Unit 2.4 — Average Acceleration (Guided Notes)

I. Launch Context

- Space Shuttle Atlantis must rapidly change its ________ to reach orbital speed.
- Any time ________ changes, the motion has acceleration.

II. What Is Average Acceleration?

- Definition: average acceleration $\bar{a}$ is **change in _________ per unit time**.
- Formula: $\bar{a} = \Delta v / \Delta t = (v_f - v_i) / (t_f - t_i)$.
- SI units: **____/____²** (meters per second per second).

III. Notation and Units

- v_i: initial velocity; v_f: final velocity; Δt: _____ ______.
- Keep units consistent. Convert **km/h** → **m/s** before using the formula.
- 1 km/h ≈ **0.27778 m/s**; 1 m/s = **3.6 km/h**.

IV. Vector Nature (Sign Matters)

- Acceleration is a vector in 1D: sign indicates direction along the **__-axis**.
- Positive acceleration points in **+x**; negative acceleration points in **−x**.
- “Negative acceleration” means a is __________ to the chosen + direction.

V. Speeding Up vs. Slowing Down

- Moving in +x and **speeding up** → a **> 0**.
- Moving in +x and **slowing down** → a **< 0** (opposite to motion).
- Moving in −x and **speeding up** toward −x → a **< 0** (same direction as motion).

VI. Skateboarder Example (Direction Focus)

- Moving right (+): slowing to a stop → a is ________.
- Turning left (−) and speeding up → v negative and a ________ (same direction).

VII. Average Acceleration from Speeds

- Use $\bar{a} = (v_f - v_i)/\Delta t$ when you know start/end velocities and time.
- Structure: identify v_i, v_f; compute **Δv**; divide by **Δt**; include sign/units.

VIII. Mixed Units Example (Why Convert?)

- If v is in **km/h** and t is in **s**, convert v to **___/s** so $\bar{a}$ is in m/s².
- Consistent units avoid ________ and make answers comparable.

IX. v–t Graphs and Acceleration

- On a velocity–time graph, the **slope equals ____________**.
- Positive slope → $\bar{a} > 0$; negative slope → $\bar{a} < 0$; **flat** → $\bar{a}$ = **__**.
- Average acceleration over an interval is the slope of the **________** line on v–t.

X. Connecting x–t, v–t, and a

- From x–t: slope gives **__**; changing slope implies changing v → acceleration present.
- From v–t: slope gives **__** directly; area under v–t gives **Δx**.
- Average acceleration over an interval equals **Δv/Δt**.

XI. Solving Strategy

- Step 1: Write given values (v_i, v_f, Δt) with **_____ and ______**.
- Step 2: Convert **units** if needed (e.g., km/h → m/s).
- Step 3: Compute **$\Delta v = v_f - v_i$** (keep the sign).
- Step 4: Compute **$\bar{a} = \Delta v / \Delta t$** with units **m/s²**.
- Step 5: Interpret the **_____** in context (speeding up vs. slowing down).

XII. Common Pitfalls

- Mixing units (km/h with s) → **________ first**.
- Dropping the **____** on Δv or $\bar{a}$.
- Calling any negative $\bar{a}$ "deceleration" **without** considering direction and motion sign.

XIII. Summary

- Average acceleration: **$\bar{a} = \Delta v/\Delta t$** with units **m/s²**.
- Signs encode direction; slowing down in +x gives **________ $\bar{a}$**.
- On v–t graphs, **slope = ____________**; flats mean a = 0.

Guided Examples (Unit 2.4)

Ex 1 — Convert km/h to m/s, then find $\bar{a}$ Prompt: A car accelerates from rest to **+60.0 km/h** in **5.00 s**.

- v_i = **0.0 m/s**; v_f = **60.0 km/h**.
- Convert 60.0 km/h to m/s: **60.0 × (1000/3600) = ______ m/s** (≈16.7).
- Δt = **5.00 s**; Δv = **_____ − 0** = **______ m/s**.
- ā = **Δv/Δt** = **______ / 5.00** = **______ m/s²** (≈ 3.33).
- Conclusion: ā ≈ **______ m/s²**.

Ex 2 — Slowing down in +x (negative ā) Prompt: An automobile slows from **+15.0 m/s** to **+5.0 m/s** in **5.0 s**.

- v_i = +15.0 m/s; v_f = +5.0 m/s; Δt = 5.0 s.
- Δv = **5.0 − 15.0 = _______ m/s**.
- ā = Δv/Δt = **(_____ m/s) / 5.0 s** = **______ m/s²**.
- Conclusion: ā is _________ (opposite the +x motion).

Ex 3 — Interpreting direction words Prompt: A skateboarder moving right **slows to a stop**; then **speeds up left**.

- Right is +x. Slowing while moving +x → ā _________.
- After turning, moving left (−x) and speeding up → ā _________ (same direction as motion).
- Conclusion: Both segments can have ___________ **acceleration**, but for different reasons.

Ex 4 — v–t slope as acceleration Prompt: On a v–t graph, how do you recognize acceleration and compute ā?

- Acceleration is the ________: ā = Δv/Δt from two points.
- Upward slope → ā > 0; downward slope → ā < 0; **flat** → ā = __.
- Conclusion: Use the **secant** _______ on v–t to get the average acceleration.