Final Project
Physics 590

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Lesson Objectives: Students will be able to

- Identify the relationship between motion and a reference point.
- Identify the two factors that speed depends on.
- Determine the difference between speed and velocity.
- Analyze the relationship between velocity and acceleration.
- Interpret a graph and calculate data showing acceleration.

The Domino Derby:

As a warm-up activity to the lesson, students will determine the factors that affect the speed of falling dominoes .

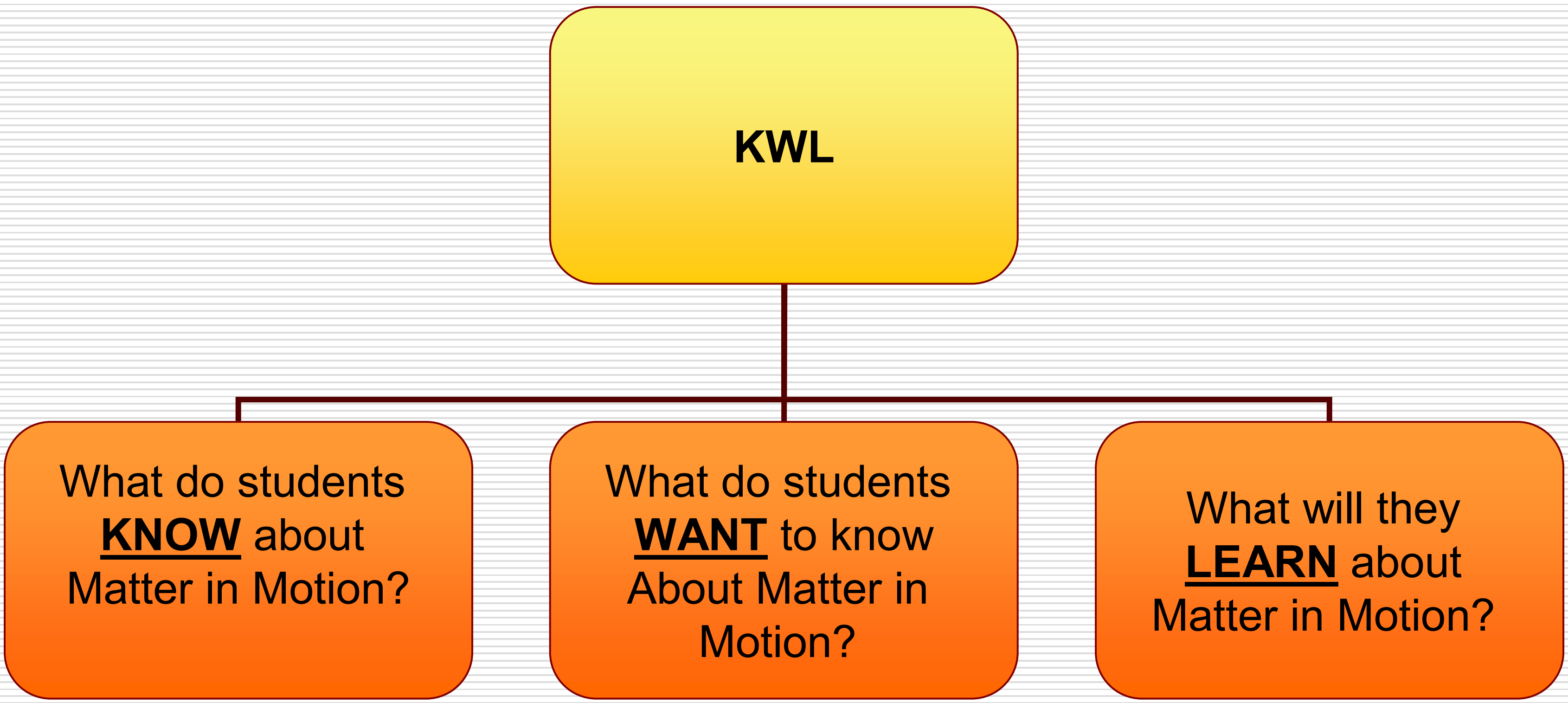
Procedure

1. Set up 25 dominoes in a straight line with equal amount of space between each.
2. Using a meter stick, measure the total length of your row of dominoes, and write it down.
3. Using a stop watch, time how long it takes for the entire row of dominoes to fall and record this measurement of time.
4. Repeat steps 2 and 3 several times, using distances between the dominoes that are smaller and larger than the distance used in your original trial.

