Name

Period Date

TERMS, DEFINITIONS, AND SYMBOLS

Name ______________________________

Period __________ Date ________________

EQUATIONS

AIR-TROLLEY CONSTRUCTION

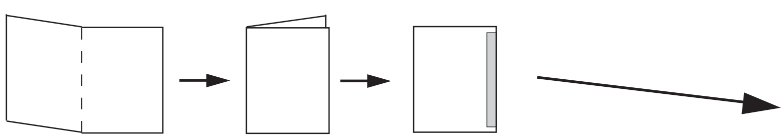
Materials

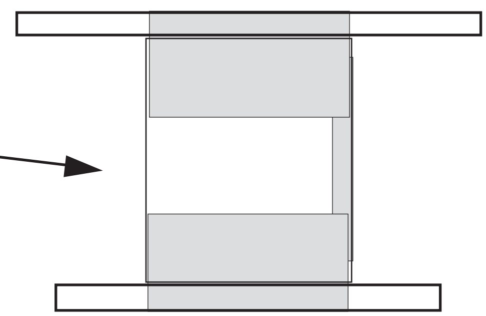
1 Jumbo straw
1 Super jumbo straw
1 Index card
1 Propeller
1 Hook
1 Rubber band
1 Meter tape
1 Scissors
• Transparent tape
• Clear packing tape, 2” wide

a. Cut the super jumbo straw (larger diameter) at 11 cm.

Cut the jumbo straw at 15 cm.

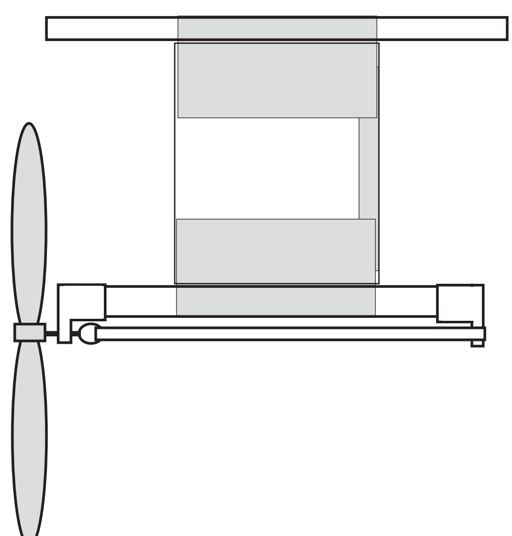
b. Fold the index card in half. Tape the edge.





c. Use the wider clear packing tape for this assembly. Center everything before taping. Tape the two straw pieces to the short edges of the folded card.

d. Attach a propeller to one end of the super jumbo straw and a hook to the other end. Connect the propeller and hook with the rubber band.



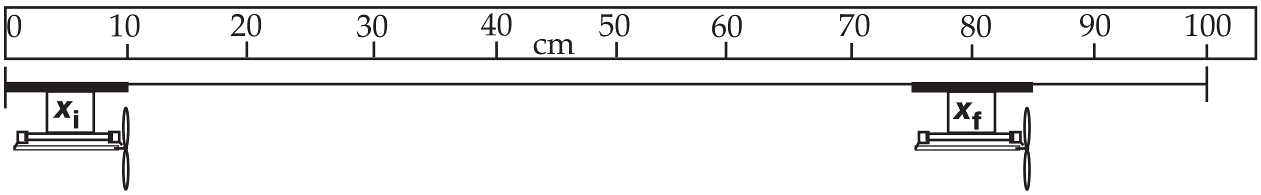
Name ______________________________

Period ____________ Date ________________

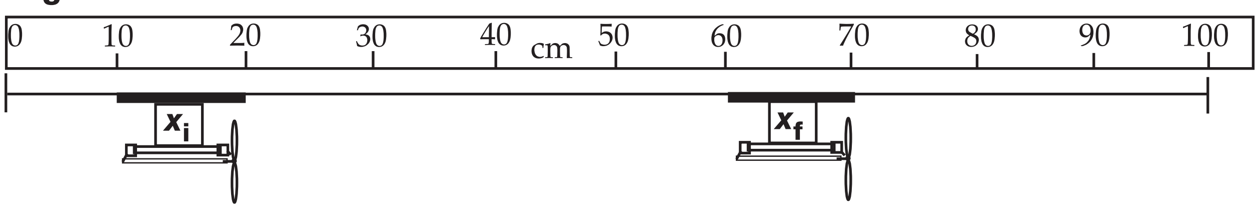
FLIGHT DISTANCES

How far did each air trolley fly? Calculate the distance of each flight, using the distance equation. Mark your reference points with arrows and show your math.

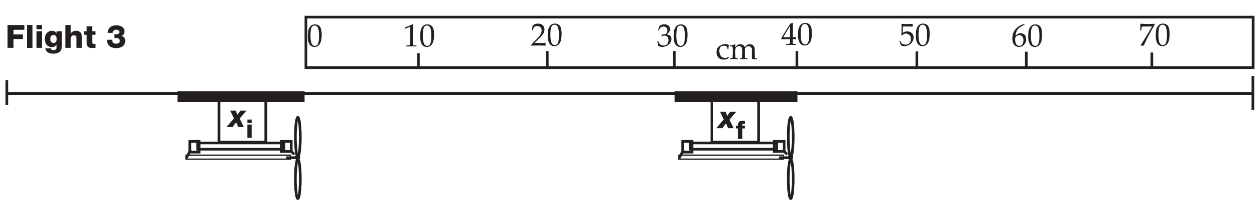
Flight 1



Flight 2



Flight 3



Name ______________________________

Period ____________ Date ________________

AIR-TROLLEY DISTANCE GRAPH

Part 1: Gather air-trolley flight data.

1. Number of winds on the propeller ____________________

2. Measured flight distances during five trials

Trial	Distance (cm)

3. Average flight distance

____

Part 2: Graph the air-trolley flight data.

Title ____

Winds	*d* (cm)

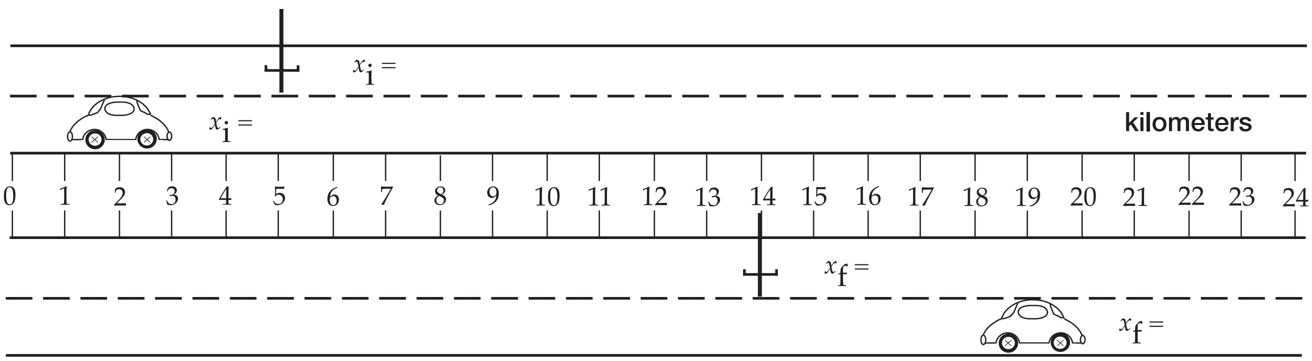
Name ______________________

Period ____________ Date ____________

ROAD RACES A

Write the equation for calculating distance. ______________________

Road Race 1 One person drove a car, and the other rode a pogo stick.



Which vehicle went farther?

____

How much farther?

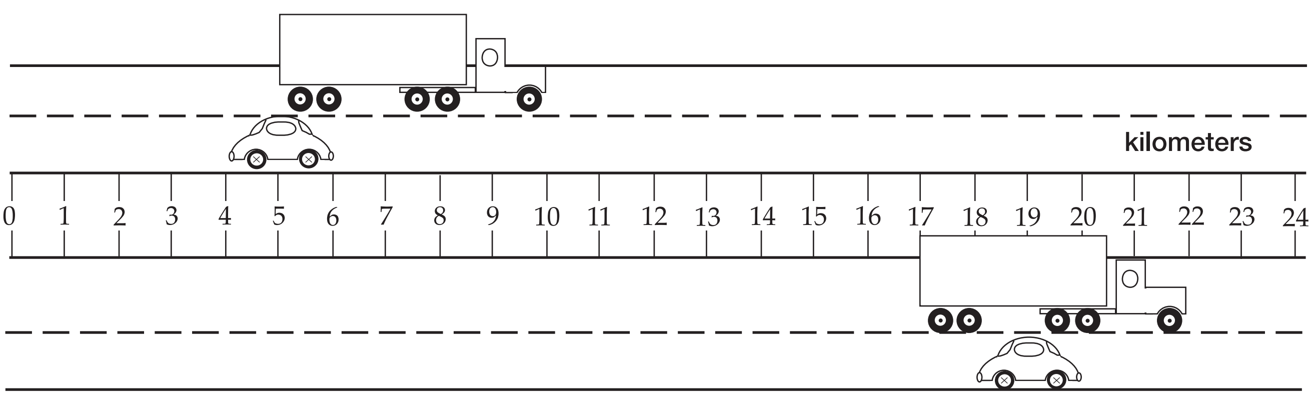
____

Pogo-stick math here.

Car math here.

Difference math here.

Road Race 2 One person drove a truck, and the other drove a car.



Which vehicle went farther?

____

How much farther?

____

Math here.

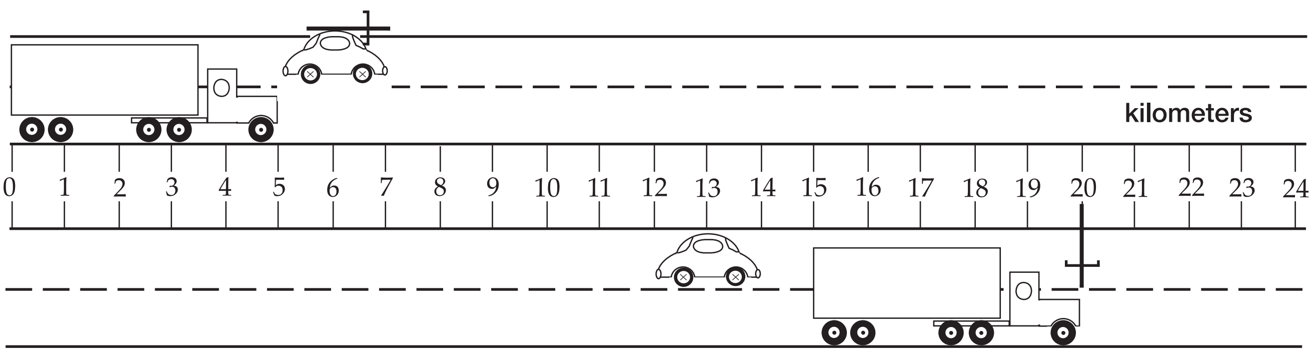
Math here.

Name ______________________________

Period ____________ Date ______________

ROAD RACES B

Road Race 3 One person started in a car, ran out of gas, and finished on a pogo stick. The other person drove a truck.



Which of the three vehicles went the greatest distance?

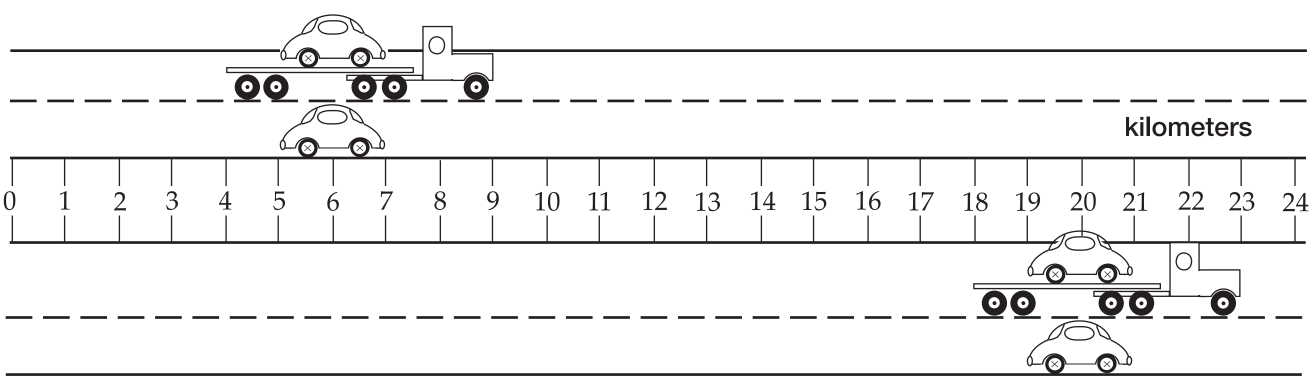
____

Which vehicle went the shortest distance?

____

Math here.

Road Race 4 A truck hauling car A raced against car B.



Which of the three vehicles went farthest?

____

How much farther?

____

Math here.

Name ______________________

Period ____________ Date ______________

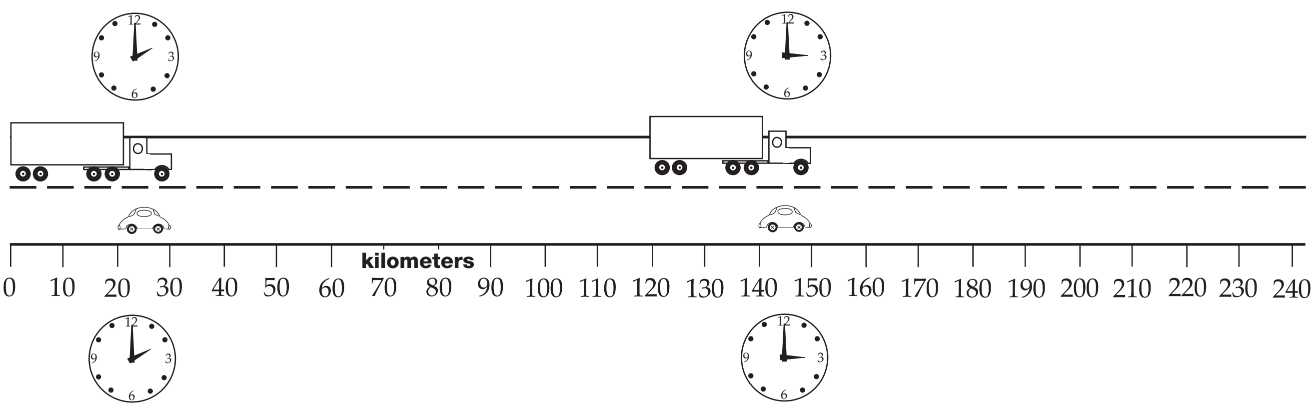
WHO GOT THERE FIRST? (race 1)

Look at race 1 between the truck and car.

Neither of the vehicles changed speed during the race.

Which vehicle reached the **150-kilometer mark first?**

Race 1



Truck *d* = ____________ Truck time interval = ____________

Car *d* = ____________ Car time interval = ____________

Which vehicle reached the 150-km mark first? ______________________

How do you know? ______________________

____

____

____

Show math here.

