Unit 1

MOTION

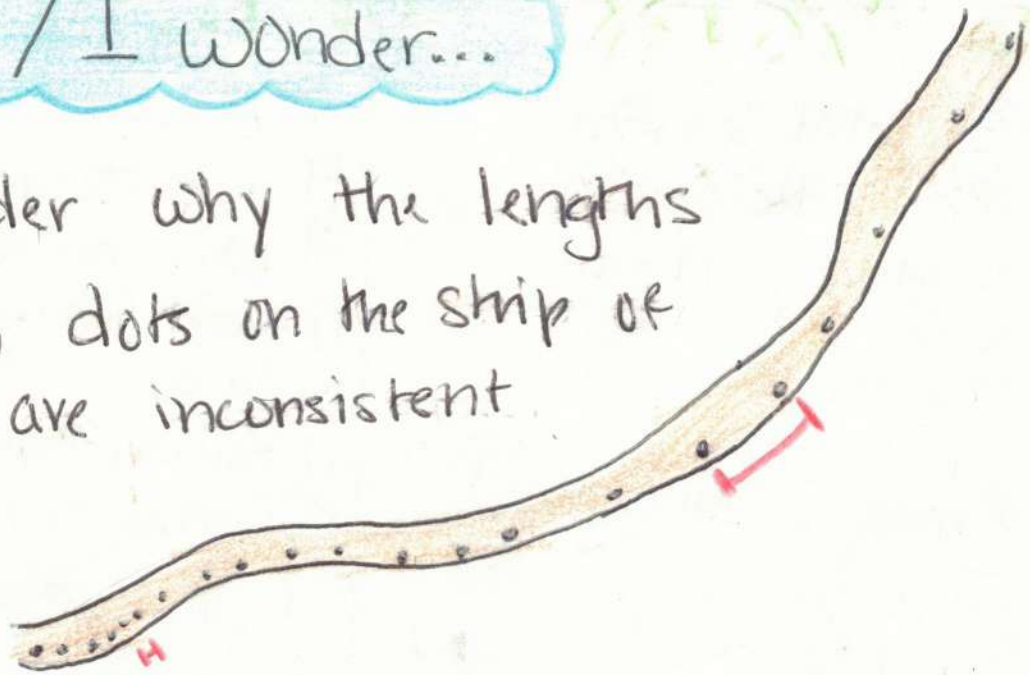
Task:

Prove understanding of basic motion by demonstrating your understanding of relationship btwn the ride you design & motions involved

How Do You Know

I notice/I wonder...

I wonder why the lengths between dots on the strip of paper are inconsistent



What I First think...

I think that as the weight falls, the paper is moving faster so the dots are more spaced out

What does it look like?

DOCUMENTATION

- You must record all times to get accurate results
- You may document times from different ramps, positions, heights, lengths or even just starting or ending points

- Measurements & Distance

MOT

CHALLENGES

- Getting a consistent/accurate time

Need:- specific/set set-up (no changes, always exact
- accurate timer

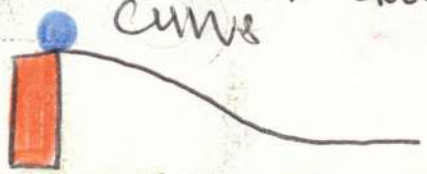
How does it Change?

KEY INGREDIENTS

ACCELERATION

ION

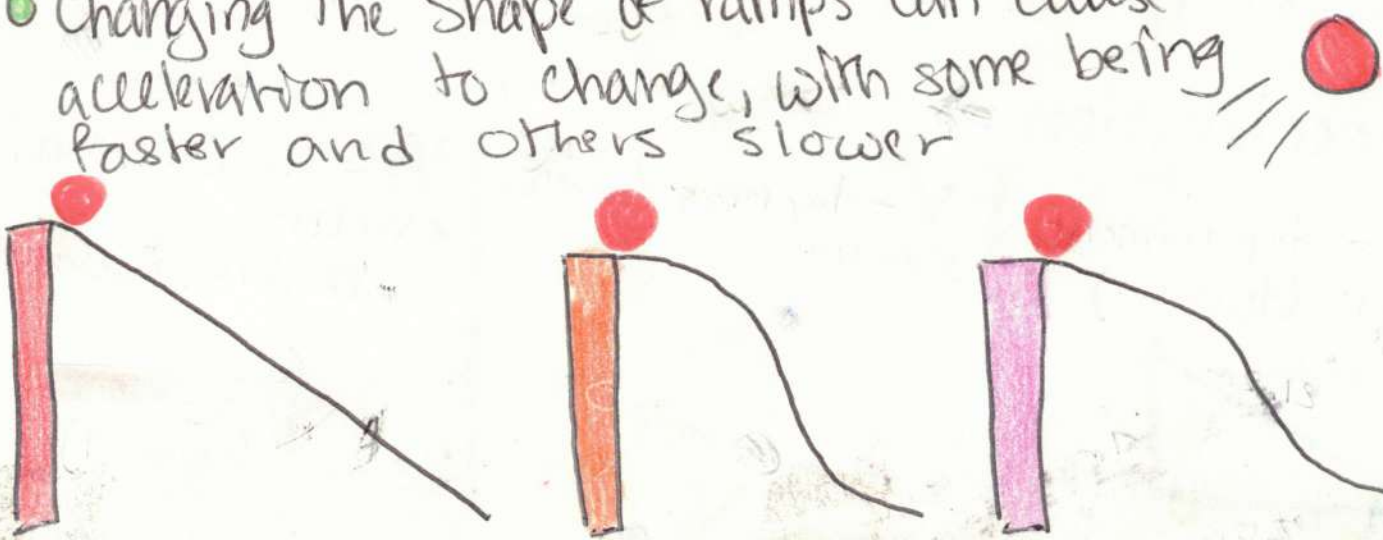
- Acceleration and deceleration will change the motion of the mar
- You can alter the ramp to speed it u or slow it down by adding a lon curve