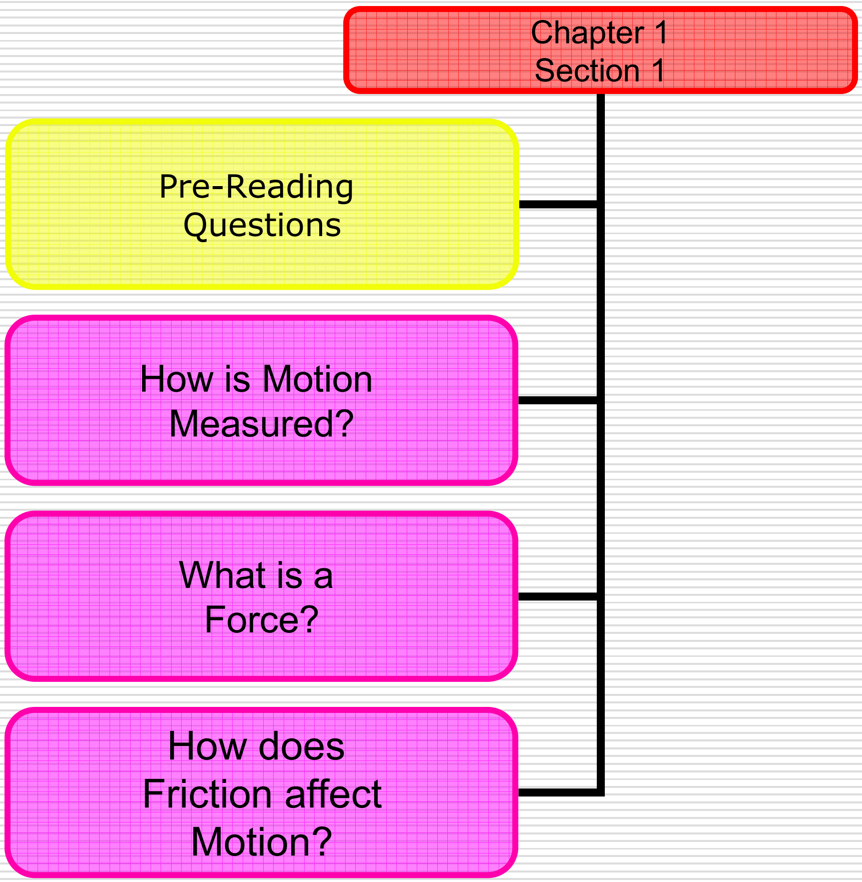
Analysis

5. Calculate the average speed for each trial by dividing the total distance (the length of the domino row) by the time taken to fall.
6. How did the spacing between dominoes affect the average speed? Is this what you expected to happen? Why or why not?

Prior Knowledge



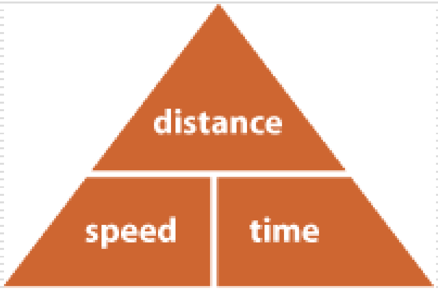
Getting Started



Measuring Motion

- Terms to learn:
  - Motion
  - Speed
  - Velocity
  - Acceleration
  - Reference Points

Determining Average Speed



- **Average speed= total distance / total time**

  If you walk for 1.5 hours and travel 7.5km what is your average speed?

  $$S=\frac{d}{t}=\frac{7.5}{1.5}=5km/h$$

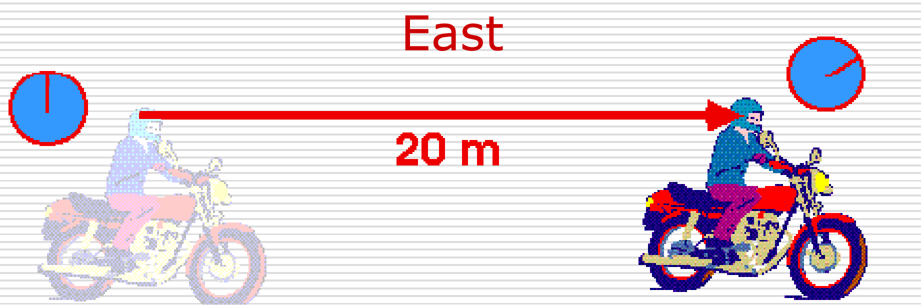
Velocity Riddle:

- Two birds leave the same tree at the same time. They both fly at 10km/h for 1 hour, 15km/h for 30minutes, and 5km/h for 1 hour. Why don't they end up at the same destination?

Answer:

- The birds traveled at the same speeds for the same amounts of time, but they didn't end up in the same place because they went in **different directions**.
- They had **different velocities.**

Calculating the average velocity



If a motorcycle travels 20 m in 2 s, then its average velocity is

Change in position

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{20\ m}{2\ s} = 10\ \frac{m}{s}\ \text{East}$$

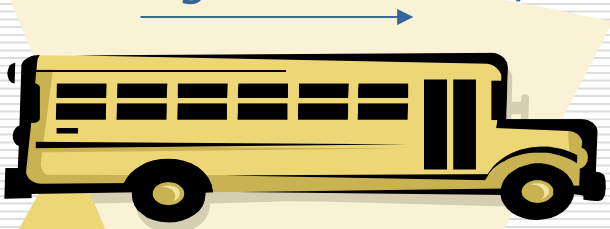
Change in time

Combining Velocities

- Determining Resultant Velocities
  - When you combine 2 velocities that are in the same direction, add them together to find the resultant velocity.
  - When you combine 2 velocities in opposite directions, subtract the smaller velocity from the larger velocity to find the resultant velocity.
    - The resultant velocity is in the direction of the larger velocity.

