



EduTrend Contents

W4C · ASTRONOMY & SPACE SCIENCE · HIGH SCHOOL

Light from the Stars

Use spectra to identify elements and measure redshift.

Ages 15–18

Level: Advanced

75 minutes

Pairs · up to 24

Activity 05

Inside: activity at a glance · step-by-step session plan · facilitator notes · 3 student worksheets · assessment checklist

ACTIVITY 05 · AT A GLANCE

Light from the Stars

Students learn how astronomers study stars they can never visit. They build a spectroscope from a diffraction grating, observe continuous and emission spectra, and match spectral lines to elements. They then analyse redshift data from galaxies to calculate recession velocities and plot a simple Hubble diagram.

Learning outcomes

By the end of the session students can:

- distinguish continuous, emission and absorption spectra;
- identify elements from spectral lines;
- calculate redshift and recession velocity;
- interpret a Hubble diagram as evidence for an expanding universe.

KEY WORDS

spectrum · emission line ·
absorption line · wavelength ·
redshift · Doppler effect · Hubble
constant

CURRICULUM LINKS

Physics: waves, light, cosmology.
Chemistry: atomic structure.
Maths: ratios, graphs, gradients.

1**QUESTION**

What do we want
to know?

2**OBSERVE**

Watch the sky

3**MODEL**

Build a model

4**MEASURE**

Take readings

5**COMPARE**

Model vs reality

6**EXPLAIN**

Use evidence

Materials (per pair)

- Diffraction grating or old CD/DVD, card tube, black paper, tape
- Light sources: filament lamp, fluorescent tube, gas discharge tubes (teacher-operated)
- Reference spectra chart
- Galaxy redshift data table
- Worksheets 1, 2 and 3

Before the session

- Prepare card and gratings for spectroscope building.
- Set up gas discharge tubes with teacher control only.
- Print reference spectra and galaxy data.
- Darken the room for observations.

SAFETY

Never look at the Sun through a spectroscope.
Gas discharge tubes use high voltage: teacher
operates only. Lamps get hot.

ACTIVITY 05 · SESSION PLAN

Step by step

Timings are for 75 minutes. If discharge tubes are unavailable, use street lights or online spectra images.

Time	What happens	Say or ask
0–10 min Hook	Show a star field and a spectrum of the Sun with dark lines. What can light tell us?	<i>"How do we know what stars are made of?"</i>
10–25 min Build	Pairs build spectroscopes with a narrow slit and grating.	<i>"Why a narrow slit?"</i>
25–40 min Observe	View a filament lamp, a fluorescent tube and teacher-run gas tubes. Sketch spectra.	<i>"How are these spectra different?"</i>
40–50 min Identify	Match observed lines to reference spectra.	<i>"Which element is in the fluorescent tube?"</i>
50–68 min Redshift	Calculate $z = \text{change in wavelength} \div \text{rest wavelength}$ and $v = z \times c$ for galaxies, then plot v against distance.	<i>"What does the gradient represent?"</i>
68–75 min Explain	Discuss the expanding universe and limitations.	

CHALLENGE CARD (print or copy onto the board)

Using the galaxy data, estimate the Hubble constant from your graph and use it to estimate the age of the universe ($1 \div H_0$). Compare with the accepted value of about 13.8 billion years.

ACTIVITY 05 · FACILITATOR NOTES

The astronomy in brief

Hot solids produce continuous spectra. Hot, low-pressure gases produce emission spectra: bright lines at wavelengths set by the energy levels of their atoms, so each element has a unique fingerprint. When light passes through cooler gas, the same wavelengths are absorbed, producing dark lines. Stellar spectra reveal the composition and temperature of stars.

If a galaxy moves away from us, its spectral lines shift to longer wavelengths (redshift). For speeds much less than light, $v = z \times c$. Edwin Hubble found that more distant galaxies recede faster, and the gradient of velocity against distance is the Hubble constant. This is key evidence that the universe is expanding.

Common ideas to listen for

- “Stars are made of different elements from Earth.” Spectra show the same elements.
- “Redshift means galaxies are red.” It is a shift in wavelength, not colour.
- “The Big Bang was an explosion into space.” Space itself is expanding.

Adapting the activity

Support

Provide pre-built spectroscopes and a worked redshift example.

Stretch

Discuss why the relativistic redshift formula is needed for high z and why different methods give slightly different Hubble constants.

WORKSHEET 1

Observed spectra

Name: _____ Class: _____ Date: _____

Sketch what you see through the spectroscope.

Spectra

Source	Sketch of spectrum	Type
Filament lamp		
Fluorescent tube		
Gas tube A		
Gas tube B		

Element identification

WORKSHEET 2

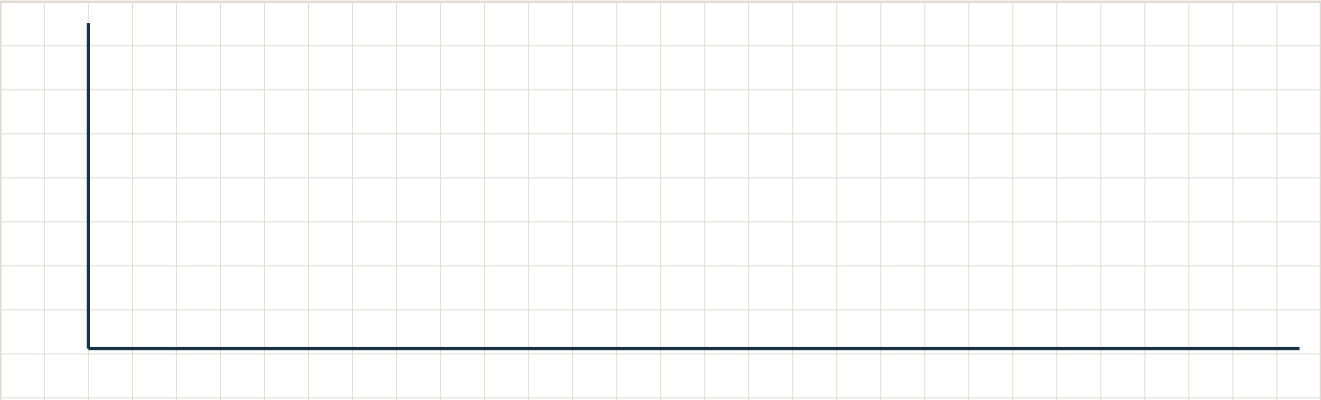
Redshift calculations

$z = (\text{observed wavelength} - \text{rest wavelength}) \div \text{rest wavelength}; v = z \times 300,000 \text{ km/s}.$

Galaxies

Galaxy	Rest (nm)	Observed (nm)	z	v (km/s)	Distance (Mpc)
1					
2					
3					
4					
5					

Hubble diagram



y-axis: velocity (km/s)

x-axis: distance (Mpc)

WORKSHEET 3

Conclusions

Show your working.

Hubble constant and age of the universe

Limitations of this analysis

FOR THE TEACHER

Assessment checklist

Use during the session. One sheet covers up to eight students; copy as needed.

Student	Identifies spectra correctly	Calculates redshift and velocity	Interprets cosmological evidence

Suggested codes: W = working towards · E = expected · G = greater depth

ABOUT THIS ACTIVITY

Light from the Stars is a sample activity from the EduTrend Contents W4C Astronomy & Space Science programme (high school, level: advanced). Every activity in the programme follows the same format: a practical challenge, a clear session plan, facilitator notes and ready-to-print worksheets, so that teachers, club leaders and parents can run it without extra preparation.

Full 15-, 20- and 32-week programmes are available from EduStore at edutrend.org.

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