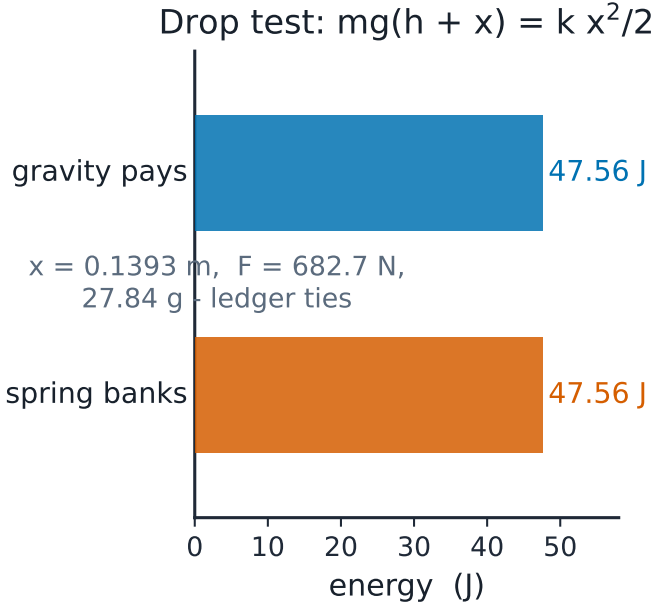
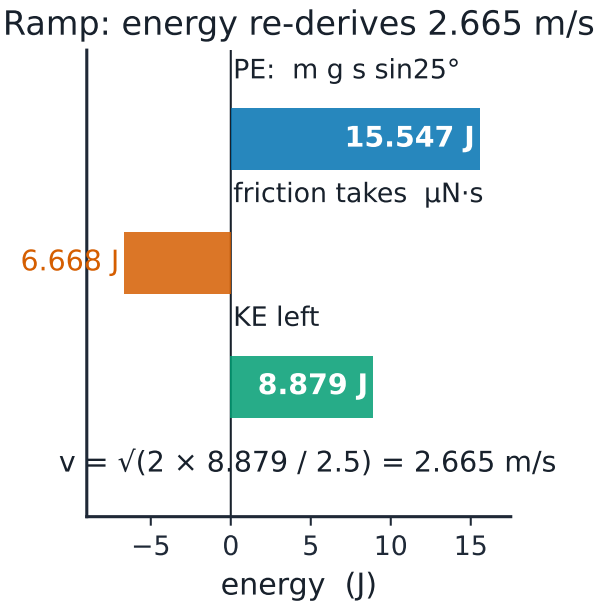
Exercise walk-through

3.4
Impulse and momentum

University Mechanical Engineering

Work and energy: the ledger must tie





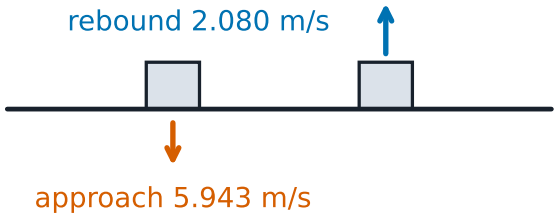
The drop ledger balances at **47.56** J; the ramp re-derives **2.665** m/s.