↳ slow

EVERYTHING EQUAL

- Not all accelerations are equal
- Changing the shape of ramps can cause acceleration to change, with some being faster and others slower



LANGUAGE OF MOTION

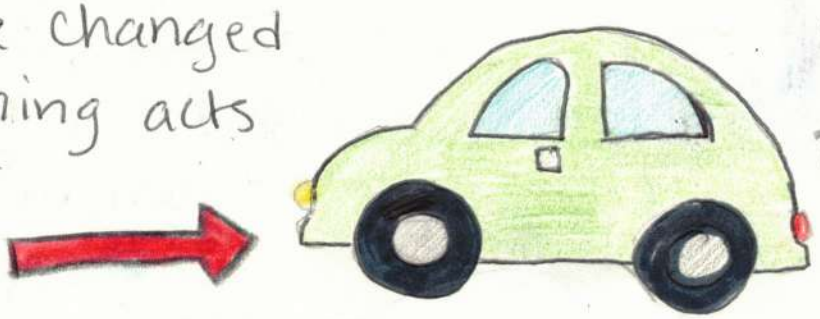
BEFORE

* You can see something move from one place to another

Words For Motion (description)

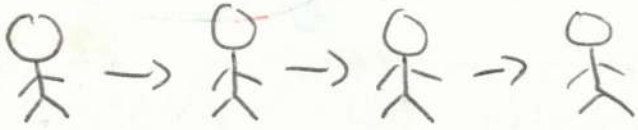
- speed
- location
- stopped (not moving)

* Motion can be changed when something acts against it



* The brakes on a car redirect its motion

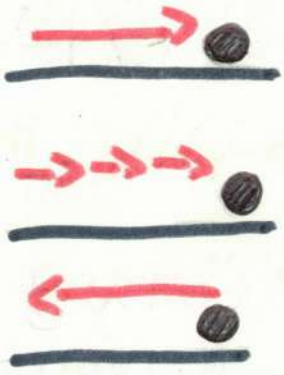
AFTER



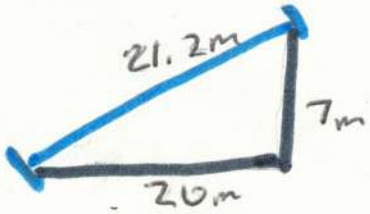
Position ➡ location

Velocity ➡ change in position over time

Acceleration ➡ change in velocity

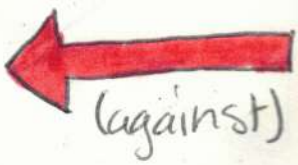


D - displacement
* scalar (distance)



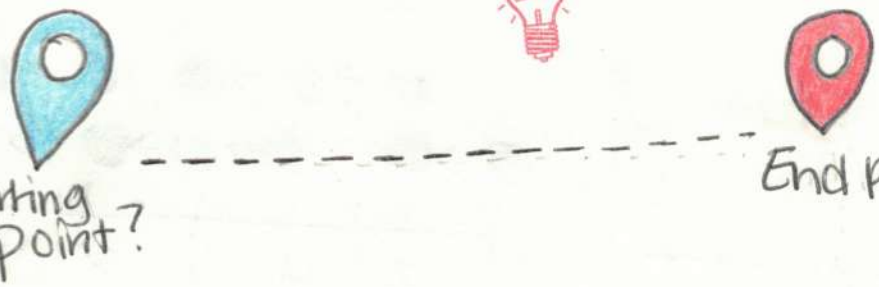
V - describes direction
* vector

A - deceleration
* vector
- negative acceleration



Where Are We At?

★ slope = speed



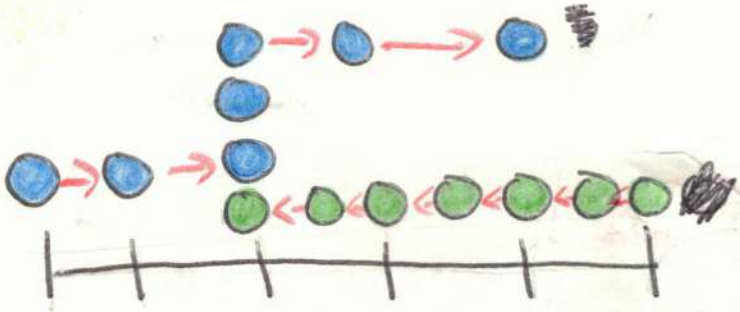
Remember...