Name ______________________

Period ____________ Date ____________

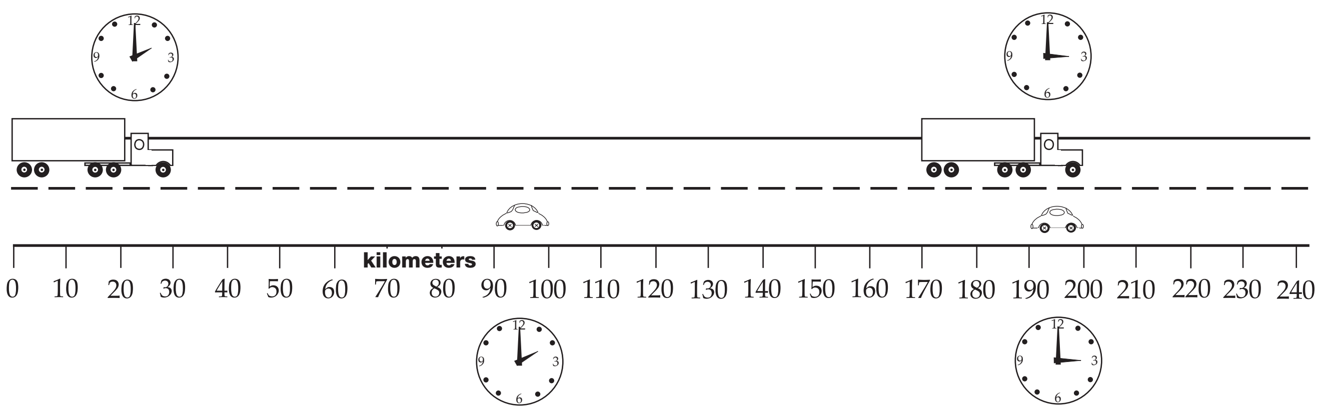
WHO GOT THERE FIRST? (race 2)

Look at race 2 between the truck and car.

Neither of the vehicles changed speed during the race.

Which vehicle reached the **150-kilometer mark first?**

Race 2



Truck *d* = ____________ Truck time interval = ____________

Car *d* = ____________ Car time interval = ____________

Which vehicle reached the 150-km mark first? ______________________

How do you know? ______________________

____

____

____

Show math here.

Name ____________________

Period __________ Date __________

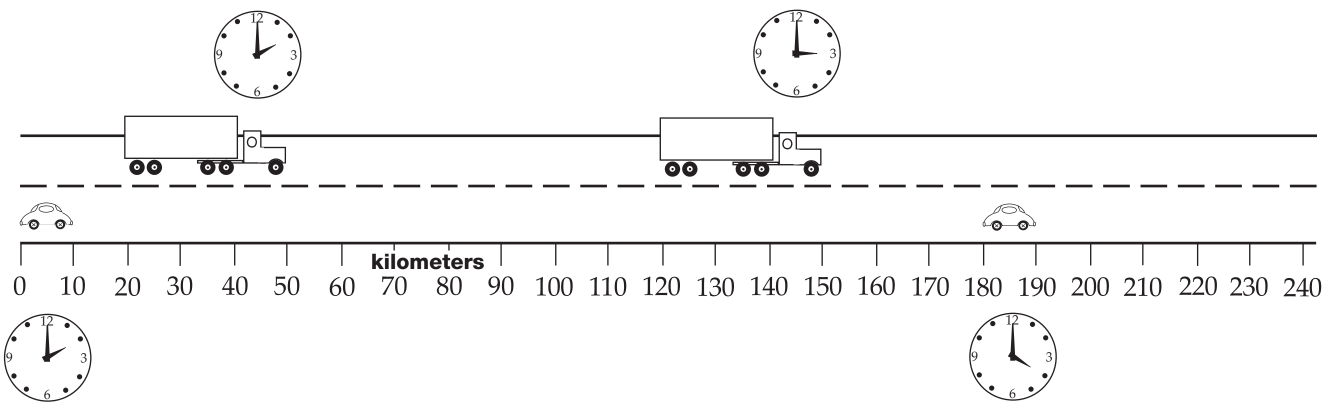
WHO GOT THERE FIRST? (race 3)

Look at race 3 between the truck and car.

Neither of the vehicles changed speed during the race.

Which vehicle reached the **150-kilometer mark first?**

Race 3



Truck *d* = __________ Truck time interval = __________

Car *d* = __________ Car time interval = __________

Which vehicle reached the 150-km mark first? ____________________

How do you know? ____________________

____

____

____

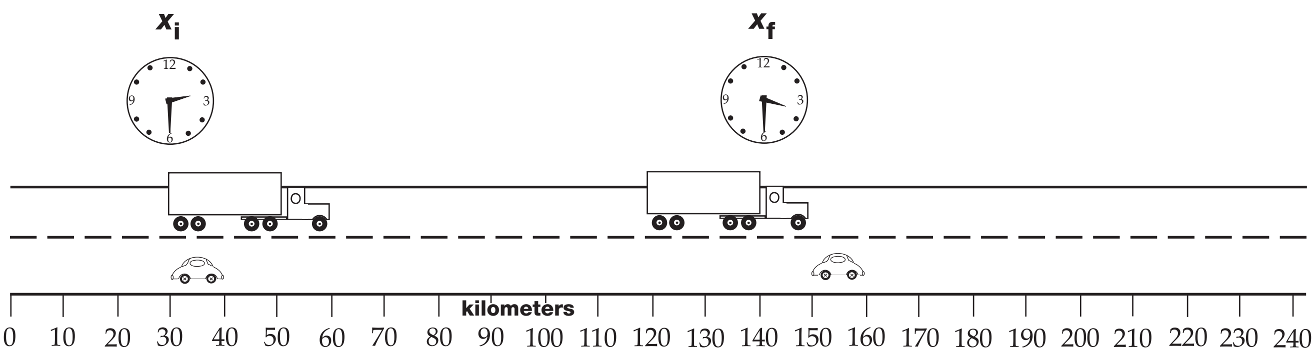
Show math here.

Name ____________________

Period __________ Date __________

TIME TRAVEL A

1. At 2:30 p.m. a car and a truck were in the positions shown at x_i. At 3:30 p.m. the car and truck were in the positions shown at x_f. They traveled at steady speed all the time.



Show math and units in these boxes.

a. How far did each vehicle travel?

Truck __________

Car __________

b. How long did it take the vehicles to get to their positions at x_f?

____

c. How fast was each vehicle going from x_i to x_f ?

____

d. What is the equation for calculating **speed?**

e. Which vehicle got to the 100-km mark first?

____

How do you know?

____

____

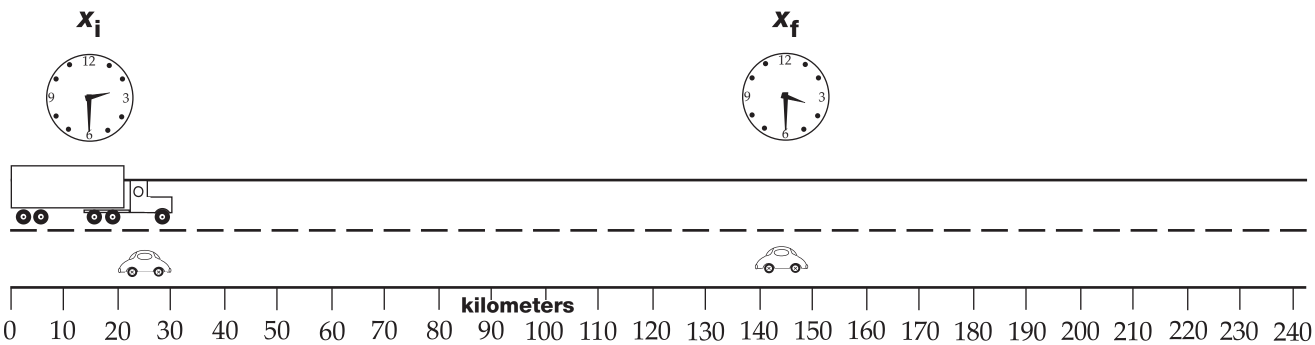
____

Name ______________________

Period ____________ Date ____________

TIME TRAVEL B

2. This time the vehicles started at the positions shown at x_i, but the truck was going **half as fast** as it was in problem 1.



Show math and units in these boxes.

a. Where would the **truck** be at 3:30 p.m.?

____

b. How far would the **truck** have traveled at 9:30 p.m.?

____

c. How far would the **car** have traveled at 3:00 p.m.?

____

d. What is the equation for calculating **distance when you know the speed and time?**

e. What is the total distance traveled by **both vehicles** (added together) at 5:00 p.m.?

____

Name ______________________

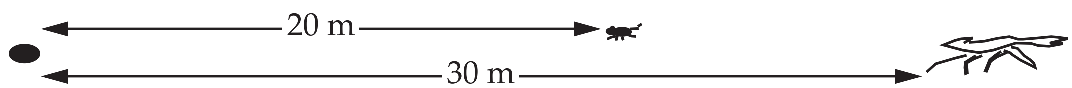
Period __________ Date ______________

SPEED AND DISTANCE PRACTICE A

1. Bonnie rode her skateboard 200 meters (m) in 30 seconds (s). Raul rode his unicycle 300 m in 50 s. Who traveled faster? How much faster?

2. It is about 384,750 kilometers (km) from Earth to the Moon. It took the Apollo astronauts about 2 days and 19.5 hours to fly to the Moon. How fast did they travel?

3. A chipmunk can run 5 m/s. A fox can run 8 m/s. If the chipmunk and fox start running at the same time, will the chipmunk make it to its burrow in time?



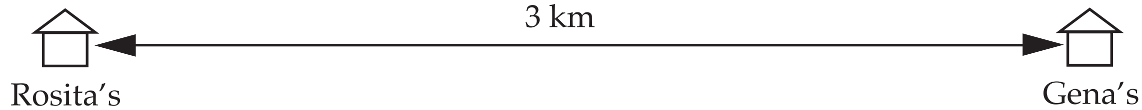
4. Rita flew from Los Angeles to Boston to visit her aunt, a distance of 4000 km. The trip took 5 hours (h). What was the average speed of the jet?

5. A truck left a diner at 1:00 p.m. and drove 360 km to Jersey City. The truck arrived at 7:00 p.m. A car left the same diner at 2:00 p.m. and drove to Jersey City at an average speed of 80 km/h.
   a. How fast did the truck travel?

   b. Which vehicle got to Jersey City first?

6. An Arctic tern can fly 85 km/h for 24 h straight. How far can it fly before landing?

7. Rosita started riding her bike 3 km to her friend Gena's place at exactly the same time Gena started skating to Rosita's house. Gena, of course, wasn't home, so Rosita rode back home. The two girls arrived at Rosita's house at the same time. It took Rosita 30 minutes to ride to Gena's and back. How fast did Gena skate?



Name ______________________

Period __________ Date ______________

SPEED AND DISTANCE PRACTICE B

8. A hiker wanted to hike to a lake 26 km from the end of the road. She started at 6 a.m. and walked steadily until 9:00 a.m. She stopped for a 1-hour rest and then continued until she stopped for 1.5 h to have lunch. She took only one 0.5 h rest in the afternoon and arrived at the lake at 7:00 p.m.

   a. What was the hiker's average speed from the end of the road to the lake?

   b. What was the hiker's average speed during the time she was actually hiking?

9. Ron put 16 gallons (gal.) of gas in his truck and reset the trip odometer to 0. He drove until he ran out of gas. The odometer read 480 km. How many kilometers per gallon does Ron's truck get?

10. Beth's motor scooter gets 110 km/gal. How far can she go on 2.5 gal. of fuel?

11. A champion jumping frog can jump 2.5 m every 4 s. What is the jumping frog's average speed?

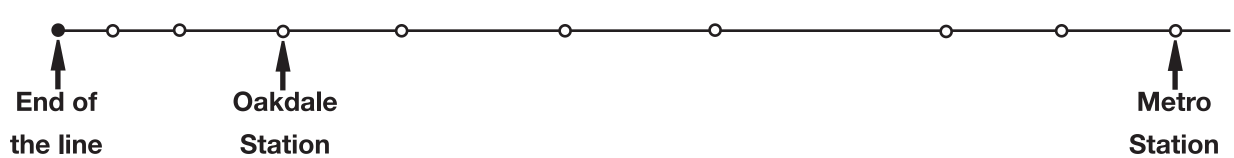
12. An ostrich can run 10 km in 15 minutes. What is its speed in kilometers/hour?

13. A basketball rolled 300 m down a hill in 25 s. What was its average speed down the hill?

14. A commuter got on the train at the Oakdale Station at 6:50 a.m. She got off at Metro Station at 8:05 a.m. The train made five 3-minute stops along the way. Oakdale is 21 km from the end of the line, and Metro Station is 96 km from the end of the line.

   a. What was the commuter's average speed getting to work?

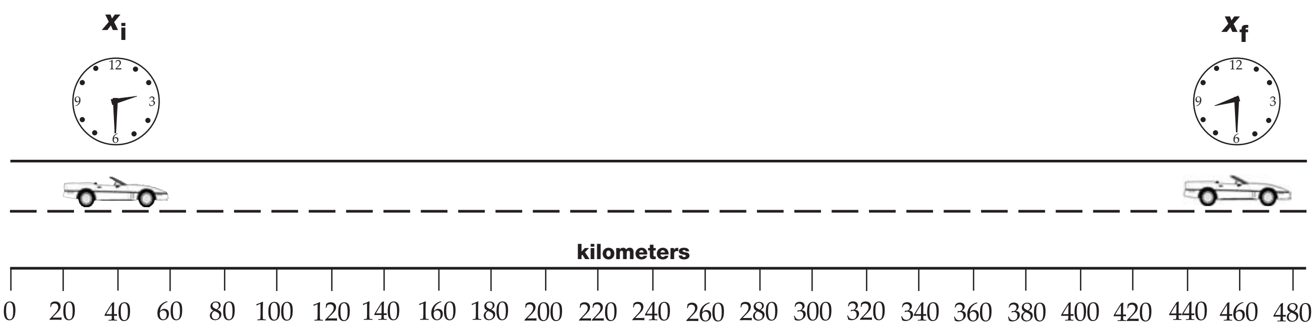
   b. What was the average speed of the train while it was under way?



Name ________________________

Period ____________ Date ______________

RESPONSE SHEET—SPEED



Abbi looked at the representation of the road trip shown above and said,

I know how far the car went and how long it took to get there, but I'm not sure how fast it went.

Gwen said,

Here, I'll show you how to figure out how fast the car was going.

1. What do you think Gwen showed Abbi?

2. Show Abbi and Gwen how to figure out how far the car had gone after 2.5 hours.

Name ______________________________

Period ____________ Date ________________

SPEEDING DOWN SLOPES

Part 1: Gather data.

a. The elevation your team worked with was ________________ .

b. The distance you ran your car was 200 cm .

c. You ran __________ trials.

d. Enter your raw data.

Time trials (s)

e. Calculate the **average time** it took the car to travel 200 cm. Use a calculator.

Average time

f. Calculate the car's **average speed.** Write the equation and show your math.

