

## 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]