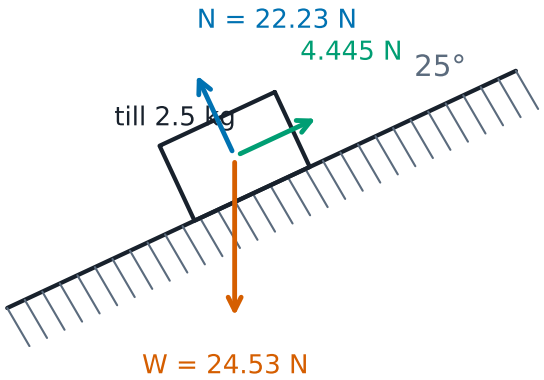
Exercise walk-through

3.6
Rigid-body kinetics

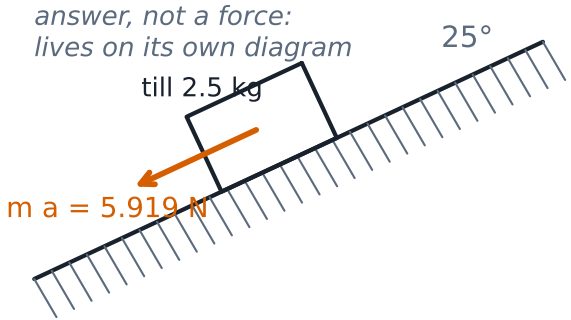
University Mechanical Engineering

Particle kinetics: forces left, answer right

Free-body diagram

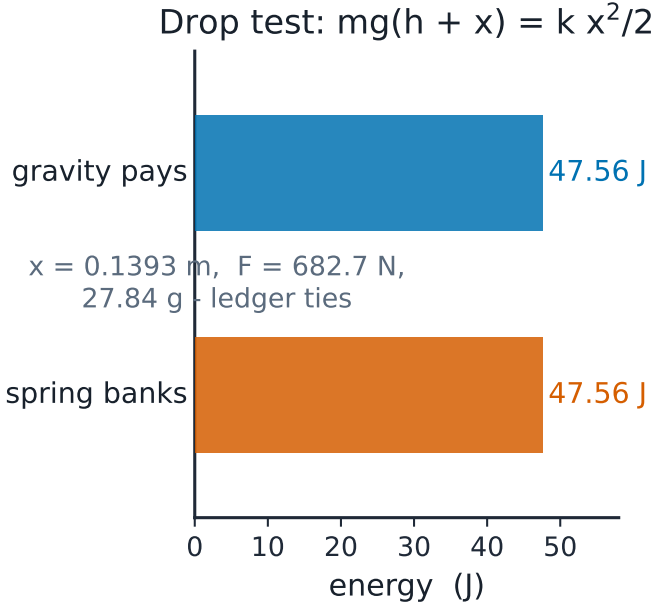


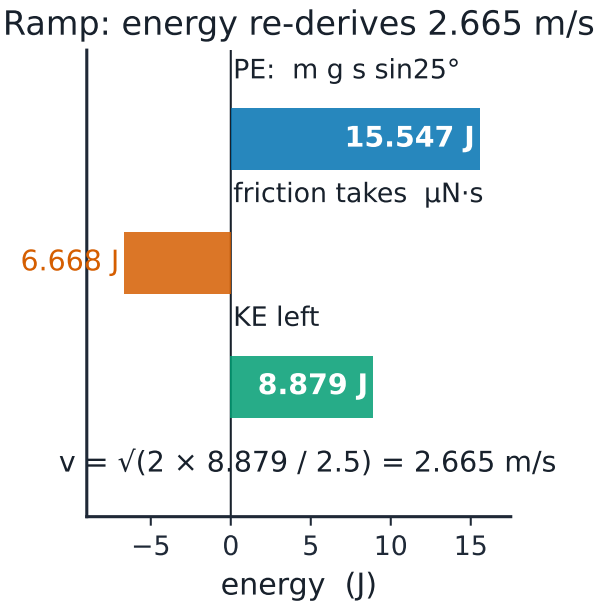
Kinetic diagram



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 $\mu \geq \mathbf{0.3058}$.

