Before the Stop

Read an equation and table in a braking model

11-12.RST.4 "Determine the meaning of symbols, equations, graphical and tabular representations, domain-specific and content-specific words and phrases including relationships among key terms (e.g., force, friction, reaction force…"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each term the passage defines, circle its matching symbol if it has one, and number the table rows from shortest to longest braking distance. Use your marks to connect the words, equation, and data.

How Far Does a Car Travel While Braking?

1 On a level road, a driver sees a fallen branch and presses the brake pedal. The car does not stop at once. During braking, friction at the tires limits how quickly the car can slow down. In this simplified model, the tires keep their grip, and the road and tire pair is represented by μ, a dimensionless measure of available traction.

2 The model uses $d = v^2/(2\mu g)$, where d is braking distance in meters, v is the speed when braking starts in meters per second, and g is about 10 meters per second squared. The exponent means speed is multiplied by itself. The table uses this equation and assumes the same car and level road throughout.

MODEL BRAKING DISTANCES AT 10 M/S, WITH G = 10 M/S²

Road surface	Traction measure μ	Braking distance d (m)
Dry pavement	0.8	6.25
Wet pavement	0.4	12.5
Packed snow	0.2	25

3 These numbers describe only the motion after the driver begins braking. Before that moment, the car travels during the driver's reaction time. That added travel is called reaction distance; total stopping distance combines reaction distance and braking distance. Real braking can differ from the model if the tires, road texture, or slope change.

2 ANSWER WITH EVIDENCE

Use the passage

1. In the equation and table, what does μ represent? Why is it not measured in meters?

2. Compare the dry and wet pavement rows. What happens to d when μ is cut in half at the same speed? How does the equation explain this?

3. If the car starts braking at twice the table's speed on dry pavement, by what factor does the model's braking distance change? Explain the role of the exponent.

4. A driver claims that the wet pavement row gives total stopping distance. Which term in the passage shows why that claim is incorrect?

3 YOUR TURN

Your own words

For a car that starts braking at 15 m/s on packed snow, write three sentences. Calculate its model braking distance using the equation and table, explain why it differs from the table value, and identify why total stopping distance would be longer.

Before the Stop

PART 1 · READ AND MARK

Underline each term the passage defines, circle its matching symbol if it has one, and number the table rows from shortest to longest braking distance. Use your marks to connect the words, equation, and data. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	In the equation and table, what does μ represent? Why is it not measured in meters?	**μ measures available tire-road traction. It is dimensionless, not a distance.**
2	Compare the dry and wet pavement rows. What happens to d when μ is cut in half at the same speed? How does the equation explain this?	**Braking distance doubles, from 6.25 m to 12.5 m. Because μ is in the denominator, halving it doubles d when v and g stay fixed.**
3	If the car starts braking at twice the table's speed on dry pavement, by what factor does the model's braking distance change? Explain the role of the exponent.	**It becomes four times as long. Doubling v multiplies v^2 by four.**
4	A driver claims that the wet pavement row gives total stopping distance. Which term in the passage shows why that claim is incorrect?	**Reaction distance. Total stopping distance includes travel during reaction time as well as the table's braking distance.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

On packed snow, μ is 0.2, so $d = 15^2/(2 \times 0.2 \times 10) = 56.25$ meters. This exceeds the table's 25 meters because the starting speed is higher while μ stays the same. Total stopping distance is longer because the car also travels during the driver's reaction time.

Accept equivalent explanations that connect the symbols to their meanings in this model. For the final task, the calculated braking distance must be 56.25 m, and the response must distinguish it from total stopping distance.