Quiz Answers: Gears and Speed

Introduction to Mobile Robotics > Gears and Speed Investigation

Condition	Teeth on driving gear (motor)	Teeth on driven gear (wheel)	Gear Ratio driven / driving	Time robot traveled (sec)	Distance robot traveled (cm)	Average distance robot traveled (cm)	Average Speed (cm/sec)
Condition 1	16	32	**2:1 or 2**	5	1) 17.9 2) 19.0 3) 18.1	**18.3**	**3.7**
Condition 2	8	**40**	5:1 or 5	5	1) 7.3 2) 7.8 3) 6.8	**7.3**	**1.5**
Condition 3	40	**8**	**1:5 or 0.2**	5	1) 180.0 2) 186.3 3) 184.0	**183.4**	**36.7**

1. Fill in all the blanks in the data table above. Use the space on this page (front, back, and additional pages if necessary) to show your work.

Condition 1

Gear Ratio

The gear ratio is defined by the number of teeth on the driven gear over the number of teeth on the driving gear.
Teeth on Driven Gear = 32
Teeth on Driving Gear = 16
Gear Ratio = (32/16) = (2/1) = *2*

Average Distance Traveled

The average is the sum of the numbers, divided by how many numbers there are (3)
Average Distance Traveled = (17.9cm + 19.0cm + 18.1cm)/3 = 55.0cm / 3 = *18.3cm*

Average Speed

Average Speed is calculated by dividing the Average Distance Traveled by the time (in seconds) to travel that distance
Average Speed = (Average Distance Traveled) / (time robot traveled) = 18.3cm / 5sec = *3.7cm/sec*

Condition 2

Teeth on Driven Gear

This can be back-calculated from the Gear Ratio. We know that Gear Ratio is defined as Teeth on Driven Gear divided by Teeth on Driving Gear. We can isolate the unknown quantity "Teeth on Driven Gear" as a function of the Gear Ratio and the Teeth on Driving Gear to get this equation:
Teeth on Driven Gear = Gear Ratio x Teeth on Driving Gear
Now, substitute in the two known quantities, Gear Ratio and Teeth on Driving Gear, and you get:
Teeth on Driven Gear = 5 x 8 = *40 teeth*

Average Distance Traveled
The average is the sum of the three numbers, divided by how many numbers there are (3)
Average Distance Traveled = (7.3cm + 7.8cm + 6.8cm)/3 = 21.9cm / 3 = *7.3cm*

Average Speed
Average Speed is calculated by dividing the Average Distance Traveled by the time (in seconds) to travel that distance
Average Speed = (Average Distance Traveled) / (time robot traveled) = 7.3cm / 5sec = *1.5cm/sec*

Condition 3

This condition is slightly more difficult than the first two, because it gives you neither Gear Ratio nor Teeth on Driven Gear. We can find its relationship to the other two conditions through Hypothesis 2 from the Gears and Speed Investigation. Hypothesis 2 states:

(Speed 2 x Gear Ratio 2) = (Speed 3 x Gear Ratio 3)

To use this, we'll need the Average Speed (Speed 3) for this condition, so we need to calculate the Average Distance and then Average Speed

Average Distance Traveled
The average is the sum of the three numbers, divided by how many numbers there are (3)
Average Distance Traveled = (180.0cm + 186.3cm + 184.0cm)/3 = 550.3cm / 3 = *183.4cm*

Average Speed
Average Speed is calculated by dividing the Average Distance Traveled by the time (in seconds) to travel that distance
Average Speed = (Average Distance Traveled) / (time robot traveled) = 183.4cm / 5sec = *36.7cm/sec*

Gear Ratio
Now we know that the speed of the robot with Gear Ratio 3 is 36.7cm/sec (Speed 3).
We can find Gear Ratio 3 itself by using this speed, and comparing it Condition 2 using Hypothesis 2

(Speed 2 x Gear Ratio 2) = (Speed 3 x Gear Ratio 3)

Speed 2 = 1.5cm/sec
Gear Ratio 2 = 5
Speed 3 = 36.7cm/sec
By substituting these numbers into the Hypothesis 2 equation we get

(1.5cm/sec x 5) = (36.7cm/sec x Gear Ratio 3)

The only unknown is now Gear Ratio 3, so we can solve for it
Gear Ratio 3 = (1.5cm/sec x 5)/(36.7cm/sec) = *0.2*
So Gear Ratio 3 = 0.2 or 1/5, which is a 1:5 Gear Ratio

Teeth on Driven Gear
Now that we know the Gear Ratio as well as the number of teeth on the driving gear, we can fill in the last blank, the number of teeth on the driven gear like we did in Condition 2.
Teeth on Driven Gear = Gear Ratio x Teeth on Driving Gear
Now, substitute in for the two known quantities, Gear Ratio and Teeth on Driving Gear, and you get:
Teeth on Driven Gear = 40 x 0.2 = *8 teeth*

Students may also come to this number by guessing, by looking at the gear sizes in Condition 2. Noting that the gears in Condition 2 have 8 and 40 teeth, respectively, they may guess that the unknown gear in Condition 3 had 8 teeth, since the known gear has 40 teeth.