

Work, Energy, and Power

AP Physics 1 ■ Unit 3

AP Physics 1



Work, Energy, and Power

What we will cover

- 1 Kinetic energy and the work-energy theorem
- 2 Work
- 3 Potential energy
- 4 Conservation of energy
- 5 Power



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Kinetic energy

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└ Kinetic energy

Kinetic energy and the work-energy theorem

Energy of motion

$$KE = \frac{1}{2}mv^2$$

A **scalar** 标量. Depends on v^2 – double the speed, **quadruple** the energy.

Work-energy theorem

$$W_{\text{net}} = \Delta KE$$

Kinetic energy 动能 links force to motion:

- positive net work $\Rightarrow$ speeds up
- negative net work $\Rightarrow$ slows down

2 kg from 3 $\rightarrow$ 5 m/s: KE rises 9 $\rightarrow$ 25 J, so $W_{\text{net}} = 16$ J.

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Work

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└ Work

Work

Energy transferred by a force

$$W = Fd \cos \theta$$

The angle θ sets the sign:

- along the motion (0°) – **positive**
- against it (180°) – **negative**
- perpendicular (90°) – **zero**

A changing force: work = area under an F - x graph.



Power is the rate of energy transfer

3 Potential energy

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└ Potential energy

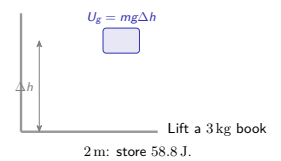
Potential energy

Potential energy 势能 is stored in an arrangement – it depends on **position**, not motion.

Two common kinds

$$\Delta U_g = mg\Delta h \quad U_s = \frac{1}{2}kx^2$$

A **conservative force** 保守力 (gravity, spring): its work depends only on start and end.



4 Conservation

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└ Conservation

Conservation of energy

Total energy 能量守恒定律 is conserved – it only changes form.

- conservative forces keep **mechanical energy** 机械能 $KE + U$ constant
- friction turns it into **thermal energy** 热能 (still conserved overall)

Drop 1 kg from 5 m: 49 J of $U_g \rightarrow KE$, so $v \approx 9.9$ m/s.



Mechanical energy trades kinetic and potential

5 Power

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└ Power

Power

Power 功率 is how **fast** energy is transferred:

Two forms

$$P = \frac{W}{\Delta t} \quad P = Fv$$

Measured in **watts** 瓦特 (joules per second).

Same work, more power = done **sooner**.

Worked example

Lift 50 kg up 10 m in 5 s:

$$W = mgh = 4900 \text{ J}$$

$$P = \frac{4900}{5} = 980 \text{ W}$$

In 2 s instead: 2450 W – same work, more power.

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Recap

Work, Energy, and Power
↳ Recap

Unit 3 – key takeaways

1 Work

$W = Fd\cos\theta$; area under an F - x graph

2 Kinetic energy

$KE = \frac{1}{2}mv^2$; net work equals ΔKE

3 Potential energy

$mg\Delta h$ and $\frac{1}{2}kx^2$ from conservative forces

4 Conservation

$KE + U$ constant; friction makes heat; $P = W/\Delta t$

Work, Energy, and Power
↳ Recap

Check yourself

- 1 Double an object's speed – what happens to its KE ?
- 2 Carrying a bag horizontally – how much work on the bag?
- 3 Friction acts. Is mechanical energy conserved?
- 4 Two motors, same lift, one twice as fast – compare power.



Answers 1. it quadruples 2. zero (force $\perp$ motion) 3. no – some becomes heat 4. twice the power