Impulse and momentum: the impact file

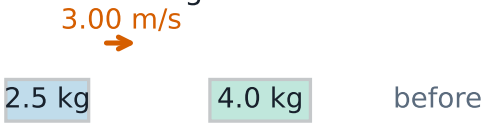
Certified impact: e = 0.35

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

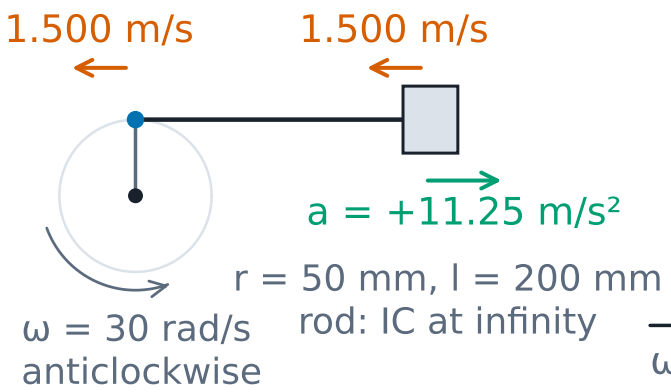


momentum 7.500 kept, 4.431 J lost;
fan: 0.120 kg/s × 8.50 m/s
= 1.020 N thrust

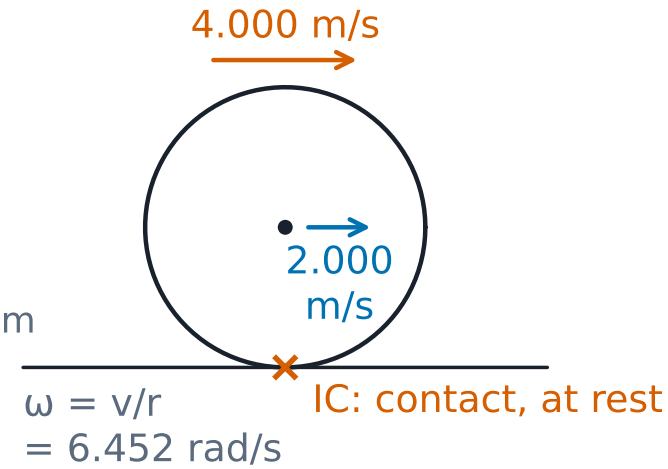
Impulse 20.06 N · s brings 2507 N over 8 ms; the carts keep momentum 7.500.

Rigid-body kinematics: constraint first

Slider-crank at 90°



Rolling wheel



At $\theta = 90°$ the slider moves at $\mathbf{-1.500}$ m/s and accelerates at $\mathbf{+11.25}$ m/s^2.

Exercises 2.1·2.2

2.1 The rebound speed and the rebound height (three decimals, four decimals). [3]

2.2 The impulse magnitude and the average force (one decimal, nearest integer). [4]

Exercises 2.1–2.2

2.1 The rebound speed and the rebound height (three decimals, four decimals). [3]

2.1

- Rebound $= ev = 2.000$ m/s.
- Height $= v^2/2g = 0.2039$ m.

2.2 The impulse magnitude and the average force (one decimal, nearest integer). [4]

2.2

- $J = m(1+e)v = 1.8 \times 1.5 \times 4.0 = 10.8$ N $\cdot$ s.
- $F = J/\Delta t = 10.8/0.0060 = 1800$ N.

Exercises 2.3·2.4

2.3 A 3.0 kg cart at 2.5 m/s couples into a 2.0 kg cart at rest with $e = 0.80$. Both final velocities (three decimals), and the kinetic energy lost (two decimals). [5]

2.4 The test rig's fan moves 0.120 kg/s of air out at 8.50 m/s. The thrust (three decimals), and why this is a momentum-flux result rather than an impact one. [2]

Exercises 2.3·2.4

2.3 A 3.0 kg cart at 2.5 m/s couples into a 2.0 kg cart at rest with $e = 0.80$. Both final velocities (three decimals), and the kinetic energy lost (two decimals). [5]

2.3

- Momentum: $7.5 = 3.0v_1 + 2.0v_2$; separation: $v_2 - v_1 = 0.80 \times 2.5$.
- $v_1 = 0.700$ m/s, $v_2 = 2.700$ m/s.
- KE: $9.375 \to 8.025$ J, loss 1.35 J.

2.4 The test rig's fan moves 0.120 kg/s of air out at 8.50 m/s. The thrust (three decimals), and why this is a momentum-flux result rather than an impact one. [2]

2.4

- $F = \dot{m}v = 0.120 \times 8.50 = 1.020$ N.
- The flow is steady - momentum passes through continuously, with no frozen before/after pair.