Redshift: matching spectral patterns

Student activity • observation and reasoning

YEAR 11 / LESSON 110 / PHYSICS ONLY

The question

How can a pattern of spectral lines reveal a wavelength shift?

Compare invented reference and observed line positions, then distinguish a low-speed motion analogy from cosmological redshift.

Equipment

- Booklet, original spectral-line templates, ruler and calculator

Printed or screen spectra only. No fragile gas discharge tubes, high voltage, lasers or solar viewing.

Course coverage: Physics only: 8.15P, 8.17P. Relative motion and redshift in galaxy spectra.

Plan, model or apparatus sketch

Draw clearly labelled astronomical axes, spectra or orbital/pathway diagrams as appropriate.

Method and reasoning

Read the whole sequence before starting

YEAR 11 / LESSON 110 / PHYSICS ONLY

1. Draw a wavelength axis and mark reference lines at 400, 500 and 600 nm. Label this an invented pattern, not a named element's actual spectrum.

2. On a second axis mark observed lines at 404, 505 and 606 nm. Match corresponding lines by the pattern and calculate each wavelength increase.

3. Calculate $\Delta\lambda/\lambda_{reference}$ for all three lines. Explain why a common fractional shift is the relevant comparison rather than an equal number of nanometres for every line.

4. Describe the pattern as redshifted because wavelengths are longer and corresponding frequencies lower. Explain that this does not mean every observed line is visibly red.

5. Use a moving-source diagram to explain the low-speed receding-source analogy. Then state that on cosmological scales expansion of space stretches travelling light; not every redshift is merely a local object moving through static space.

6. Discuss how several identified lines give a more reliable inference than one ambiguous feature. Keep local motion, cosmological expansion and possible line-identification errors distinct.

Cleanup

- Retain the matched spectra and return calculators.

Record your evidence

Blank spaces are for your own work

YEAR 11 / LESSON 110 / PHYSICS ONLY

Reference and task data

The three invented lines all have fractional shift z = 0.010. The activity uses printed spectra and requires no discharge tubes or spectroscope viewing. A single redshift does not alone establish a galaxy's distance without a model.

Reference / nm	Observed / nm	Δλ / nm	Fractional shift
400	404		
500	505		
600	606		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

YEAR 11 / LESSON 110 / PHYSICS ONLY

1. Find the shift of the 500 nm line.

2. Find its fractional shift.

3. Are all absolute wavelength shifts equal?

4. What happens to frequency at longer wavelength?

5. Must a redshifted line look red?

6. Why compare several lines?