Position - where you are
Time - how long it takes
Velocity - how fast
Acceleration - Δ in velocity

Δ in position = movement

Motion Maps

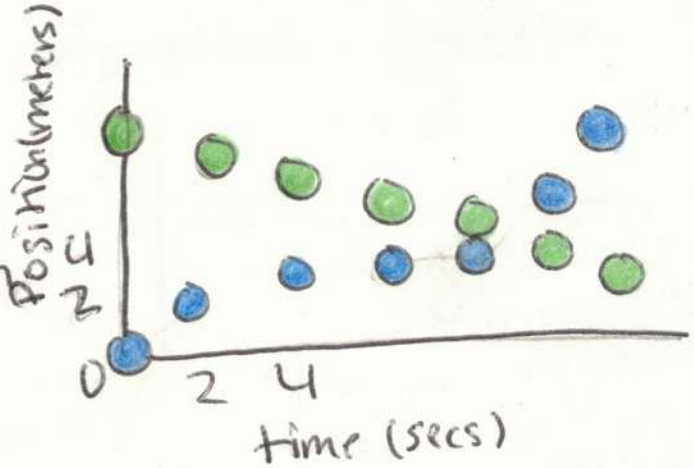
- indicate motion & direction
  - dot for start
  - dot for time
  - arrow for direction



What do you see? Blue going right, green going left
Blue stops, green constantly moving

Position Maps

- indicate position & time
  - dot's location @ every time interval
  - line connecting common dots
  - position vs time



* Green is moving faster in the negative direction (down)

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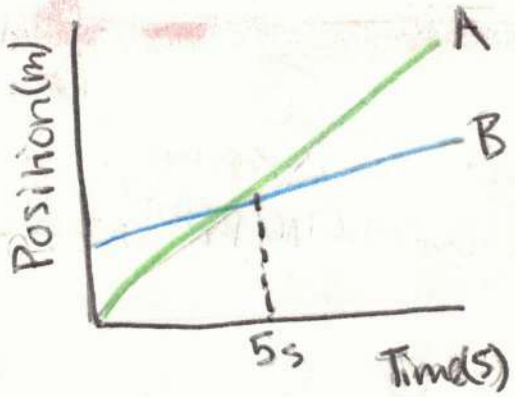
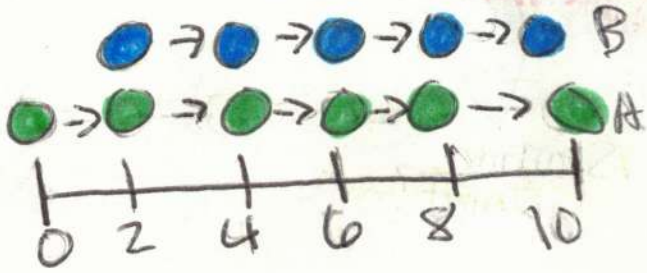
Location Plotted

1.





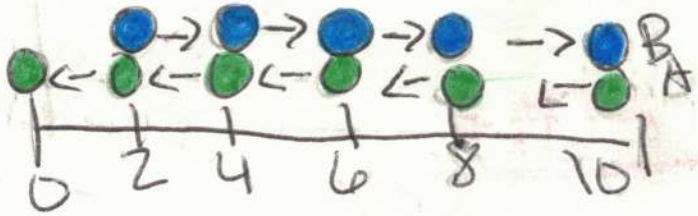
C. The cyclists do not start @ same position
Cyclists A comes from origin
B does not

D. The velocities are equal @ 5 secs b/c the two lines cross at that point

E. Where the lines intersect, they are going the same speed

F.

2.



C. Cyclist A changed b/c it is going in opposite direction.

D. Cyclist A has the greater speed, b/c it changes positions at a faster rate.

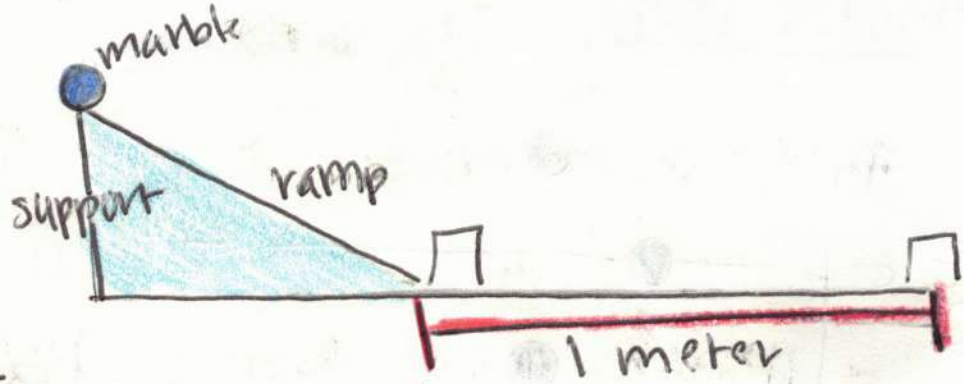
E. Cyclist A traveled the greatest distance because it has a steeper/longer slope.

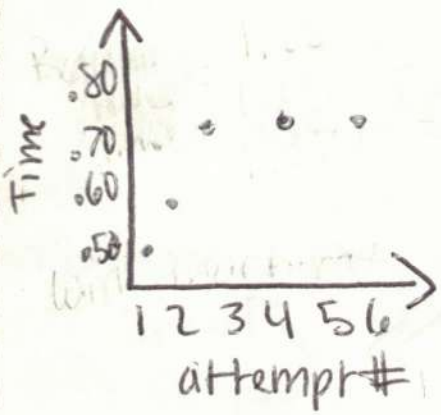
F. At the intersection the two lines have the same velocity.

