SLOW AND STEADY WINS!
Uniform Motion

LEARNING OBJECTIVES

Students will:

- Collect data for uniform motion
- Graph uniform motion

STANDARDS ALIGNMENT

NGSS 3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion
CCSS 3.MD.B.3 Draw a scaled bar graph to represent a data set.

OVERVIEW

A slow-moving constant speed dune buggy can be used to teach about uniform motion.
Students can easily mark the location of the car during a specific time interval, such as just counting slowly. Comparing the distances travelled during each time interval will help students understand uniform (constant velocity) vs nonuniform (accelerated) motion.

MATERIALS

Constant motion cars such as dune buggies
Strips of paper such as adding machine tape
Markers, coins, washers, or sticky notes
Measuring tape or meter stick

ENGAGE OR PHENOMENON

Based on the photo, predict how fast is the snail moving across the sidewalk. What is the basis for your prediction? What prior knowledge would be needed to verify your prediction.

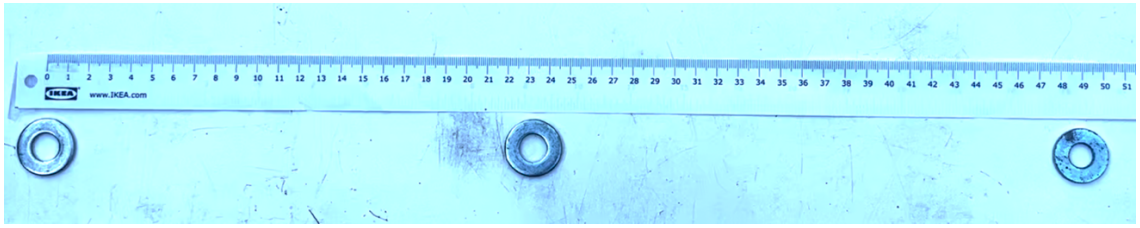
EXPLORE

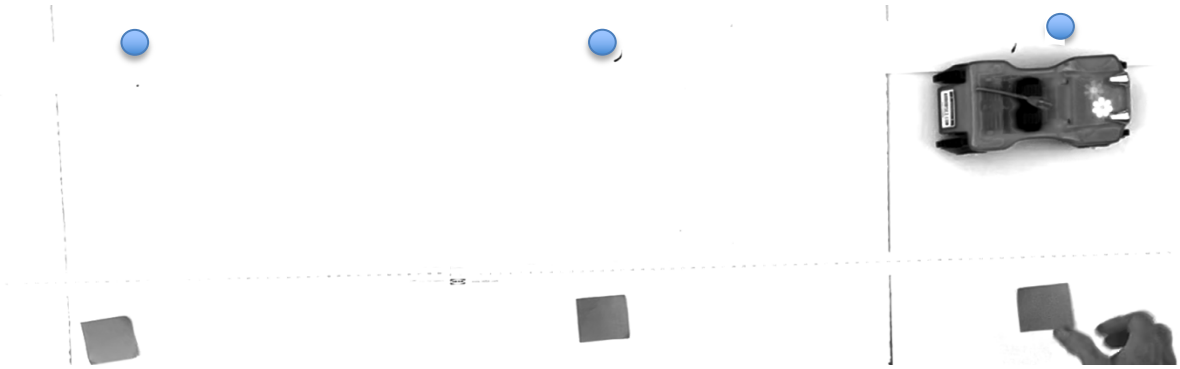
Use the paper trips or machine tape as a way to mark the distance a constant speed dune buggy travels each second. Start with about 2 meters of a paper strip and secure each end to the floor with painters/masking tape.
Assign roles to members of the group as follows:

- Cadence/beat director: role is to count out rhythmically so each count is approximately 1 second (does not have to be exact)
- Dune Buggy Driver: role is to start the dune buggy when everyone is in place and hold the buggy near the tape before the Cadence director counts down to a release time. “3…2…1…go”. Gently place the car near the tape when the Cadence Director says “go”. If the car veers to one side, gently tap it with a stick or your foot to try to keep it in a straight path. When the car reaches the end of the tape, pick it up and turn it off.
- 3-4 marking judges: the marking judges need to spread out evenly over the projected course (i.e. along the tape). On the Cadence Director’s count, the judges should mark where the front wheels of the dune buggy are located. It is typically easier for each judge to do only one or two of the marks as the car passes them. The marks can be made on the paper or by putting a washer, coin, or sticky note to indicate the location at each count.

Note: it may take more than one trial to get the rhythm and marking synchronized. Be sure students do not “anticipate” where the car will be, but instead only put a mark when they hear the count.

