Measuring constant velocity lab answers

Tevin
Josh

Lab 2
Linear Kinematics

This lab will consist of two parts: (A) constructing your running profile, and (B) measuring your running velocity from a standing start.

A. Running Profile

Average running velocity is dependent upon the average length of each step (step length) and the number of steps taken during a given time (step rate). In the equation form, the relationship is expressed as:

$$V = SL \times SR$$

If any two of these variables are known, the third can be calculated.

Procedure

Work in groups of four to collect the data. One person will run, a second will count the steps, and the remaining two will time the trials. The average time will be used. Runs will be performed at 4 speeds: slow, medium, fast, and maximum. A run up distance will be allowed so that a constant velocity can be reached throughout the trials. Time and number of steps in the run up zone do not need to be measured.

Data collection (8 points)

Record your times and number of steps in the following table. Calculate velocity according to both equations.

(1)V = D/t (2)V = SL x SR

D/steps 19/8.95

Speed	Distance	Time	# Steps	Velocity (1)	Step Length	Step Rate	Velocity (2)
Slow	20m	8.95s	19	2.23 m/s	1.05 m/step	2.13 step/s	2.24 m/s
Medium	20m	5.37s	14	3.72 m/s	1.43 m/step	2.61 step/s	3.73 m/s
Fast	20m	4.50s	12	4.44 m/s	1.67 m/step	2.67 step/s	4.46 m/s
Maximum	20m	3.45s	10	5.79 m/s	2 m/step	2.90 step/s	5.8 m/s

Step rate = # steps / Time

LABORATORY EXERCISE

FIVE

INTRODUCTION: (projectile motion)

In this exercise we will be investigating the motion of a steel ball as it rolls down a ramp and onto the floor. We have studied the equations for constant acceleration and we need to make use of them here. Our goal is to use these equations to predict the range of the steel ball.

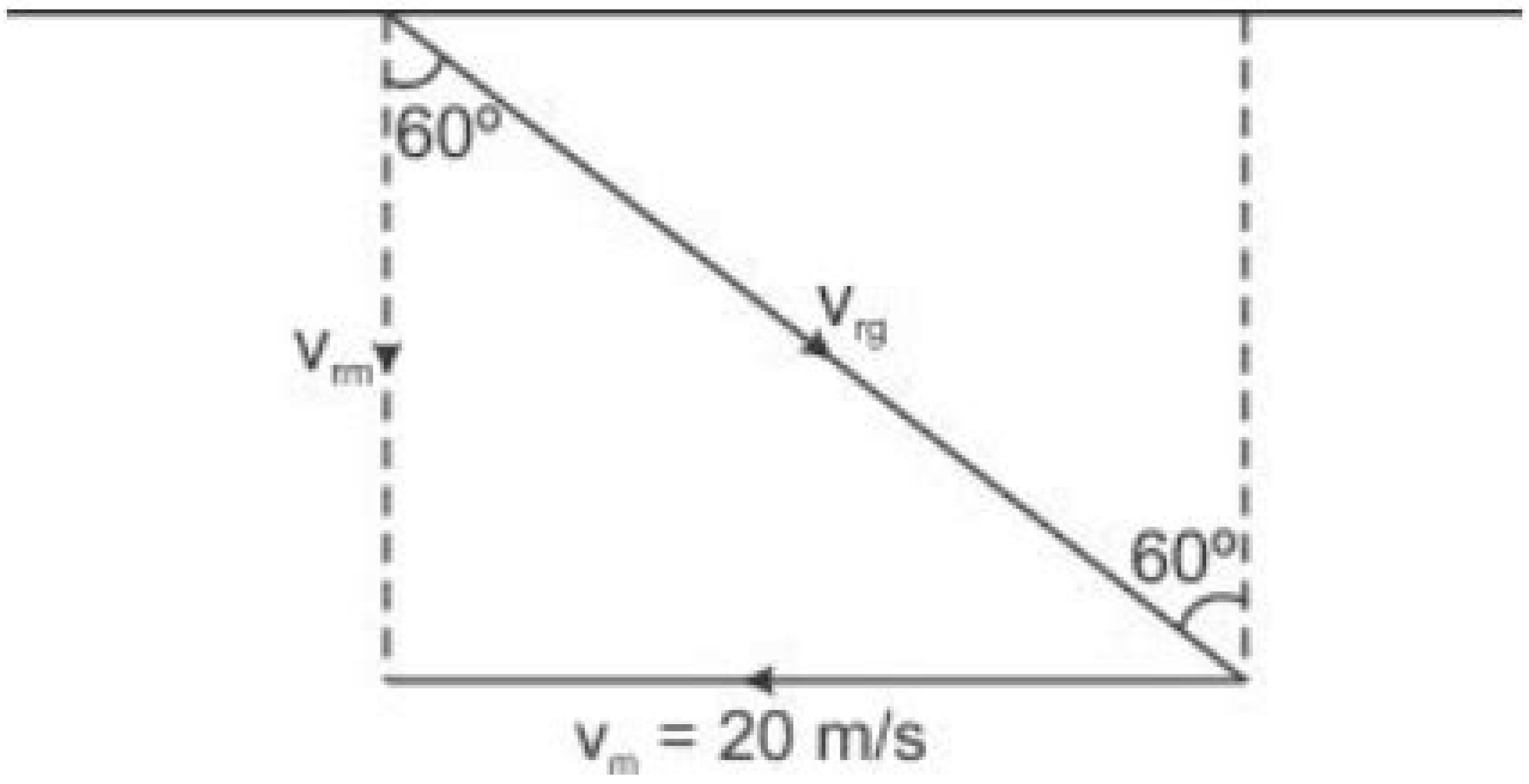
OBJECTIVES:

