

Questions

Q1.

The wavelength of a line in the spectrum produced by a distant star is found to be shorter than the wavelength of the corresponding line in the spectrum produced by the Sun.

This is because the distant star is

- ☐ **A** cooler than the Sun.
- ☐ **B** hotter than the Sun.
- ☐ **C** moving away from the Earth.
- ☐ **D** moving towards the Earth.

(Total for question = 1 mark)

Q2.

A pulsar is a rotating neutron star. The pulsar emits electromagnetic radiation as it rotates.

Scientists have recently detected the highest ever energy gamma ray photons received from a pulsar.

The pulsar is estimated to be travelling away from the Earth with a velocity of 750 m s^{-1} .

State why this motion away from the Earth does not significantly affect the wavelength of radiation received at the Earth.

(1)

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(Total for question = 1 mark)

Q3.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The diagram shows a source of sound waves and an observer.



Which row of the table shows a situation which would result in a decrease in the frequency of sound observed?

	Source	Observer
☐ A	moves to the right at 20 m s^{-1}	moves to the left at 20 m s^{-1}
☐ B	moves to the right at 20 m s^{-1}	moves to the right at 20 m s^{-1}
☐ C	moves to the right at 20 m s^{-1}	stationary
☐ D	stationary	moves to the right at 20 m s^{-1}

(Total for question = 1 mark)

Q4.

When light from the galaxy in Andromeda is analysed, it is found that the wavelengths are shorter than expected.

This tells us that the galaxy is

- ☐ A moving towards us.
- ☐ B moving away from us.
- ☐ C a very distant galaxy.
- ☐ D rotating on an axis.

(Total for question = 1 mark)

Q5.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

There are several different methods that can be used to determine the distance from our solar system to astronomical objects. These include the measurement of red shift, trigonometrical parallax and the use of standard candles.

Which row of the table shows a suitable method for each of the objects named?

	Nearby star	Nearby galaxy	Very distant galaxy
☐ A	parallax	red shift	standard candle
☐ B	red shift	standard candle	parallax
☐ C	parallax	standard candle	red shift
☐ D	red shift	parallax	standard candle

(Total for question = 1 mark)

Q6.

A line in the hydrogen spectrum of a star in the Milky Way galaxy is observed to have a wavelength of 656.3 nm. In a laboratory on Earth this line has a wavelength of 654.9 nm.

Which of the following expressions gives the magnitude of the velocity of the star relative to Earth?

(1)

☐ A $\frac{656.3}{654.9} \times 3 \times 10^8 \text{ m s}^{-1}$

☐ B $\frac{654.9}{(656.3 - 654.9)} \times 3 \times 10^8 \text{ m s}^{-1}$

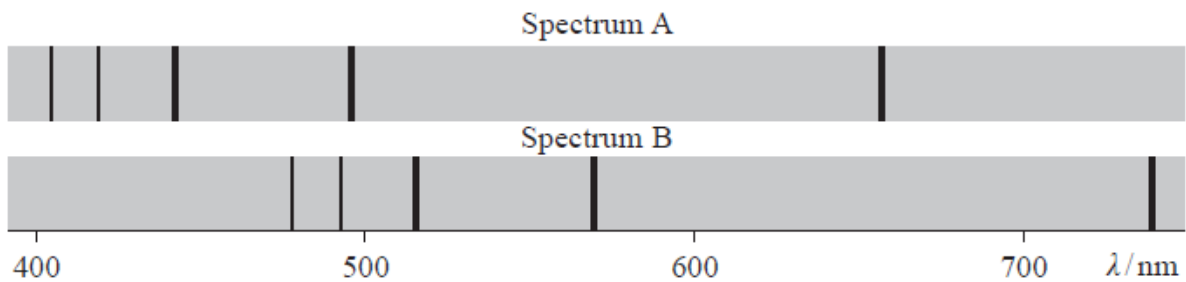
☐ C $\frac{654.9}{656.3} \times 3 \times 10^8 \text{ m s}^{-1}$

☐ D $\frac{(656.3 - 654.9)}{654.9} \times 3 \times 10^8 \text{ m s}^{-1}$

(Total for question = 1 mark)

Q7.

The diagram shows the spectra produced by two stars. Spectrum A is produced from the light from the Sun and spectrum B is produced from the light from a distant star.



The dark lines are produced when light from the core of the star is absorbed by hydrogen atoms in the outer regions of the star. Light is then re-radiated, but in all directions, giving rise to the dark lines in the spectrum.

Explain why the long wavelength lines are shifted by a greater amount than the short wavelength lines.

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(Total for question = 2 marks)

Q8.

