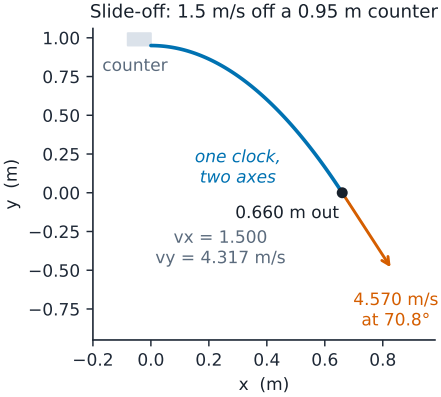
Engineering Mechanics — Dynamics

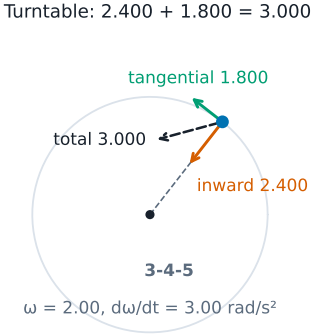
Curated undergraduate study track (not accredited, no external exam). Original explanations and practice only, following the reviewed course handout.

Statics with the sums alive

- The festival till, 2.5 kg, is dropped, slid, spun, vibrated, impacted and rolled - every number computed for this course and checked a second way.
- The habit - **one clock for all components, a ledger that ties, momentum that keeps to the digit**.

Particle kinematics: one clock, two axes

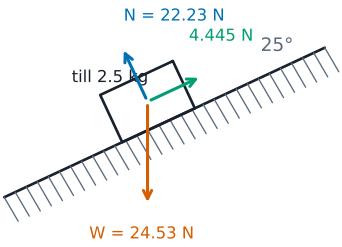




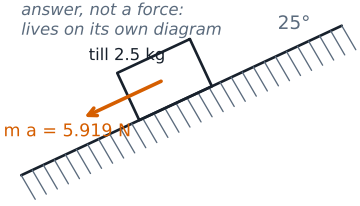
Lands **0.660** m out at **4.570** m/s; the turntable gives a 3-4-5 triangle.

Particle kinetics: forces left, answer right

Free-body diagram



Kinetic diagram

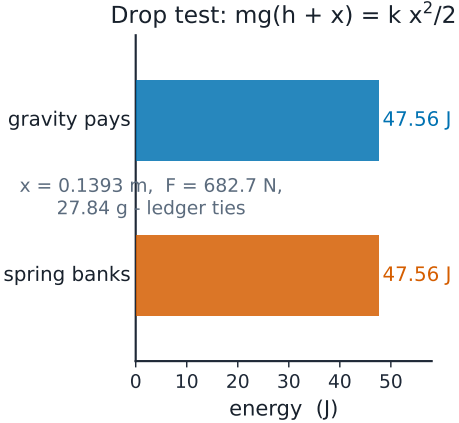


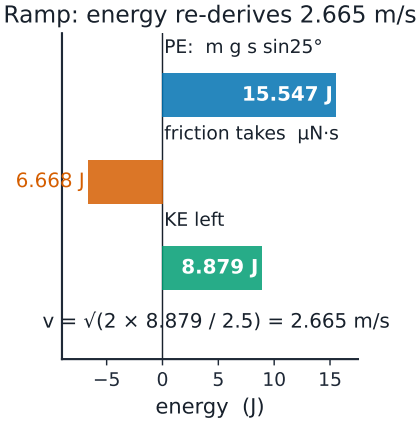
The 25° ramp, $\mu_k = 0.20$: $N = \mathbf{22.23}$ N, **friction** $\mathbf{4.445}$ N, $a = 9.81(\sin 25° - 0.20\cos 25°) = \mathbf{2.368}$ m/s^2, $v = \mathbf{2.665}$ m/s after 1.50 m. Cart slip at $\mu_s g = \mathbf{3.434}$ m/s^2; the turntable needs $\mu \geq \mathbf{0.3058}$.

Particle kinetics in action: the turntable verdict

1. **Demand Friction** must supply $ma = 2.5 \times 3.000 = 7.50$ N, so $\mu \geq 0.3058$.
2. **Supply** The mount measures $\mu_s = 0.35$: it holds with margin 12.6%.
3. **Edge** First slip at $\dot{\omega} = 4.09$ rad/s^2, when $r\sqrt{\omega^4 + \dot{\omega}^2} = \mu_s g$.

Work and energy: the ledger must tie





The drop ledger balances at **47.56** J; the ramp re-derives **2.665** m/s.

Work and energy in action: the rating check

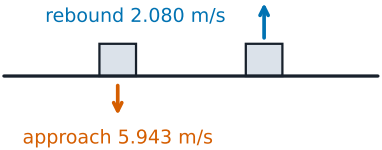
1. **Read** Margin $(30 - 27.84)/30 = 7.2\%$ - it passes.
2. **Escalate** Halve the drop: $h = 0.900$ m gives $x = 0.1001$ m and $F = 490.3$ N.
3. **Insight** That is 20.0 g - two thirds of the rating for half the height, because of the $+x$.

