Physics 20

Unit C: Circular motion and energy

Mechanical energy

A skateboarder drops in from 3.20 m

- A 48.0 kg skateboarder starts from rest at a height of 3.20 m on a quarter pipe.
- At the bottom the height is zero on the chosen scale, and the speed is 7.92 m/s.



Conservation of mechanical energy

- Em = Ek + Ep, with Em the mechanical energy, Ek the kinetic energy, and Ep the gravitational potential energy.
- Ek = (1/2) m v^2, where m is the mass and v is the speed.
- Ep = m g h, where h is the height and g is 9.81 m/s^2 downward.
- When the object keeps that energy to itself, Ek plus Ep stays the same number.

Key terms

mechanical energy

Mechanical energy is the sum of kinetic energy and gravitational potential energy for the object in the model. (Em = Ek + Ep)

kinetic energy

Kinetic energy is the energy of motion, equal to one half the mass times the speed squared. (Ek = (1/2) m v^2)

gravitational potential energy

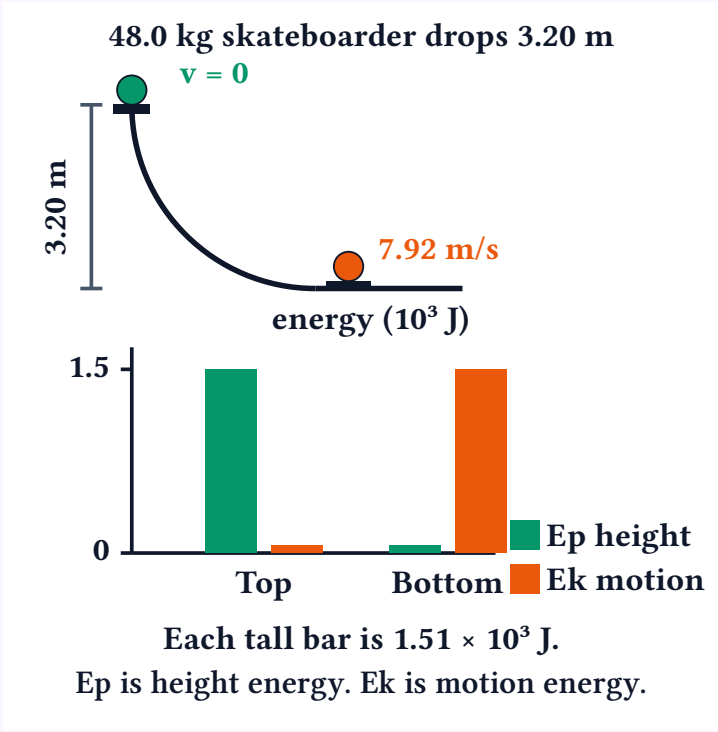
Gravitational potential energy near Earth is mass times g times height, with height measured from a chosen zero. (Ep = m g h)

isolated system

An isolated system keeps its mechanical energy constant because that energy stays inside the chosen boundary.

Energy bar charts

- At the top of a hill, gravitational potential energy holds the mechanical energy.
- At the bottom, the energy is kinetic, and the total matches the potential energy from the top.
- The bar chart keeps Ep and Ek side by side so the trade is visible.



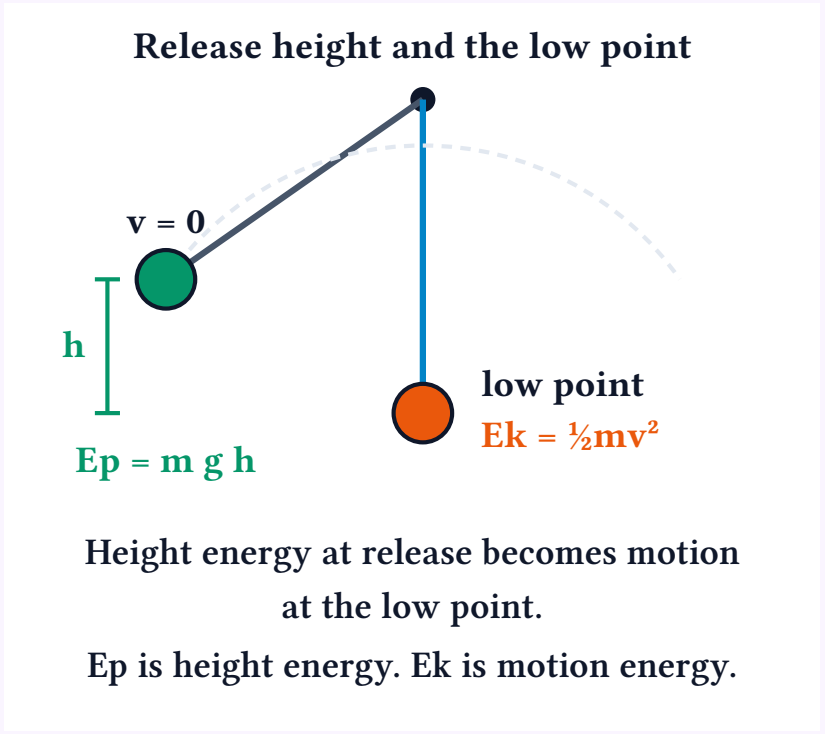
Each tall bar is 1.51 × 10³ J.
Ep is height energy. Ek is motion energy.

A ski hill checked two ways

- A 62.0 kg skier starts from rest at a height of 8.50 m. The slope length is 25.0 m.
- From the height, speed = square root of 2 × 9.81 × 8.50 = 12.9 m/s.
- The 25.0 m slope gives the same 12.9 m/s.

A pendulum lab and Joule’s paddles

- A pendulum or a rolling cart can test whether the energy total stays the same when friction is tiny.
- Release height sets Ep, and the low point converts that store into Ek.
- Joule’s falling weights and paddles linked mechanical work with thermal energy and named the joule.



Pendulum speed at the low point

- A 0.200 kg bob is released from rest 0.150 m above the low point.
- Ep at release equals m g h.
- At the low point the height energy has become kinetic energy, one half m v squared.

A toboggan hill

- A 35.0 kg toboggan starts from rest at a height of 4.80 m.
- Find Ep at the top and the speed at the bottom.
- State the quantity that stays the same from the top of the hill to the bottom.

Image credits

Tiia Monto, Skateboard ramp, CC BY-SA 3.0