SPEED / Velocity / Acceleration

Calculating Speed with Roller Cars

Part A

NAME ___________________ Per ___ Due date ___________ Mail Box_______

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$\text{Distance} = \text{Speed} \times \text{Time}$$

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

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-rodders and drag racers built and souped up racers using car engines, piston aircraft engines and, eventually, 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.

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Velocity – There is a distinction between speed and velocity. Speed describes only how fast an object is moving, whereas velocity gives both how fast and in what direction the object is moving. If a car is said to travel at 60 km/h, its speed has been specified. However, if the car is said to move at 60 km/h to the north, its velocity has now been specified.

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 average velocity 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 always set while driving on a straight path with a *constant velocity* and speed, no circles or turning.

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Acceleration – In physics acceleration or deceleration, is the **rate of change** of speed of an object. An object's acceleration is the net result of all forces acting on the object, as described by Newton's Second Law. The Standard International (SI) unit for acceleration is meters per second squared (ms^2).

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. If the car turns, there is an acceleration toward the new direction. You can feel the **force** of acceleration of car as it pushes you back into your seat just like the land speed racers on Utah's Bonneville Salt Flats. They just likely felt this **force** pushing them back into their seats a *little* more so. Deceleration is a **force** too, felt any time the brakes are applied and the seat belt feels snug 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 →**____________________________

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

(1) – SPEED	(2) – DISTANCE	(3) - TIME

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Velocity -

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

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

Hint: ####, units, direction Make up an example and **WRITE →**____________________________

(4) What kind of velocity does a *land speed record* setter and there car have?

WRITE →____________________________

(5) Think about how fast they are going and why they must maintain a *constant velocity*? Why was it a good idea to travel in a straight line and not try turning at those high speeds?

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Acceleration -

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

WRITE →____________________________

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

WRITE →____________________________

Acceleration cont.-

(8) Describe acceleration in your own words using a compete sentence?

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Wheel Driven Land Speed Record

←←←← "Making Science Relevant"

The ***wheel-driven land speed record*** *differs from the [absolute land speed record] in requiring that the vehicle be wheel-driven; thus, jet engine and rocket propelled vehicles are ineligible.*

The chart you will look at below contains only wheel driven cars, meaning cars with a more standard engine like what you more typically think use to riding in. They have combustion engines with pistons and a drive shaft that makes the wheels go around. The absolute land speed record includes "cars" that are jet or rocket propelled and really more like jet air planes just without wings.

Until 1963, the absolute land speed record holder was always a wheel-driven car. The first jet-car to exceed the absolute record was Craig Breedlove's Spirit of America. Since then, no wheel-driven car has held the absolute record.

There is no "wheel-driven" category as such. The Fédération Internationale de l'Automobile (FIA) *validates records in a variety of classes, of which the "wheel-driven" classes are in Category A (Special cars) and Category B (Production cars). The accepted record is fastest average speed recorded over one mile or one kilometer with a flying start, averaged over two runs in opposite directions within one hour of each other. The most recent Wheel-driven" record holders have been from a variety of different classes within Category A.*

Category A Special cars are more than fast enough for our purposes of learning about speed.

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QUESTIONS:

(9) Which are faster wheel-driven cars or absolute land speed record cars? ______________________

(10) Why are they faster? Explain, and mention the type of engine advantage that they have?

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Bonus: In your opinion is even fair to have Category A compete against Category B? State a claim and then defend your position *scientifically*.

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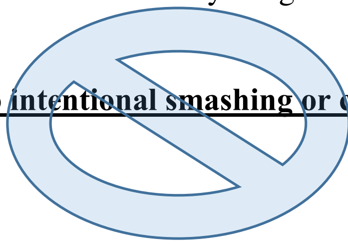
LAB Instructions PAGE:

Materials: One roller car, one stop watch, lab manual and roller car lane**.**
NOTE: we may need to share lanes

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.

Warning: No intentional smashing or crashing of the roller cars. No "speeding" be safe and roll slow.



Instructions: Take several practice trials 1-3 to make sure you get a feel for how the cars roll. Practice with the stop watches during this time as well. 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.

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DATA TABLE I: *Constant Speed Calculation*

TRIALS	Distance (ft)	TIME sec.	Speed units:	Roller's Name
Trial 1				
Trial 2				
Trial 3				
Trial 4				

"Try and make your roller *cruise* at **constant speed** from start to finish by releasing just before the start and catching it just after. The timer has to focus to try and start and stop the watch when the car crosses at just the right moment."

Take the average of your 3 best trails that have the closest times. 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.

(11) What was your car's average ***constant speed*** across the classroom floor? ______________________

(12) What was your car's velocity on your final trial across the classroom? ______________________

DATA TABLE II: *Deceleration Calculation*

TRIALS	Distance (ft)	TIME sec.	Speed units:	Roller's Name
Trial 1				
Trial 2				
Trial 3				

"Try and coast your car nice and slow so it just crosses the finish line, kind of like *curling*." Try and simulate negative acceleration.

GRAPH: *Deceleration*

- Graph what your car's deceleration looks like.
- Put time on the **x-axis** and distance on the **y-axis**.
- Be sure and title your graph too.
- Label the units

GRAPH: *Speed / Velocity*

- Graph speed/velocity.
- Put time on the **x-axis** and distance on the **y-axis**.
- Be sure and title your graph too.
- Label the units

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(13) What the roller car's units of speed? ____________________

(14) How do your graphs of speed and deceleration differ? Explain why ____________________________
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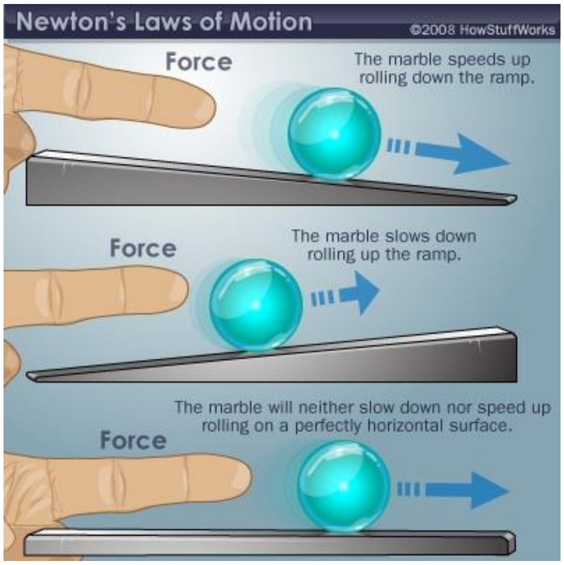
Newton's First Law (Law of Inertia)



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.


Sir Isaac Newton

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 change 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.

(15)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 **gravity** in your answer.

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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:

Label: Start & Finish

Acceleration “zone” & 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: <u>Units for Speed</u>

- m/s (meters per second)
- mi/h (miles per hour)
- km/h (kilometers per hour)
- ft/s (feet per second)

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$\text{Distance} = \text{Speed} \times \text{Time}$$

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

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

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

(18) Suppose your roller car traveled a distance of 6.096 meters. You timed the distance traveled at 1.3 seconds. How fast did your car go on this trial?

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

(20) 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.

(21) 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?

(22) 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?