SPEED / Velocity / Acceleration

Calculating Speed with Roller Cars & Constant Velocity Cars

Part A

NAME ___________________  Per___  Due date __________  Mail Box_______

Speed = Distance / Time
Distance = Speed × Time
Time = Distance / Speed
**Speed** – Until the 1950s, the land speed record was held by a series of European gentlemen racers such as British driver John Cobb, who hit 394 miles per hour in 1947. That record held for more than a decade, until the car culture swept the U.S. Hot-rodgers and drag racers built and souped up racers using car engines, piston aircraft engines and, eventually even jet engines. For this determined and dedicated group, the land speed record was no longer an honor to be held by rich aristocrats with industrial backing, it was brought stateside to the common man in places like Utah and Nevada.

In the summer of 1960, the contest moved into overdrive, with eight men contending for the record on Utah's Bonneville Salt Flats. Some men died in horrific crashes, others prudently retired, and by mid-decade only two men were left driving: Art Arfons and Craig Breedlove. By 1965, Arfons and Breedlove had walked away from some of the most spectacular wipeouts in motor sport history and pushed the record up to 400, then 500, then 600 miles per hour!

----------------------------------------

**Velocity** – There is a distinction between speed and velocity. Speed describes only how fast an object is moving. This is referred to as a scalar quantity, because it only describes magnitude (size). Velocity gives the magnitude of how fast and in what direction the object is moving, so it is termed a vector quantity, because it takes two variables into consideration. If a car is said to travel at 60 km/h, its speed has been specified. However, if we are concerned with car’s direction too; 60 km/h to the north, we now refer to it as a velocity.

The big difference can be noticed when we consider movement around a circle. When something moves in a circle and returns to its starting point, its displacement is zero, because we arrived back at the start and we are facing the same direction. For example, a car moving at a constant 20 kilometers per hour in a circular path has a constant speed, but does not have a constant velocity, but rather a changing velocity because its direction is changing. The land speed records were typically set while driving on a straight path with a constant velocity and speed, no circles or turning. Changing direction causing additional forces of motion (inertial forces) to be felt. Inertial force resists changes in velocity. In other words turning will slow you down.

----------------------------------------

**Acceleration** – In physics acceleration or deceleration, is the rate of change in the speed of an object. We can also think about acceleration as described by Sir Isaac Newton's Second Law. If we know the force an object is exerting we can divide it by the mass and find the rate of acceleration for that object. More typically however, let’s consider acceleration as equal to the change in speed divided by the change in time. The Standard International (SI) unit for this type of acceleration is meters per second squared (m/s²).

For example, when a car first starts out and then travels in a straight line at increasing speeds, it is accelerating in the direction of travel. You can feel the force of acceleration of a car as it pushes you back into your seat, just like the land speed racers of old on the Utah's Bonneville Salt Flats. The greater the acceleration, the greater the force one experiences. Deceleration is a force too, felt any time the brakes are applied and the seat belt then snugs across your chest.
**Speed**

What was John Cobb’s record in kilometers per hour? 1 mile equals 1.6 kilometers: (1m = 1.609km)

Hint: this is just a ratio, you just need to multiple

(1) **WRITE →**


**Velocity**

(2a) Explain how velocity is different than speed?

(2b) Give an example of velocity: How do you record an answer to a velocity question?

(2c) How might changing velocity slow top speed down?

**Acceleration**

(4a) Which type of force does one experience or feel the most when it comes to high speed racing?

(4b) Which of Newton’s laws describes acceleration, the net result of all forces acting on a land racer?

**Acceleration cont.**

(5) Define acceleration? Then use **acceleration** in a sentence. Describe a time you felt it.

---

**Question:** Answer the following the reading.
LAB Instructions PAGE:

**Materials:** One roller car or constant velocity vehicles (tank), stop watch, lab manual and roller car lane.

**Duty assignments:** stop watch boss, data recorder, car roller, car receiver, safety boss supervises operations and reports to Mr. Burns regarding lab team issues.

**NOTE:** Rotate duty assignments – give everyone a chance to roll car or operate tanks.

**Warning:** No intentional smashing or crashing of the roller cars. No “speeding” be safe and roll slow. DO NOT STAND ON ROLLER CAR AS THOUGH IT WERE A ROLLER SKATE

**Instructions:** Know your equipment. How will you calculate speed accurately? Will you be accurate with the tape measure? Can you be precise with the stop watch? Think about the best way to get an accurate constant speed from start to finish. Use low speeds and practice with the stop watches.

Everyone is responsible for collecting all of the data. If ABSENT, you must make up the lab or make other arrangements with myself.

-----------------------------------------------

Roller cars:

The timer has to focus to try and start and stop the watch when the car crosses at just the right moment. The car driver must communicate with stop watch operator to get a precise timing.

Eliminate a trial if something goes wrong. For example if the car bumps the table or stool leg, stop watch error, or other mess up.