NEED FOR SPEED

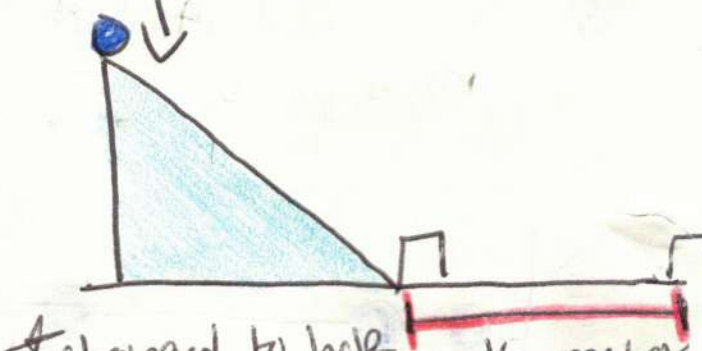
PROBLEM: How can you accurately & consistently measure velocity of an object moving at a fixed value?

EVIDENCE:





Times
- .53
- .59
- .72
- .72
- .72
- .72



*changed to half meter for consistency (stability)

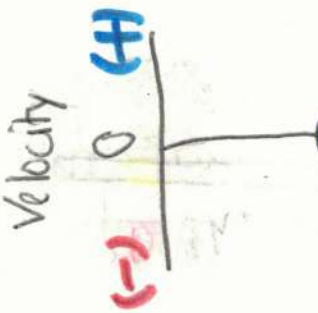
CLAIM: You can accurately and consistently measure the velocity of an object moving @ a fixed value by using the EXACT same procedures everytime and having a good timing system.

REASONING: When we attempted to get a consistent time we had difficulties b/c we did not have the most accurate timing system. When we used the machine our times became more consistent due to accuracy. We also had troubles with making sure we used the same procedures each time. When we stabilized our ramp properly and used the same procedures we got more consistent times.

How Fast Are We Going?

We have Motion, Position AND... Velocity Map

Velocity Map

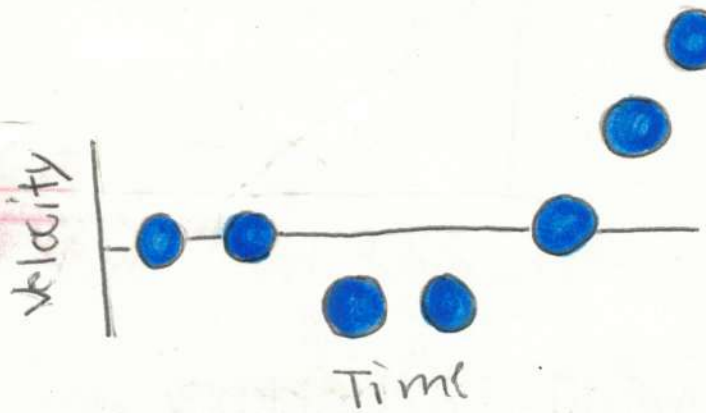


← stationary (stopped)

time

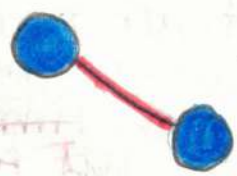
ΔV = acceleration

Slope +/- = acceleration

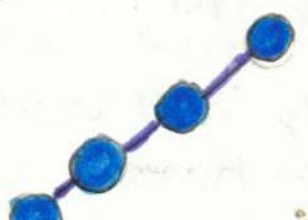


Flat line = 0 to no acceleration →

= constant velocity



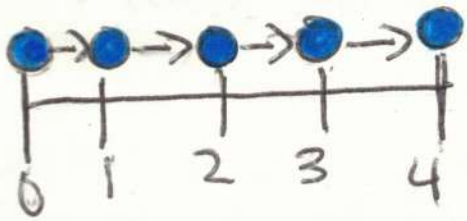
= Negative slope (slowing down or reverse direction)

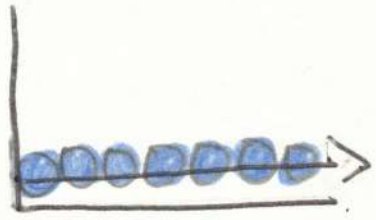


= Positive slope (speeding up or positive direction)

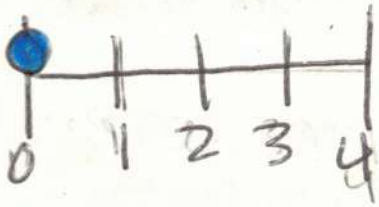
Mapping Motion

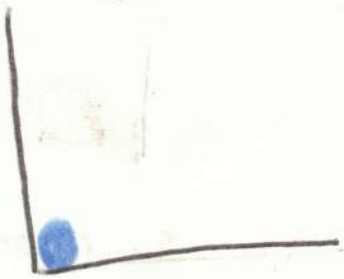
1. A ball is travelling @ a constant speed away from the origin.



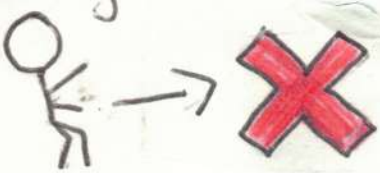


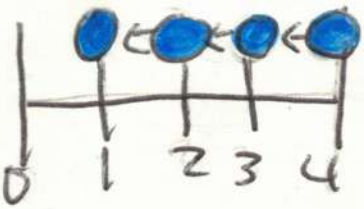
2. A car is stopped at a red light waiting for it to turn green.

