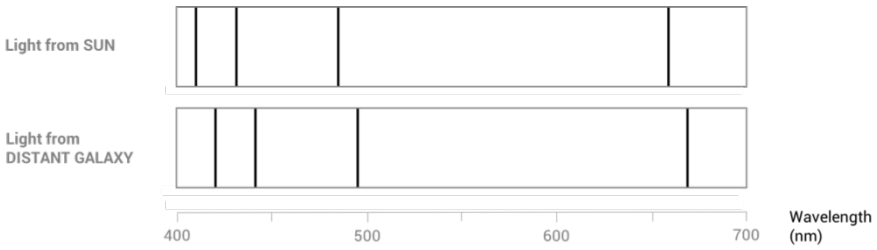
0 1

Astrophysicists are very interested in the spectra of stars. The spectrum of a star can tell us, among other things, the types of elements which it contains. The below diagram shows four of the **absorption lines** in the spectrum of the Sun, and the corresponding lines which are observed in the light we receive from a distant galaxy.



0 1 . 1

Describe the way in which the absorption lines which we observe in the light we receive from a distant galaxy differ from those of the Sun.

[1 mark]

0 1 . 2

Explain the reason for this difference.

[1 mark]

0 1 . 3

The absorption line at 656 nm in the light from the Sun is observed at a wavelength of 668 nm in the light from the distant galaxy. Calculate the difference in **frequency** between these two wavelengths.

The speed of light in vacuum is $v = 3 \times 10^8$ m/s.
One nanometer (1 nm) = 10^{-9} m.

Difference in frequency = _____ Hz

[4 marks]

0 1 . 4

Edwin Hubble was the first person to investigate how the red-shift of a galaxy depended on its distance from us.

The overall trend which he saw in his data is summarised by the below graph.

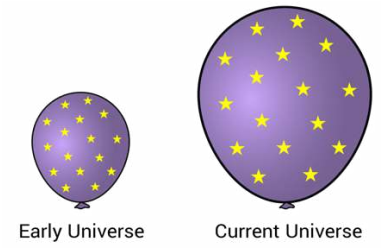
Describe the trend which is shown in the above graph.

[1 mark]

0 1 . 5 Explain the significance of this trend in relation to the development of the Universe.

[2 marks]

0 1 . 6 A teacher uses a starry balloon to explain the expansion of the Universe. She tells the class that the motion of the stars printed on the surface of the balloon as it is inflated as like the motion of the stars in the Universe as it expands.



Write down one strength and one weakness of this model for the expansion of the Universe.

Strength _____

Weakness _____

[2 marks]