-----------------------------------------------

Tanks:

The timer has to focus to try and start and stop the watch when the car crosses at just the right moment. Click start only when the tank is rolling and hits the tape start and then again when it hits the tape finish. Eliminate a trial if something goes wrong. For example if the tank bumps something, stop watch error, or other mess up.
DATA TABLE I: *Average Speed Calculation* - Roller Car

<table>
<thead>
<tr>
<th>TRIALS</th>
<th>Distance (ft)</th>
<th>TIME sec.</th>
<th>Speed:</th>
<th>Roller’s Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(6) What was your car’s average *speed* across the classroom floor? _________________

(7) What was your car’s velocity on your final trial across the classroom? _________________

The library is **west** of classroom.

**GRAPH: Average Speed**

- Graph speed/velocity.
- Label x and axis appropriately.
- Be sure and title your graph too.
- Label all units
- Plot some reference data

```
```

```
```
DATA TABLE 2: Constant Speed Calculation - Constant Velocity Vehicle TANKS

<table>
<thead>
<tr>
<th>TRIALS</th>
<th>Distance (ft)</th>
<th>TIME sec.</th>
<th>Speed:</th>
<th>Tank Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(8) What was your tank’s constant speed across the hallway floor? ____________________

(9) What was your car’s velocity on your final trial across the hallway floor? ____________________

The library is west of classroom.

GRAPH: Constant Speed

- Graph speed/velocity.
- Label x and axis appropriately.
- Be sure and title your graph too.
- Label all units
- Plot some reference data

__________

__________
Newton's First Law (Law of Inertia)

According to Newton's first law, the marble on that bottom ramp should just keep going. And going and going and going...

An object at rest will stay at rest, forever, as long as nothing pushes or pulls on it. An object in motion will stay in motion, traveling in a straight line, forever, until something pushes or pulls on it.

The "forever" part is difficult to swallow sometimes. But imagine that you have three ramps set up as shown below. Also imagine that the ramps are infinitely long and infinitely smooth. You let a marble roll down the first ramp, which is set at a slight incline. The marble speeds up on its way down the ramp. Now, you give a gentle push to the marble going uphill on the second ramp. It slows down as it goes up. Finally, you push a marble on a ramp that represents the middle state between the first two -- in other words, a ramp that is perfectly horizontal. In this case, the marble will neither slow down nor speed up. In fact, it should keep rolling.

Inertia – is the tendency of a body (our roller car) at rest to remain at rest, or if having been acted on by a force (you rolling the car) to stay in motion in a straight line unless acted on by an outside force. It is the resistance of a body to changing momentum. Once set in motion an object will continue along that path forever, unless acted on by another outside force. Gravity, friction & air resistance are all forces acting on our car here on earth.

(6)Why doesn’t our roller car, roll on forever the way inertia suggests? Disregard the fact that there is a wall in the way. Use the words friction and air resistance in your answer.
Draw a diagram of your roller car and the track our 12” by 12” tile floor. It can be top-down, in profile, horizontal, vertical, color coded, be creative. However, you must label the following: **Start & Finish**

- Acceleration “zone” and/or Deceleration “zone”
- Constant speed “zone”
- Approximate time in fractions of a second along the track, ex: 0.25s, 0.5s, 0.75s etc.
- Label east (toward stairwell and Rm 31) and west (toward Library)
- Draw your car and label with a vector arrow and its speed with proper units.
Math Section:

Write out formula, show work, box answer w/ proper units.

Write out the 3 equations concerning speed, in the boxes below.

(1) – SPEED (2) – DISTANCE (3) - TIME

(4) Convert your roller cars approximate average speed from ft/s to m/s
   1 foot equals 0.3048 meters: (1’ = 0.3m)

(5) Convert the tank’s constant speed from 9.84 ft/s to meters per second.
   1 foot equals 0.3048 meters: (1’ = 0.3m)

(6) Suppose your roller car traveled a distance of 9 meters. You timed the distance traveled at 6 seconds.
    What was your average speed?

(7) Suppose your roller car traveled a distance of 6 meters. You timed the distance traveled at 2 seconds.
    What was your average speed?

(8) Suppose your roller car traveled a distance of 10 ft. You timed the distance traveled at 2.25 seconds. What was the speed in meters per second?
(9) Your roller car’s speed is clocked at 3.5 meters per second by radar gun. Your stop watch says 3.2 seconds. Find the distance for your lab report. Calculate the distance traveled.

(10) Your roller car’s speed is clocked at 4.689 m/s by radar gun. Your stop watch says 2 seconds. However, the tape came up off the floor during lab and you desperately must find the distance for your Lab report. Calculate the distance traveled.

(11) You know the roller car’s speed to be exactly 5 m/s. Your stop watch has broken however. The distance is 20 feet. You must report the time in seconds. However, your speed is in m/s and your distance is in feet so you must first convert the units.

(12) You know the roller car’s speed to be exactly 4 m/s. Your stop watch has broken however. The distance is 10 meters. Report the time in seconds.

(13) Suppose your roller car traveled a distance of 6 meters. You timed the distance traveled at 2 seconds in the direction of the library. What was your roller car’s velocity? \(V = \frac{d}{t} \) & direction

(14) Suppose your roller car traveled a distance of 6.096 meters. You timed the distance traveled at 1.3 seconds in moving in the direction of the stairwell. What was your roller car’s velocity? \(V = \frac{d}{t} \) & direction