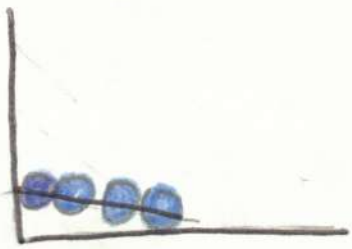


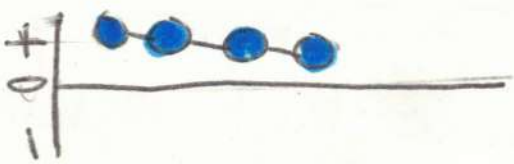


3. A person walks steadily towards the origin & stops before reaching it.

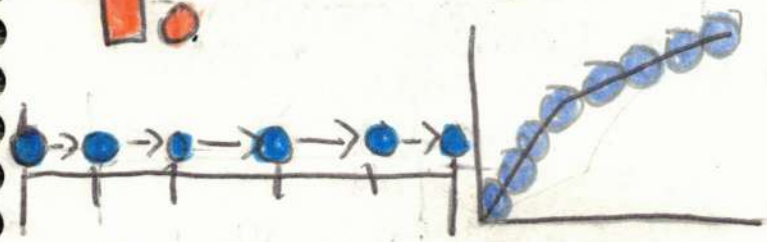


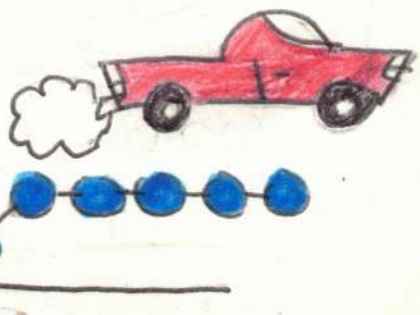




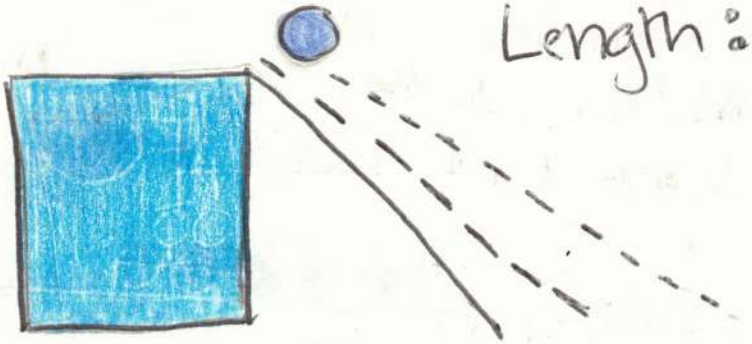


4. A car moves away from red light @ constant accele for 3 secs & then proceeds @ higher acceleration our 5 secs & continues @ constant velocity.



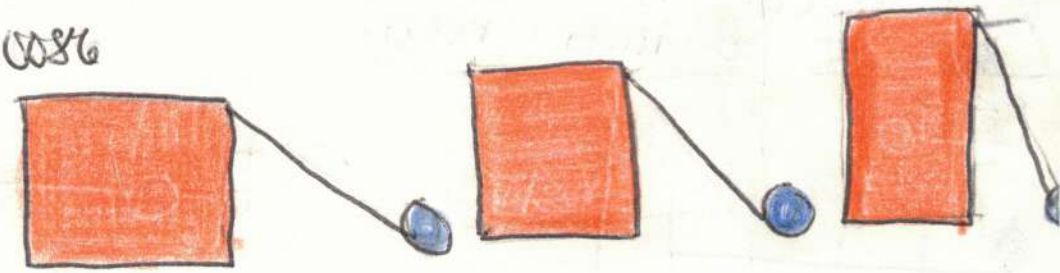


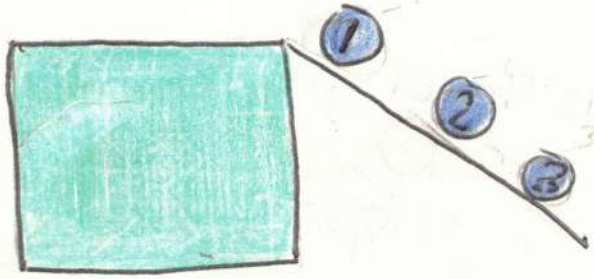
SPEEDING UP



Length:
- -> .0107, .0105, .0103
- -> .0099, .0098, .0105
- -> .0095, .0095, .0099

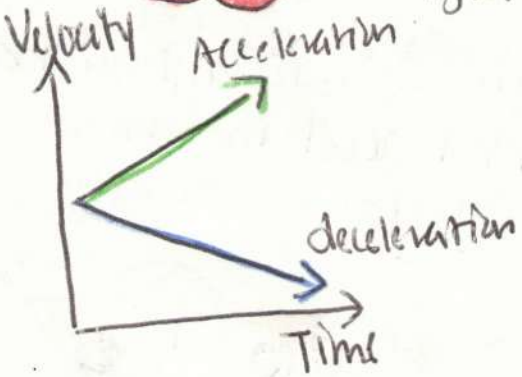
Low: .0130, .0116, .0122
Medium: .0097, .0092, .0086
High: .0091, .0082, .0080





Position 1: .0099, .0095, .0092
Position 2: .0109, .0111, .0117
Position 3: .0101, .0088, .0086

