8.3 Red-shift and the Big Bang

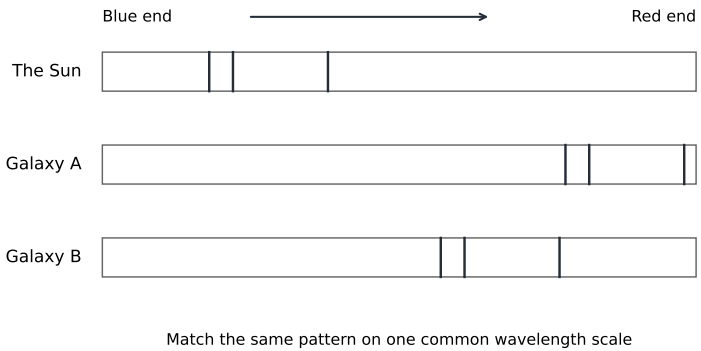
Name: _____ Class: _____ Date: _____ **Total: 15 marks**

KEY WORDS red-shift

Objective

State the red-shift observation, its link to receding speed and distance, and the chain to the expanding universe and the Big Bang. Physics only. Original questions for spec statement 4.8.2.

1 Key knowledge and worked examples



Schematic redrawing of AQA June2024 8463/2H Q03.4

For distant galaxies, compare matching lines on the same wavelength scale.

Red-shift : light from **most distant galaxies** shows an **increase in wavelength** – a shift towards the red.

- The **further away** the galaxy, the **faster** it recedes and the **bigger** the observed red-shift.

The chain to the Big Bang (use the links required by the question and its mark allocation):

1. red-shift observed in light from distant galaxies → they are **receding**;
2. further = faster → space itself is **expanding**;
3. run the expansion backwards → everything began in **a very small, extremely hot and dense region** – the **Big Bang**.

Since 1998: observations of **supernovae** suggest distant galaxies recede **ever faster** – the expansion is accelerating.

Scientific method: red-shift surveys are the **observations**; the Big Bang is the **theory** they support. Much remains unknown – **dark matter** and **dark energy** are current mysteries.

2 Practice

2.1 State what red-shift is. [2]

2.2 State the link between a galaxy's distance and its receding speed. [1]

2.3 What do observations since 1998 suggest about distant galaxies? [1]

3 Exam-style questions

3.1 Explain how red-shift provides evidence for the Big Bang theory. [4]

3.2 Light from galaxy A shows a larger red-shift than light from galaxy B.

(a) State which galaxy is moving faster away from us. [1]

(b) State which galaxy is probably further away. [1]

(c) A third galaxy shows no measurable spectral shift. In the simple school model, state what this suggests about its motion along our line of sight. [1]

3.3 "Scientists are sure the Big Bang is complete." Evaluate this statement using the evidence and the open questions. [4]

Solutions

2.1 An increase in the wavelength of light from most distant galaxies; the spectral lines shift towards the red end.

2.2 The further away the galaxy, the faster it is receding.

2.3 Distant galaxies are receding ever faster – accelerating expansion.

3.1 Light from most distant galaxies shows an increase in wavelength (red-shift); this shows the galaxies are moving away from us – receding; the further the galaxy, the faster it recedes, so the whole universe is expanding; traced backwards, the expansion began from a very small, extremely hot and dense region – the Big Bang.

3.2 (a) Galaxy A. (b) Galaxy A. (c) No recession along our line of sight; sideways motion is still possible. Do not infer zero total velocity.

3.3 Supporting evidence: red-shift of distant galaxies matches an expanding universe, and the 1998 supernova observations extend the picture with accelerating recession. But the account is incomplete: the nature of dark matter is not yet understood nor the cause of accelerated expansion, described using dark energy – so "complete" is not justified; it is the best-supported current model.