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WS Assessment

Target 12:

Driving safely data

**I can:**

* Use the formula for the relationship between distance, fuel economy, and gas usage.
* Calculate and use the total stopping distance in both the English Standard and Metric Systems.
* Determine the minimum skid speed using the skid mark formula, yaw mark formula.

**Unit 5 Math Topics:**

* Circles (radius, diameter, chord)
* Distance Formula
* Exponential growth and decay
* Linear equations and inequalities
* Linear and exponential functions
* Measures of central tendency
* Metric System
* Natural logarithm
* Percent and Proportions
* Piecewise functions
* Range
* Read and interpret data: frequency tables, stem-and-leaf plots, box plots
* Quartiles
* Straight line equations (depreciation)
* Slope, slope-intercept form
* Square root equations
* Spreadsheets and formulas
* Systems of linear equations and inequalities in two variables

The dashboard of an automobile is an information center. It supplies data on fuel, speed, time, and engine-operating conditions. It can also give information on the inside and outside temperature. Some cars even have a global positioning system mounted into the dashboard. This can help the driver find destinations or map out alternate routes. Your cellular phone can be wirelessly connected to your car so that you can send and receive hands-free calls. There have been many advances in the information that the driver has available to make trips safer, smarter, and more energy efficient.

The **odometer** indicates the distance a car has traveled since it left the factory. The speedometer tells

you the rate at which the car is traveling. The rate, or speed, is reported in miles per hour (mi/h or mph) or kilometers per hour (km/h or kph). Drivers are concerned not only with distance traveled and speed,

but also with the amount of gasoline used. Gasoline is sold by the gallon or the liter. Economizing on fuel is a financial necessity. Car buyers are usually interested fuel economy measurements. These are calculated in miles per gallon (mi/g or mpg) or kilometers per liter (km/L). In order to understand these fuel economy measurements, it is necessary to have a good sense of distances in both the English Standard System of measurement used in the United States, and the Metric System of measurement used in most countries throughout the world.

1 kilometer ≈ 0.621371 mile 1 liter ≈ 0.26 gallons

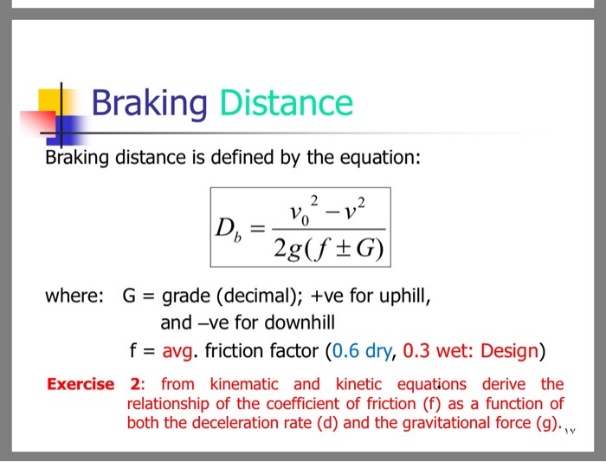
1 mile ≈ 1.60934 kilometers 1 gallon ≈ 3.8 liters

Danielle drove from Atlanta, Georgia, and Denver, Colorado, which is a distance of 1,401 miles. If she averaged 58 miles per hour on her trip, how long is her driving time? Express your answer rounded to the nearest tenth of an hour and to the nearest minute.

Bill left Burlington, Vermont, and traveled to Ottawa, Ontario, the capital of Canada. The distance from Burlington to the Canadian border is approximately 42 miles. The distance from the Canadian border

to Ottawa is approximately 280 kilometers. If it took him 4.3 hours to complete the trip, what was his average speed in miles per hour? In kilometer per hour? If he filled up the tank with gas that cost $4.15 per gallon, her total bill for the trip was $59.76 find his car mileage in miles per gallon and kilometer per liter? He need to fill the tank again for his trip back, how much it cost him in Canadian dollars? How much is gas price in Canada? Dollars per litter?

Reid will be driving through Spain this summer. He did some research and knows that the average price of gas in Spain is approximately 1.12 euros per liter. a. What is this amount equivalent to in U.S. dollars? What is this rate equivalent to in U.S. dollars per gallon?

Although a dashboard can give you much information about the car’s ability to **go**, it gives little or no information about the car’s ability to **stop**. It takes time to stop a moving car safely. Even during the time your foot switches from the gas pedal to the brake pedal, the car continues to travel.

The average, alert driver takes from approximately three-quarters of a second to one and a half seconds to switch from the gas pedal to the brake pedal. This time is the **reaction time** or **thinking time**. During the reaction time, the car travels a greater distance than most people realize. That distance is the **reaction distance**. The distance a car travels while braking to a complete stop is the braking distance.

Suppose your reaction time is 1 seconds, find the reaction distance of a car travelling 55 mi/h in feet?

*A conservative rule of thumb for the reaction distance is that a car travels about one foot for each mile per hour of speed*.

What is the approximate braking distance for a car traveling at 48 mi/h? Given the general formula for the braking distance is

Rachel is driving at 48 mi/h on a one-lane highway. She sees an accident directly ahead of her about 200 feet away. Will she be able to stop in time?

Total stopping distance = Reaction distance + Braking distance

Desireé is traveling through Canada. Determine Desireé’s total stopping distance if she is traveling

88 kilometers per hour.