Variables
- length of ramp
- height of ramp
- starting point on the ramp

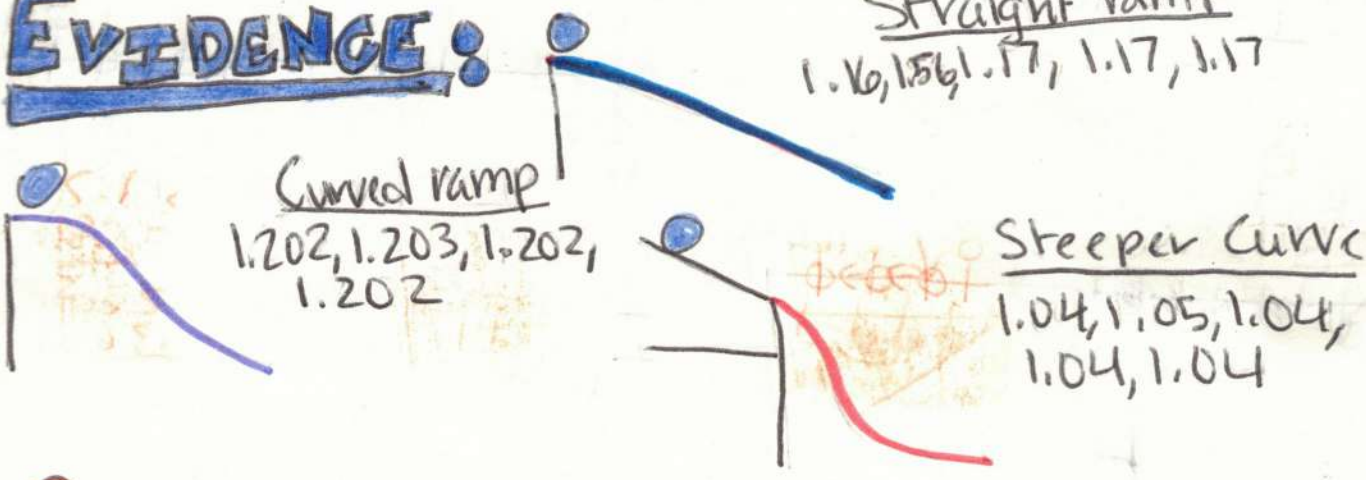


Length: change in length caused acceleration
Height: change in height caused acceleration
Position: change in position caused both acceleration & deceleration

Racing Ramps

Question: What effect do the ramps hav
and is there more than one way
to bend the ramp?

Evidence:



Straight ramp
1.16, 1.16, 1.17, 1.17, 1.17

Curved ramp
1.202, 1.203, 1.202,
1.202

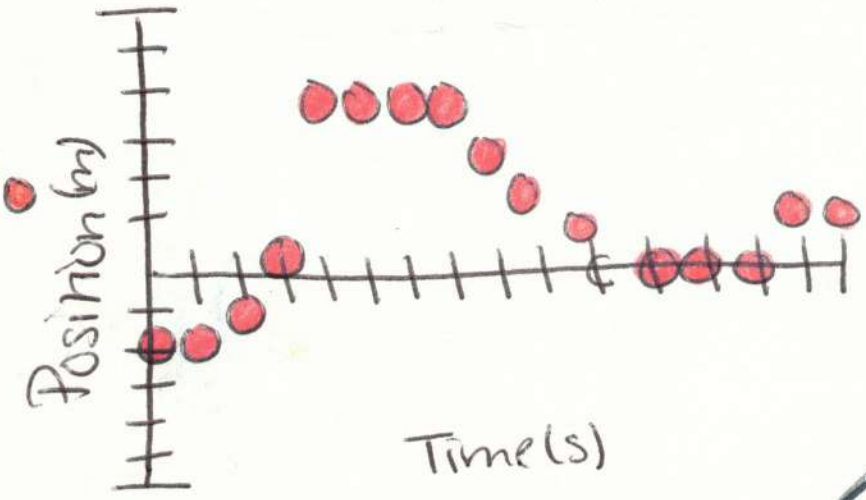
Steeper curve
1.04, 1.05, 1.04,
1.04, 1.04

Claim: The ramps cause a change in speed and
how long it takes the ball to get from point
A to point B. There are multiple ways to bend
the ramp.

Reasoning: For our lab we tested 3
ramps: a straight one, curved, and then a steeper curve.
The steeper curve had the fastest times, then the straight ram
and the regular curve was the slowest. The steepness of
The curve caused the marble to go faster, but the moderat
curve did [redacted] the opposite; it slowed the ball down.
We used paper for our ramp, which allowed us
to bend it and alter its curvature.

