

Exercise walk-through

8.2

Cosmology and red-shift (P)

Pearson Edexcel · International GCSE · Physics

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The method

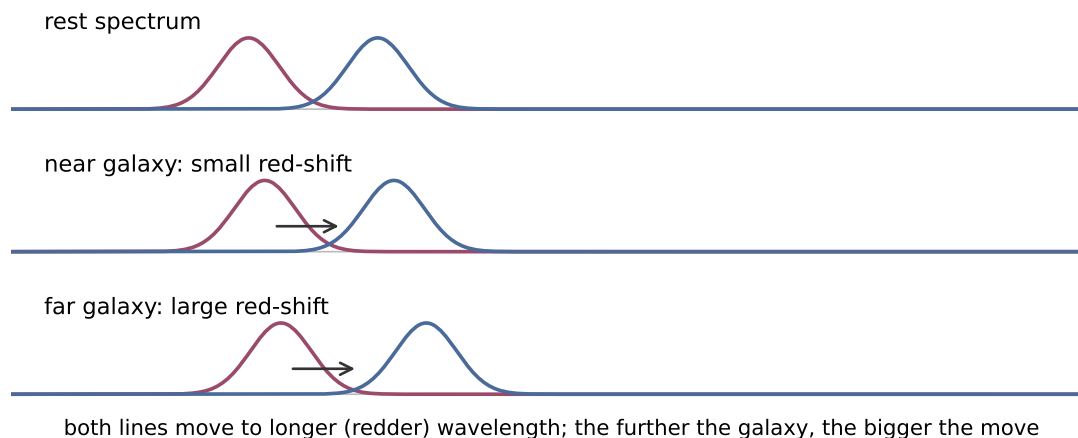
Method — Red-shift: the recession gauge

$$\frac{\Delta\lambda}{\lambda_0} = \frac{v}{c}$$

Worked check. A 600 nm line appears at 609 nm: $\Delta\lambda/\lambda_0 = 9/600 = 0.015 \rightarrow v = 0.015 \times 3 \times 10^8 = 4.5 \times 10^6$ m/s.

Method — Red-shift: the recession gauge

[$0 = v c$] Worked check.



Spectral lines move redder as a galaxy recedes faster; further galaxies shift more.

Exercises 2.1·2.3

2.1 (P) What happens to a wave's observed wavelength when its source recedes? [1]

2.2 (P) A 500 nm line appears at 502 nm. Calculate v/c . [2]

2.3 (P) Name the two main pieces of evidence for the Big Bang. [2]

Exercises 2.1·2.3

2.1 (P) What happens to a wave's observed wavelength when its source recedes? [1]

2.1 (P) It increases – stretched to the red (red-shift).

2.2 (P) A 500 nm line appears at 502 nm. Calculate v/c . [2]

2.2 (P) $\Delta\lambda/\lambda_0 = 2/500 = 0.004 = v/c$.

2.3 (P) Name the two main pieces of evidence for the Big Bang. [2]

2.3 (P) Galaxy red-shift increasing with distance; the cosmic microwave background.

Exercises 2.4·3.2

2.4 (P) What is the cosmic microwave background?

[1]

3.1 (P) Galaxies twice as far away show twice the red-shift. Explain how this supports an expanding universe.

[3]

3.2 (P) A spectral line of rest wavelength 656 nm is observed at 659 nm in a galaxy. Calculate the galaxy's speed in m/s ($c = 3 \times 10^8$ m/s).

[3]

Exercises 2.4·3.2

2.4 (P) What is the cosmic microwave background? [1]

2.4 (P) Faint microwave radiation reaching us from every direction – the stretched, cooled remnant of the early universe’s radiation.

3.1 (P) Galaxies twice as far away show twice the red-shift. Explain how this supports an expanding universe. [3]

3.1 (P) Red-shift measures recession speed; red-shift proportional to distance means the further a galaxy, the faster it recedes; everything receding from everything else is exactly what expansion of space produces – a fixed centre is not needed.

3.2 (P) A spectral line of rest wavelength 656 nm is observed at 659 nm in a galaxy. Calculate the galaxy’s speed in m/s ($c = 3 \times 10^8$ m/s). [3]

3.2 (P) $\Delta\lambda = 659 - 656 = 3$ nm; $v/c = 3/656 = 4.57 \times 10^{-3}$; $v = 1.37 \times 10^6$ m/s.

Exercise 3.3

3.3 (P) Explain why the CMB counts as evidence for a hot early universe.

[2]

Exercise 3.3

3.3 (P) Explain why the CMB counts as evidence for a hot early universe. [2]

3.3 (P) A hot, dense early universe would be filled with high-energy radiation; expanding space has stretched and cooled it into today's uniform microwaves – exactly what is observed from all directions.