Average speed

Part 2: Graph results.

a. Copy the other teams' time and elevation data to your table.

b. Graph distance versus time for each elevation.

Elevation (cm)	Average Δt (s)	d (cm)
		200
		200
		200
		200
		200

Name ______________________________

Period ____________ Date ________________

AVERAGE SPEED PRACTICE A

1. When Belinda walks to school in the morning, it takes her 12 minutes to walk the 1 kilometer (km). When she walks home after school with her little sister, it takes twice as long. Does Belinda's speed increase or decrease when she walks with her sister?

2. Frank's car rolled 300 centimeters (cm) in 1.5 seconds (s).

   Noah's car rolled 360 cm in 2 s.

   Whose car ran on a steeper ramp?

3. A biker rode up a 20-km hill in 2 hours and down the hill in 0.5 hour without stopping. What was his average speed

   a. going up the hill?

   b. going down the hill?

   c. for the whole trip?

4. It took Ellie 4 hours to paddle her canoe 10 km upstream. After a leisurely 3-hour picnic, she paddled back home in 1 hour.

   a. How fast did Ellie paddle upstream?

   b. What was Ellie's average speed while she was paddling her canoe?

5. Mark's family drove 180 km to the beach at 90 km/h. They drove home at 60 km/h. What was their average driving speed for the time they were on the road?

6. Three girls raced their model cars down a 40-meter track. Their times are in the table. What was the average speed at which the cars rolled down the track?

	Δt (s)	d (m)
Jessica	10	40
Kristi	20	40
Laticia	8	40

7. Ben took off in a plane at 9:30 a.m. from Seattle and landed in Baltimore, 4030 km away, at 7:00 p.m. There was a 1.5-hour layover in Denver. (The time in Baltimore is 3 hours later than in Seattle.)

   a. What was Ben's average speed on his trip from Seattle to Baltimore?

   b. What was the plane's average speed while in the air?

Name ____________________

Period __________ Date ____________

AVERAGE SPEED PRACTICE B

8. A high school varsity hardball pitcher can throw his fastball 28.5 m in 0.75 s. A high school varsity softball pitcher can throw her fastball 12.0 m in 0.3 s. Which pitcher's ball travels faster?

9. A boat sailed out to an island at a speed of 18 km/h in 4 h and then immediately sailed back to port at 36 km/h in 2 h. What was its average speed for the trip?

10. Sweta entered a skate, row, and bike race. Her time and distance for each leg of the race are entered in the chart.

    a. What was Sweta's average speed for each leg?

    b. What was her average speed over the whole race?

	Δt (h)	d (km)	v (km/h)
Skate	1.25	20	
Row	0.75	6	
Bike	2.5	100	

11. Biff's dog loves to catch his tennis ball. It takes the ball 5 s to fly 60 m.

    a. How fast does Biff's dog have to run to catch it?

    b How fast is that in kilometers per hour?

12. Lily's family took a motor boat 24 km down a river for a picnic. It took them 1 h to get to the picnic spot. The ride back to the dock took an hour and a half.

    a. What was the boat's average speed going to the picnic?

    b. What was the boat's average speed coming home from the picnic?

    c. What was the boat's average speed for the whole boat ride to and from the picnic?

    d. What was the average speed at which the river flowed?

    e. What would the boat's average speed be on a lake?

13. What is the average speed of an arrow that takes 1.25 s to hit a target 75 m away?

Name ______________________

Period __________ Date ______________

WALK AND RUN SPEEDS

a. Write the name of your group's walker and runner in the tables.

b. Record the distance that will be traveled.

c. Time three walks and three runs. Record the times in the tables.

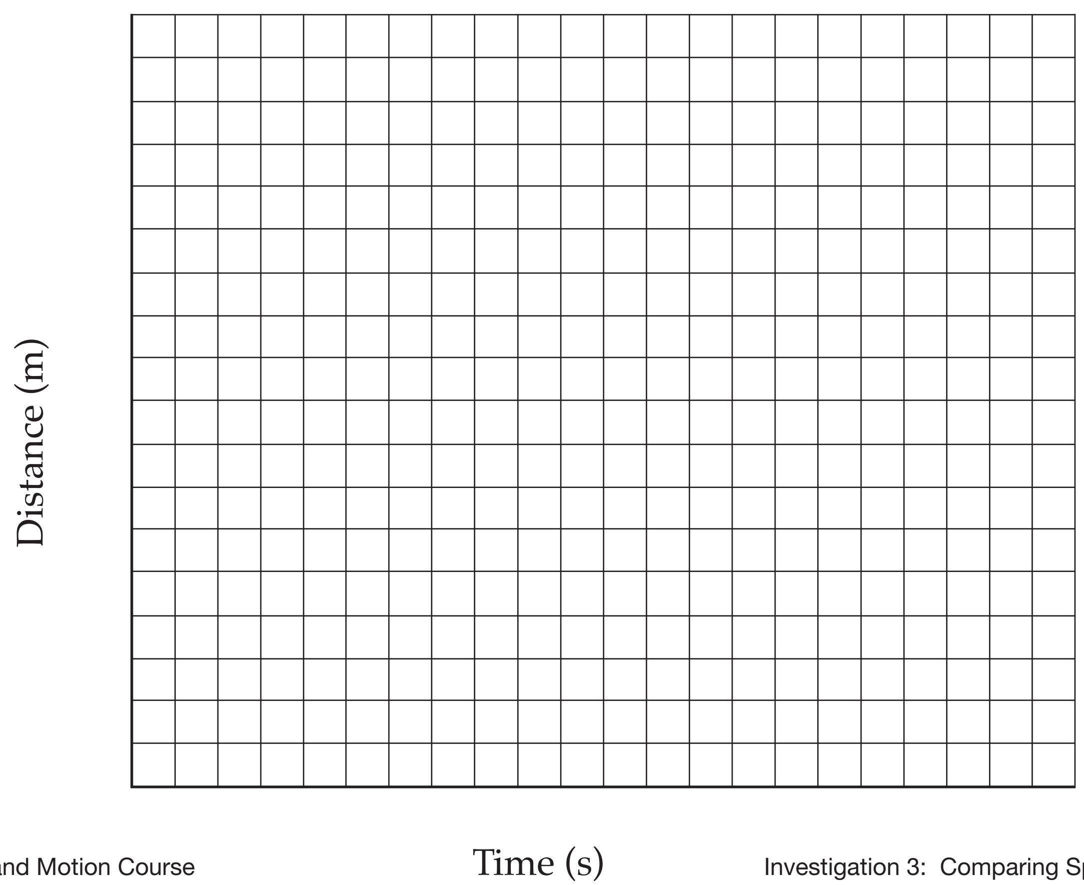
Walker's name	**Δt_1 (s)**	**Δt_2 (s)**	**Δt_3 (s)**	**Δt_{av} (s)**	***d*** **(m)**

Runner's name	**Δt_1 (s)**	**Δt_2 (s)**	**Δt_3 (s)**	**Δt_{av} (s)**	***d*** **(m)**

d. Calculate the **average time** for the walker and for the runner.

e. Calculate the **average speed** for the walker and the runner. Show your math.

f. Graph the average walking speed and the average running speed on this grid.



Name ______________________

Period __________ Date ______________

WALK/RUN RACES

Your walker and your runner will have a race. These are the objective and rules.

Objective: The walker and runner should cross the finish line at the same time.

Rules

- The race distance is 20 meters.
- The walker and runner must maintain constant speed. Don't slow down or speed up.
- You can use a **time** head start or a **distance** head start to achieve your objective.

20-meter race

Walker's name	Starting position	Starting time	Δt (s)	d (m)

Runner's name	Starting position	Starting time	Δt (s)	d (m)

10-meter race (optional)

Walker's name	Starting position	Starting time	Δt (s)	d (m)

Runner's name	Starting position	Starting time	Δt (s)	d (m)

40-meter race (optional)

Walker's name	Starting position	Starting time	Δt (s)	d (m)

Runner's name	Starting position	Starting time	Δt (s)	d (m)

Name ______________________________

Period ____________ Date ________________

PHOTO FINISH RESULTS

Record your results of three Photo Finish computer races.

Before the race	Runner 1	Runner 2
Name		
Average speed		
Who had a head start?		
Race results	**You said**	**Math said**
Short race head start		
Time to finish short race		
Long race head start		
Time to finish long race		

Before the race	Runner 1	Runner 2
Name		
Average speed		
Who had a head start?		
Race results	**You said**	**Math said**
Short race head start		
Time to finish short race		
Long race head start		
Time to finish long race		

Before the race	Runner 1	Runner 2
Name		
Average speed		
Who had a head start?		
Race results	**You said**	**Math said**
Short race head start		
Time to finish short race		
Long race head start		
Time to finish long race		

Name ______________________________

Period ____________ Date ______________

BOAT SPEED

Four friends met at the park to run their boats. They decided to find out how fast each boat could go. They collected the distance and time data shown in the table.

Boat	Δt (s)	d (m)
Mango	90	150
Perky	100	100
Whisper	30	150
Tornado	60	120

Use the graphing program or the graph on page 31 to graph the speed of all four boats on one graph. Then answer the questions.

1. List the boats from fastest to slowest.

   (1) ____________ (2) ____________ (3) ____________ (4) ____________

2. How far will each boat travel in 5 minutes?

   (M) ____________ (P) ____________ (W) ____________ (T) ____________

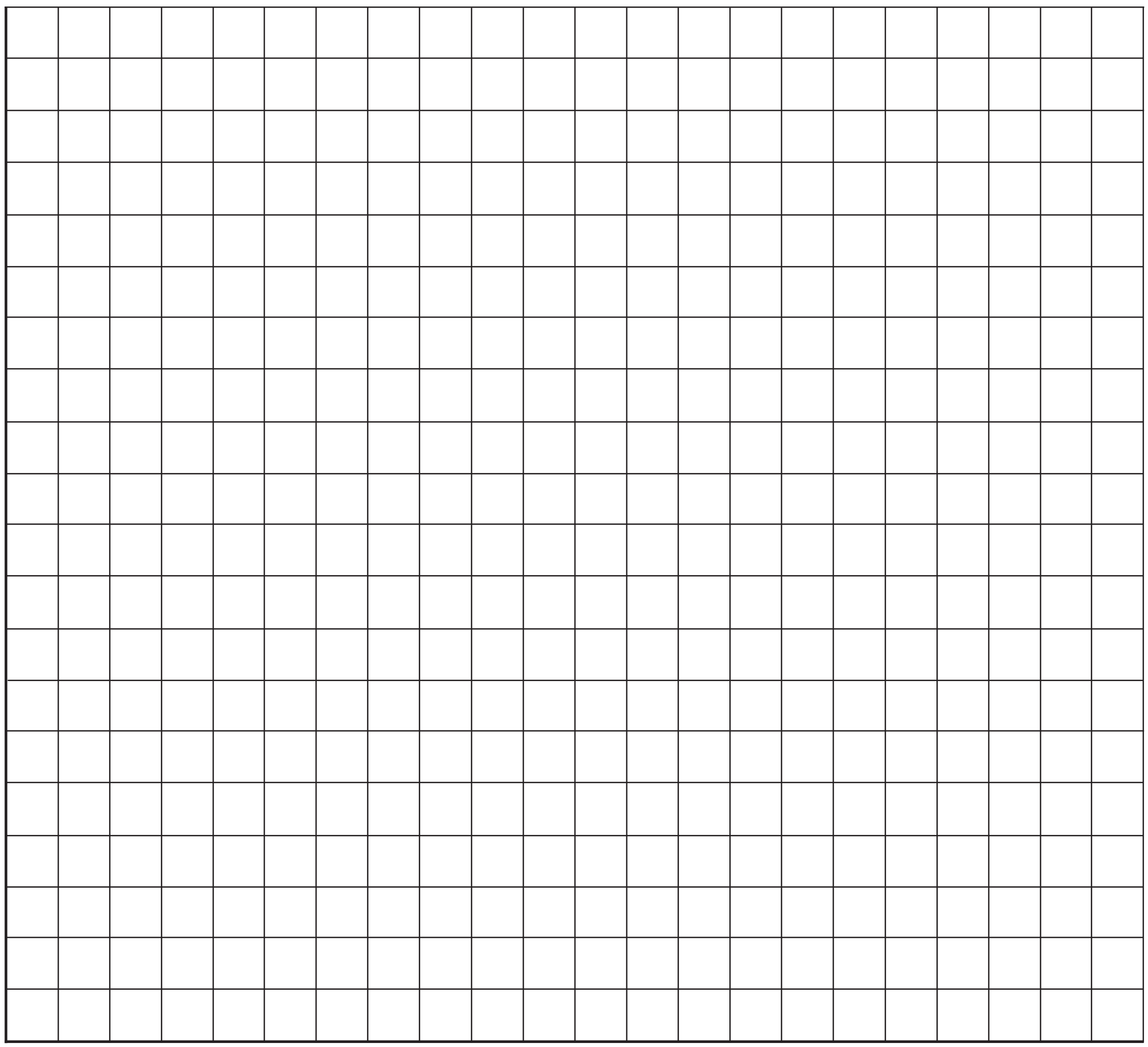
3. (Extra credit) At what time should each boat start so all the boats will cross the finish line at 100 meters at the same time?

Boat	Starting time
Mango	
Perky	
Whisper	
Tornado	

Name ______________________________

Period ____________ Date ________________

BOAT-SPEED GRAPHS



Name ______________________________

Period ____________ Date ________________

RESPONSE SHEET—COMPARING SPEEDS

Bert and Gaston each chose a snail that he thought might be the fastest. They each timed their snail and got the data on the right. They shared data and each reached a conclusion.

Snail	**Distance**	**Time**
Bert	12 cm	40 s
Gaston	15 cm	1 min.

Bert said,

I calculated the speed, and Gaston's snail is faster.

Gaston said,

Yes, mine is faster. The graph proves it. The line is longer.

Look at the boys' work and write comments below.

