3 Conservation of energy and power – Part 2

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)		
mechanical energy	机械能			
conserved	守恒			
thermal energy	热能			
Power	功率			
watts	瓦特			
efficiency	效率			

Recall

In Part A you met kinetic energy $K = \frac{1}{2}mv^2$ and potential energy $U = mgh$. Now put them together:

- Energy is never lost – it only changes form.
- A falling ball speeds up (gains K) as it drops (loses U).
- Doing the same job faster needs more **power** – that is the last idea on this sheet.

Each idea has a worked example before the Practice.

New ideas

1 Mechanical energy

The **mechanical energy** 机械能 of an object is its kinetic plus potential energy:

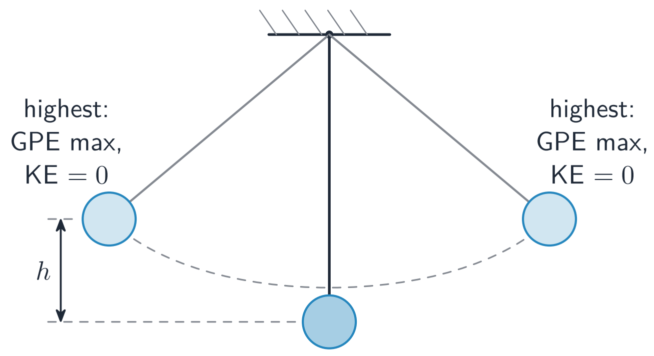
$$E = K + U.$$

2 Conservation of energy

When only gravity and springs act (no friction), the mechanical energy is **conserved** 守恒 – it stays the same:

$$K_1 + U_1 = K_2 + U_2.$$

So energy lost from one form appears in another.



Worked example. A ball is released from rest at the top of a smooth ramp 5.0 m high. All its potential energy becomes kinetic: $mgh = \frac{1}{2}mv^2$, so $v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 5.0} = 9.9$ m/s. The mass cancels, so every object reaches the same speed.

3 When friction acts

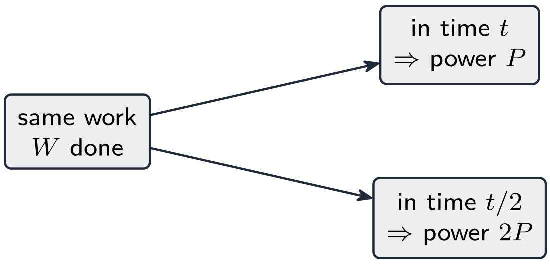
Friction turns mechanical energy into **thermal energy** 热能 (heat). Then energy is still conserved overall, but some has left the "useful" $K + U$ pool.

Worked example. If the ramp above loses 30 J to friction, you subtract it: $mgh - 30 = \frac{1}{2}mv^2$.

4 Power

Power 功率 is the **rate** of transferring energy, measured in **watts** 瓦特 (W):

$$P = \frac{W}{\Delta t}, \qquad \text{and at steady speed} \qquad P = Fv.$$



$$P = \frac{W}{t} \text{ — less time, more power}$$

Worked example. A motor lifts a 50 kg load at a steady 2.0 m/s. The force equals the weight, so $P = Fv = mgv = 50 \times 9.8 \times 2.0 = 980$ W.

■ 5 Efficiency

Real machines waste some energy, so we quote **efficiency** 效率 – useful output divided by total input:

$$\text{efficiency} = \frac{\text{useful output}}{\text{total input}}.$$

Worked example. A motor that draws 1400 W but delivers 980 W of useful lifting is $\frac{980}{1400} = 0.70 = 70\%$ efficient.

Watch out: at constant speed the net force is zero, but power is **not** zero – the motor still does work against gravity or friction. “Balanced forces” does not mean “no energy used.”

Practice

Try these in order. The methods are all above.

2.1 A 0.20 kg ball is dropped from 1.8 m. Using energy conservation, find its speed just before it lands ($g = 9.8$ m/s^2). [3]

2.2 State the energy change as a pendulum swings from its highest point down to its lowest point. [2]

2.3 A crane does 6000 J of work in 4.0 s. Find its power output. [2]

2.4 A machine takes in 500 W and delivers 300 W of useful power. Find its efficiency as a percentage. [2]

2.5 A ball rolls down a smooth slope 2.0 m high but 15 J is lost to friction. If the ball's mass is 1.0 kg, find its speed at the bottom. [3]

2.6 Explain why a car moving at constant speed still uses fuel (energy), even though the net force on it is zero. [2]