Toni’s car is traveling 75 km/h. Randy’s car is behind Toni’s car and is traveling 72 km/h. Toni notices a family of ducks crossing the road 50 meters ahead of her. Will she be able to stop before she reaches the ducks? What is the least distance that Randy’s car can be from Toni’s car to avoid hitting her car, if he reacts as soon as he sees her brakes?

Model the total stopping distance by the equation where x represents the speed in km/h and y represents the total stopping distance in meters.

a. Graph this equation for the values of x, where x ≤100 km/h.

b. Use the graph to approximate the stopping distance for a car traveling at 60 km/h.

c. Use the graph to approximate the speed for a car that stops completely after 60 meters.

Auto accidents happen. Many times, it is clear who is at fault, but that may not always be the case. When fault is uncertain, it is up to the authorities to get detailed and accurate information from witnesses and each of the parties involved. It may be necessary to examine the data that was left behind at the scene. That data is interpreted by **accident reconstructionists**, who have knowledge of both crime scene investigations and mathematics that can help them understand the circumstances surrounding the accident.

Reconstructionists pay very close attention to the marks left on the road by the tires of a car. A skid mark is a mark that a tire leaves on the road when it is in a locked mode, that is, when the tire is not turning, but the car is continuing to move. When the driver first applies the brakes, the skid mark is light and is a **shadow skid mark**. This mark darkens until the car comes to a complete stop either on its own or in a collision. Some cars have an **anti-lock brake system (ABS),** which does not allow the wheels to continuously lock. In cars equipped with this feature, the driver feels a pulsing vibration on the brake pedal and that pedal moves up and down. The skid marks left by a car with ABS look like uniform dashed lines on the pavement. A driver without ABS may try to simulate that effect by pumping the brakes. The skid marks left by these cars are also dashed, but they are not uniform in length. When a car enters a skid and the brakes lock (or lock intermittently), the driver cannot control the steering. Therefore, the skid is usually a straight line. The vehicle is continuing to move straight ahead as the wheels lock making the tire marks straight. When the vehicle is slipping sideways

while at the same time continuing in a forward motion, the tire marks appear curved. These are called **yaw marks**.

Taking skid and yaw measurements, as well as other information from the scene, can lead reconstructionists to the speed of the car when entering the skid. The formulas used are often presented in court and are recognized for their strength in modeling real world automobile accidents.

<https://www.youtube.com/watch?v=c3q9_MesC3c>



The braking efficiency of the car. is determined by an examination of the rear and front wheel brakes. It can run from 0% efficiency (no brakes at all) to 100% efficiency (brakes are in excellent condition). The braking efficiency number is expressed as a decimal when used in the formula.

The drag factor is the pull of the road on the tires. It is a number that represents the amount of friction that the road surface contributes when driving. Many accident reconstructionists perform drag factor tests with a piece of equipment known as a drag sled. The table lists acceptable ranges of drag

factors for the road surfaces.

A car is traveling on an asphalt road with a drag factor

of 0.78. The speed limit on this portion of the road is

35 mi/h. The driver just had his car in the shop and his mechanic informed him that the brakes were operating at 100% efficiency. The driver must make an emergency stop, when he sees an obstruction in the road ahead of him. His car leaves four distinct skid marks each 80 feet in length. What is the minimum speed the car was traveling when it entered the skid? Round your answer to the nearest tenth. Was the driver exceeding the speed limit when entering the skid?

Melissa was traveling at 50 mi/h on a concrete road with a drag factor of 1.2. Her brakes were working at 90% efficiency. To the nearest tenth of a foot, what would you expect the average length of the skid marks to be if she applied her brakes in order to come to an immediate stop?

**Yaw Marks formula**  where f is drag factor and r is the radius of the arc of the yaw mark

An accident reconstructionist took measurements from yaw marks left at a scene. Using a 43-foot length chord, she determined that the middle ordinate measured approximately 4 feet. The drag factor for the road surface was determined to be 0.8. Determine the radius of the curved yaw mark to the nearest tenth of a foot. Determine the minimum speed that the car was going when the skid occurred to the nearest tenth.

**Assessment Target 12**

**I can…** se the formula for the relationship between distance, fuel economy, gas usage and skid mark

Marielle was in an accident. She was traveling down a road at 36 mi/h when she slammed on her brakes. Her car left two skid marks that averaged 50 ft in length with a difference of 4 ft between

them. Her brakes were operating at 80% efficiency at the time of the accident. What were the lengths of each skid mark? What was the possible drag factor of this road surface?

A car leaves four skid marks each 50 feet in length. The drag factor for the road is 0.9. Let x represent the braking efficiency. What is the range of values that can be substituted for x?

Let the speed be represented by the variable y and x represent the braking efficiency. Write the skid speed equation in terms of x and y.

Graph the skid speed equation using the braking efficiency as the independent variable and the skid speed as the dependent variable. Stamp

Use your graph to estimate the skid speed for braking efficiencies of 20%, 40%, 60%, 80%, and 100%.

Juanita is an accident reconstruction expert. She measured a 70-ft chord from the outer rim of the yaw mark on the road surface. The middle ordinate measured 9 ft in length. The drag factor of the road

surface was determined to be 1.13. Determine the radius of the yaw mark to the nearest tenth of a

foot. Determine the minimum speed that the car was going when the

skid occurred to the nearest tenth.