

- 1 (a) Figure 2 shows some lines in the absorption spectra from four different galaxies (A, B, C, and D) and from a laboratory source.

All the spectra are aligned and to the same scale.

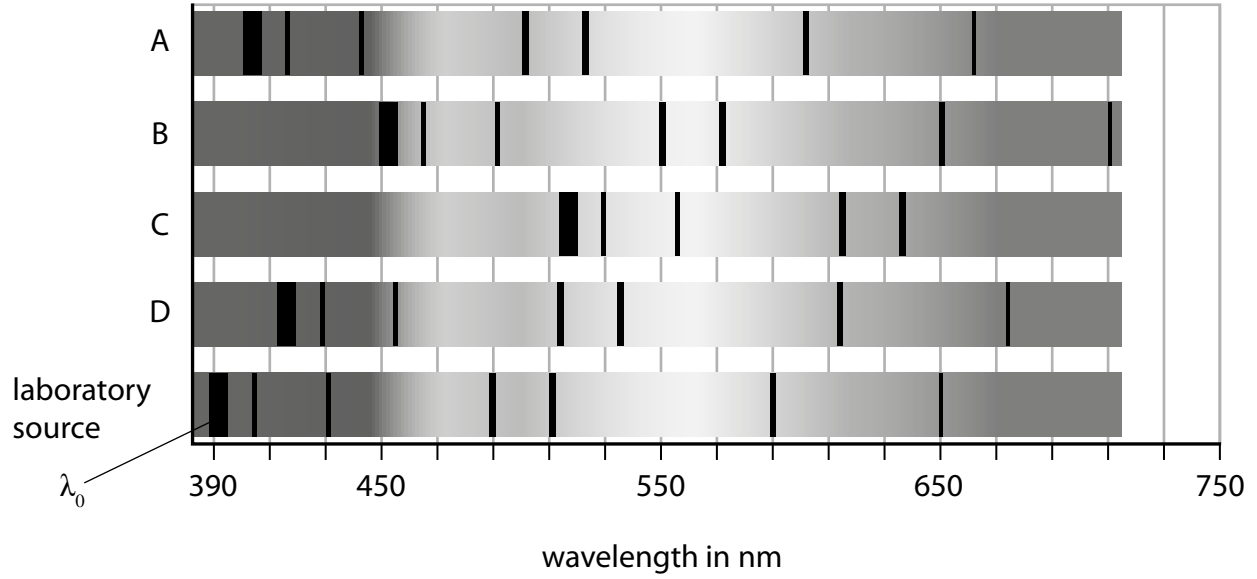


Figure 2

- (i) Explain, using Figure 2, which galaxy is furthest away from us.

(3)

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(ii) In Figure 2, the reference wavelength, λ_0 , is shown at 390 nm.

Estimate the change in the reference wavelength, $\Delta\lambda$, for the light from galaxy D.

(1)

$\Delta\lambda = \dots\dots\dots$ nm

(iii) Calculate the speed, v , of galaxy D.

Use the equation

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

[$c = \text{speed of light} = 3 \times 10^8 \text{ m/s}$]

(2)

$v = \dots\dots\dots$ m/s

(b) Figure 3 shows a photograph of galaxy D.

This photograph was taken by a student at his home.



(Source: Paul Curtis)

Figure 3

State **two** ways that the student can improve the observational techniques so that the quality of the image is improved.

(2)

- 1
- 2

(Total for Question 3 = 8 marks)

(c) The distance between the Earth and the Sun is 1.50×10^{11} m.

Light takes 500 s to travel from the Sun to the Earth.

The wavelength of red light is 670 nm.

Calculate the frequency of red light, using only the data provided.

(4)

frequency = Hz

(Total for Question 9 = 12 marks)
