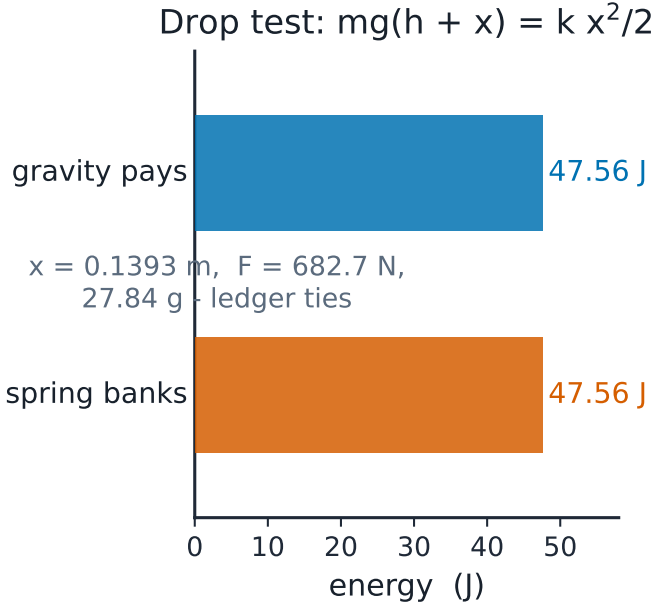
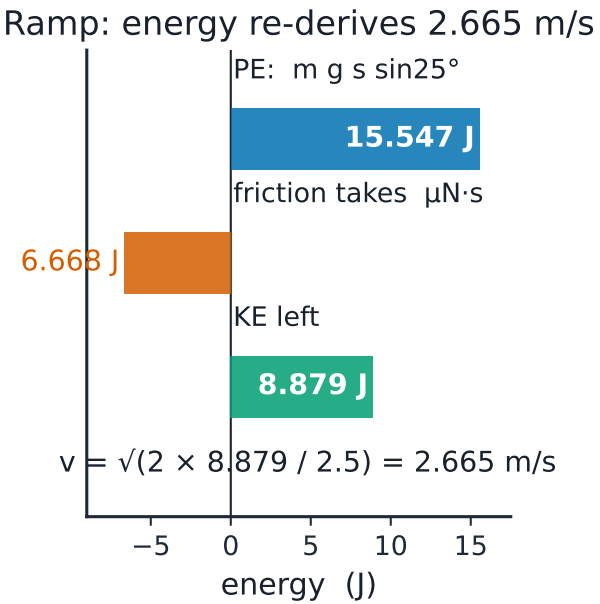
Exercise walk-through

3.3 Work and energy

University Mechanical Engineering

Work and energy: the ledger must tie





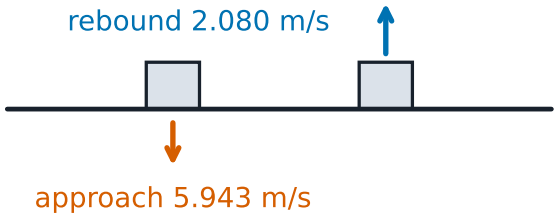
The drop ledger balances at **47.56** J; the ramp re-derives **2.665** m/s.

Impulse and momentum: the impact file

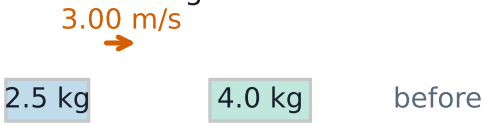
Certified impact: e = 0.35

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

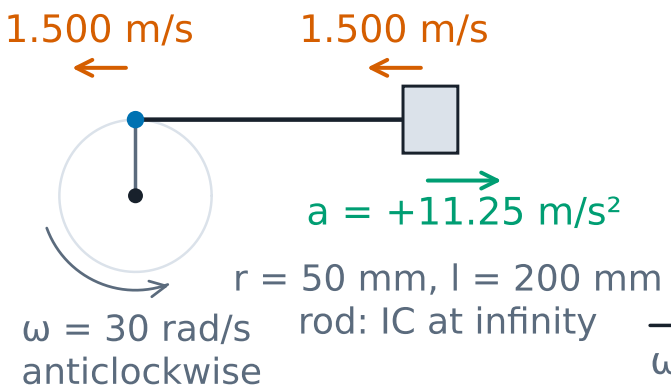


momentum 7.500 kept, 4.431 J lost;
fan: 0.120 kg/s × 8.50 m/s
= 1.020 N thrust

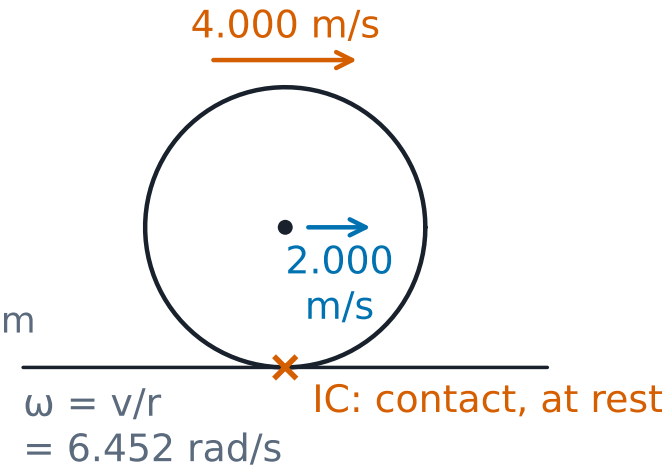
Impulse 20.06 N · s brings 2507 N over 8 ms; the carts keep momentum 7.500.

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 energy balance equation with the $+x$ term explained, and the maximum deflection (metres, four significant figures). [4]

2.2 The peak force and the peak deceleration in g (one decimal for the force, two for the g-load). [3]

Exercises 2.1·2.2

2.1 The energy balance equation with the $+x$ term explained, and the maximum deflection (metres, four significant figures). [4]

2.1

- $mg(h + x) = \tfrac{1}{2}kx^2$ - gravity keeps working through the deflection x.
- $1800x^2 = 29.43(1.20 + x)$ gives $x = 0.1485$ m.

2.2 The peak force and the peak deceleration in g (one decimal for the force, two for the g-load). [3]

2.2

- $F = kx = 3600 \times 0.1485 = 534.5$ N.
- $534.5/(3.0 \times 9.81) = 18.16$ g.

Exercises 2.3·2.4

2.3 The same module slides 2.00 m down the 20° ramp of sheet 3.2 ($\mu_k = 0.25$). The potential energy released, the friction work, and the speed at the end (three decimals). [4]

2.4 One sentence: why does halving the drop height NOT halve the peak force? [2]

Exercises 2.3·2.4

2.3 The same module slides 2.00 m down the 20° ramp of sheet 3.2 ($\mu_k = 0.25$). The potential energy released, the friction work, and the speed at the end (three decimals). [4]

2.3

- Released: $mgs\sin 20° = 3.0 \times 9.81 \times 2.00 \times 0.342 = 20.13$ J.
- Friction: $0.25 \times 29.43 \times \cos 20° \times 2.00 = 13.84$ J.
- $KE = 20.13 - 13.84 = 6.30$ J, so $v = \sqrt{2 \times 6.30/3.0} = 2.049$ m/s.

2.4 One sentence: why does halving the drop height NOT halve the peak force? [2]

2.4

- Gravity supplies $mg(h+x)$: halving h halves only part of the payment, and x shrinks less than proportionally.