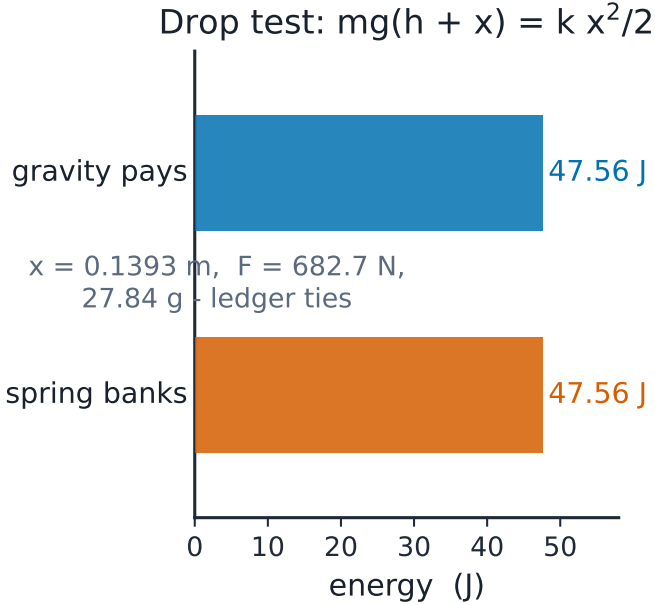
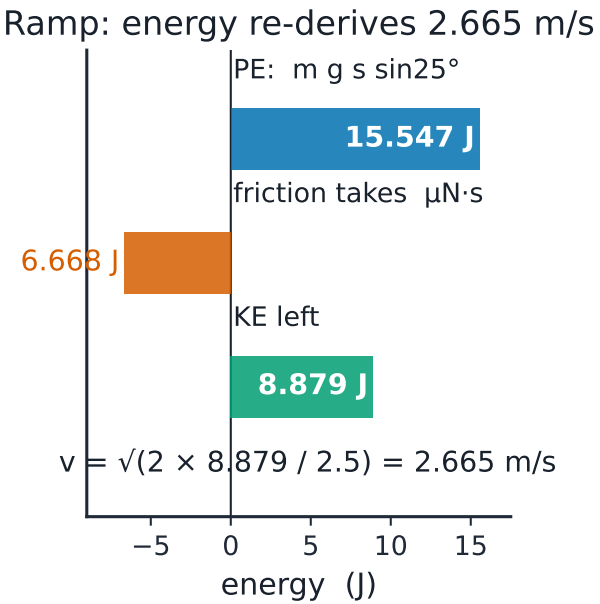
Exercise walk-through

3.1
Particle kinematics

University Mechanical Engineering

Work and energy: the ledger must tie





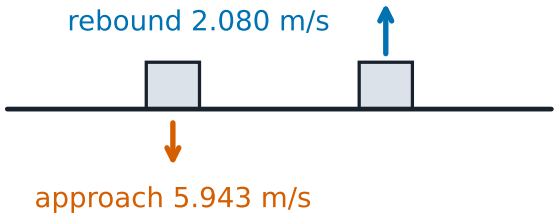
The drop ledger balances at **47.56** J; the ramp re-derives **2.665** m/s.