Barnard's star is a red dwarf star in the vicinity of the Sun. The wavelength of a line in the spectrum of light emitted from Barnard's star is measured to be 656.0 nm. The same light produced by a source in a laboratory has a wavelength of 656.2 nm.

Calculate the velocity of Barnard's star relative to the Earth.

(3)

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Velocity =

(Total for question = 3 marks)

Q9.

A spectral line with wavelength 655.88 nm is detected on Earth from the Triangulum Galaxy. The wavelength of this spectral line measured using a laboratory source is 656.28 nm.

Calculate the velocity of the Triangulum Galaxy relative to the Earth.

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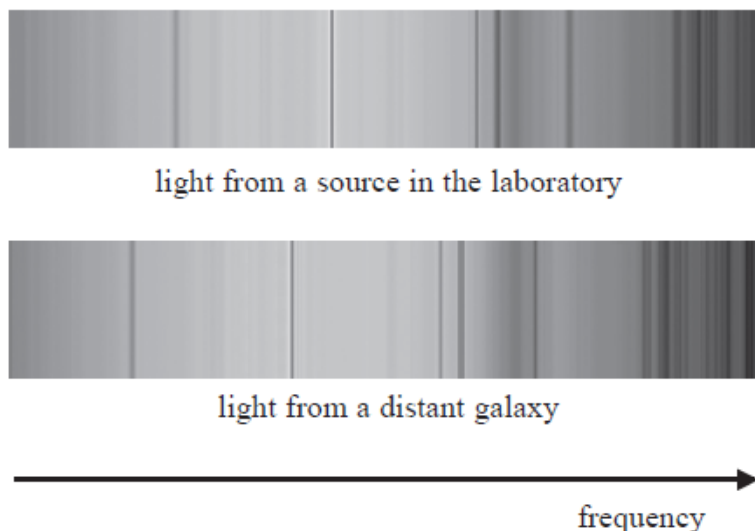
Magnitude of velocity =

Direction =

(Total for question = 3 marks)

Q10.

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 4.570×10^{14} Hz.

The same line in the spectrum of light from a distant galaxy has a frequency of 4.547×10^{14} Hz.

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

(3)

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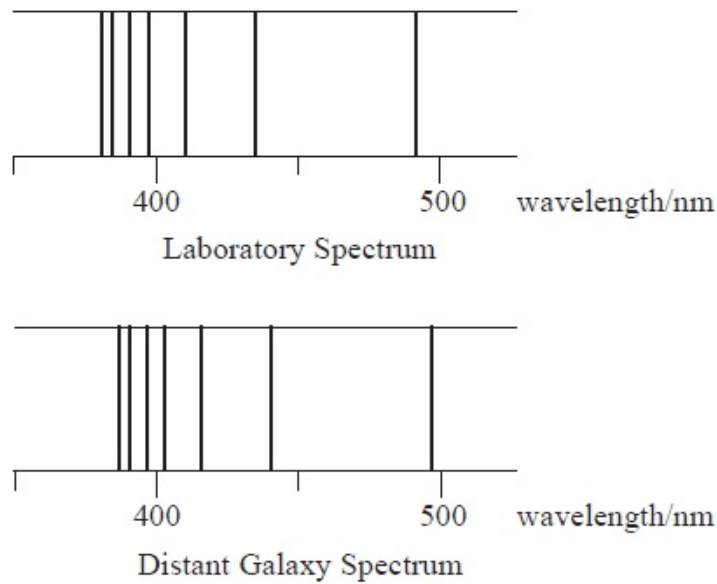
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(Total for question = 3 marks)

Q11. The diagram shows part of the hydrogen line spectra obtained for radiation emitted from hydrogen in the laboratory and received from hydrogen in a distant galaxy.



The lines in the distant galaxy spectrum are all shifted in wavelength compared to the lines in the laboratory spectrum.

State why the lines are shifted and what we can conclude about this distant galaxy.

(2)

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(Total for Question = 2 marks)

Q12.

The photograph below was taken by the James Webb Space Telescope (JWST) and shows a group of galaxies that formed shortly after the big bang, about 13×10^9 years ago.



(Source: © NASA, ESA, CSA, STScI)

The light from one of the galaxies, called Maisie, has a redshift z of 14.
 The wavelength of light from Maisie detected at the telescope is 4.0×10^{-6} m and lies within the infrared section of the electromagnetic spectrum.

(i) Calculate the wavelength of light emitted by Maisie.

(3)

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Wavelength emitted =

(ii) Explain why the light emitted by Maisie arrives at the telescope as infrared.

(2)

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(Total for question = 5 marks)