How to Find Average Velocity of a Multi-Part Trip

Physics with Tiaotiao 跳跳 · Kinematics · High School Physics

Study sheet for the video "How to Find Average Velocity of a Multi-Part Trip": key ideas, practice questions, answers

Matches: NCERT Class 11 Ch 2 · FSc Part 1 Ch 3 · AS & A Level 9702 · WAEC/JAMB · HSC · AP Physics 1 Unit 1 · College Physics

Key ideas

Two big ways to analyze a problem: **piecewise analysis** (cut the motion into parts, e.g. a vertical throw: up = slowing down, down = speeding up) and **overall analysis** (treat the whole thing as one, e.g. a stack of blocks as one body).

This problem type trains you to see a problem as a whole.

How to spot it: **one-way straight-line motion**, and you must find the average velocity of the whole trip. You are given the average velocity of each segment. The trip is split in one of two ways: by time or by displacement.

Core idea: average velocity is always **x / t**, whether the motion is uniform or not, speeding up or slowing down.

1. Find the **total displacement** x.
2. Find the **total time** t.
3. Divide: x / t is the average velocity of the whole trip.

Keep telling yourself: look at the whole. Put all your attention on the total displacement and the total time.

Problem-solving card: multi-segment average velocity

Split by time (Example 1)



Use time to find the total displacement

Split by displacement (Example 2)



Use displacement to find the total time

Either way, end with: $\bar{v} = \frac{x}{t}$ (total displacement ÷ total time)

Split by time	Split by displacement
You are given the average velocity in each time segment. Use time to find the total displacement.	You are given the average velocity over each displacement segment. Use displacement to find the total time. The calculation is a bit harder.

Practice

Try these before checking the answers on the next page.

1. A particle moves along a straight line, always in the same direction. In the first 2/3 of the time its average velocity is v/2; in the last 1/3 of the time it is 2v. What is the average velocity of the whole trip? ( )

A. 3v/4 B. 3v/2 C. v D. 2v/3

Answer: _____ Working:

2. A particle moves along a straight line, always in the same direction. Its average velocity is v_1 over the first 1/3 of the displacement and v_2 over the last 2/3. What is the average velocity of the whole trip?

Answer: _____ Working:

3. A car drives along a straight, level road. It first travels 1/4 of the whole distance at 20 m/s, then travels the remaining 3/4 of the distance at speed v. The average velocity for the whole trip is 16 m/s. Then v equals ( )

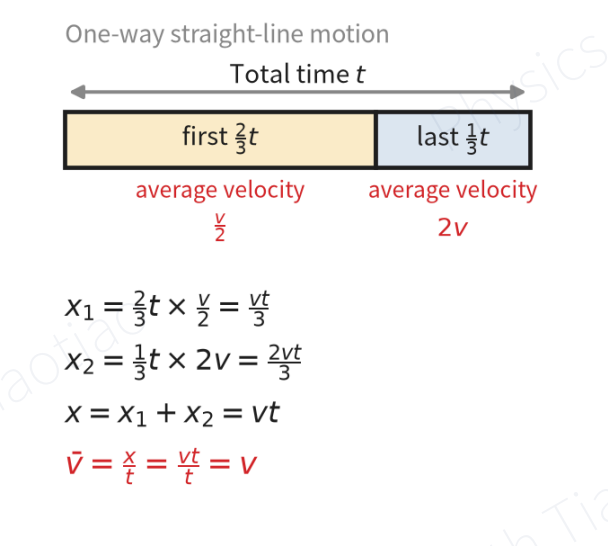
A. 18 m/s B. 36 m/s C. 15 m/s D. 17.1 m/s

Answer: _____ Working:

Answers and explanations

Tap a blue time to jump to the part of the video that explains the question.

1. C. One-way straight line, and we are given time information, so split by time. Let the total time be t. Segment 1 lasts 2t/3 and segment 2 lasts t/3.
x_1 = (2t/3)(v/2) = vt/3, x_2 = (t/3)(2v) = 2vt/3, so x = x_1 + x_2 = vt. Then average velocity = x / t = v.