Below are samples: 1) using washers along a measuring tape, 2) marking dots, 3) using small sticky notes



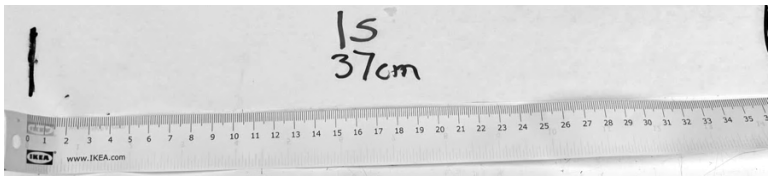


Have your teacher check your marks on the tape before proceeding to the next step.

If coins or washers were used to indicate locations, mark the location of them on the paper (i.e. draw the center of the washer or draw around the coin).
Number each “mark” with the corresponding count, starting with 0 (where the car started such as 0, 1s, 2s, etc.).

Measure the total distance the car travelled after each period/second and record it on the paper at the appropriate mark (see sample below). Be sure to write the total distance on the paper AT THE MARK where the distance was measured.
Measure the distance between EACH mark and write it on the tape.
Transfer the data collected to a data table like what is shown below.
Cut the paper strips so each strip represents the distance the car travelled in the given increment of time (i.e. one count or second). See Sample Data.
Compare the size of the strips of paper after they have been cut.

Sample below shows in the first second the car travelled 37 cm.



Sample Data from Dune Buggy

Note the number on the far left is the total distance travelled. The measurements in the middle of the strip indicate the distance travelled each second.

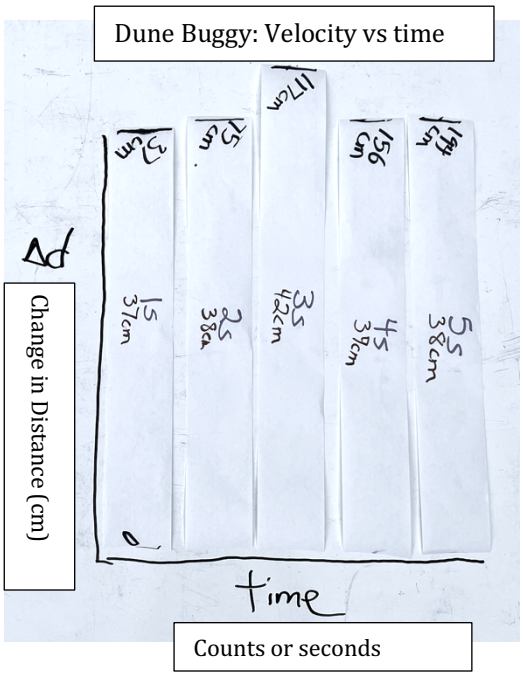
Time (count or second)	Total Distance Travelled	Distance travelled each second
0	0	0
1	37 cm	37 cm
2	75 cm	38 cm
3	117 cm	42 cm
4	156 cm	39 cm
5	194 cm	38 cm

EXPLAIN/TEACHER NOTES

Have students compare the strips (i.e. for each interval or second) within their own group as well as with other groups.
How are they similar? How are they different? Discuss why there may be discrepancies.
Note: there will be slight variations in the distance travelled each second by the car. Variables can be due to the rhythm of the cadence director and/or accuracy for placement of markers.

What conclusions can be made from the data that has been collected? Cite evidence to support your conclusions.
The cars cover about the same distance for each time interval. This is constant velocity or nonaccelerated motion.

Have students use the strips of paper to make a “bar graph” on their tables. Discuss the units for this “graph” and the title of the graph.



The y-axis is the change in distance, or the distance covered during each interval of time. The x-axis represents each interval of time. The title of the graph would be “Change in distance vs time interval” OR “Velocity vs time”. Note the graphs will appear relatively “constant” or “consistent” in the distance they travelled during any time period. This means the dune buggy was not accelerating because it was travelling the same speed and covering the same distance during each time interval, much like having a cruise control set on an automobile.

Acceleration is **nonuniform motion**.

NOTE: The change in distance (Δd) is NOT the same as **total** distance travelled. This is a velocity vs. time graph because velocity =*(Δd/Δt)*. To find the distance travelled, one would multiply the average velocity x Δt or $d = vt$. Plotting the total distance travelled would show that the total distance increased each second because the object was farther down the path being travelled.

EXTEND

How could you use the picture of the snail to determine the speed of the snail? Compare your method with others in your group.

The slime marks left by the snail are like the positions marked on the sheet with dots/washers. Although one could closely estimate the distance the snail traveled, there is no indication of how long it took the snail to cover the given distance. Therefore, it would be difficult to know the speed of the snail.