

Substitute Guide: Interpreting Motion Graphs

Course: Physics (Grades 9–12) **Subject:** Science **Time:** ~50 min standard · ~90 min block Science

Learning goal (plain language)

Students learn to **read and interpret motion graphs** — a **position–time** graph (where the **slope is the velocity**) and a **velocity–time** graph (where the **slope is the acceleration** and the **area under the line is the displacement**). Working alone with a pencil (a calculator is allowed), students read values off two labeled graphs, compute an average velocity and an acceleration using $\text{speed} = \text{distance} \div \text{time}$ and $\text{acceleration} = \Delta v \div \Delta t$, match described motions to the correct graph, fix a common graph-reading error, and write an evidence-based explanation (CER). **You do not need a physics background to run this.** Everything students need is printed in their packet. This is a **paper** activity — no lab, no materials, no hazards.

Standards alignment

Framework: 19 TAC Chapter 112 (Physics). Knowledge & skills on **describing motion with graphs** and **calculating velocity and acceleration**.

- **Provisional — describing motion / graphs:** represent and interpret the motion of an object using position–time and velocity–time graphs, relating the slope of a line to velocity or acceleration.
- **Provisional — calculating velocity and acceleration:** calculate average velocity and acceleration from data or graphs using $\text{speed} = \text{distance} \div \text{time}$ and $\text{acceleration} = \text{change in velocity} \div \text{change in time}$, with correct units.

Provisional — pending educator verification against the current official TAC source. A specific section number is intentionally not asserted here; confirm the exact citation and student-expectation codes before use.

(Standards are paraphrased here, not quoted. Please confirm the section and wording against your official source. This packet does not claim formal alignment to the TEKS.)

Setup Before class (5 min)

- Count and hand out one **student packet** per student.
- Confirm each student has a **pencil**. A **calculator is allowed** but not needed — the numbers are simple ($\div 4$, $\div 3$, $\div 2$). No computers or lab items are required.
- Write the date on the board and remind students to fill in the name line.
- Keep the **answer key** with you — it is a separate file and is **not** in the student packet.

Materials What's needed

- Printed student packet (4–6 pages) per student.
- Pencil per student; a calculator is optional (allowed).
- This guide and the separate answer key (teacher only).
- No lab equipment, no chemicals, no safety hazards — this is a paper investigation.

Timing Suggested pacing — standard vs. block

Segment	Standard (~50 min)	Block (~90 min)	What students do
Start — Notice & Wonder	5 min	5 min	Q1–Q2 warm-up
Build — Read the science	8–12 min	12 min	Read reference, word bank, Graphs A & B; Q3
Apply — Use the graphs	20–25 min	25 min	Q4–Q9 (read values, average velocity, acceleration, match, error analysis)
Explain — CER	7–10 min	10 min	Q10 explanation (claim/evidence/reasoning)
Close — ACE	5 min	5 min	Articulate / Connect / Extend
Continue — early finishers	optional	+30 min	Sketch a graph; block adds computing displacement as area under Graph B

On a **standard ~50-minute** period, the core stops after the CER (Q10) and ACE; the early-finisher sketch is optional. On a **~90-minute block**, everyone also completes the block extension — computing Object B's total displacement as the area under the velocity–time graph (rectangles + a triangle), which comes to 180 m.

Script Read aloud to start

"Today's assignment is a paper science investigation called *Interpreting Motion Graphs*. You will work by yourself with just a pencil — a calculator is fine if you want one, but the math is simple. Nothing to build or mix, and no computer needed. First read the short reference and study the two graphs: Graph A shows an object's *position* over time, and Graph B shows an object's *velocity* over time. Then answer the questions in order; if one is tricky, skip it and come back. When you do math, always keep your units — meters, seconds, meters per second, and meters per second squared — and show your work. Write in complete sentences where it asks you to explain. You may quietly read a question aloud to yourself. Put your name, class period, and date at the top now. You have about 50 minutes (or the full block); raise your hand if you need help understanding a word."

Support When students ask for help

- **You may read any part aloud** to a student or the class.
- If they mix up the graphs, point to the **vertical axis label**: Graph A says "Position (m)," Graph B says "Velocity (m/s)." The slope means velocity on A and acceleration on B.
- For the calculations (Q5–Q7), remind them slope = rise ÷ run: velocity = $\Delta \text{position} \div \Delta \text{time}$; acceleration = $\Delta v \div \Delta t$. A calculator is allowed.
- Encourage the printed **sentence stems** for the CER (Q10) and ACE sections.
- Do **not** give answers; prompt with "What does the graph show at that time?" or "Which is steeper?"
- It is fine if a student cannot finish the optional early-finisher or block task.

Access Accommodations & language support

- **Read-aloud** of any passage or question is allowed for all students.
- Point students to the **sentence stems** and the **Word Bank** (definitions provided).
- Extended time is fine; the core can stop after Q10 if time runs short.
- Students may answer in phrases if writing full sentences is a barrier, as long as the idea is clear. Showing the rise-over-run step with units is enough for Q5–Q7.
- The packet is grayscale-safe — it prints and reads clearly in black and white; the graphs use gridlines and text labels, not color.

Tools Allowed & not allowed

Allowed: pencil, a **calculator**, the printed packet, quiet self-read-aloud. **Not needed / not allowed:** phones, computers, internet, lab materials. The math is simple enough to do by hand, so a calculator is a convenience, not a requirement.

Collect at the end: Collect every packet, whether finished or not, with names on them. Stack them for the teacher. Note on a sticky how far most students got and any questions that caused confusion.

Answer key: The **answer key is a separate file** (answerkey.html) and is for the teacher only. Please do not hand it to students.

Teacher follow-up (for the returning teacher)

Watch for two high-value misconceptions: students reading a *horizontal line on a position–time graph as constant speed* (it means stopped), and confusing *height on the graph with speed* when the real cue is the *steepness* (slope). A quick next-day discussion contrasting a position–time graph with a velocity–time graph — and tying slope to velocity (p–t) versus acceleration (v–t) — would reinforce this well. The slope calculations (Q5–Q7) show who can compute velocity and acceleration with units; the Q9 error-analysis and the CER (Q10) responses show who can distinguish position from velocity.

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