

2.8 Spring Forces

Name: _____ Class: _____ Date: _____

Total: 14 marks

KEY WORDS spring constant 劲度系数 • hooke's law 胡克定律 • force 力

Objective

Build the skills to answer exam questions on **spring forces**.**You must be able to:**

- use **Hooke's law** 胡克定律: the restoring force has magnitude $F = kx$
- explain the minus sign in $F = -kx$ (the force opposes the displacement)
- use the **spring constant** 劲度系数 k as force per unit stretch
- relate stiffness to k (larger k = stiffer)

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Hooke's law

The size of the spring force grows with the stretch or compression:

$$F = kx.$$

A spring with $k = 200 \text{ N m}^{-1}$ stretched 0.1 m pulls back with $F = 200 \times 0.1 = 20 \text{ N}$.**■ The restoring direction**Written with direction, $F = -kx$: the minus sign means the force always points back toward the natural length, opposing the displacement.**■ The spring constant** k is the force needed per metre of stretch. A stiffer spring has a larger k . From data, $k = F/x$: if 15 N stretches a spring 0.05 m, then $k = 15/0.05 = 300 \text{ N m}^{-1}$.

2 Practice

Now apply the methods above.

2.1 A spring with $k = 100 \text{ N m}^{-1}$ is stretched 0.2 m. Find the force. [2]

2.2 State the meaning of the minus sign in $F = -kx$. [1]

2.3 A force of 12 N stretches a spring 0.03 m. Find k . [2]

2.4 Two springs stretch the same distance; spring A needs more force. Which has the larger k ? [1]

3 Exam-style questions

3.1 The magnitude of a spring's force is proportional to [1]

A	B
C	D

A the mass on it

B its displacement from the natural length

C the square of the displacement

D time

3.2 A spring force always points [1]

A	B
C	D

A in the direction of the stretch

B back toward the natural length

C downward

D perpendicular to the spring

3.3 A spring with $k = 500 \text{ N m}^{-1}$ is compressed 0.04 m.

(a) Find the size of the spring force. [2]

(b) State the direction of the force relative to the compression. [1]

3.4 A 2 kg mass hangs at rest from a spring, stretching it 0.1 m ($g = 10 \text{ m s}^{-2}$).

(a) State the spring force (it balances the weight). [1]

(b) Find the spring constant k . [2]