17 Simple harmonic motion – 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)		
simple harmonic motion	简谐运动			
displacement	位移			
equilibrium	平衡			
angular frequency	角频率			

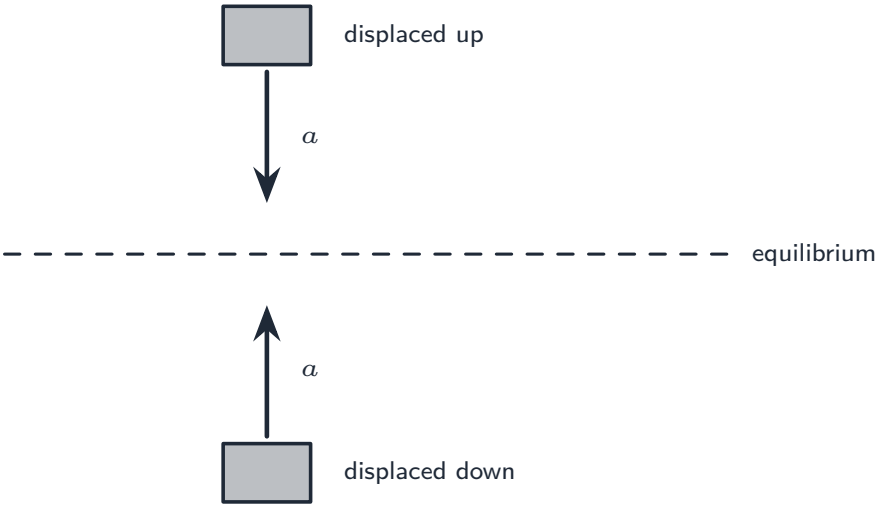
Recall

Many things swing or vibrate around a rest point — a pendulum, a mass on a spring, a guitar string. Many of them do **simple harmonic motion** 简谐运动 (SHM), the motion behind clocks, music and even the swaying of tall buildings.

New ideas

Read these first. Each idea has a short worked example. Then do the Practice.

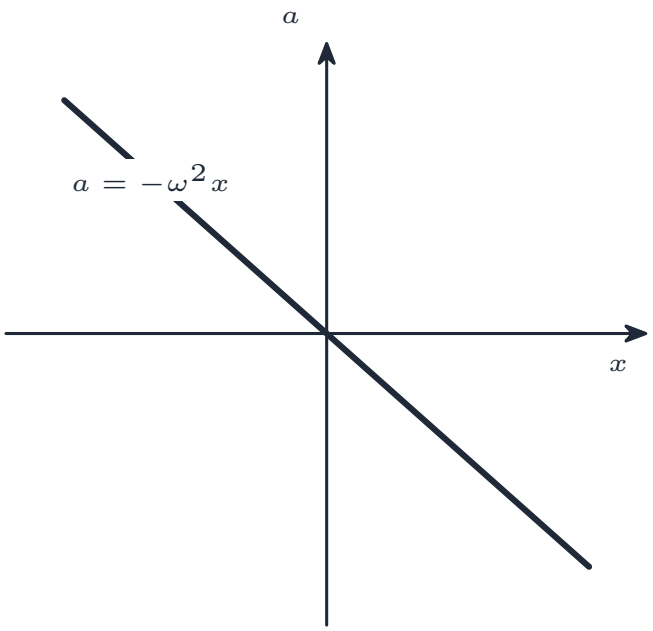
■ 1 The definition



In SHM the **acceleration** is proportional to the **displacement** 位移 from **equilibrium** 平衡, and always points *back* towards it.

Worked example. Pull a mass on a spring to the right and let go. The stretched spring pulls it back to the left, so the acceleration points left — opposite to the displacement. The further you pull it, the larger that pull-back.

2 The graph



The defining equation is $a = -\omega^2 x$, where ω is the **angular frequency** 角频率. The minus sign means "back towards equilibrium".

Worked example. A body with $\omega = 5.0$ rad s^{-1} is at displacement $x = 0.020$ m. Its acceleration is $a = -\omega^2 x = -(5.0)^2(0.020) = -0.50$ m s^{-2} — magnitude 0.50, pointing back to the centre.

Watch out: because $a \propto x$, the acceleration is *largest at the ends* (largest x) and *zero at the centre* — the opposite of where the speed is largest.

Practice

Try these in order.

17.1 In SHM, what is the acceleration proportional to? [1]

17.2 In which direction does the acceleration always point? [1]

17.3 Write the defining equation of SHM. [1]

17.4 What does the minus sign in $a = -\omega^2 x$ mean? [1]

17.5 A body in SHM has $\omega = 4.0$ rad s^{-1}. Find its acceleration when $x = 0.050$ m. [2]

17.6 Where in the motion is the acceleration greatest, and where is it zero? Explain. [2]

17.7 Challenge. A mass on a spring oscillates with no one touching it. Explain why it speeds up as it moves towards the centre and slows down towards the ends. [2]