12 Period and centripetal force – 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)		
revolution	圈			
period	周期			
frequency	频率			
centripetal force	向心力			

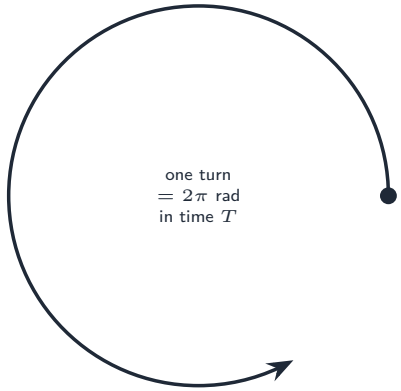
Recall

An object going round once completes one **revolution** 圈 of 2π rad. The time for one revolution is the **period** 周期 T — for a wheel, a planet, or a fairground ride, the period tells you how long one full turn takes.

New ideas

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

■ 1 Period and frequency



$$\omega = 2\pi/T = 2\pi f$$

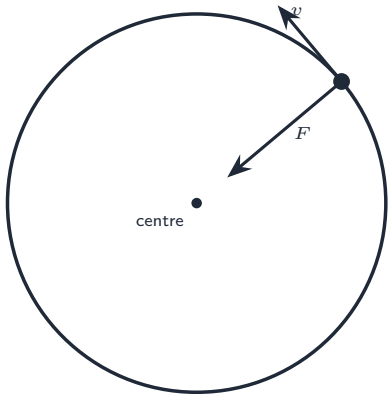
In time T the object turns 2π rad, so

$$\omega = \frac{2\pi}{T} = 2\pi f,$$

where $f = 1/T$ is the **frequency** 频率 (turns per second, in Hz).

Worked example. A wheel turns once every 0.50 s, so $f = 1/T = 1/0.50 = 2.0$ Hz and $\omega = 2\pi/T = 2\pi/0.50 \approx 12.6$ rad s^{-1}.

■ 2 Force towards the centre



force points to the centre

The velocity points along the tangent, but a **centripetal force** 向心力 always points to the centre — it keeps changing the *direction* of motion. Its size is

$$F = m\omega^2 r = \frac{mv^2}{r}.$$

Worked example. A 0.20 kg ball on a string moves in a circle of radius 0.50 m at $v = 3.0$ m s^{-1}. The string tension provides the centripetal force: $F = mv^2/r = 0.20 \times 3.0^2/0.50 = 3.6$ N.

Watch out: the centripetal force is not an extra force you add on — it is the name for whatever real force (string tension, gravity, friction) happens to point to the centre.

Practice

Try these in order.

12.1 What is the *period* of circular motion? [1]

12.2 Write ω in terms of the period T. [1]

12.3 A wheel turns once every 4.0 s. Find its angular speed. [2]

12.4 In which direction does the *centripetal force* point? [1]

12.5 A 0.50 kg ball moves in a circle of radius 0.40 m at 2.0 m s^{-1}. Find the centripetal force ($F = mv^2/r$). [2]

12.6 A car drives at a steady speed around a flat circular track. Name the real force that provides the centripetal force. [1]

12.7 Challenge. A ball on a string is swung in a horizontal circle. Explain *why* the string must be pulled harder if the ball is swung faster, even though the circle stays the same size. [2]