3 Work, kinetic energy, and potential energy – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	**中文**	**Write it 3 times** (English)		
Energy	能量			
joules	焦耳			
kinetic energy	动能			
Work	功			
work–energy theorem	动能定理			
Potential energy	势能			
Gravitational potential energy	重力势能			
Elastic potential energy	弹性势能			

Recall

You already know a lot about energy:

- Energy comes in forms –movement, height, heat, light –and can change from one form to another.
- You cannot make energy from nothing or destroy it; it is only moved around.
- You met the idea that a fast or heavy object carries more energy. At AP we make this exact with formulas.

Each idea below has a worked example. Then do the Practice.

New ideas

1 Kinetic energy

Energy 能量 is the capacity to do work, measured in **joules** 焦耳 (J). A moving object has **kinetic energy** 动能:

$$K = \tfrac{1}{2}mv^2.$$

It depends on the **square** of the speed, so doubling the speed makes the kinetic energy **four times** larger.

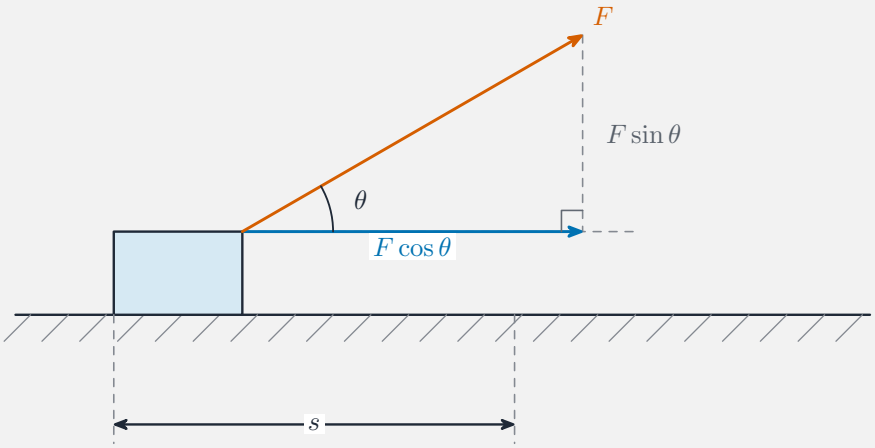
Worked example. A 1500 kg car at 20 m/s has $K = \frac{1}{2} \times 1500 \times 20^2 = 3.0 \times 10^5$ J. At 40 m/s it is four times as much.

2 Work

Work 功 is energy transferred when a force pushes something through a distance:

$$W = Fd\cos\theta,$$

where θ is the angle between the force and the movement. Work is **positive** if the force helps the motion, **negative** if it opposes it, and **zero** if the force is at right angles to the motion.



Worked example. A 20 N force pushes a box 3.0 m in its own direction: $W = Fd = 20 \times 3.0 = 60$ J.

3 The work–energy theorem

The net work done on an object equals the change in its kinetic energy –the **work–energy theorem** 动能定理:

$$W_{\text{net}} = \Delta K.$$

Worked example. If 60 J of net work is done on a resting 3.0 kg trolley, then $60 = \frac{1}{2} \times 3.0 \times v^2$, giving $v^2 = 40$ and $v = 6.3$ m/s.

■ 4 Potential energy

Potential energy 势能 is stored energy that depends on position:

- **Gravitational potential energy** 重力势能 (from height h): $U_g = mgh$.
- **Elastic potential energy** 弹性势能 (in a stretched spring): $U_s = \frac{1}{2}kx^2$.

Worked example. Lifting a 2.0 kg book 1.5 m stores $U_g = mgh = 2.0 \times 9.8 \times 1.5 = 29.4$ J.

Watch out: carrying a bag horizontally at steady height does **no** work on the bag – the lifting force is vertical but the movement is horizontal, so $\cos 90° = 0$.

Practice

Try these in order. The methods are all above.

2.1 Find the kinetic energy of a 0.50 kg ball moving at 6.0 m/s. [2]

2.2 A 40 N force pushes a crate 5.0 m in its own direction. Find the work done. [2]

2.3 State whether the work is positive, negative, or zero when (a) friction acts on a sliding box, (b) you carry a box horizontally at constant height. [2]

2.4 A 3.0 kg mass is lifted 2.0 m. Find the gain in gravitational potential energy ($g =$

9.8 $\mathrm{m/s^2}$). [2]

2.5 A 2.0 kg trolley starts at rest. A net work of 36 J is done on it. Use the work–energy theorem to find its final speed. [3]

2.6 A car's speed triples. By what factor does its kinetic energy increase? [1]
