FORCES DAY 19: UNIT REVIEW

THE TOOLBOX

Tool	Statement	Watch out for
Newton's 1st	balanced forces $\Longleftrightarrow$ constant velocity	"moving" does not require a force
Newton's 2nd	$\Sigma F = ma$ $(N = kg \cdot m/s^2)$	ΣF is the *net* force — sum the FBD first
Newton's 3rd	pairs: equal, opposite, different objects, same type	F_N and F_g on one object are never a pair
Friction	$f_k = \mu_k F_N$; $f_s \leq \mu_s F_N$	uses F_N, which is not always mg
Normal force	from the vertical (or $\perp$) equation	angled pulls shrink it; pushes grow it
Inclines	mg sin θ along, mg cos θ into; $F_N = mg \cos \theta$	test sin/cos at θ = 0° and 90°
Systems	$a = F_{ext}/m_{total}$, then isolate for T	tension lands between the two weights
Lab graph	a vs F: slope = 1/m $((m/s^2)/N = 1/kg)$	intercept ≠ 0 confesses friction

Reliable starting sequence: free-body diagram → choose axes → ΣF = ma per axis → kinematics if needed.

AP FRQ FIELD GUIDE — WHERE YOU PRACTICED EACH TYPE

AP free-response problems repeatedly ask you to model systems, use mathematical routines, analyze data, and justify claims. You practiced those modes throughout this unit (and in Unit 1 — the modes repeat every unit, the physics changes).

FRQ Type	What it asks	You practiced it
Mathematical Routines	Multi-step calculation; points for symbolic setup, substitution with units, cross-checks.	Day 9 — Atwood Machine
Translation Between Representations	Words ↔ FBDs ↔ equations, all telling one consistent story.	Day 2 — Words ↔ Diagrams
Experimental Design & Analysis	Design a procedure, hold variables constant, linearize a graph, read its slope and intercept.	Day 7 — Second Law Lab
Qualitative/Quantitative Translation	Paragraph arguments connected to calculations: claim → evidence → reasoning.	Day 4 — Truck Meets Car

THIS UNIT'S FAVORITE TRAPS

- Drawing a "force of motion" arrow — velocity is not a force
- Using $F_N = mg$ under an angled pull or on a ramp
- Calling the normal force the third-law pair of gravity
- Setting tension equal to the hanging weight in an accelerating system
- Forgetting that constant velocity means $\Sigma F = 0$ — it hands you an equation for free

SYNTHESIS FRQ — THE WHOLE UNIT IN ONE PROBLEM

AP FRQ · SYNTHESIS **Up the Ramp and Let Go**

A 5.0 kg block starts from rest and is pulled 4.0 m up a frictionless 30° incline by a 35 N force directed parallel to the ramp.

(a) Draw the block's FBD during the pull, with tilted axes.

(b) Find the block's acceleration during the pull — symbols, then numbers with units.

(c) Find the block's speed at the end of the 4.0 m pull. At that instant the force is removed. Find how much *farther* the block slides up the ramp before stopping.

(d) In one or two sentences: how does the FBD after release differ from the FBD during the pull, and why does the block decelerate even on a frictionless ramp?

PAPER PRACTICE

PRACTICE PROBLEMS — TEST-STYLE MIX

P1 Elevator Cable

A 650 kg elevator accelerates upward at 1.2 m/s². Find the cable tension.

P2 Find μ_k

A skidding crate decelerates at 3.43 m/s² with friction as the only horizontal force. Find μ_k.

P3 Frictionless Incline

Find the acceleration of a cart rolling down a frictionless 45° incline.

P4 Atwood, One Last Time

An Atwood machine carries 7.0 kg and 3.0 kg. Find the acceleration and the string tension, and confirm the tension lands between the two weights.