- Apply two-dimensional kinematic equations to predict the impact point (range) of a ball in projectile motion
- Measure the velocity of a steel ball using the CBL and photogate
- Apply concepts of measurement uncertainty
- Write hypothesis - This should be done now and inserted at this point in your lab (it will help if you read the entire lab to determine what you will be doing...then make your prediction with the criteria for testing your hypothesis - the percent difference allowed)

APPARATUS:

- GLX
- Photogate
- Steel Ball
- "Plumb bob" (cord with screweye)
- Carbon Paper
- Ramp with C-clamp
- Half meter stick and measuring tape

The person is holding the umbrella at 60� with vertical.



Then, he starts running with speed v_m = 20 m/s. Thus, the rain appears to fall vertically to him.

Thus, the speed of rain drops w.r.t road/ground is

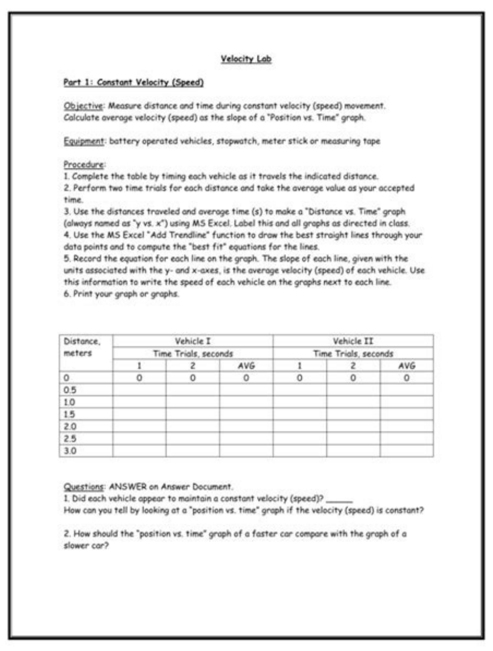
$$\sin 60 = \frac{V_m}{V_{rg}}$$

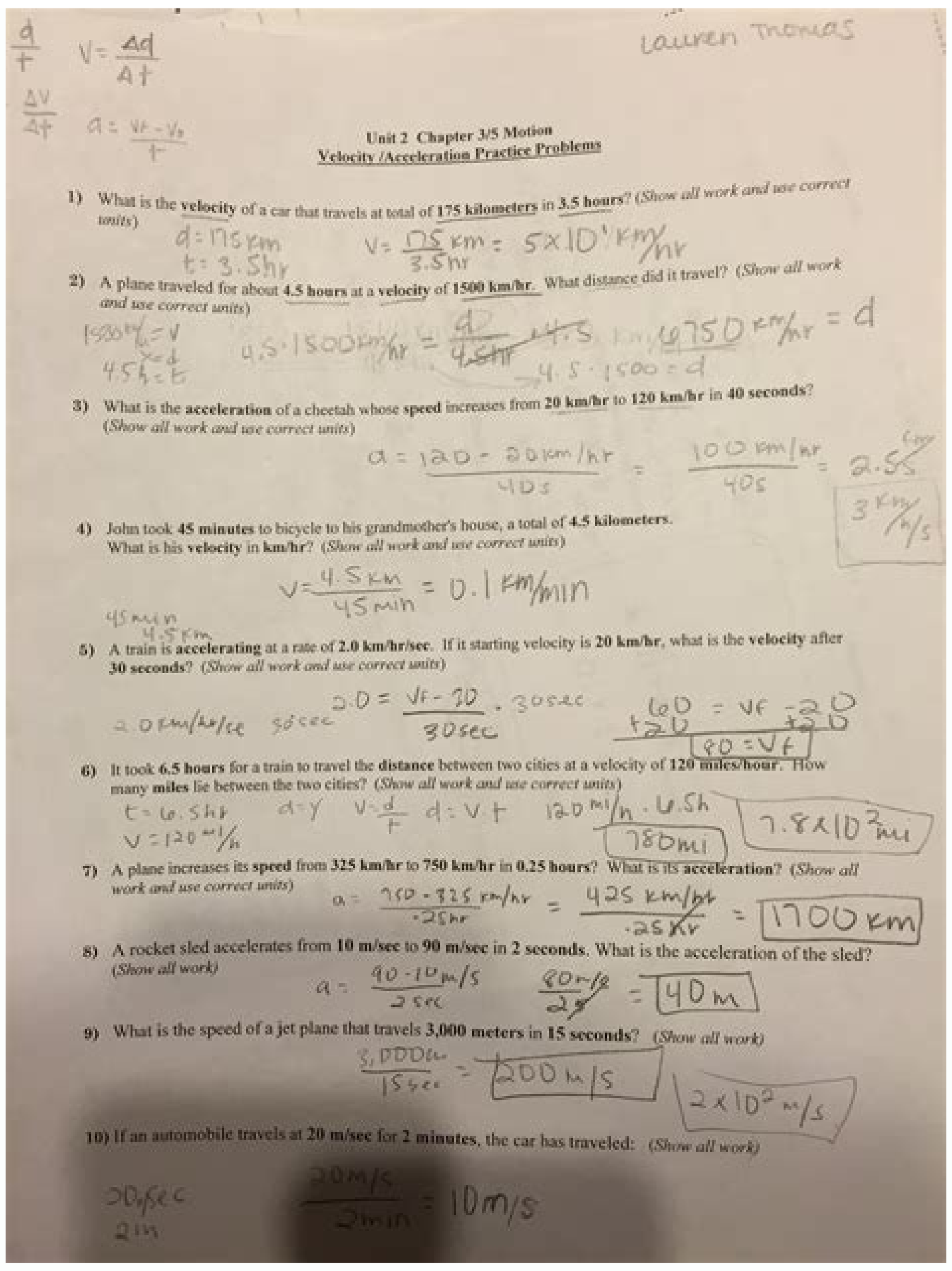
$$\therefore V_{rg} = \frac{V_m}{\sin 60} = \frac{20 \times 2}{\sqrt{3}} = \frac{40}{\sqrt{3}} = 23.1\ m/s$$

And, the speed of rain drops w.r.t. person is

$$\tan 60 = \frac{V_m}{V_{rm}}$$

$$\therefore V_{rm} = \frac{V_m}{\tan 60} = \frac{20}{\sqrt{3}} = 11.55\ m/s$$




Lauren Thomas

Unit 2 Chapter 3/5 Motion
Velocity /Acceleration Practice Problems

1) What is the **velocity** of a car that travels at total of **175 kilometers** in **3.5 hours**? (*Show all work and use correct units*)

2) A plane traveled for about **4.5 hours** at a **velocity** of **1500 km/hr**. What distance did it travel? (*Show all work and use correct units*)

3) What is the **acceleration** of a cheetah whose **speed** increases from **20 km/hr** to **120 km/hr** in **40 seconds**? (*Show all work and use correct units*)

4) John took **45 minutes** to bicycle to his grandmother's house, a total of **4.5 kilometers**. What is his **velocity** in **km/hr**? (*Show all work and use correct units*)

5) A train is **accelerating** at a rate of **2.0 km/hr/sec**. If it starting velocity is **20 km/hr**, what is the **velocity** after **30 seconds**? (*Show all work and use correct units*)