Work and energy: the ledger must tie

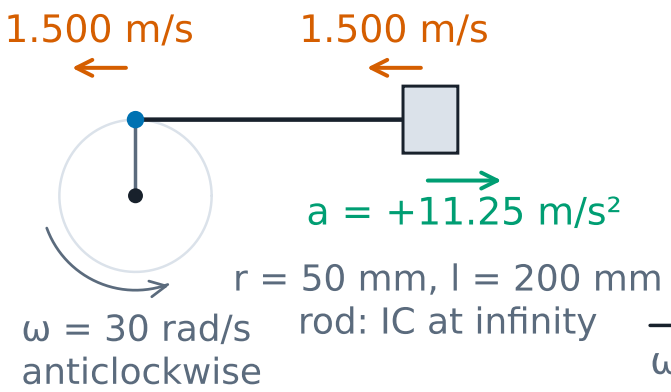




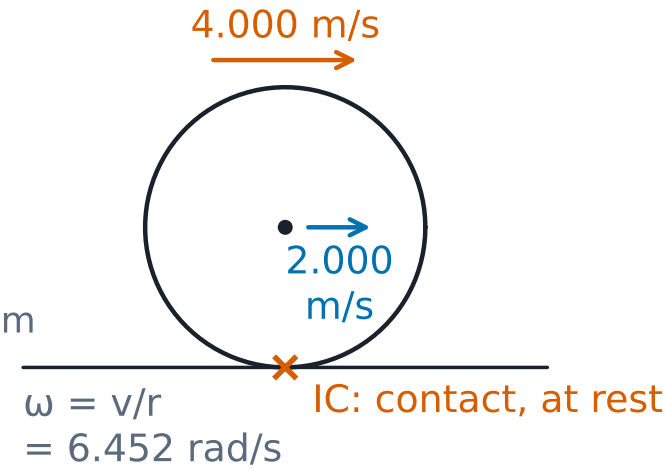
The drop ledger balances at **47.56** J; the ramp re-derives **2.665** m/s.

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 2.1·2.3

2.1 The moment of inertia about the axle and the angular acceleration. [3]

2.2 The angular velocity and the angle turned after 5.0 s, and the energy stored (check it against the motor's work). [5]

2.3 The power is cut and the flywheel coasts to rest in 50 s. The friction torque (three decimals), assuming it constant. [3]

Exercises 2.1·2.3

2.1 The moment of inertia about the axle and the angular acceleration. [3]

2.1

- $I = \tfrac{1}{2} m r^2 = \tfrac{1}{2} \times 6.0 \times 0.040 = 0.120$ kg · m^2.
- $\alpha = \tau / I = 3.6 / 0.120 = 30.0$ rad/s^2.

2.2 The angular velocity and the angle turned after 5.0 s, and the energy stored (check it against the motor's work). [5]

2.2

- $\omega = \alpha t = 150$ rad/s; $\theta = \tfrac{1}{2}\alpha t^2 = 375$ rad.
- $E = \tfrac{1}{2} I \omega^2 = 1350$ J $= \tau \theta = 3.6 \times 375$ ✓.

2.3 The power is cut and the flywheel coasts to rest in 50 s. The friction torque (three decimals), assuming it constant. [3]

2.3

- $\alpha_f = -150/50 = -3.00$ rad/s^2, so $\tau_f = 0.120 \times 3.00 = 0.360$ N · m.

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Exercise 2.4

2.4 A carton with half-width 0.12 m and centre of mass 0.20 m up stands on a floor with $\mu_s = 0.32$. Which happens first as the floor accelerates - sliding or tipping - and at what value? [4]

Exercise 2.4

2.4 A carton with half-width 0.12 m and centre of mass 0.20 m up stands on a floor with $\mu_s = 0.32$. Which happens first as the floor accelerates - sliding or tipping - and at what value? [4]

2.4

- Slide at $\mu_s g = 3.139$ m/s^2; tip at $gb/h = 9.81 \times 0.12/0.20 = 5.886$ m/s^2.
- $3.139 < 5.886$: it slides first, at 3.14 m/s^2.