Bert's work

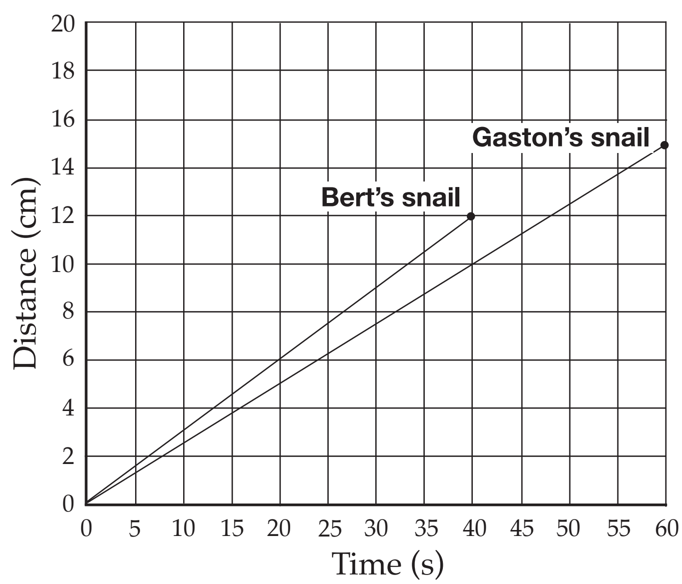
Bert's snail

$$v = \frac{d}{\Delta t} = \frac{12}{40} = 0.3 \text{ cm/s}$$

Gaston's snail

$$v = \frac{d}{\Delta t} = \frac{15}{1} = 15 \text{ cm/s}$$

Gaston's work



____

____

____

____

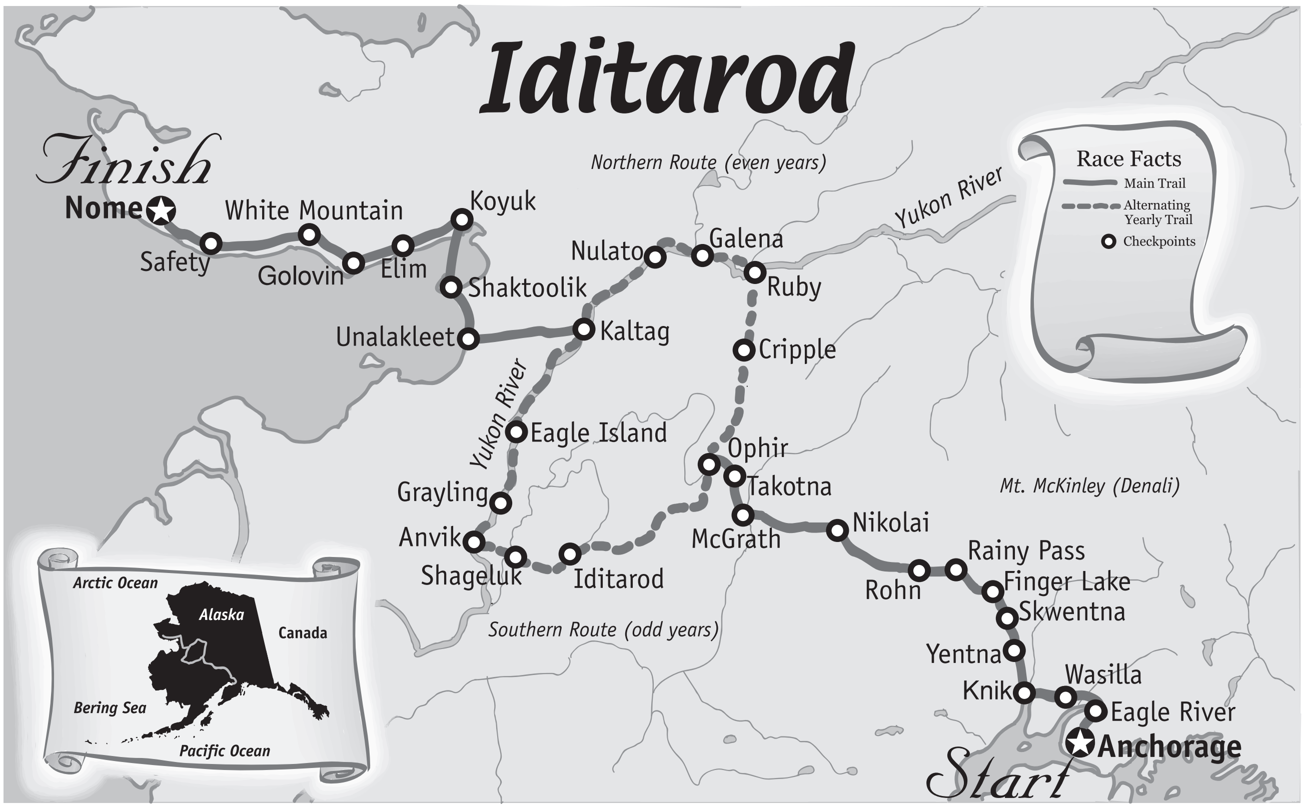
____

____

Name ______________________

Period __________ Date ______________

IDITAROD



The Iditarod is a dog-sled race run each year in March. The mushers start in Anchorage, Alaska, and race to Nome. The distance is about 1800 kilometers (1125 miles).

In 1986 Susan Butcher won the race. Her record-breaking time was 11 days and 15 hours.

At each checkpoint the dogs were fed, rested, and examined by a vet. This took an average of 3 hours at each checkpoint. In addition, each team was required to make one 24-hour stop at one of the checkpoints, and two 8-hour stops at two other checkpoints.

1. What was the average speed of the dog team from start to finish?

2. What was the average speed of the dog team while it was actually on the trail?

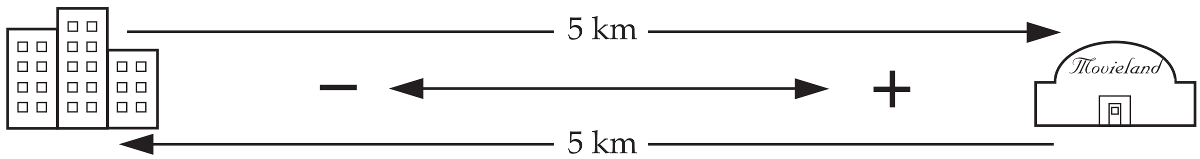
Name ____________________

Period __________ Date __________

SHOW TIME A

Sue Ellen and Josie went to the show Saturday afternoon. Josie's mom drove them the 5 kilometers to the show. The ride took 10 minutes.

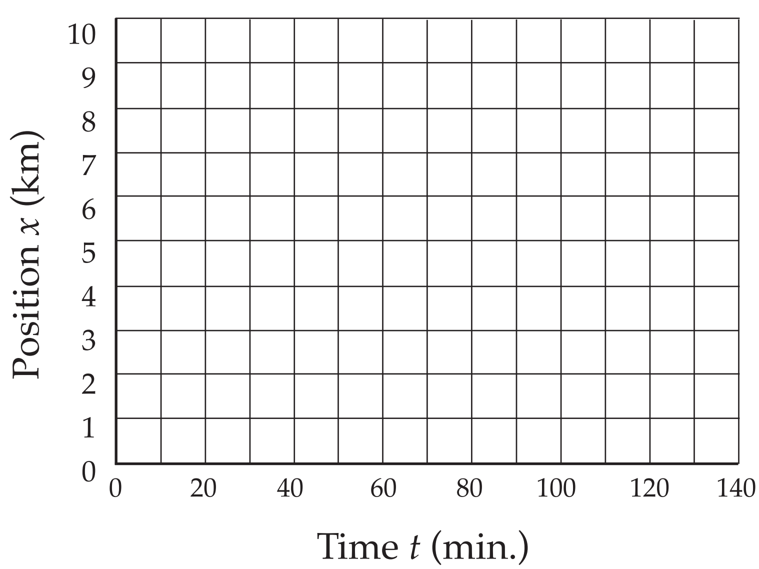
The movie, *The Lizard Queen,* lasted 1 hour and 20 minutes. The girls then jogged home. It took them 40 minutes.



Leg	Time at end of leg t (min.)	Position at end of leg x (km)	Time interval during leg Δt (min.)	Displacement during leg Δx (km)	Total distance of travel d (km)
0	0	0			

a. Make a position graph that represents the girls' outing.

____

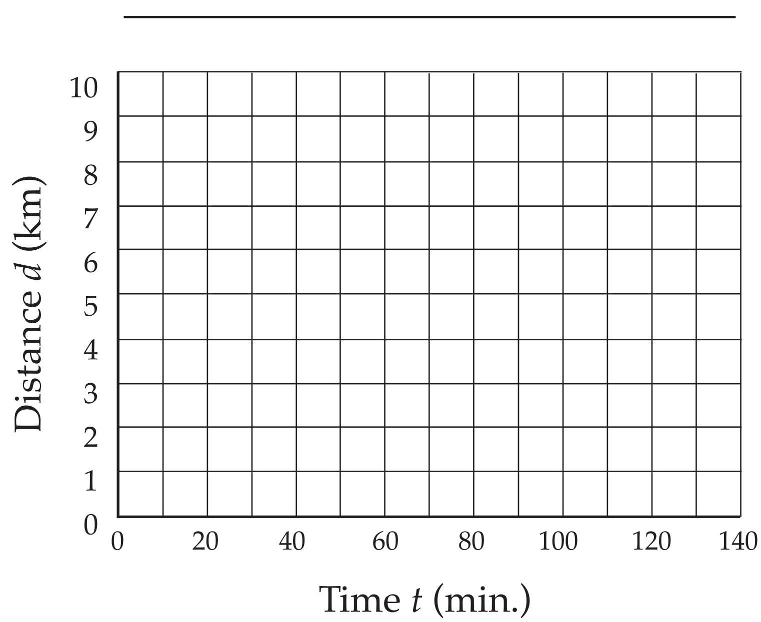


Name ______________________

Period ________ Date ____________

SHOW TIME B

b. Make a distance graph that represents the girls' outing.



c. What was the average speed for leg 1 of the trip? Show your math.

d. What was the average speed for leg 2 of the trip? Show your math.

e. What was the average speed for the whole outing? Show your math.

Name ____________________

Period __________ Date __________

CLANCEY'S AFTERNOON A

It took Clancey 10 minutes to ride his skateboard 2 kilometers down the hill to Richie's house.

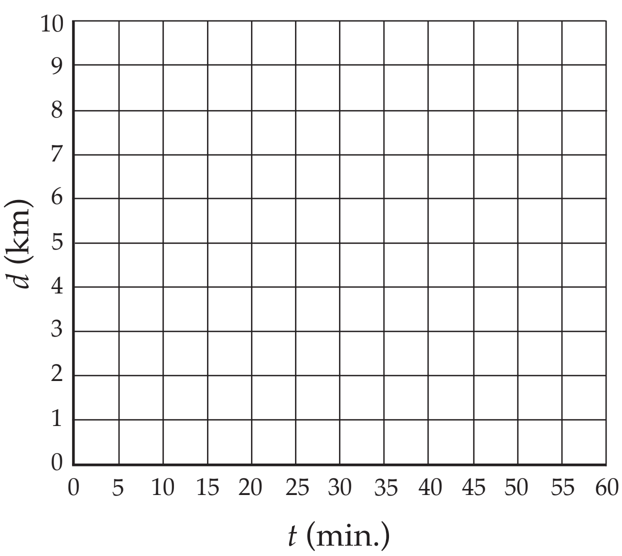
They played Claw on the computer for 20 minutes.

It took Clancey 20 minutes to walk back home up the hill.

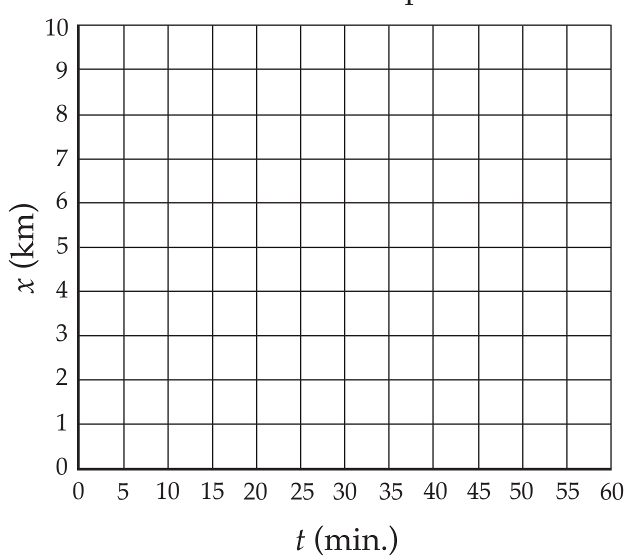
Make a data table and two graphs to show Clancey's movement.

Leg	t (min.)	x (km)	Δt (min.)	Δx (km)	d (km)
0	0	0			0

Distance Graph



Position Graph



Name ______________________

Period ____________ Date ______________

CLANCEY'S AFTERNOON B

1. What was Clancey's speed going to Richie's house?
   (Write the equation and show your math.)

2. What was Clancey's speed coming home from Richie's house?

3. What was Clancey's average speed for the whole outing?

4. What was Clancey's average speed while he was on the move?

Name ______________________________

Period ____________ Date ____________

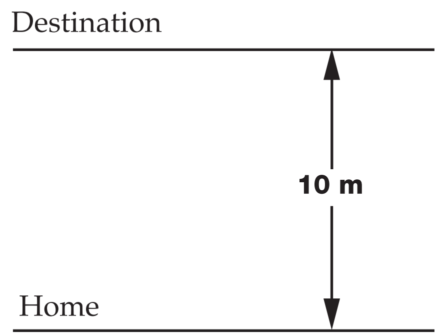
LEISURELY WALKS

Directions

a. Walk together as a team. Two team members, **timer 1** and **timer 2,** will carry stopwatches.

b. Study the instructions for the leisurely walks. Figure out how many legs are in each walk.

c. Decide what timer 1 and timer 2 will time. Walk the walk and record data.



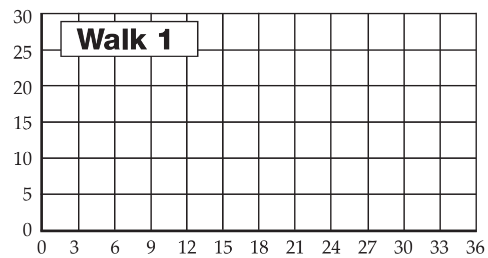
Leisurely Walk 1

Start at home.

Walk to the destination.

Immediately walk back home.

Leg	Δt (s)	Δx (m)	t (s)	x (m)	d (m)
0			0	0	0



Leisurely Walk 2

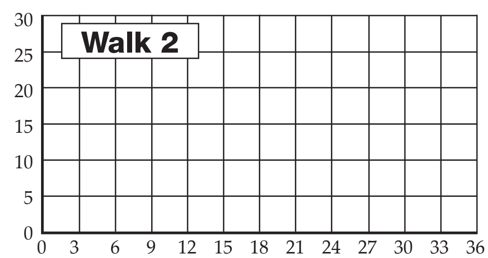
Start at home.

Walk to the destination.

Look at view 15 seconds.

Walk back home.

Leg	Δt (s)	Δx (m)	t (s)	x (m)	d (m)



Leisurely Walk 3

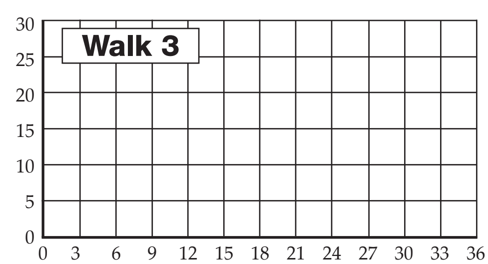
Start at home.

Walk to the destination, turn, walk halfway home.

Stop and rest 10 seconds.

Complete the walk home.