6) It took **6.5 hours** for a train to travel the **distance** between two cities at a velocity of **120 miles/hour**. How many **miles** lie between the two cities? (*Show all work and use correct units*)

7) A plane increases its **speed** from **325 km/hr** to **750 km/hr** in **0.25 hours**? What is its **acceleration**? (*Show all work and use correct units*)

8) A rocket sled accelerates from **10 m/sec** to **90 m/sec** in **2 seconds**. What is the acceleration of the sled? (*Show all work*)

9) What is the speed of a jet plane that travels **3,000 meters** in **15 seconds**? (*Show all work*)

10) If an automobile travels at **20 m/sec** for **2 minutes**, the car has traveled: (*Show all work*)

If the car veers to the left or the right (more than twice the width of the car, or over 3 meters), modify the track to correct the path. Test the constant velocity vehicle and change batteries if necessary. Place it on the track you prepared, and switch on the power. Repeat the experiment 2 more times. Test the vehicle. Prompt students by suggesting the methods discussed in the notes for step 1.Students should ensure that the car will travel a straight path over the length of 3 meters before proceeding. Switch on the car to make sure it works. Record the position of each student with a timer from the start position. Teacher: The car may veer. It may be necessary to set up a guide to keep the car traveling in a straight path. If students run the experiment with the same conditions during each trial, the small amount of friction will not adversely affect the results. Allow the car to run the length of the track. Make sure the compartment is secure. Look at the car prior to the experiment, and make sure you have any tools necessary to open, close, and secure the compartment. Repeat procedure A with the modified vehicle. Remove 1 battery from the constant velocity vehicle. One student should be located behind the finish line to recover the car. One group member needs to be behind the start point to activate the car. See the notes for step 1, the preparation of the track. Recording multiple measurements for trials is a good practice that helps reduce error and identify outliers.If you have more timers or stopwatches, multiple students may record the data at each position, eliminating the need for multiple trials. Setting the car behind the start point allows the car to reach full speed before crossing the start point.It also allows the students operating timers to prepare so that they may start their devices when the car crosses the start point. A second member stands at the start point to signal the timers to start. Recording the time interval measured from t = 0 for several positions along the track provides several data points. This can be done by arranging a row of books, taping meter sticks to the floor, or running the car along a wall.This will slow the car due to friction. Start the car by switching on the power and release the car to travel the track. Make sure to securely replace the battery cover.Dispose of the aluminum foil in the classroom trash or recycle. Mark this position on the track with a piece of tape. Procedure A Student: Prepare a straight, level track/path at least 3 meters long, where you can operate the constant velocity vehicle. Students must make certain the dowel is completely covered. On the starter’s signal, all timers start their stopwatches/timers. When the car crosses the start point, the student at that position signals the timers to start. There must be a complete, secure connection between the aluminum foil and the battery connectors. Identify a location where students may perform the experiment. Place it in the battery compartment so the jumper is in the negative end of the battery compartment, near the spring. Students should be located where they can directly observe the car as it crosses the designated position to remove parallax error. A small screwdriver may be required to open and close the compartment. Do not discard the dowels as they can be reused. Wrap the wooden dowel completely with aluminum foil to make a battery jumper. Three students stand at designated meter points to take times. This gives students an idea about the minimum amount of error introduced due to reaction time. A loose compartment door can detach during the experiment and catch on a book, meter stick, or other object, affecting results and possibly damage the vehicle. As the vehicle crosses the position on the track next to each timer, that student will stop his/her stopwatch. Prepare the vehicle by installing the batteries and closing the battery compartment. Record the time for each trial at each position. Positioning the student who signals the timers to begin at the start point puts this student in a position where he/she can look straight down as the car crosses the start point, eliminating parallax error.Before starting the experiment, students should test their timers to make sure they know how to start, stop, and reset them.You may also want to ask students to start and stop their devices as quickly as possible. Allow students to develop their own methods for correcting the motion of the car, if necessary. Once your test track is prepared, set the car on the floor at least a car length behind the start point. Place students in groups of 5 or 6. Average the 3 times for each position. Students observing the experiment should record the data in their notebooks.You may choose to assign additional students to record data on a whiteboard or laptop, or to use a probe or video recorder. (The area should be clear, level, and free from foot traffic.) Precut the dowels and the aluminum foil squares.

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