Impulse and momentum: the impact file

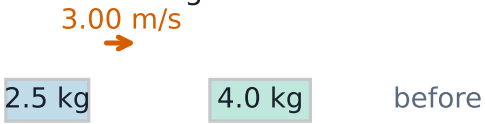
Certified impact: e = 0.35

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

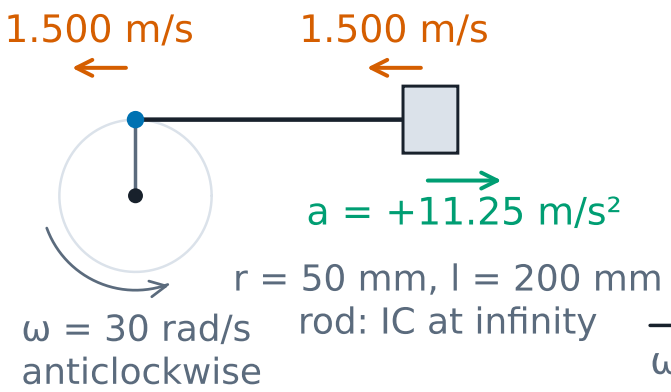


momentum 7.500 kept, 4.431 J lost;
fan: 0.120 kg/s × 8.50 m/s
= 1.020 N thrust

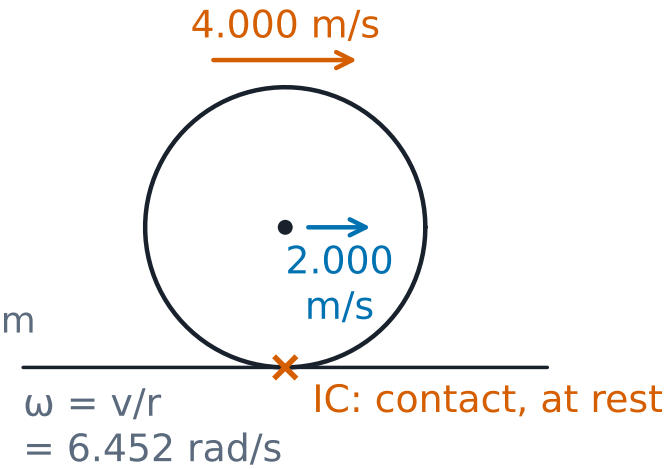
Impulse 20.06 N · s brings 2507 N over 8 ms; the carts keep momentum 7.500.

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 flight time and the horizontal distance to landing (three decimals). [3]

2.2 The landing velocity: magnitude and direction (three decimals, degrees to one decimal). [4]

Exercises 2.1·2.2

2.1 The flight time and the horizontal distance to landing (three decimals). [3]

2.1

- $t = \sqrt{2 \times 1.25/9.81} = 0.505$ s.
- Range $= 2.2 \times 0.505 = 1.111$ m.

2.2 The landing velocity: magnitude and direction (three decimals, degrees to one decimal). [4]

2.2

- $v_y = gt = 4.952$ m/s, so $v = \sqrt{2.2^2 + 4.952^2} = 5.419$ m/s.
- Direction $\arctan(4.952/2.2) = 66.1^\circ$ below horizontal.

Exercises 2.3·2.4

2.3 A turntable test runs $r = 0.450$ m at $\omega = 3.00$ rad/s speeding up at $\dot{\omega} = 2.00$ rad/s^2. The speed, both acceleration components and the total magnitude (three decimals). [5]

2.4 State, with one sentence of reason each: (a) why the horizontal and vertical motions of the bracket share one clock; (b) why a point on the turntable accelerates even at constant ω. [2]

Exercises 2.3·2.4

2.3 A turntable test runs $r = 0.450$ m at $\omega = 3.00$ rad/s speeding up at $\dot{\omega} = 2.00$ rad/s^2. The speed, both acceleration components and the total magnitude (three decimals). [5]

2.3

- $v = \omega r = 1.350$ m/s.
- $a_r = \omega^2 r = 4.050$ m/s^2 inward; $a_\theta = r\dot{\omega} = 0.900$ m/s^2.
- Total $= \sqrt{4.050^2 + 0.900^2} = 4.149$ m/s^2.

2.4 State, with one sentence of reason each: (a) why the horizontal and vertical motions of the bracket share one clock; (b) why a point on the turntable accelerates even at constant ω. [2]

2.4

- (a) The vertical fall fixes t; the horizontal ride ends at the same instant - one clock, two axes.
- (b) Constant ω still turns the velocity's direction: $a_r = \omega^2 r \neq 0$.