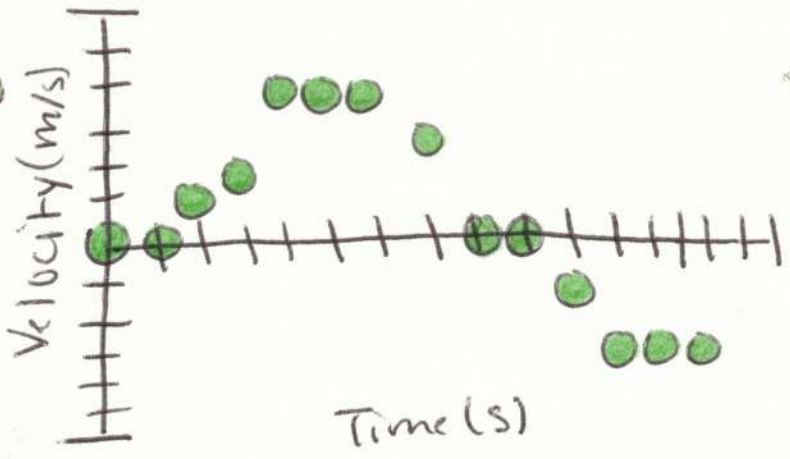
Piecing It All Together

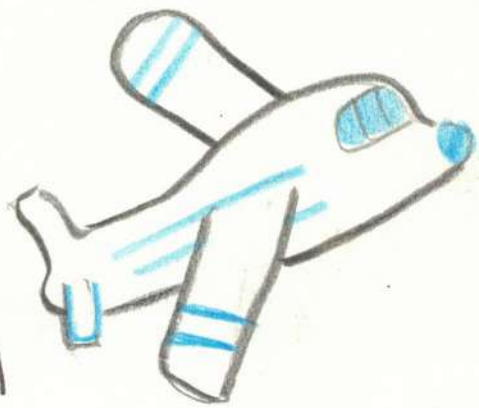
1.



The car slows down and suddenly accelerates to maintain a constant speed (4 secs). Then it slows down as it comes to red light for a complete stop (3 secs); it accelerates when the light turns green.

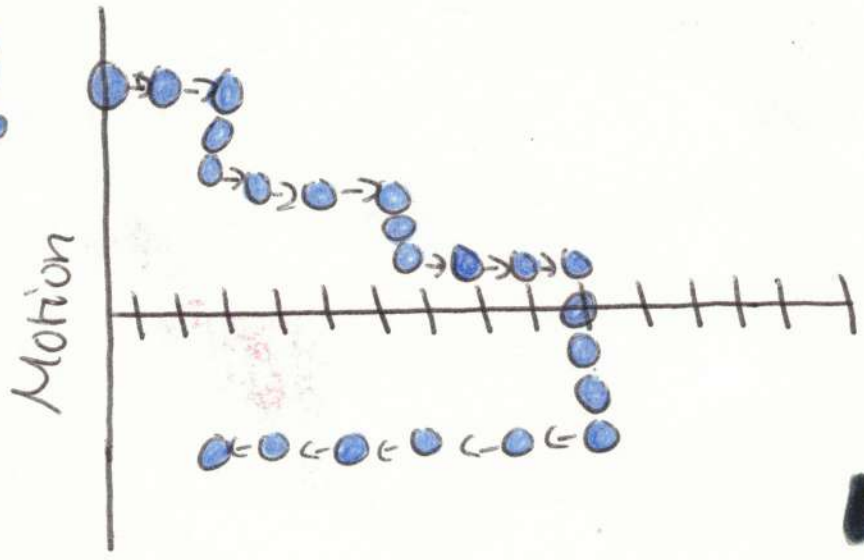
2.





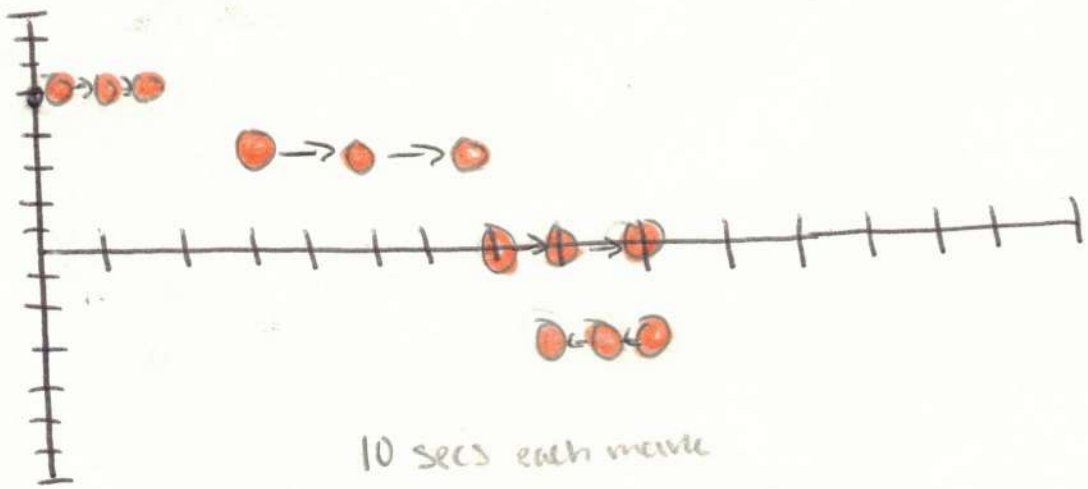
A plane is getting ready for a test run takeoff. It accelerates to take of and maintains a constant speed before decelerating quickly for landing.

3.



A person is going for a run. They run at a constant speed (3secs) then stops and continues at a constant slower pace (2secs) They stop and continue at another decelerated pace for 3 seconds and take a rest and continue at a constant speed in the opposite direction.

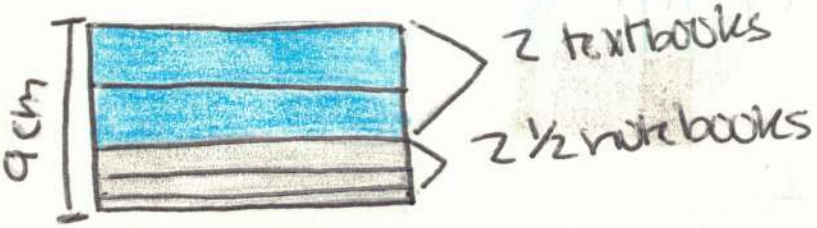
4.