Determining Resultant Velocity

Traveling East at 15m/s.



Walking towards the front (east) at 1m/s.

- 15m/s +1m/s= 16m/s east
  east east

Traveling East at 15m/s.

Walking towards the back (west) at 1m/s.

- 15m/s -1m/s= 14m/s east
  east west

Think about it:

- Which of the following are examples of velocity?

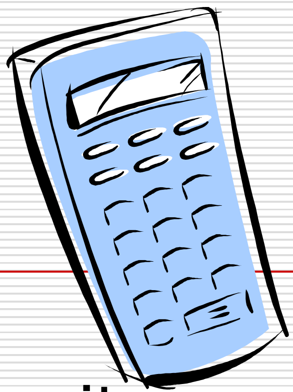
1. 25m/s forward
2. 1,500 km/h
3. 55m/h south
4. All of the above

Answer: Numbers 1 and 3 are examples of velocity because they both state direction.

Determining Acceleration

- To accelerate means to change velocity.
  - If velocity is speed in a specific direction, then when you change your speed and direction you accelerate.
  - So, the faster the velocity changes, then the greater the acceleration is.

Calculating Acceleration



$$\text{Acceleration} = \frac{\text{final velocity - starting velocity}}{\text{total time}}$$

Measurement Units:

Velocity is expressed in meters per second (m/s), while acceleration is expressed as meters per second per second (m/s/s).

Calculating Acceleration

- A plane passes over Point A with a velocity of 8,000m/s north. 40s later it passes over Point B at a velocity of 10,000m/s north. What is the plane's acceleration from A to B?

$$A = \frac{10{,}000\text{m/s} - 8{,}000\text{m/s}}{40\text{s}} = \frac{2{,}000\text{m/s}}{40\text{s}} = 50\text{m/s/s north}$$

Acceleration Examples vs. Changing Velocity

Acceleration Examples	Changing Velocity
A plane taking off	Increase in speed
A car stopping at a stop sign	Decrease in speed
Jogging on a winding trail	Change in direction
Driving around a corner	Change in direction
Standing at Earth's Equator	Change in direction

Review what we’ve learned:

- The speed of a moving object depends on the distance traveled by the object and the time taken to travel that distance.
- Speed and velocity are not the same thing. Velocity is speed in a given direction.
- Acceleration is the rate at which velocity changes.
- An object can accelerate by changing speed, changing direction, or both.

Think about it:

- A student riding his bicycle on a straight flat road covers one block every 7 seconds. If each block is 100m long, he is traveling at:

a. Constant speed

b. Constant velocity

c. 10m/s

d. Both a and b

Answer: D

Think some more:

- If a bus traveling 15m/s south speeds up to 20m/s, this is a change in its:

a. Speed

b. Velocity

c. Acceleration

d. All of the above

Answer: D

Lab: Detecting Acceleration

1. Cut a piece of string to reach ¾ into a liter bottle.
2. Use a pushpin to attach the string to plastic foam ball.
3. Use clay to attach the other end of the string to the center of the bottle lid.
4. Fill the bottle with water.
5. Put lid on the bottle with string and ball inside.
6. Turn bottle upside down. The ball should float up inside the bottle. Now, you are ready to use the accelerometer.
7. Gently start pushing the accelerometer across the table at a constant speed. Notice that the cork quickly moves in the direction you are pushing and then swings backward.
8. Try the following and record your observations:
    1. Push a little faster.
    2. Slow down
    3. Change the direction you are pushing.
    4. Make any other changes in motion you can think of.

Lab Analysis

- Explain why the ball moves forward when you speed up but backward when you slow down.
- At a constant speed, why does the ball quickly swing back after it shows you the direction of acceleration?
- If you move the bottle in a circle at a constant speed, predict what the ball will do. Try it, and check your answer.

Touring the City Extension Activity

The assignment: You have just been appointed Philadelphia's director of Tourism. Your first assignment in your new position is to plan a sightseeing tour of this historical city.

The task: You need to obtain a map of Philadelphia, and a map of public transportation schedules (bus, train, trolley, etc.)

Using the maps, equipped with routes, you will need to accurately estimate the distance between points (landmarks).

You will calculate the average speed, velocity and acceleration between checkpoints and compare each. Comparisons should be made using data graphs illustrating each segment over time.

The Result: You will publish a brochure with your data.