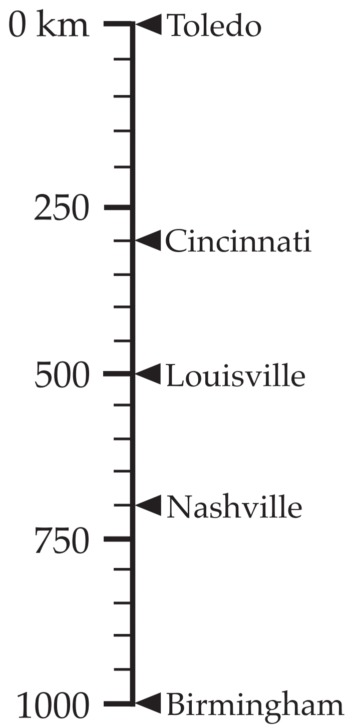
Leg	Δt (s)	Δx (m)	t (s)	x (m)	d (m)



Name ______________________

Period __________ Date __________

ROAD TRIP



Hi Beth, this is Rita. I moved. I left Toledo at 9:00 a.m. on Saturday and drove 700 km. I arrived in Nashville at 7:00 p.m. and spent the night. I arrived in Birmingham Sunday afternoon at 5:00 p.m. I now know it is 1000 km from Toledo to Birmingham.

Actually, Beth, the trip didn't go exactly like that. Sunday morning at 9:00, I realized I left my credit card in Louisville when I stopped for gas. It took me 2 hours to drive back 200 km for it. I was so mad. Then I got on the road and made it to Birmingham.

Leg	Δt (h)	Δx (km)	t (h)	x (km)	d (km)

a. Fill in your data table.

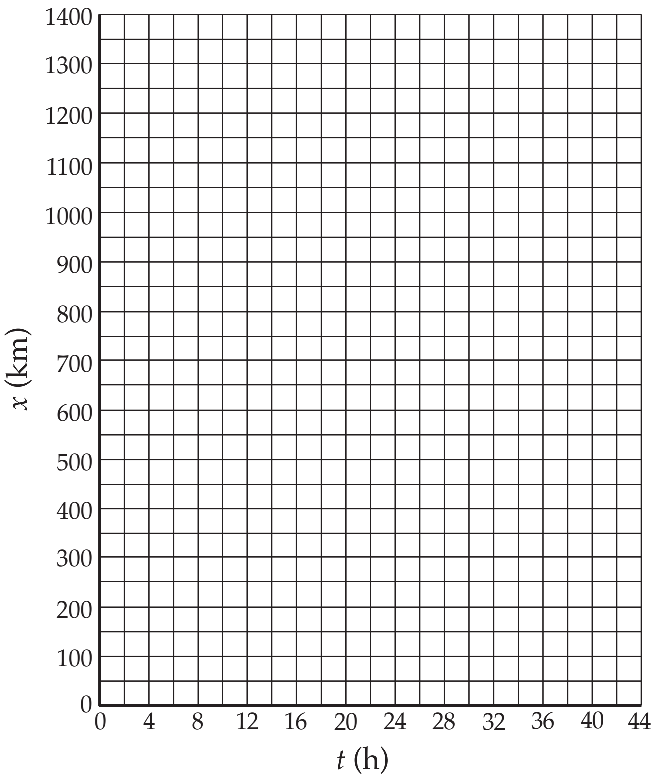
b. Make a position graph of Rita's road trip.

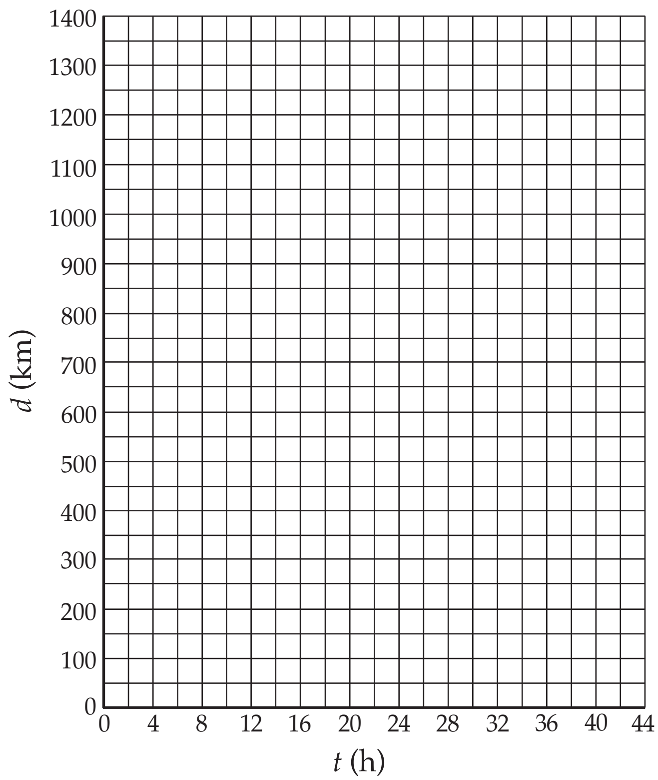
c. Make a distance graph of Rita's road trip.

Name ______________________________

Period ____________ Date ________________

ROAD-TRIP GRAPHS





1. During which leg of the trip was Rita's speed the fastest?

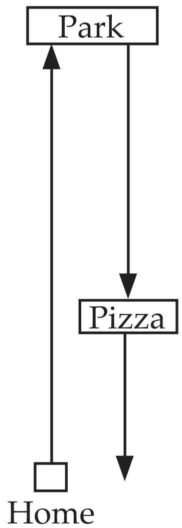
2. What was Rita's average speed on her trip between Toledo and Birmingham?

3. What was Rita's average speed while she was actually driving on the road?

Name ______________________

Period ____________ Date ____________

RESPONSE SHEET—REPRESENTING MOTION



Marybeth and two friends went on a leisurely outing. They walked to the park 1500 meters from Marybeth's house.

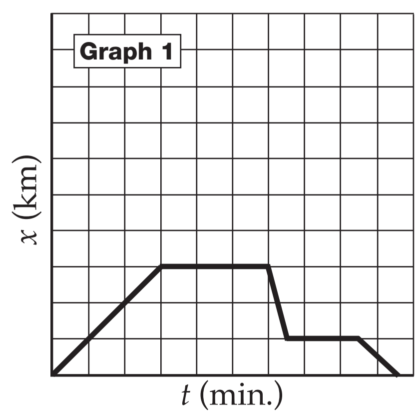
They watched the skateboarders awhile.

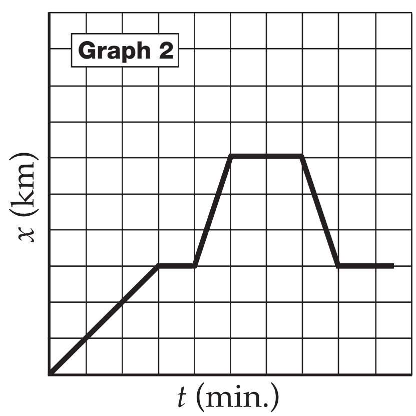
Then they took the bus toward home.

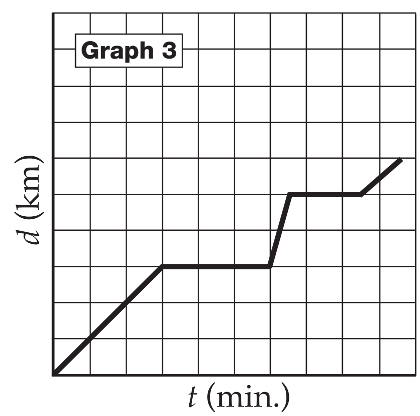
They got off at the pizza shop and shared a pineapple and ham pizza.

They walked the remaining 500 m home.

Marybeth and her two friends made motion graphs of the outing. Which graph or graphs represent Marybeth's movements during the outing?







Explain which graph or graphs represent Marybeth's movements.

____

____

____

____

____

____

____

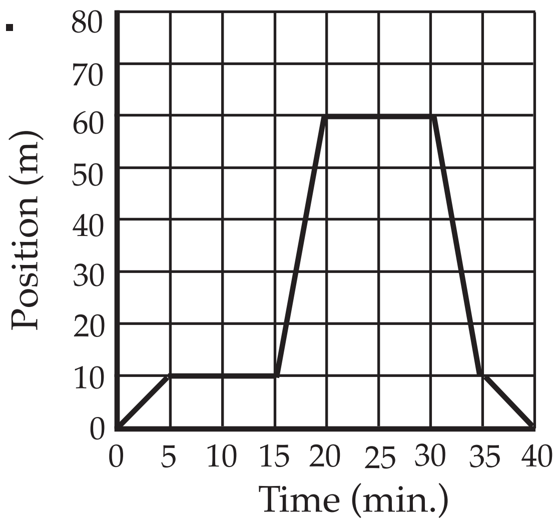
Name

Period Date

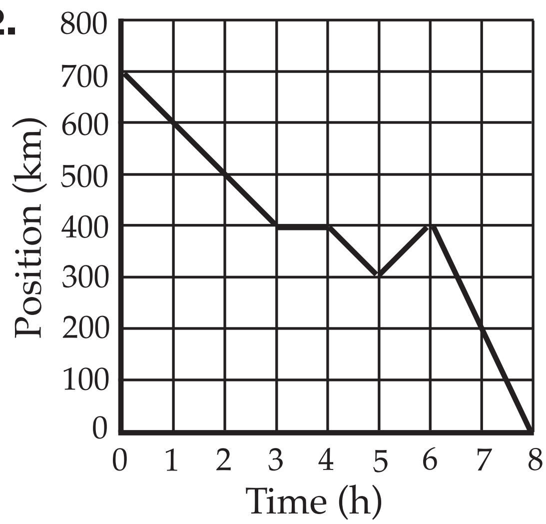
GRAPH A MOTION EVENT

Make up a story to go with each of these motion graphs.

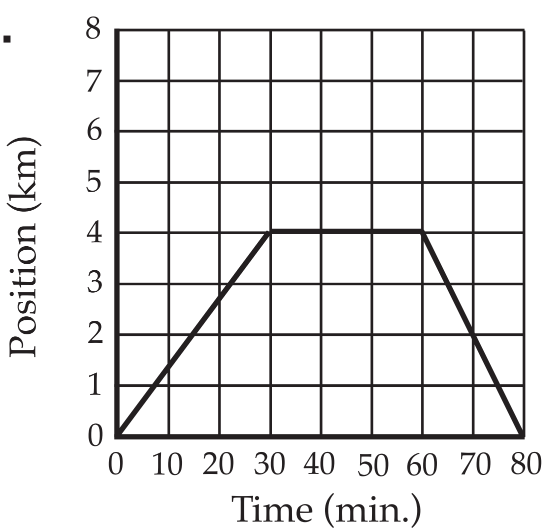
1.



2.



3.



Name ______________________

Period ____________ Date ____________

CREATE A MOTION STORY

Make up a motion story for another student to graph.

Note: Make a graph of your story to make sure you have included enough information to complete the graph.

Story 1

Graph of story 1

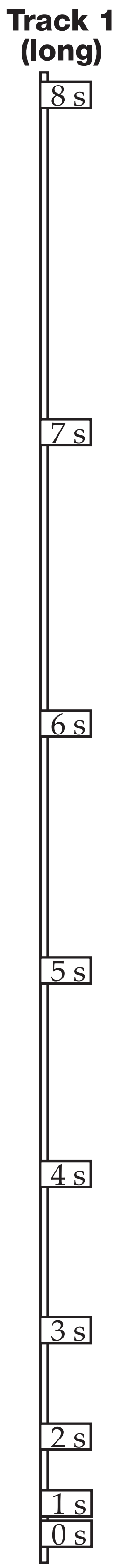
Story 2

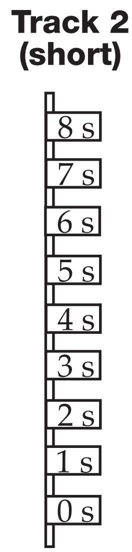
Graph of story 2

Name ______________________________

Period ____________ Date ______________

COMPARING TRACKS A





Walk the length of the long track and the short track.

Walk at a speed that will bring you to each number as it is called out. (The whole walk will take 8 seconds.)

The distance from the start (0 seconds) to each of the numbers is recorded in the data tables. Fill in the rest of both data tables.

Make position-versus-time graphs for both tracks.

1. Compare your positions (x) on the two tracks after 8 seconds.

____

____

____

2. Compare your velocities ($\overline{v}$) as you traveled on the two tracks.

____

____

____

3. Compare your change of velocity ($\Delta\overline{v}$) as you traveled the two tracks.

____

____

____

4. Discuss the difference between constant velocity and acceleration.

____

____

____

Name ______________________

Period ____________ Date ______________

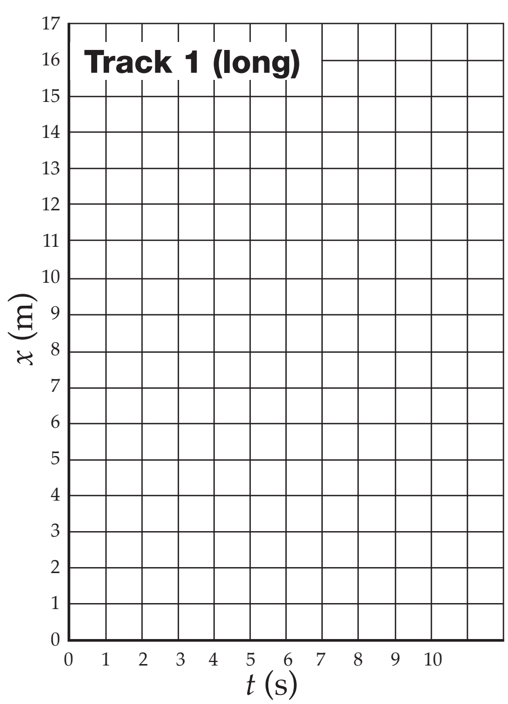
COMPARING TRACKS B

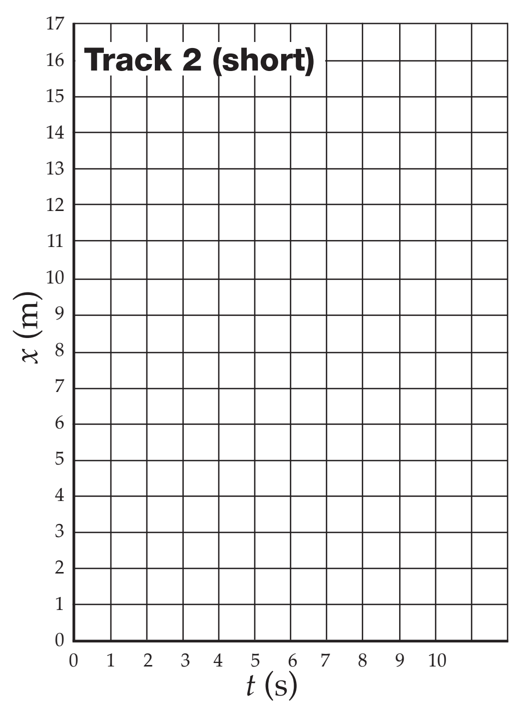
Track 1 (long)

t (s)	x (m)	Δx (m)	Δt (s)	$\overline{v}$ (m/s)	$\Delta\overline{v}$ (m/s)	a (m/s^2)
0	0					
1	0.25					
2	1.0					
3	2.25					
4	4.0					
5	6.25					
6	9.0					
7	12.25					
8	16.0					

Track 2 (short)

t (s)	x (m)	Δx (m)	Δt (s)	$\overline{v}$ (m/s)	$\Delta\overline{v}$ (m/s)	a (m/s^2)
0	0					
1	0.5					
2	1.0					
3	1.5					
4	2.0					
5	2.5					
6	3.0					
7	3.5					
8	4.0					





