3 Further Mechanics – 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)		
Hooke's law	胡克定律			
modulus of elasticity	弹性模量			
elastic potential energy	弹性势能			
coefficient of restitution	恢复系数			

Recall

In **Part 1** you met projectiles and circular motion. Part 2 adds stretchy **elastic strings** (Hooke's law) and **bouncy collisions** (the coefficient of restitution).

New ideas

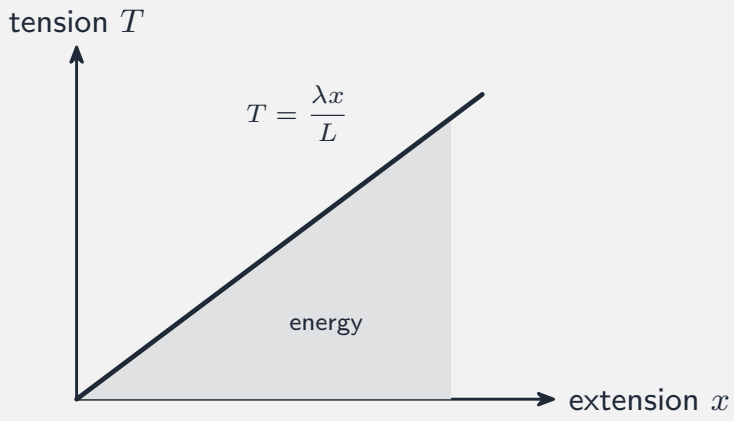
1 Hooke's law

Hooke's law 胡克定律 says the tension in an elastic string or spring is proportional to its **extension** x:

$$T = \frac{\lambda x}{L},$$

where L is the natural length and λ is the **modulus of elasticity** 弹性模量. Stretching it stores **elastic potential energy** 弹性势能:

$$E = \frac{\lambda x^2}{2L}.$$



Worked example. $L = 2$ m, $\lambda = 50$ N, $x = 0.5$ m: $T = \dfrac{50 \times 0.5}{2} = 12.5$ N.

Micro-check. An elastic string has $L = 1$ m, $\lambda = 20$ N and extension $x = 0.2$ m. Find the tension. [1]

■ 2 The coefficient of restitution

In a collision, momentum is conserved. The bounciness is measured by the **coefficient of restitution** 恢复系数 e:

$$e = \frac{\text{speed of separation}}{\text{speed of approach}}, \qquad 0 \leqslant e \leqslant 1.$$

Here $e = 1$ is perfectly elastic (no energy lost) and $e = 0$ is perfectly inelastic (the bodies stay together).

$$e = \frac{\text{separation speed}}{\text{approach speed}}$$

Worked example. Two balls approach at 4 m s^{-1} and separate at 2 m s^{-1}: $e = \dfrac{2}{4} = 0.5$.

Micro-check. Two bodies approach at 6 m s^{-1} and separate at 3 m s^{-1}. Find e. [1]

Watch out: in $T = \dfrac{\lambda x}{L}$, x is the **extension** —the extra length, not the total stretched length. The stored energy uses x^2, so doubling the stretch **quadruples** the energy. The coefficient of restitution is separation ÷ approach, always between 0 and 1.

Practice

3.1 An elastic string has natural length 2 m, modulus 40 N, and is stretched by 0.5 m. Find the tension. [2]

3.2 For the string in 3.1, find the stored elastic energy ($E = \dfrac{\lambda x^2}{2L}$). [2]

3.3 Two balls approach at 8 m s^{-1} and separate at 2 m s^{-1}. Find the coefficient of restitution. [2]

3.4 State the value of e for (a) a perfectly elastic collision; (b) a perfectly inelastic one. [2]

3.5 State what is conserved in **every** collision. [1]

3.6 Challenge. An elastic string of natural length 1.5 m and modulus 60 N is stretched

to a total length of 2 m. Find the tension and the stored elastic energy. [3]