A-LEVEL PHYSICS • HOLIDAY HOMEWORK 假期作业

7 Waves – 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)		
intensity	强度			
point source	点源			
phase difference	相位差			
observer	观察者			
Doppler effect	多普勒效应			

Recall

In **Part 1** you used the wave quantities (amplitude, wavelength, frequency, period), the wave equation $v = f\lambda$, and transverse vs longitudinal waves. Part 2 adds how strong a wave is (intensity), how out-of-step two waves are (phase), and the Doppler effect.

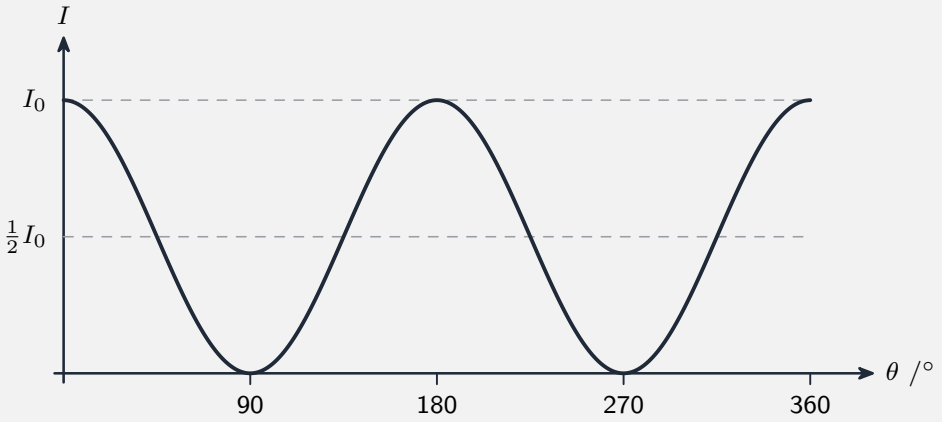
New ideas

1 Intensity

The **intensity** 强度 of a wave is the power passing through unit area: $I = \dfrac{P}{A}$ (in W m^{-2}). It is proportional to the **square of the amplitude**: $I \propto A^2$.

A **point source** 点源 spreads its power over a sphere of area $4\pi r^2$, so

$$I = \frac{P}{4\pi r^2}, \qquad I \propto \frac{1}{r^2}.$$

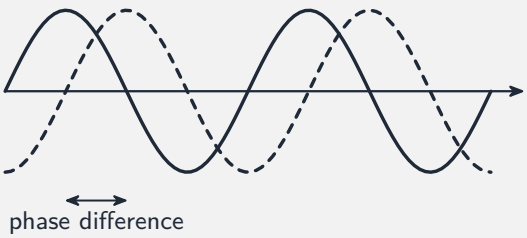


Worked example. A lamp emits 60 W equally in all directions. At 2.0 m: $I = \dfrac{60}{4\pi(2.0)^2} \approx 1.2$ W m^{-2}.

2 Phase difference

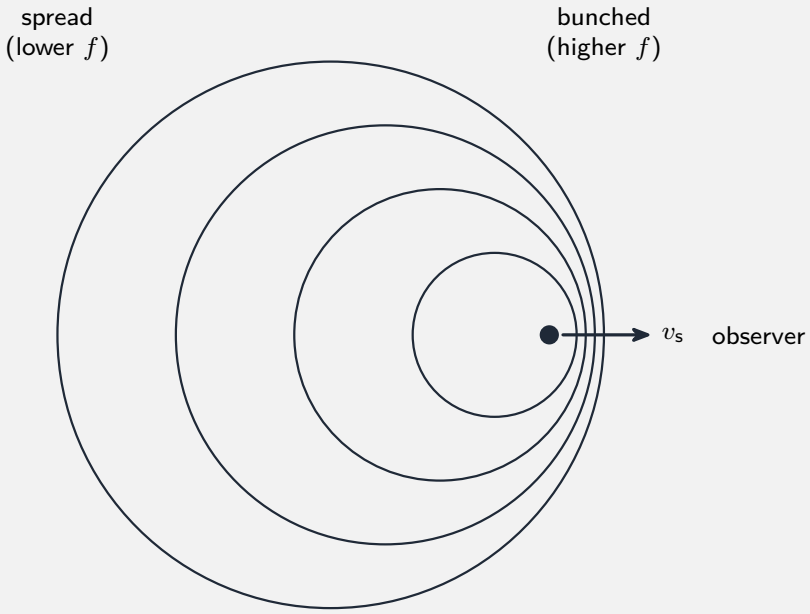
The **phase difference** 相位差 tells how far one oscillation leads or lags another, measured in radians (a full cycle is 2π) or degrees (a full cycle is 360°).

- two points one wavelength apart are *in phase* (phase difference 0);
- two points half a wavelength apart are *exactly out of phase* (phase difference π, or 180°).



3 The Doppler effect

When a sound **source** moves relative to a still **observer** 观察者, the heard frequency changes —the **Doppler effect** 多普勒效应. Moving **towards** → wavefronts squashed → higher frequency; moving **away** → lower.



$$f_o = \frac{v\, f_s}{v \pm v_s} \quad \text{(minus when approaching)}.$$

Worked example. A 800 Hz horn moves at 30 m s^{-1} towards a still listener (v = 340 m s^{-1}): $f_o = \dfrac{340 \times 800}{340 - 30} \approx 877$ Hz.

Watch out: use *minus* in the bottom when the source moves *towards* the listener (pitch rises) and *plus* when it moves *away* (pitch falls).

Practice

7.1 A point source emits 100 W equally in all directions. Find the intensity 5.0 m away. [2]

7.2 The amplitude of a wave is doubled. State the factor by which its intensity changes. [1]

7.3 State the phase difference, in degrees, between two points half a wavelength apart on a wave. [1]

7.4 A car horn of frequency 500 Hz moves away from a still listener at 25 m s^{-1} (v = 340 m s^{-1}). Find the heard frequency. [2]

7.5 The distance from a point source is doubled. State the factor by which the intensity changes. [1]

7.6 Explain *why* the pitch of an ambulance siren suddenly drops as it passes you. [2]

7.7 Challenge. Light from a distant star is measured with a *longer* wavelength than expected (a "red-shift"). Using the Doppler idea, state whether the star is moving towards or away from us, and why. [2]