Impulse and momentum: the impact file

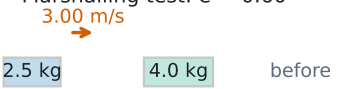
Certified impact: e = 0.35

rebound height 0.2205 m;
87.8% of arrival energy absorbed

J = 20.06 N s
F_avg = 2507 N
(8.0 ms)



Marshalling test: e = 0.60



momentum 7.500 kept, 4.431 J lost;
fan: 0.120 kg/s × 8.50 m/s
= 1.020 N thrust

Impulse 20.06 N · s brings 2507 N over 8 ms; the carts keep momentum 7.500.

Impulse in action: size the welds

1. **Average** $F = J/\Delta t = 20.06/0.0080 = 2507$ N - no force curve needed.
2. **Budget** Arrival 44.15 J, rebound 5.41 J: 38.74 J - 87.8% - absorbed by floor and mount.
3. **Flux** The fan's thrust is $\dot{m}v = 1.020$ N - momentum passing through continuously.

Rigid-body kinematics: constraint first

Slider-crank at 90°: pure translation

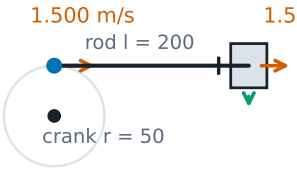
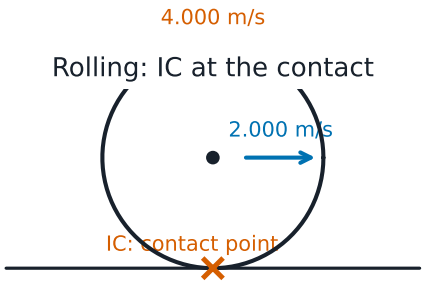


table a = +11.25 m/s²

ω = 30 rad/s, λ = 0.25; IC at infinity

Rolling: IC at the contact

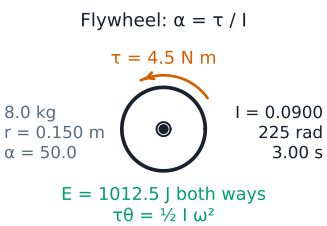


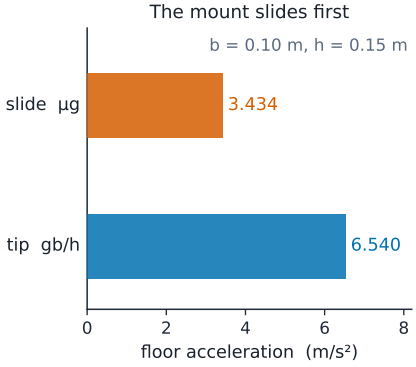
v = omega r: omega = 6.452 rad/s

Rigid-body kinematics in action: the rod translates

1. **Perpendiculars** Both ends' velocities are horizontal, so both perpendiculars to the rod are vertical and parallel.
2. **Centre** Parallel perpendiculars meet at infinity: the rod's IC is at infinity.
3. **Verdict** Pure translation - every rod point at 1.500 m/s, checked independently at both ends.

Rigid-body kinetics: the last rows of the file





$\alpha = \tau / I = \mathbf{50.0}$ rad/s^2; the mount slides at **3.434** before **tipping** at **6.540**.

Rigid-body kinetics in action: the rolling tax

1. **Accelerate** $a = \frac{2}{3} g \sin 15^\circ = 1.693\ \text{m/s}^2$, so $v = 2.253\ \text{m/s}$.
2. **Split** Carried $\frac{1}{2} m v^2 = 12.70\ \text{J}$, spun $\frac{1}{4} m v^2 = 6.35\ \text{J}$.
3. **Tie** Total 19.04 J $= mg \times 1.50 \sin 15^\circ$ - two thirds carried, one third taxed.

The project sheet, reproducible

1. **Motion** Drop 5.943 m/s in 0.6058 s; slide-off 4.570 m/s at 70.8°; turntable 2.400 + 1.800 = 3.000.
2. **Forces** Ramp $a = 2.368$, $v = 2.665$ m/s, $N = 22.23$ N; cart slip 3.434; turntable μ 0.3058.
3. **Ledger** Mount 0.1393 m, 682.7 N, 27.84 g, 47.56 J = 47.56 J; impact J 20.06 N · s, 2507 N; crank 1.500 m/s, 11.25 m/s^2; flywheel 0.0900, 1012.5 J; slide 3.434 before tip 6.540.

Check yourself

- The landing pair and the triangle? (4.570 m/s at 70.8°; 2.400 + 1.800 = 3.000.)
- The ramp and the slip? ($a = 2.368$, $v = 2.665$ m/s, $N = 22.23$ N; 3.434 m/s^2.)
- The ledger and the rating? (0.1393 m, 682.7 N, 27.84 g; 47.56 = 47.56 J.)
- The impact and the inertia? ($J = 20.06$ N $\cdot$ s, 2507 N; $I = 0.0900$, 1012.5 J.)