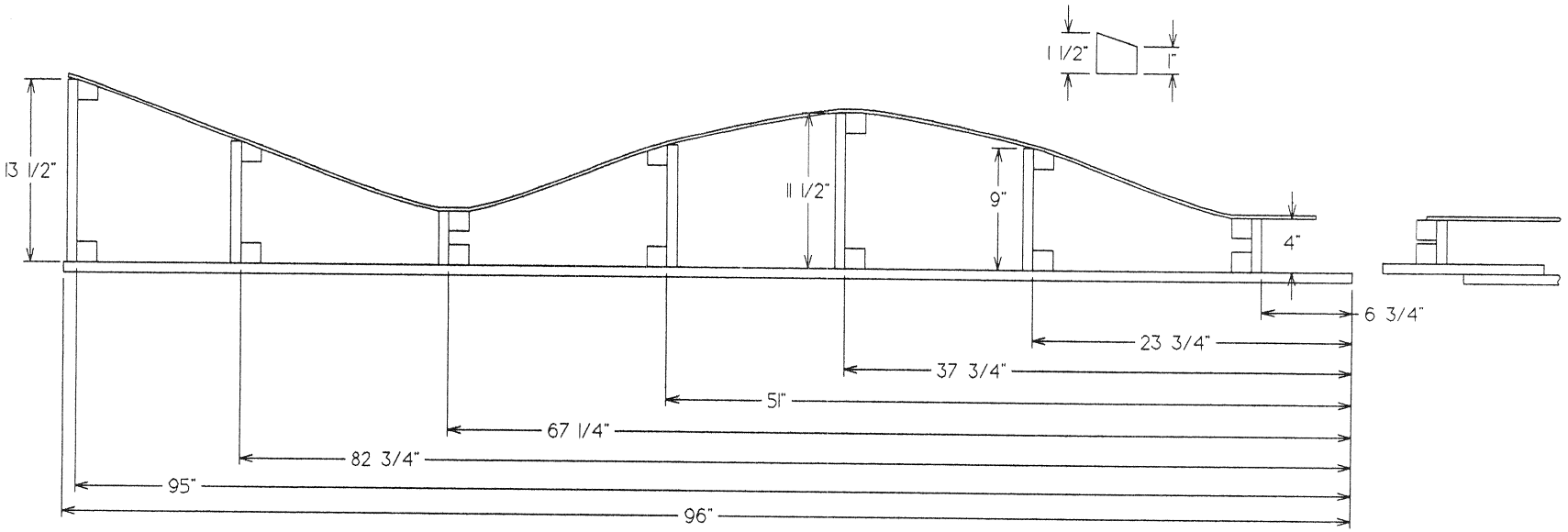
SHORT JUMP



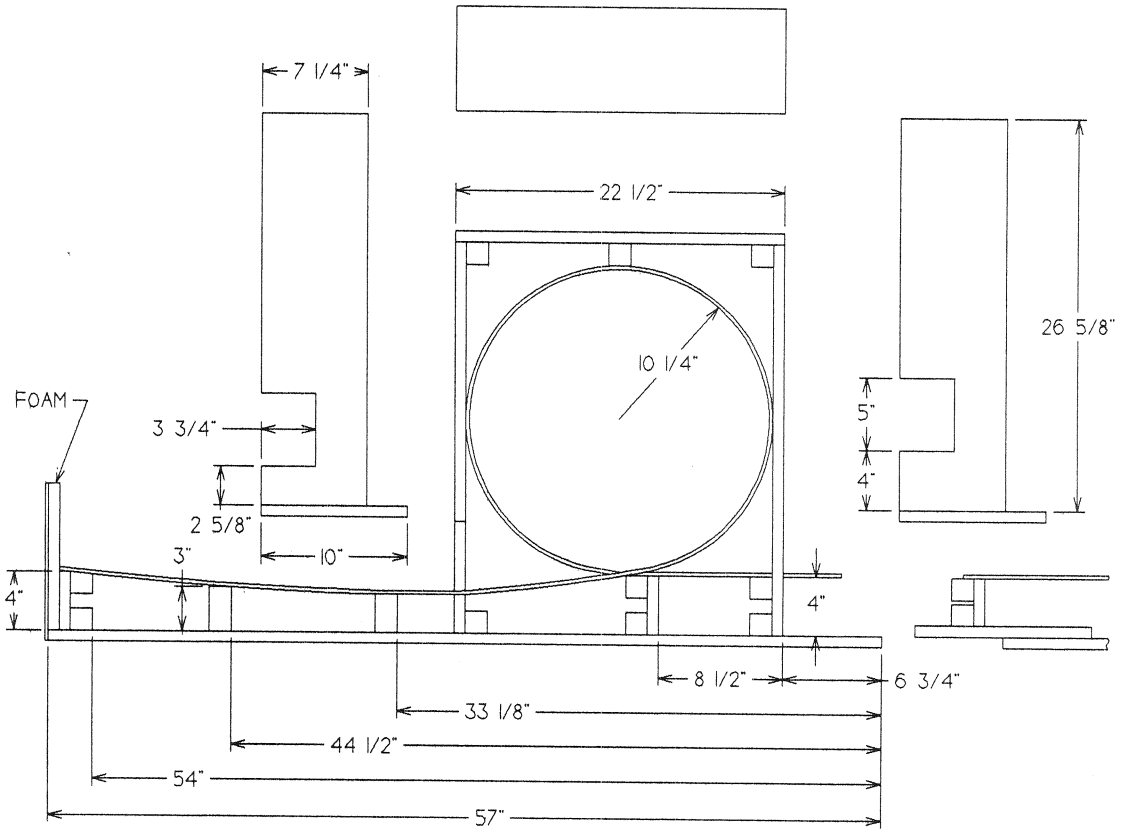