Name ______________________

Period ____________ Date ____________

ROLLING DOTCAR

1. How often does the Dotcar make a dot?

2. Which slope did your Dotcar run down?

   10 cm 15 cm 20 cm

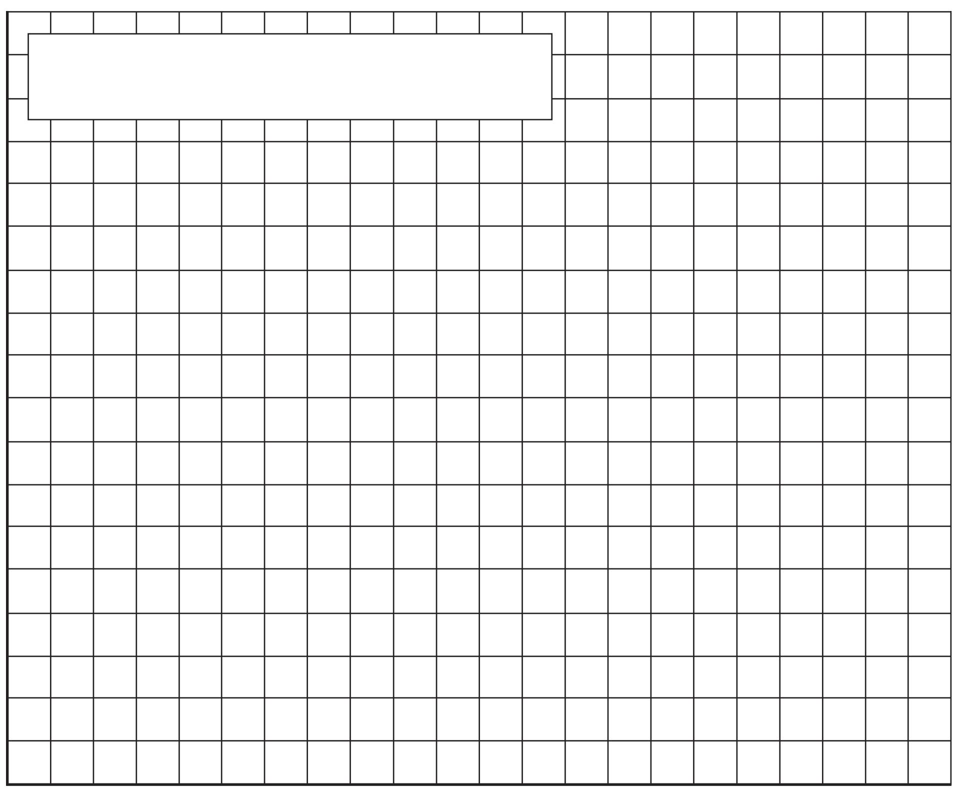
3. Use the dot record on your paper to fill in the first four columns on the data table.

4. Calculate the velocity at the end of each half second.

5. Calculate the average velocity for the run.

6. Make a graph of position versus time.

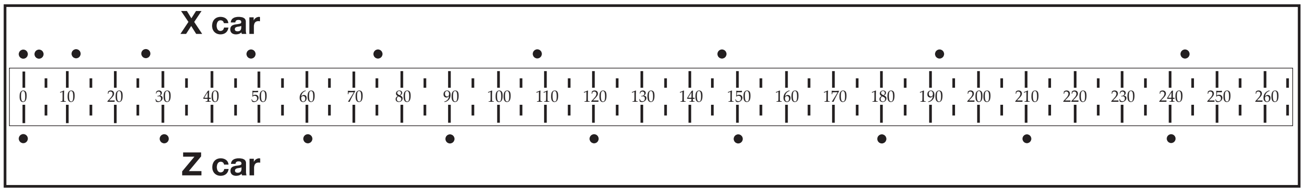
Dot	t (s)	x (cm)	Δx (cm)	Δt (s)	$\overline{v}$ (cm/s)
0	0	0			
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					



Name ____________________

Period __________ Date __________

X CAR AND Z CAR A



Look at the Dotcar data for the X car and the Z car.

The Dotcars made a dot every 0.5 second.

The measuring tape is marked off in centimeters.

Answer the questions below.

1. Which car was moving with positive acceleration? ____________________
2. Which car was moving with negative acceleration? ____________________
3. Which car was moving with constant velocity? ____________________

4. Which car traveled with the greater average velocity for the first 4 seconds? (Show your math.)

5. Which car was going faster at the end of 4 seconds? (Show your math.)

6. At what time will the two cars be the same distance from the start, and how far will they be? (Hint: Make a graph.)

Name ____________________

Period __________ Date __________

X CAR AND Z CAR B

X car

Dot	t (s)	x (cm)	Δx (cm)	Δt (s)	$\bar{v}$ (cm/s)

Z car

Dot	t (s)	x (cm)	Δx (cm)	Δt (s)	$\bar{v}$ (cm/s)

Name ______________________________

Period ____________ Date ________________

DOTMAKER A

Select the movie group called Bike Walk.

a. Choose the movie called **Bike Walk 1.**

b. Play the movie and watch the action. Then press Rewind.

Select walker from the "choose an object" menu.

a. Choose a **reference point** on the yellow-shirted walker, like his nose.

b. Use the cross hairs to place a dot on the reference point.

c. Use the Step button to advance the action five frames (five clicks).

d. Place another dot on the reference point.

e. Continue placing dots on the reference point every five frames.

Select bicyclist from the "choose an object" menu.

a. Click Rewind. Click the Step button until the bike enters the scene.

b. Choose a reference point on the bike and place a dot.

c. Place a dot on the bike's reference point every five frames.

1. Which moving object, the walker or the bicyclist, traveled faster? (Click Hide Movie to see the dots clearly.) ______________________

2. How do you know which object was faster?

____

____

3. Click the Graph Data button, then the Automatic button to see graphs of the two motions. Are the objects traveling at constant velocity or accelerating?

____

4. What additional information is provided by the graphs?

____

____

____

Name ______________________________

Period ____________ Date ______________

DOTMAKER B

Compare additional movies.

You can compare the movement of up to four moving objects in a movie group.

The objects can be in the same movie or in different movies.

You can place dots close together (every frame) or far apart (every ten or more frames).

Comparison 1

I selected these movies: ______________________________

I placed dots every ________frames.

This is what I learned about these moving objects.

____

____

____

Comparison 2

I selected these movies: ______________________________

I placed dots every ________ frames.

This is what I learned about these moving objects.

____

____

____

Comparison 3

I selected these movies: ______________________________

I placed dots every ________ frames.

This is what I learned about these moving objects.

____

____

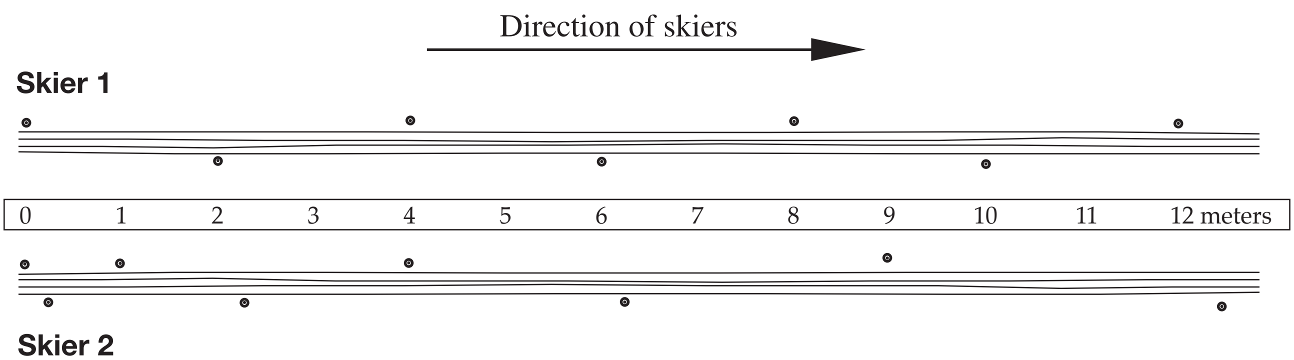
____

Name ______________________

Period __________ Date ______________

RESPONSE SHEET—ACCELERATION

Quinn and Mattie watched two skiers go by on a trail. They noticed that both skiers pushed one ski pole into the snow exactly once per second. They studied the trail after the skiers went past.



Quinn said,

It looks to me like skier 1 was accelerating. He was going fast all the way.

Mattie said,

It looks to me like skier 2 was accelerating. He was going slower at the start.

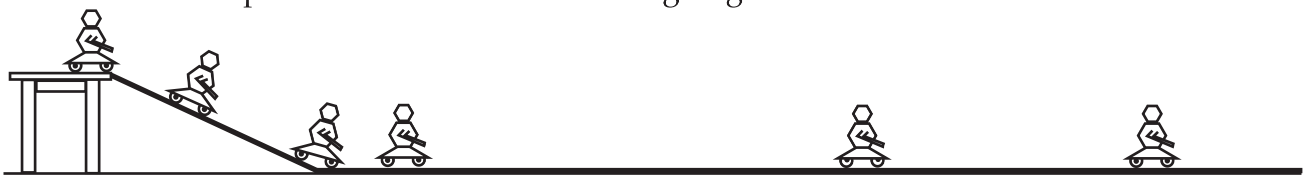
Discuss Quinn's and Mattie's ideas about the skiers.

Name ______________________________

Period ____________ Date ______________

ACCELERATION PRACTICE A

1. A robot rolled down a ramp and across the floor.
   a. Circle the position where the robot was going fastest.



   b. Why do you think it was going fastest at that point?

____

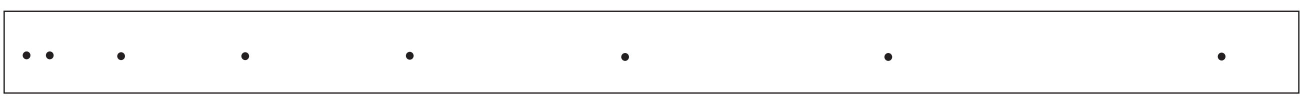
____

____

2. Mr. Bell's students had two Dotcars that made one dot every second. The students made these two runs. Answer the questions below.

Dotcar 1

Dotcar 2



   a. Which Dotcar accelerated in the first 3 seconds? ________________

   b. Which Dotcar accelerated in the last 3 seconds? ________________

   c. Which Dotcar had gone farther after 6 seconds? ________________

   d. Which Dotcar was going faster after 6 seconds? ________________

   e. How do you know it was going faster after 6 seconds?

____

____

____

Name ______________________________

Period ____________ Date ________________

ACCELERATION PRACTICE B

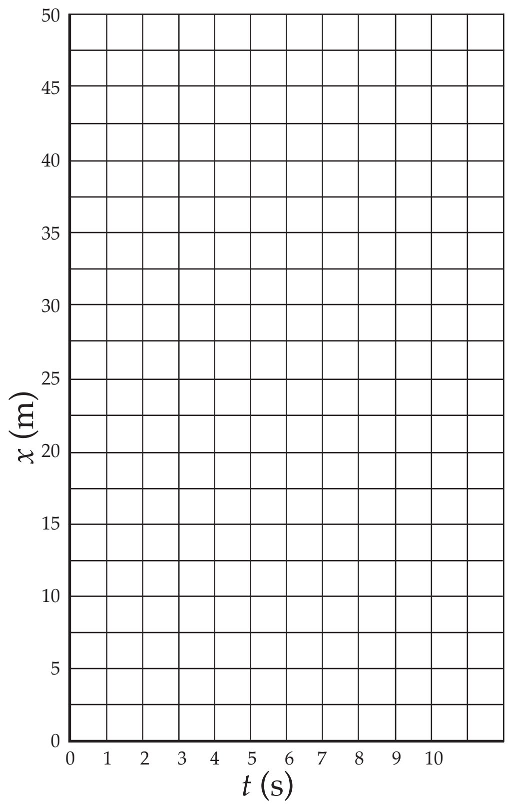
3. Some students observed the motion of a toy car and a toy bus. The data records, however, were incomplete. Graph the car and the bus motion and answer the questions.

Car

t (s)	*x* (cm)
0	0
1	0.5
2	2
3	4.5
4	
5	12.5
6	18
7	
8	32
9	40.5
10	50

Bus

t (s)	*x* (cm)
0	0
1	
2	8
3	12
4	
5	
6	24
7	28
8	
9	36
10	40



a. Was the car traveling at a constant velocity or accelerating? How do you know?

____

____

b. Was the bus traveling at a constant velocity or accelerating? How do you know?

____

____

c. When were the two vehicles going the same velocity?

____

____

Name ______________________

Period __________ Date __________

CARS AND LOADS A

Part 1: Think about loads on cars.

If you add a heavy load to a Dotcar, will it roll down a ramp faster, slower, or at the same velocity as the empty Dotcar on the same ramp? Explain why you think so.

____

____

____

____

Part 2: Gather data and graph results.

Dotcar mass ______________________

Load mass ______________________

Dotcar—no load

t (s)	x (cm)	Δx (cm)	Δt (s)	$\overline{v}$ (cm/s)

Dotcar—with load

t (s)	x (cm)	Δx (cm)	Δt (s)	$\overline{v}$ (cm/s)

Name ____________________

Period __________ Date ______________

CARS AND LOADS B

Part 3: What did you find out about rolling Dotcars from this experiment?

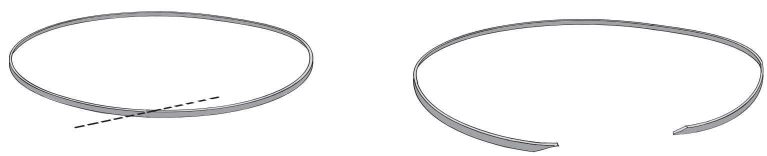
PUSHER ASSEMBLY

Materials

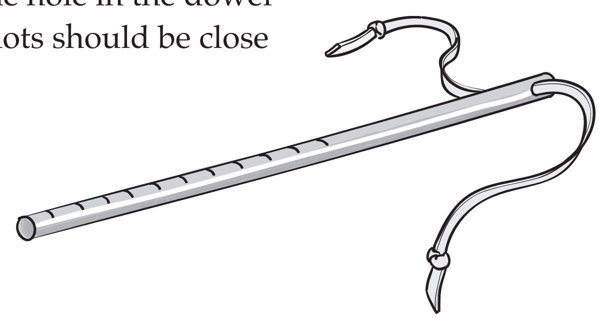
1 Vial and cap with hole
1 Wood dowel, drilled and marked
1 Rubber band
1 Paper slider
1 Scissors

Assembly

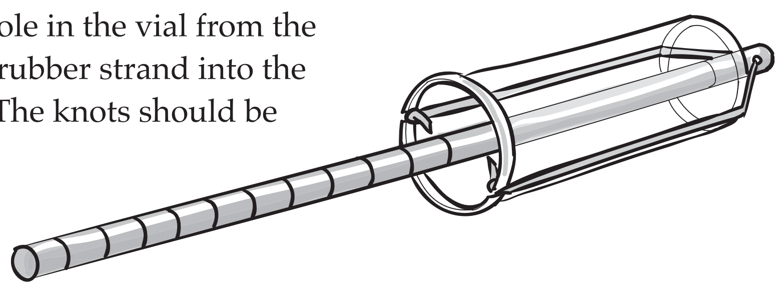
a. Cut the rubber band on an angle to make a rubber strand with pointed ends.



