

Gears: Figuring Out Pit Road Speed

If you listen to a driver's scanner prior to a race, you'll hear the spotter tell the driver something like, "Pit road speed...now." The driver will respond with two numbers, like "forty-three hundred, second gear." The driver is telling his crew that when the car is in second gear and going at pit road speed, the tachometer – which measures how fast the engine is rotating – reads 4500 rpm (revolutions per minute).

The tachometer is important because race cars don't have speedometers – the driver has to estimate his speed from the tachometer reading. The primary time a driver is concerned about not going too fast is on Pit Road. Pit Road speed limits range from 35 mph to 55 mph and are enforced to ensure the safety of the pit crews. The driver is penalized if he goes more than 5 mph faster than the Pit Road speed limit.

There are two ways to determine what the tachometer should read when the car is at Pit Road speed. Every race starts with parade laps, in which the race cars follow a *pace car*. During the parade laps, the pace car

travels at the Pit Road speed limit and the driver reports his tachometer reading to his crew chief.

Tachometer: A tachometer measures how fast the engine is turning. Race cars have tachometers instead of speedometers.

The second way of determining the appropriate tachometer reading is to calculate it – and that's what you're about to do. Your team is preparing to head to Watkins Glen, a road course in upstate New York. Your crew chief asks you to calculate the appropriate Pit Road tachometer readings so that the crew has an independent way to check the driver's reading during the parade laps.

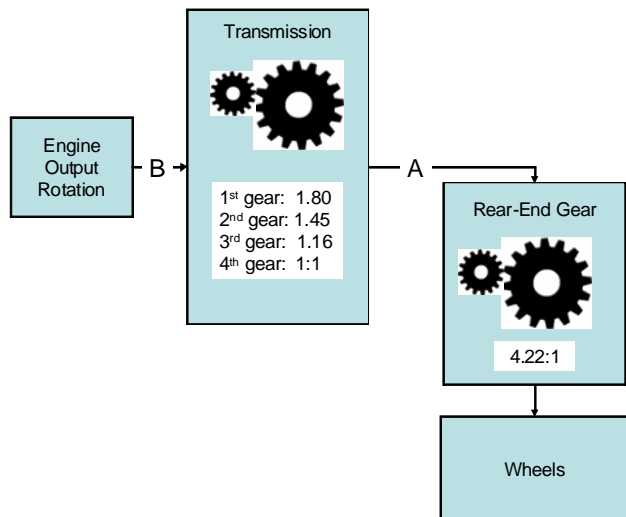
Pace Car: A car that is not in the race, but guides the race cars prior to the race so that they know when they are going at pit road speed, and during cautions so that all cars maintain a safe speed while there might be

Start Your Engines...

SE.1. The tires used at Watkins Glen have a circumference of 88.6 in (225 cm). Pit road speed is 35.00 mph (15.65m/s). How many rotations do the tires make in one minute?

SE.2. You head down to the engineering department and one of the employees gives you the gear ratios that are used in the transmission and the rear-end gear for this race, as shown below.

The first set of gears is in the transmission. There are five sets of gears in a NASCAR race car - four



forward gears, plus reverse. The set of gears closest to the rear (drive) wheels is the rear end gear. NASCAR gives the teams two or three choices for rear-end gears at each track. At Watkins Glen, your team is running a rear-end gear of 4.22:1, which you'll hear crew members call a "422, gear". They know that "422 means that the smaller gear makes 4.22 rotations for every 1 rotation the larger gear makes.

SE.3. The gears are drawn in the correct orientation in the picture above. Is the rotation rate before the rear-end gear greater than, less than or equal to the rotation rate of the wheels? Explain why.

SE.4. Starting from Pit Road speed and using the information from the drawing, find the rotation rate after the rear end gear is taken into account based on your calculation of how fast the wheels are moving. (This is the point labeled A in the figure.)

SE.5. By how much does the transmission change the rotation rate if the transmission is in second gear? (This is the rotation rate at point B.)

SE.6. What tachometer reading reflects the appropriate Pit Road speed?

Extension A: Changing Gears

EA.1. Sometimes the driver needs to be in first gear coming in to (or out of) a pit stop. Given the data from the main exercise, what should the tachometer read if the car is traveling at pit road speed in first gear?

Extension B: Stretching Pit Road Speed

EB.1. A car has to be going less than 5 mph over the Pit Road speed limit without being penalized. What would the tachometer read when the car is going at the maximum possible speed without getting in trouble?

EB.2. How fast would you tell your driver to go? Explain your reasoning

Extension C: Tire Size

EC.1. A car has an engine that rotates at 2500 rpm in third gear (1.190:1) with a rear-end gear of 3.60:1. How fast is the car going (in m/s) if the tires have a circumference of 225 cm?

The tire circumference changes from 82.1 inches (225 cm) to 95.1 inches(242 cm). How much does the speed change?

Extension D: How Precisely Can the Driver Estimate Speed?



<http://www.streetperformance.com/index.html?detailedlisting=252>

This is a picture of a tachometer like those used in NASCAR race cars. If the driver is running a 1.45:1 second gear in the transmission and a 4.22:1 rear-end gear, how precisely do you think the driver can read the gauge? The tires are 82.1 inches (225 cm) in circumference.