

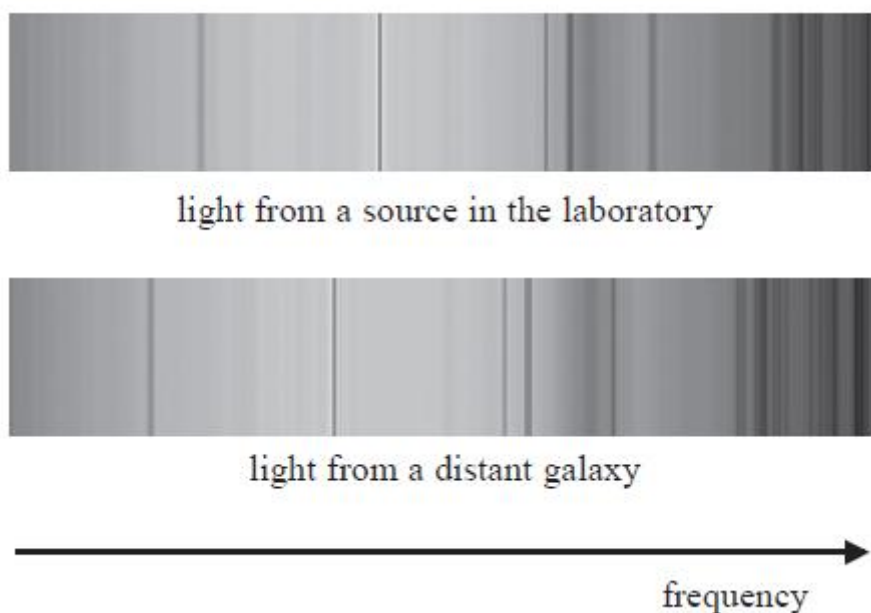
Name of the Student: \_\_\_\_\_

Max. Marks : 19 Marks

Time : 19 Minutes

Q1.

The spectra below show dark absorption lines against a continuous visible spectrum.



A particular line in the spectrum of light from a source in the laboratory has a frequency of  $4.570 \times 10^{14}$  Hz. The same line in the spectrum of light from a distant galaxy has a frequency of  $4.547 \times 10^{14}$  Hz.

With the aid of a calculation state what should be concluded about the distant galaxy.

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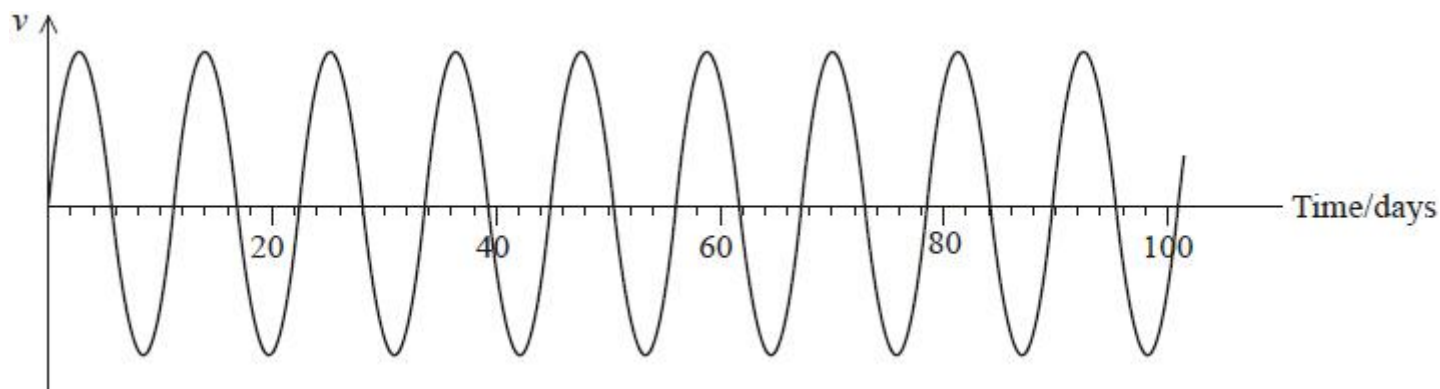
(Total for question = 3 marks)

**Q2.**

In 2016 astronomers announced the discovery of an Earth-like planet orbiting Proxima Centauri, the closest star to the Sun.

The planet was detected because of the small movement of the star as the planet orbited. The movement was detected using the Doppler shift in the frequency of light travelling to the Earth.

The graph shows how the component of the star's velocity  $v$  towards the Earth varied over time.



Explain how the Doppler shift was used to obtain the data shown on the graph.

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**(Total for question = 4 marks)**

**Q3.**

About 100 years ago the first measurements of spectra from galaxies beyond the Milky Way were made. Wavelengths of spectral lines were observed to be shifted and Hubble discovered a rough correlation between the shift in the spectral line and the distance to the galaxy.

The graphs below show plots for data collected in 1929 (Figure 1) and 1931 (Figure 2).

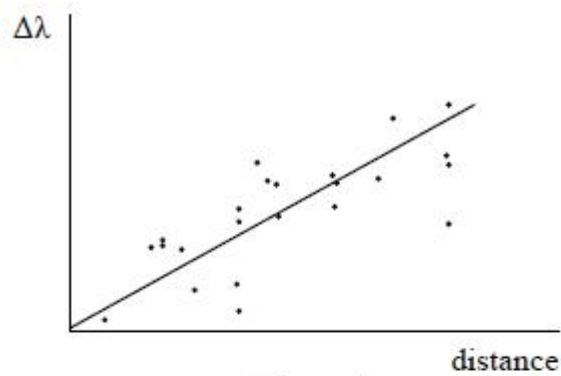


Figure 1

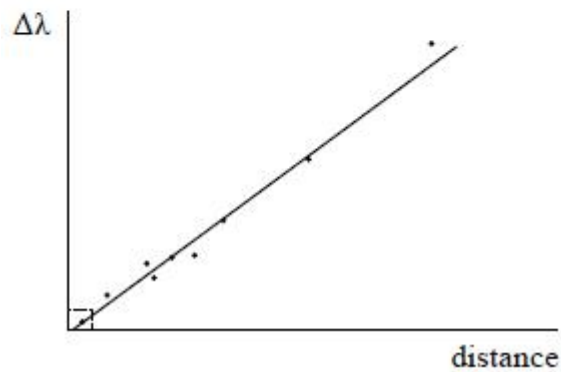


Figure 2

The data used by Hubble for his 1929 plot (Figure 1) is contained within the rectangle close to the origin of the 1931 plot (Figure 2).

Explain how Hubble's observations support the conclusion that the universe is expanding, and assess the reliability of this conclusion on the basis of Hubble's original data.

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(Total for question = 5 marks)

**Q4.**

A simple model of the hydrogen atom consists of an electron moving in a circular path around a proton.

- (i) In this simple model it is the electrostatic force, rather than the gravitational force, that is responsible for keeping the electron in a circular path.

By means of calculations justify this statement.

radius  $r$  of the hydrogen atom =  $5.3 \times 10^{-11}$  m

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- (ii) Ignoring the gravitational force, calculate the velocity of the electron in this simple model of the hydrogen atom.

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Velocity = .....

**(Total for question = 7 marks)**