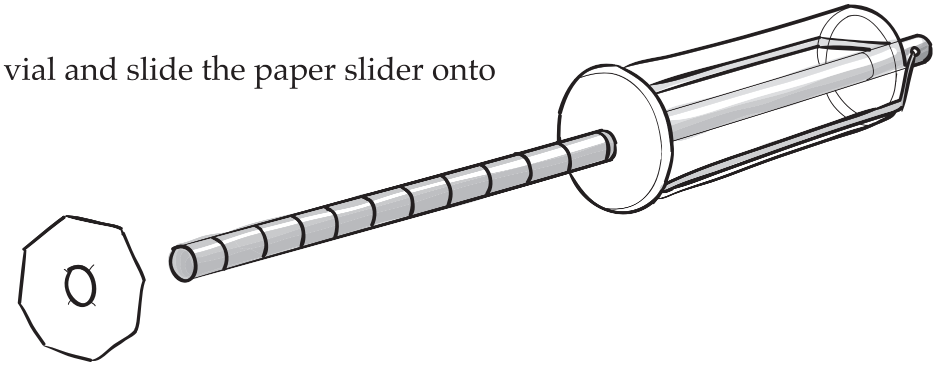
b. Push the rubber strand through the hole in the dowel and tie a knot at each end. The knots should be close to the ends of the strand.



c. Push the dowel through the hole in the vial from the bottom. Push the ends of the rubber strand into the notches in the lip of the vial. The knots should be inside the vial.



d. Snap the cap on the vial and slide the paper slider onto the dowel.



Name ______________________

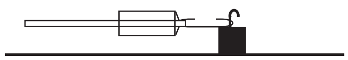
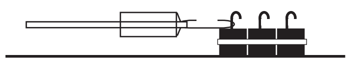
Period __________ Date __________

PUSHES AND PULLS A

Part 1: Pushing and pulling different masses

You will need one pusher and three masses.

1. How much force does it take to **push**		**Three trials**	**Average**
1 mass?		______________	________
3 masses?		______________	________
Predict the force required to push 2 masses.			________
What force was needed to push 2 masses?		______________	________

2. How much force does it take to **pull**		**Three trials**	**Average**
1 mass?		______________	________
3 masses?		______________	________
Predict the force required to pull 2 masses.			________
What force was needed to pull 2 masses?		______________	________

3. What is the relationship between the mass of an object and the force needed to slide it across a surface?

____

____

____

Part 2: Push against push

You will need two pushers.

1. What happens when pusher A and pusher B **both push** with a 4-N force on each other?

Pusher A  **Pusher B**

4 N → ← **4 N**

____

____

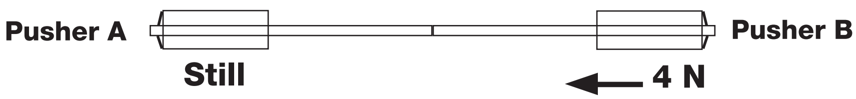
____

Name ____________________

Period __________ Date __________

PUSHES AND PULLS B

2. Hold pusher A **still** and **push** with a 4-N force with pusher B.



   a. What happened to pusher A?

   ____

   ____

   b. Explain why that happened.

   ____

   ____

Part 3: Forces on cars

You will need two pushers and one Dotcar.

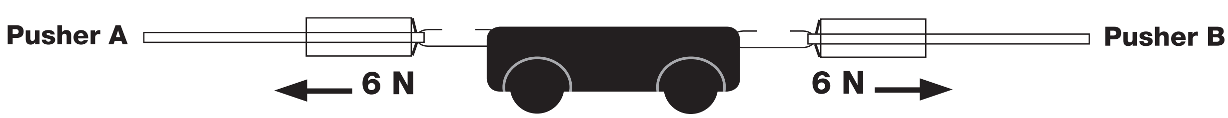
1. What happens when pusher A **pushes** with a 2-N force on one side of the car and pusher B **pushes** with a 3-N force on the other side of the car?

   ____

   ____

   ____

2. What happens when pusher A **pulls** with a 6-N force on one side of the car and pusher B **pulls** with a 6-N force on the opposite side of a car?



   ____

   ____

   ____

Name ______________________

Period ____________ Date ____________

PUSHES AND PULLS C

3. Apply a 2-N **pull** with pusher A and a 2-N **push** with pusher B on the car.

a. Explain what happens to the car when the forces are applied.

____

____

____

b. How could you use one pusher to produce the same result?

____

____

____

4. What causes cars to move?

____

____

____

Name ______________________

Period __________ Date __________

FORCE AND SLEDS

Set up a pulley and load system. Use it to answer the following questions.

1. Use a spring scale to lift a load attached to a string that runs over a pulley. How much force is needed to lift the load? __________

2. How much force is needed to lift the load when you have a sled between the end of the string and the scale? __________

3. How much force is needed to lift the load with 1, 2, 3, and 4 masses on the sled?

Masses on sled	Force (N) to lift the load	Change of force (N)	Force (N) to lift the load using rollers	Change of force (N)
0				
1				
2				
3				
4				

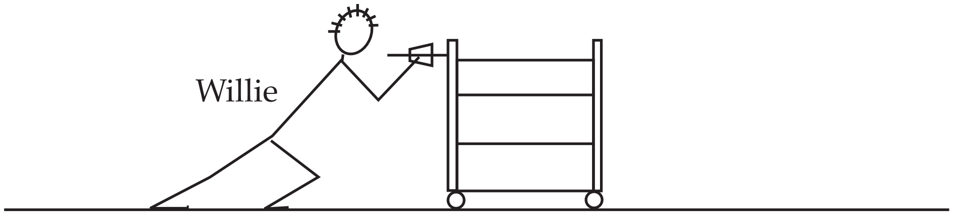
4. How much force is needed to lift the load when straw rollers are placed **under** the sled and 1, 2, 3, and 4 masses are placed **on** the sled?

5. Friction exerts a force to oppose movement. What did you find out about friction?

Name ______________________________

Period ____________ Date ______________

FORCES ON CARTS A

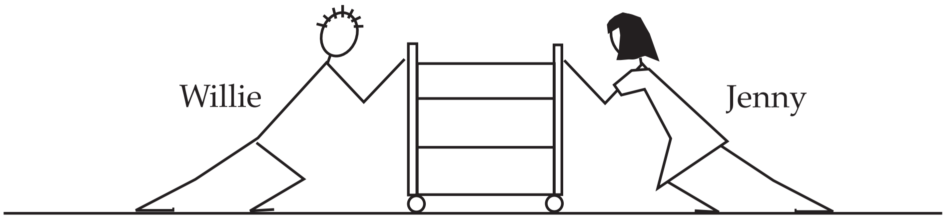


1. Willie's class found that the cart will move when pushed with 50 newtons of force. When Willie pushed on the cart with 10 newtons of force, why didn't the cart move?

____

____

____



2. Willie pushed on the cart with 500 newtons of force. Jenny pushed on the other side of the cart. The cart didn't move. How much force did Jenny apply? ______________

   Why do you think so?

____

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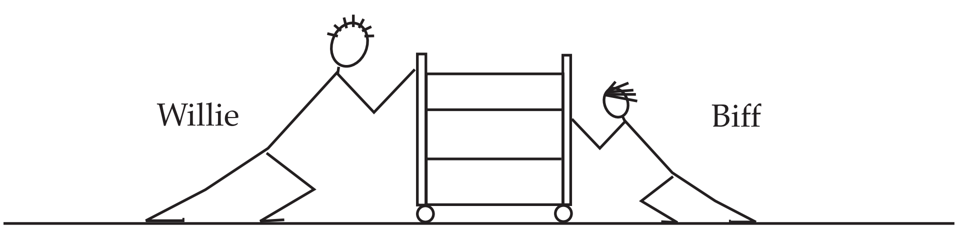

3. Willie and Biff pushed on the cart and it didn't move. Biff pushed with 400 newtons of force. How much force did Willie apply?

____

____

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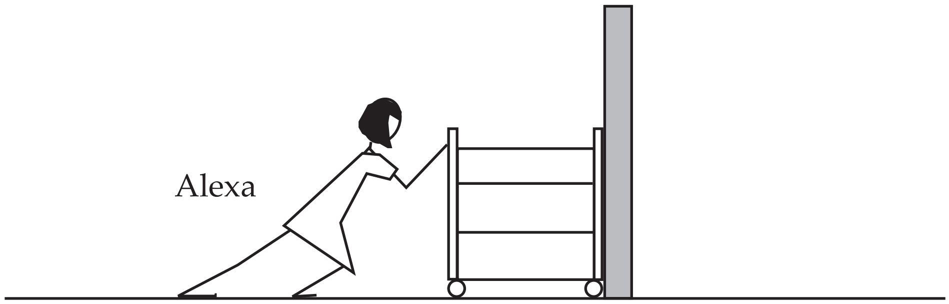
Name ____________________

Period __________ Date __________

FORCES ON CARTS B



4. Alexa pushed on a cart against the wall with 500 newtons of force. The cart didn't move. How do you explain what happened?

____

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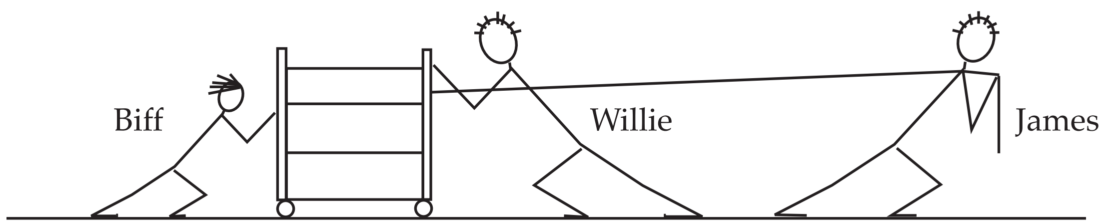

5. Willie pushed on the cart with 1000 newtons of force. James pulled on a rope attached to the cart with 500 newtons of force. Biff pushed on the cart with 400 newtons. What will happen to the cart and why?

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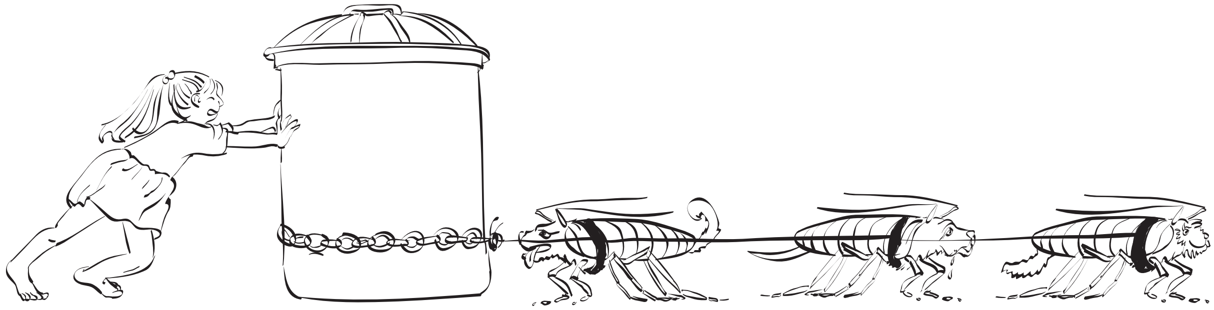
Name ______________________

Period __________ Date ______________

RESPONSE SHEET—FORCE



Gloria wanted to move her compost bin. She hitched her roach-hound team to one side of the bin. She pushed on the other side. She couldn't get it to move. Gloria said,

Billie and I moved that compost bin last week. I thought the hounds and I could move it this week.

How would you expain the two different outcomes to Gloria?

Gloria can push with 500 newtons (N). Billie can push with 200 N. Each hound can pull with 100 N.

Name ______________________

Period __________ Date ______________

FORCE BENCH EXPERIMENTS

The force gizmo can push or pull, depending on which button you push.

○ push
◉ pull

You can decide when to start applying force and when to end the force by putting numbers in the Start and End boxes. When the start time is set to zero, the force starts as soon as you press the Exert button.

start 2
end 4

You can select the number of masses to load on the sled and whether the sled is sliding on a surface with friction or without it.

Force Bench problems

1. Make the sled go slowly for 2 seconds and then speed up with both gizmos pushing.

Left force ____ start ____ end ____ Right force ____ start ____ end ____

2. Make the sled go slowly for 2 seconds and then speed up with one gizmo pushing and one pulling.

Left force ____ start ____ end ____ Right force ____ start ____ end ____

3. Make the sled move off-screen to the right and then return to its starting position.

Left force ____ start ____ end ____ Right force ____ start ____ end ____

4. Make the sled move to the right slowly, pause 3 seconds, and then move off-screen left.

Left force ____ start ____ end ____ Right force ____ start ____ end ____

5. Put three masses on the sled and make the surface frictionless. Exert a force of 5 newtons on the left side of the sled for 2 seconds. Explain what you observe.

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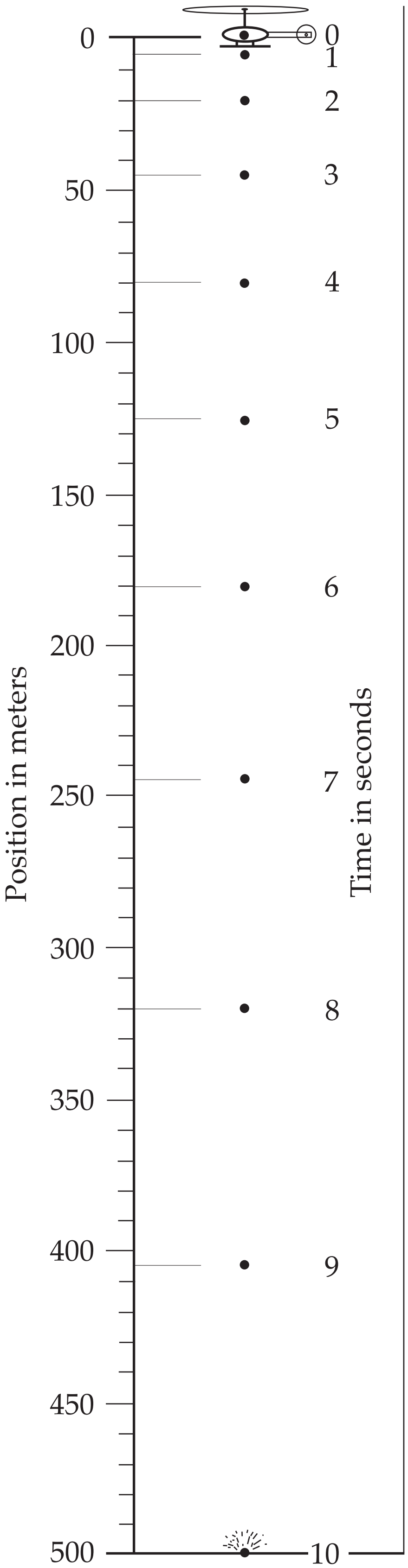
Name ____________________

Period __________ Date __________

LIFE-RAFT DROP A



Ocean rescues sometimes require the Coast Guard to drop life rafts to shipwreck victims. In a recent test a raft was dropped from 500 meters. The drop was videotaped.