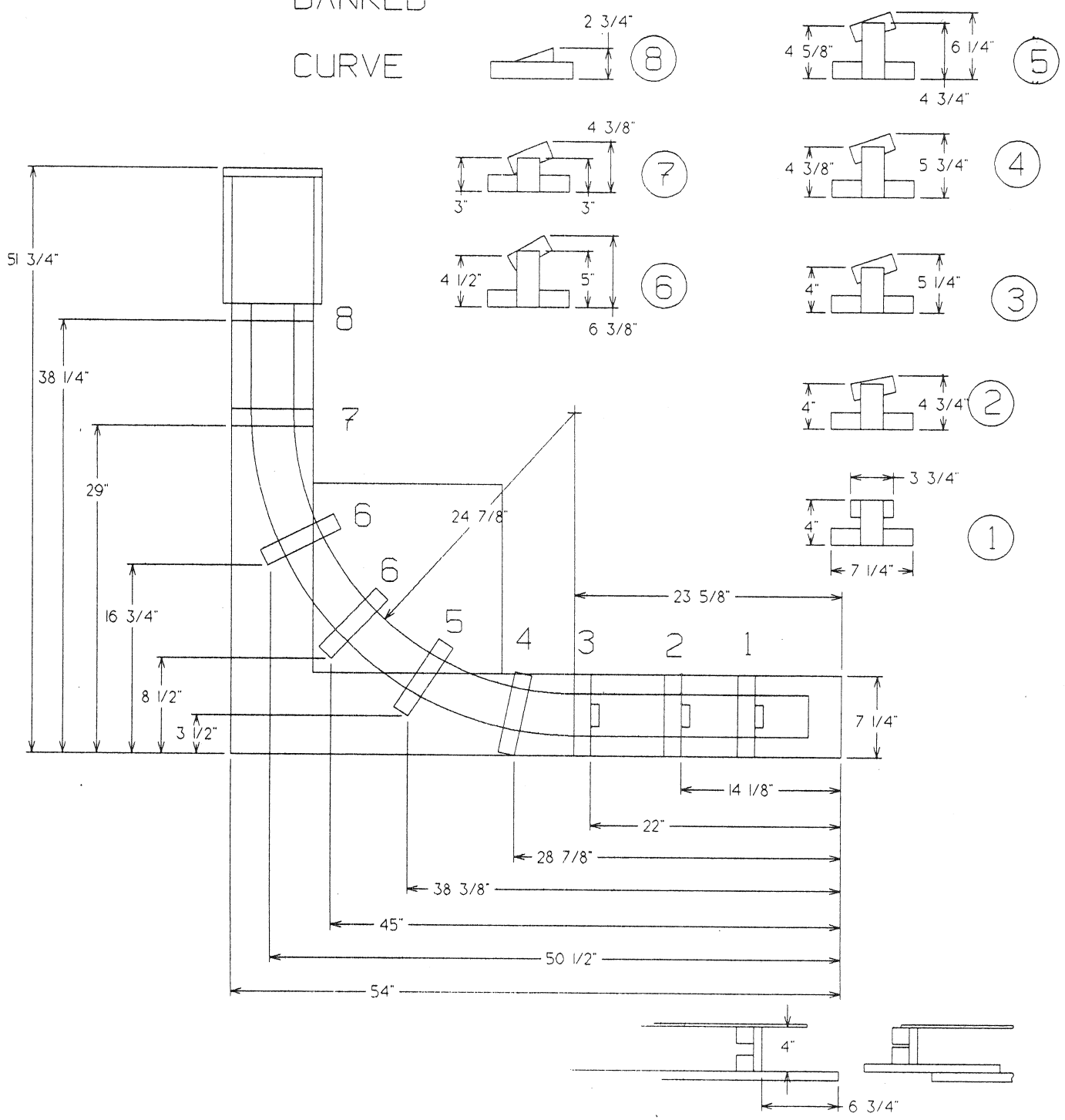
LONG JUMP



DOUBLE HUMP



LOOP-THE-LOOP



BANKED CURVE