A person stopped at a crosswalk, as the light turns green they walk quickly at .5m/s for 15 secs across the street. When they reach the other side the slow down .2 m/s and continue walking down the street for 50s. As they reach the news stand they stop to talk to a friend for 30s and then turn down street at .4 m/s for 25s to get back to red light.

SUMMATIVE TASK

Marble Diameter: .0165m ⇒ $\frac{.0165m}{1\ sec}$



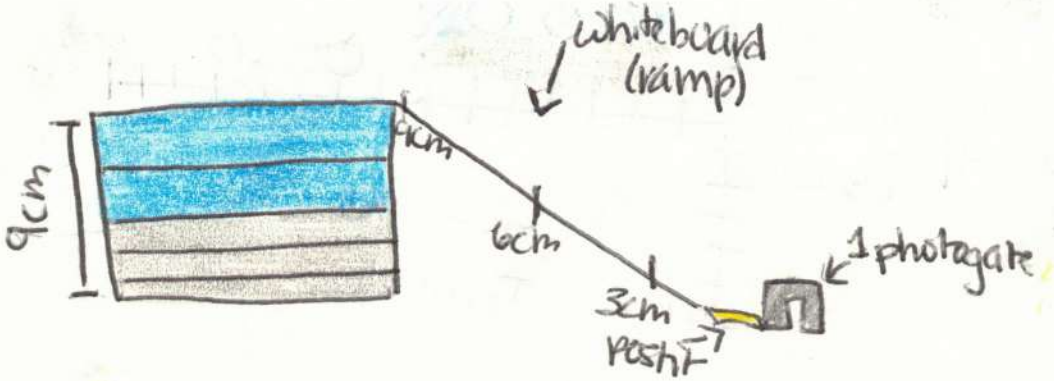
Prediction for 9cm:

$V = 1.58$ m/s

$t = .0100$

b/c ⇒ 1.22 − .86 = .36

1.22 + .36 = 1.58



3cm: .0194, .0191, .0191 (avg), .0189, .0188, .0190 = .8cm

6cm: .0137, .0136, .0134, .0134, .0133 (3% error) = 1.22m/s

9cm: .0113, .0112, .0115, .0114 = 1.45 m/s

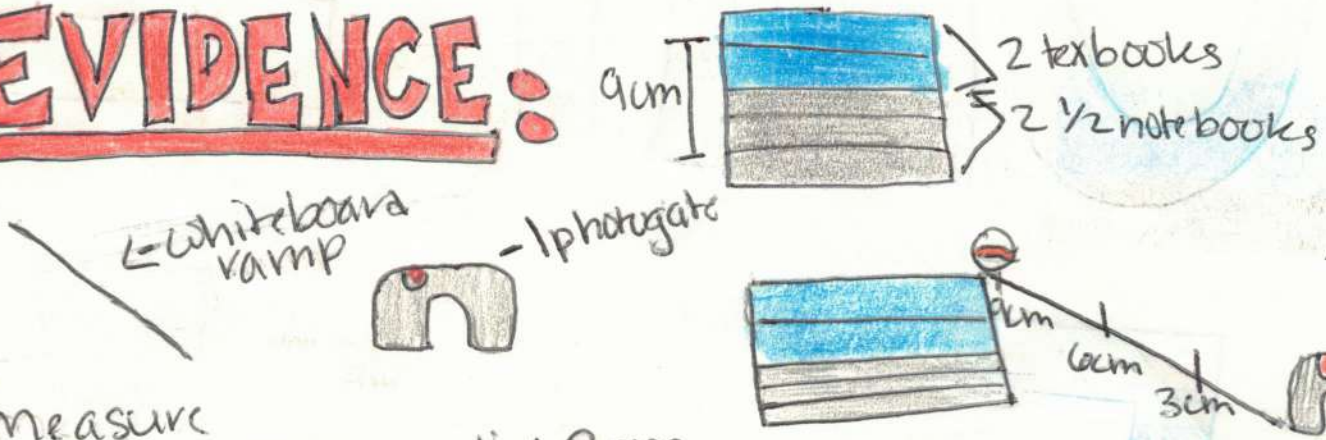
Result	vs.	Prediction
1.45m/s		1.58 m/s

SUMMATIVE TASK

QUESTION:

Is there a way to accurately predict speed?

EVIDENCE:



measure 3cm, 6cm, predict 9cm (3 measurements)

CLAIM:

Yes, there is a way to accurately predict speed.

REASONING:

You can predict the velocity at one height by using your results from two other heights. Our group got the velocity from 3cm (.86 m/s) and 6cm (1.22 m/s). We got the difference of those two velocities (.36) and added the difference of .36 to 1.22 in order to predict the velocity @ the next height. Our prediction came out to 1.58 m/s second at 9cm. Then we tested dropping the marble down the ramp from 9cm; we got 1.45 m/s. To decide if our prediction was accurate or not we got our % error: $\frac{.13}{1.45} \cdot 100 = 8.96 \approx 9$ Ten percent or under is usually considered closely accurate, so it is safe to say we accurately predicted speed.