When the tape was studied in the lab, the engineers could see that the velocity of the falling raft changed as it fell.

a. Fill in the data table.

b. Make a graph that shows how the **position** of the falling raft changes over time.

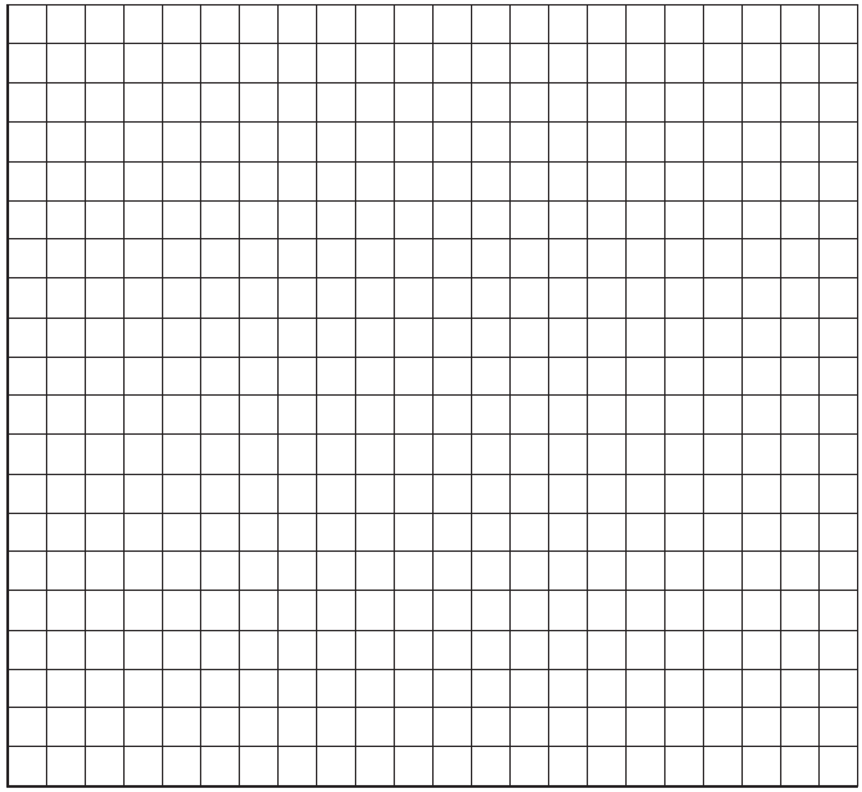
c. Answer the questions.

Time (s) t	Position (m) x_f	Change of position (m) $\Delta x = x_f - x_i$	Average velocity (m/s) $\bar{v} = \Delta x/\Delta t$	Change of velocity (m/s) $\Delta\bar{v} = \bar{v}_f - \bar{v}_i$	Acceleration (m/s^2) $a = \Delta\bar{v}/\Delta t$

Name ______________________

Period ____________ Date ____________

LIFE-RAFT DROP B



1. Did the raft fall at a constant velocity or did it accelerate? How do you know?

____

____

____

2. What was the acceleration of the raft as it fell?

____

3. What caused the raft to stop accelerating?

____

____

____

Name ______________________

Period __________ Date __________

CALCULATING VELOCITY AND DISTANCE

If you know

- an object's **acceleration,** and
- **how long** it has been accelerating,

you can calculate its **velocity** and **distance (or position).**

1. The equation for calculating velocity ($\overline{v}$) is $\overline{v} = a \times t$, where a is acceleration and t is time.

2. The equation for calculating total distance traveled (d) is $d = \frac{a \times t^2}{2}$, or $\frac{1}{2} a t^2$ where a is acceleration and t is time.

Example. A soccer ball was dropped from a window in a tall building. It hit the ground in exactly 3 seconds. How fast was it going when it hit the ground? How far did it fall?

We know the ball is accelerating at 10 m/s^2 (the acceleration due to gravity). Using the velocity equation (1) and a time of 3 seconds, we can make the following calculation:

$\overline{v} = a \times t = 10\text{ m/s}^2 \times 3\text{ s} = 30\text{ m/s}$, the velocity at 3 s, the time it hit the ground.

Using the distance equation (2), we can calculate how high the window was.

$$d = \frac{a \times t^2}{2} = \frac{10\text{ m/s}^2 \times (3\text{ s})^2}{2} = \frac{10\text{ m/s}^2 \times 9\text{ s}^2}{2} = \frac{90\text{ m}}{2} = 45\text{ m}$$

Name ______________________________

Period ____________ Date ________________

VELOCITY AND DISTANCE PRACTICE

1. A jet airplane taxied down the runway at a constant acceleration of 3 m/s^2. It lifted off 30 seconds after starting its taxi. How fast was the plane going when it left the ground, and how far down the runway had it gone? (To convert meters per second into kilometers per hour: $km/h = m/s \times 3.6$.)

2. A bowling ball started rolling down a long, gentle slope at constant acceleration of 10 cm/s^2. How fast would it be going after 2 minutes and how far down the slope would it be?

3. It takes a parachute 4 seconds to open. What is the lowest platform a sky diver could safely jump from? How fast would she be going just as the chute opens?

4. A soccer player kicked a ball straight up in the air. It hit the ground exactly 5 seconds after the ball left the kicker's foot. How high did the ball go and how fast was it traveling when it hit the ground? (Hint: The upward and downward parts of the ball's flight take exactly the same amount of time.)

5. Jack made an air trolley powered by a balloon. The trolley can accelerate at a constant acceleration of 2 m/s^2 for 2 seconds. How far does the trolley go before the air runs out? If Jack got a larger balloon that could accelerate the balloon twice as long, how far would the trolley go before running out of air?

6. How long would it take a free-falling sky diver to reach a velocity of 180 km/h? How far would he fall before reaching that velocity?

Name ______________________________

Period ____________ Date ________________

RESPONSE SHEET—GRAVITY

Donna said,

I think a falling apple would accelerate more slowly on the Moon than on Earth because the force of gravity is less.

Anita said,

I think a falling apple would accelerate faster on the Moon than on Earth because there is no air on the Moon.

Who do you think has a better idea? Explain your reasons.

Name ______________________

Period ________ Date ____________

TESTING GALILEO'S RULE

a. Look at your Dotcar data. Divide it into four to seven equal time intervals. Note: Time intervals on steep ramps might be two- or three-tenths of a second long. Time intervals on low ramps might be five-tenths of a second. Write your time interval here.

Time interval ______________________

b. Fill in the x column on the table. This is **Dotcar's position compared to the start position (x = 0),** not change of position during each time interval.

c. Calculate the Δx column on the table. This ***is*** the change of position during each time interval.

d. Fill in the theoretical change of position column by multiplying your first Δx by the number in the column.

e. Compare your experimental Δx values to the theoretical Δx values.

Time interval	Position x (cm)	Change of position Δx (cm)	Theoretical change of position Δx (cm)
1			1 × =
2			3 × =
3			5 × =
4			7 × =
5			9 × =
6			11 × =
7			13 × =

Name ______________________________

Period ____________ Date ________________

RUNAWAY FLOAT A

Materials

1 Float (Dotcar)

1 Ramp and surface

• Ramp prop

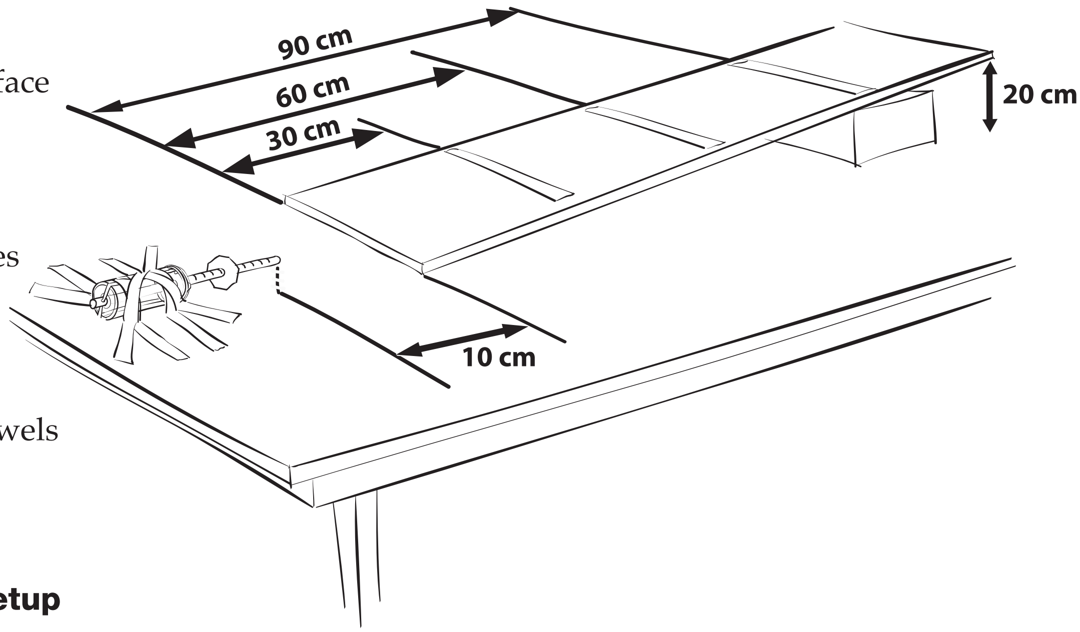
1 Pusher

2 Washer bundles

1 Meter tape

• Masking tape

• Sweaters or towels



Experimental Setup

a. Set up a ramp with one end raised 20 cm. Attach the plastic ramp surface to the board. Tape down the bottom of the ramp.

b. Tape the pusher to the table so that the end of the dowel is 10 cm from the end of the ramp. Make sure the tape doesn't touch the rubber band on the pusher.

c. Use tape to mark 30 cm, 60 cm, and 90 cm from the bottom edge of the ramp.

d. Use sweaters or towels to set up a soft wall around the pusher to capture stray floats.

Procedure

a. Zero your pusher.

b. Position the float facing downhill with its front bumper right on the 30-cm line.

c. Aim for the pusher dowel and release the float.

d. Record the force data.

e. Repeat the process with the float at 60 cm and 90 cm.

f. Repeat steps a–e with one washer bundle on board.

g. Repeat steps a–e with two washer bundles on board.

Name ______________________

Period __________ Date __________

RUNAWAY FLOAT B

1. Which floats were traveling with the greatest velocity at the time of impact? How do you know?

____

____

____

2. Which floats were most massive at the time of impact? How do you know?

____

____

____

____

Float	Distance (cm)	Force to stop the float (N)
NO added mass	40 cm	
	70 cm	
	100 cm	
ONE added mass	40 cm	
	70 cm	
	100 cm	
TWO added masses	40 cm	
	70 cm	
	100 cm	

3. What effect does velocity just before impact have on the force needed to stop the float?

____

____

____

4. What effect does mass have on the force needed to stop the float?

____

____

____

5. Could a 1000-kg car stop a 4000-kg dump truck if they crashed head-on? Explain.

____

____

____

____

Name ______________________________

Period ____________ Date ______________

FLOAT MOMENTUM A

a. Set up a ramp with one end elevated 20 centimeters (cm). Tape a pusher 10 cm from the bottom of the ramp.

b. Plan to collect data on your electronic Dotcar for one float condition—one mass and one distance from starting point to the pusher.

c. Run your float into the pusher. Write your position data in the *x* column. Fill in the other columns of the table to determine the velocity of your float at the time of impact.

Float mass ________

Distance from starting point to pusher ________

t (s)	x (cm)	Δx (cm)	$\bar{v}$ (cm/s)	$\Delta \bar{v}$ (cm/s)	a (cm/s^2)
0.0					
0.1					
0.2					
0.3					
0.4					
0.5					
0.6					
0.7					
0.8					
0.9					
1.0					
1.1					
1.2					
1.3					
1.4					
1.5					
1.6					

Name ______________________

Period __________ Date __________

FLOAT MOMENTUM B

Float	Distance from pusher (cm)	Mass (g)	Velocity at impact (cm/s)	Momentum (*p*) (g-cm/s)
NO added mass	100	~130		
	70	~130		
	40	~130		
ONE added mass	100	~190		
	70	~190		
	40	~190		
TWO added masses	100	~250		
	70	~250		
	40	~250		

1. What is the relationship between an object's mass and its momentum? How do you know?

2. What is the relationship between an object's velocity and its momentum. How do you know?

3. In a head-on collision, how fast would a 1000-kg car have to be going to stop the motion of a 4000-kg truck traveling at 20 km/h?

Name ______________________

Period __________ Date ______________

CAR CRASHES

1. Why did the crash dummy fall off the back of the truck when the truck drove off?

2. What do seat belts do for passengers during a car crash?

3. What two factors affect a vehicle's momentum?

4. What happens to a vehicle's momentum when it crashes into a wall?

5. What is a crumple zone, and what advantage does it provide passengers in a crash?

6. What causes injury and death when people are in car crashes?

Name ______________________________

Period ____________ Date ________________

RESPONSE SHEET—MOMENTUM

If you drop an egg on the floor from a height of 2 meters, it will break. How can you drop that egg to prevent it from breaking?

Cindy said,

Drop it on a pillow. That will change the egg's inertia when it lands. Too much inertia makes the egg break.

Perry said,

Wrap it in foam rubber. That will extend the time that force is applied to the egg as it lands. Too much force makes the egg break.

Lily said,

Put air bags on it. That will give the egg less momentum as it falls. Too much momentum makes the egg break.

Comment on the students' ideas and their explanations for why the egg breaks.

EQUATIONS

Equation for calculating distance (d) when initial and final positions are known $$d = x_f - x_i$$ x_i = initial position x_f = final position	Equation for calculating speed (v) when distance and time are known $$v = \frac{d}{\Delta t}$$ d = distance Δt = change of time
Equation for calculating distance (d) when speed and time are known $$d = v \times \Delta t$$ v = speed Δt = change of time	Equation for calculating time (t) when speed and distance are known $$\Delta t = \frac{d}{v}$$ d = distance v = speed
Equation for calculating acceleration (a) when change of velocity and time are known $$a = \frac{\Delta \overline{v}}{\Delta t}$$ $\Delta \overline{v}$ = change of velocity Δt = change of time	Equation for calculating velocity ($\overline{v}$) when acceleration and time are known $$\overline{v} = a \times t$$ a = acceleration t = time Equation for calculating velocity ($\overline{v}$) when change of position and time are known $$\overline{v} = \frac{\Delta x}{\Delta t}$$ Δx = change of position Δt = change of time
Equation for calculating distance (d) when acceleration and time are known $$d = \frac{a \times t^2}{2}$$ a = acceleration t = time	Equation for calculating momentum (p) when mass and velocity are known $$p = m \times \overline{v}$$ m = mass $\overline{v}$ = velocity

NOTES

NOTES