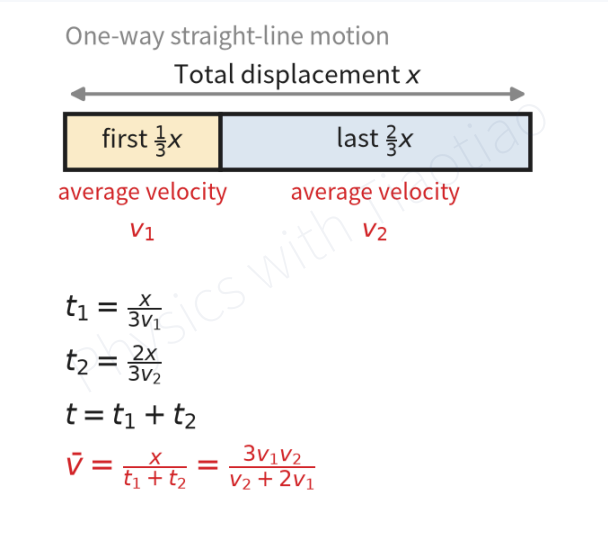


$$x_1 = \frac{2}{3}t \times \frac{v}{2} = \frac{vt}{3}$$
$$x_2 = \frac{1}{3}t \times 2v = \frac{2vt}{3}$$
$$x = x_1 + x_2 = vt$$
$$\bar{v} = \frac{x}{t} = \frac{vt}{t} = v$$

Do not average v/2 and 2v directly. Always use total displacement ÷ total time.

▶ **Watch 6:16, Example 1**

2. $3v_1v_2 / (v_2 + 2v_1)$. We are given displacement information, so split by displacement. Let the total displacement be x. Segment 1 is x/3 and segment 2 is 2x/3.
t_1 = (x/3) ÷ v_1 = x / (3v_1), t_2 = (2x/3) ÷ v_2 = 2x / (3v_2). Then average velocity = x / (t_1 + t_2). Cancel x and use a common denominator to get $3v_1v_2$ / (v_2 + 2v_1).

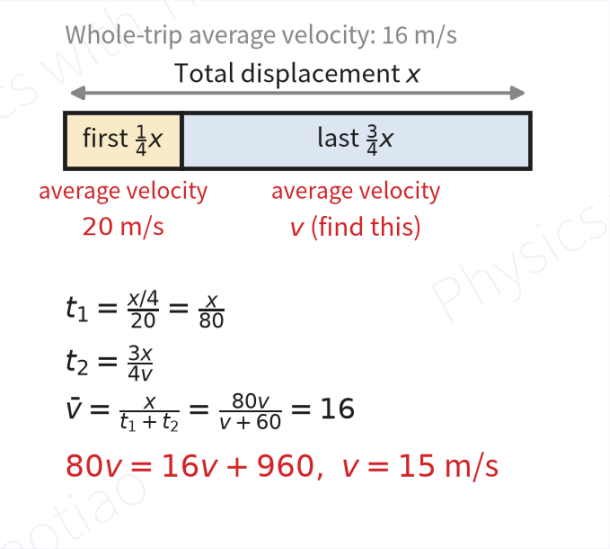


$$t_1 = \frac{x}{3v_1}$$
$$t_2 = \frac{2x}{3v_2}$$
$$t = t_1 + t_2$$
$$\bar{v} = \frac{x}{t_1 + t_2} = \frac{3v_1v_2}{v_2 + 2v_1}$$

Check: if v_1 = v_2 = v, the result is v.

▶ **Watch 8:27, Example 2**

3. C. Split by displacement. Let the total displacement be x. Then t_1 = (x/4) ÷ 20 = x/80 and t_2 = (3x/4) ÷ v = 3x/(4v).
Average velocity = x / (t_1 + t_2) = 80v / (v + 60) = 16. So 80v = 16v + 960, and v = 15 m/s.



▶ **Watch 10:49, Example 3**

One-line summary

Look at the whole: find the total displacement and the total time, then divide. Split by time → use time to find displacement. Split by displacement → use displacement to find time.

Key terms

Term	Meaning	Chinese
average velocity	total displacement divided by total time	平均速度 píngjūn sùdù
total displacement	the displacement of the whole trip	总位移 zǒng wèiyí
total time	the time of the whole trip	总时间 zǒng shíjiān
piecewise analysis	cutting a motion into parts and studying each	分段分析 fēnduàn fēnxī
overall analysis	treating the whole as one	整体分析 zhěngtǐ fēnxī
one-way straight-line motion	moving along a straight line, never turning back	单向直线运动 dānxiàng zhíxiàn yùndòng
split by time / by displacement	the two ways a trip is cut into segments	按时间 / 按位移分段 àn shíjiān / àn wèiyí fēnduàn