Analyzing Numerical Data: Using Ratios
I.B Student Activity Sheet 5: Changing Tires

You have just purchased a new vehicle equipped with factory-installed P245/70R16 tires. You think these tires look too small, so you replace them with P285/75R16 tires. How does this change in tire size affect the accuracy of speedometer and odometer readings? Specifically, your goal is to complete the following statements:
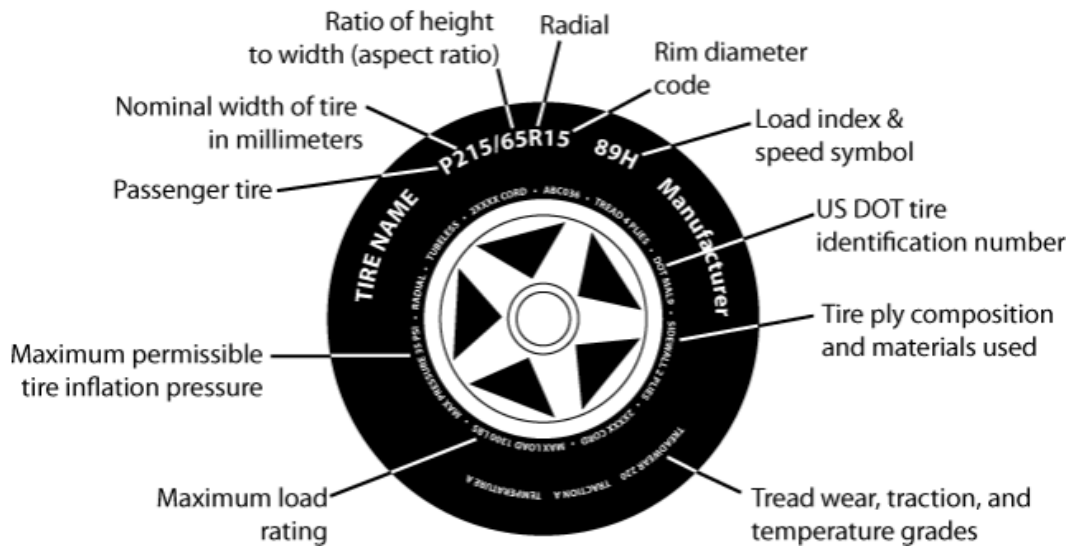
If your odometer reading is 2 0 0 0 0 *, you have actually traveled _____ miles.*

If your speedometer reading is 60, your actual speed is _____ miles per hour.

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The calibration of a vehicle's speedometer and odometer is based on the circumference of the vehicle's factory-installed tires. For the P245/70R16 tires,

- *P* means passenger tire;
- *245* specifies the tire's width in millimeters;
- *70* is the tire's aspect ratio—that is, the ratio of the tire's height to its width reported as a percent; and
- *16* is the diameter of the tire's rim in inches.

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1. Fill in the missing information for each tire size. Find the circumference of each tire.

Tire	P245/70R16	P285/75R16
Width (mm)		
Aspect ratio (%)		
Height (in.)		
Diameter (in.)		
Circumference (in.)		

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2. After one rotation of the wheel, how many inches further has the truck with the larger tires traveled than the truck with the factory-installed tires?

3. After one rotation of the wheel, the truck with the larger tires has traveled _____ times further than the truck with the factory-installed tires.

4. Use the results from the table in Question 1 to assist in completing the following statements about the truck after the larger tires have been installed on it.

If the odometer reading is 2 0 0 0 0 *, you have actually traveled _____ miles.*

If the speedometer reading is 60, your actual speed is _____ miles per hour.

The following principles apply when determining actual distance and speed traveled according to tire size:

Actual mileage = **k** • odometer reading (mileage)

Actual speed = **k** • speedometer reading (miles per hour)

where **k** = $\dfrac{\text{circumference of bigger tire}}{\text{circumference of factory-installed tire}}$

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5. What is the percent error in the odometer readings? In the speedometer readings?

6. Using the odometer readings in the truck equipped with the larger tires, you determine that the gas mileage is 18 miles per gallon. What is your actual gas mileage in miles per gallon?

7. If you were driving in the truck with the larger tires and the speedometer showed a speed of 65 miles per hour, could you be ticketed for exceeding the 65-mph speed limit by more than 5 mph? More than 10 mph? Justify your answers.

8. **REFLECTION:** What is the relationship between the ratio of an actual distance to an odometer distance of 1 mile and the ratio of the circumference of a current tire to the circumference of a factory-installed tire?

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9. **EXTENSION:** On your new small car, you replace the factory-installed P185/75R14 tires with slightly larger P205/75R14 tires. Find the missing number in each statement:

If your odometer reading is 2 0 0 0 0 *(miles), you have actually traveled* _____ *miles.*

If your speedometer reading is 60, your actual speed is _____ *miles per hour.*

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10. EXTENSION

The ability of birds and airplanes to fly is related to the aspect ratio of their wings.

Since early airplane wings were usually nearly rectangular, the aspect ratio of a wing was the ratio of the span of a wing or airfoil to the chord of a wing, where the span is the maximum cross-stream dimension (longer side) and the chord is the dimension in the stream-wise direction (shorter side), as shown in the figure below. Later, when wings were tapered or had complex platforms, another definition became necessary; currently, the general definition of aspect ratio is $A = \dfrac{b^2}{S}$, where A is the aspect ratio, b is the span, and S is the area.
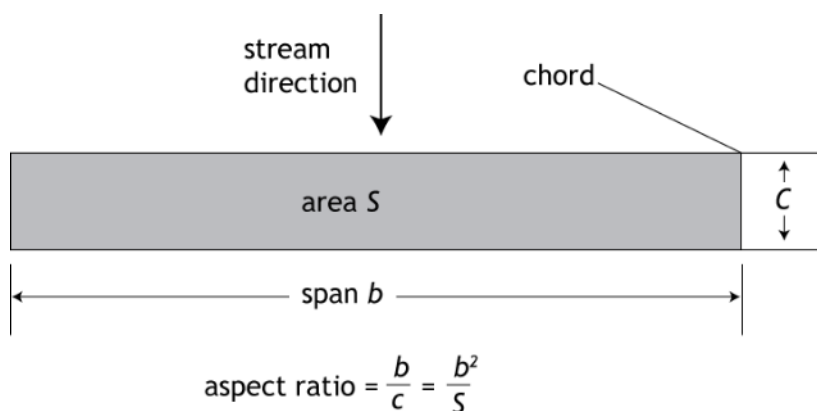
$$\text{aspect ratio} = \frac{b}{c} = \frac{b^2}{S}$$

Demonstrate that the current definition of the aspect ratio of a wing coincides with the earlier definition when the wing was rectangular.

Conduct independent research on how the aspect ratio of a wing is related to the flight of airplanes and birds.