Higher Doppler Effect and Red Shift Questions

1. a) What is meant by the term **'Doppler Effect'**?

b) **State and explain a real life example** of the 'Doppler Effect'.

2. a) i) **State the equation** of a source **moving towards** a **stationary observer**.

ii) **Show using the equation**, how the frequency of sound changes when reaching the stationary observer.

b) i) **State the equation** of a source **moving away** from a **stationary observer**.

ii) **Show using the equation**, how the frequency of sound changes when reaching the stationary observer.

3. An Ambulance travelling at **12ms^{-1}** in a built up area emits sounds of frequency **1000Hz** from its siren. A person standing in a bus queue hears the siren coming towards and then passing him.

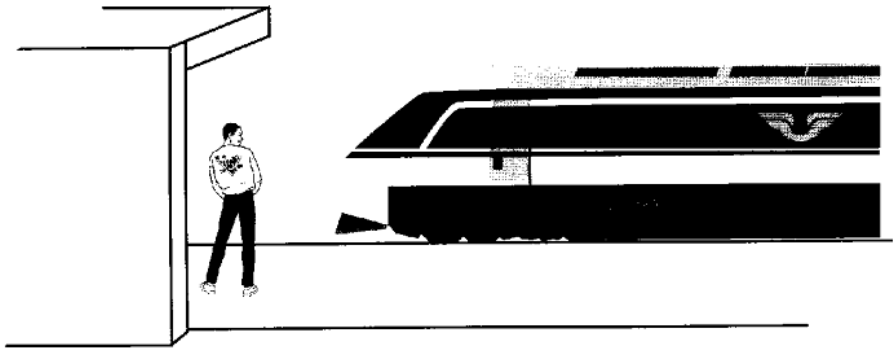
Calculate or find:

a) **Frequency heard by the person** when the ambulance **moves towards him**.

b) **Frequency heard by the person** when the ambulance **moves away from him**.

4. A train emits a sound of frequency **900Hz** as it passes through Larbert station.

The sound is heard by a pupil on the station platform as shown below.

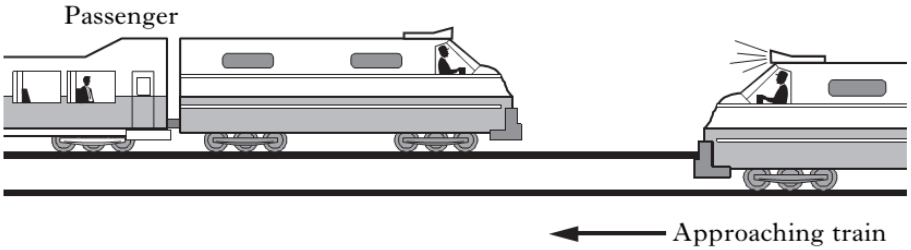


a) **Describe how the frequency of the sound**, heard by the pupil, **changes** as the train passes through the station.

b) **Explain in terms of wavefronts**, why this frequency change occurs.
(You may wish to use a diagram as part of your answer!!!)

c) At one instant the pupil hears a sound of frequency **850Hz**.
Calculate the speed of a train relative to the pupil on the platform at this instant.

5. A train has stopped on the track and a passenger hears a siren on another train approaching along a parallel track. The approaching train is travelling at a constant speed of **25.0ms^{-1}** and the siren produces a frequency of **284Hz**.



Calculate the frequency heard:

a) When the **train approaches** the passenger.

b) Once the **train has passed** the passenger.

6. A man standing at the roadside hears a frequency of **500Hz** from a car horn driving towards him.

If the car horn has a frequency of **480Hz** then:

a) Calculate the **speed of the approaching car**.
b) If the car maintains a constant speed then **calculate the frequency** of the sound heard by the man as the car passes him.

7. Stars or Galaxies **moving away** from us is known as a **Red Shift**.

Stars or Galaxies **moving towards** us is known as a **Blue Shift**.

Explain using the Doppler Effect how these names have been given in each case.

8. **Explain how you can tell** from the **Red Shift Ratio** whether stars or Galaxies are coming towards or moving away from Earth.

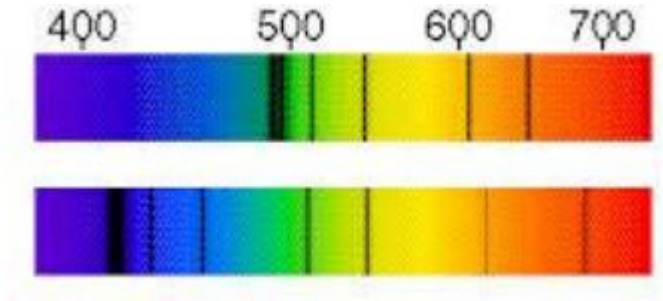
9. A distant star is travelling directly away from Earth at **$2.1 \times 10^{7} ms^{-1}$**.

a) Calculate the **Red Shift Ratio Z** for this star.

b) A hydrogen line of the spectrum of light from this star is measured to be **486nm**.

Calculate the wavelength of this line when it is observed from a Hydrogen source **on Earth**.

10. **Top Spectrum** -> From a distant Star. **Bottom Spectrum** -> From Earth.



A Hydrogen source when **viewed on Earth** emits an emission line of wavelength **410nm**.

Observations have been made for the same line in the spectrum of light from a **distant star** giving a wavelength of **485nm**.

(Look at the **thick absorption line** on each spectrum!!!)

a) **Calculate the Red Shift Ratio Z for this star**.

b) **Calculate the speed of the star relative to Earth**.

11. The spectrum of light from most stars contains lines corresponding to **helium gas**.

Figure 15 (a) shows the helium **spectrum from the Sun**.

Figure 15 (b) shows the helium **spectrum from a distant star**.

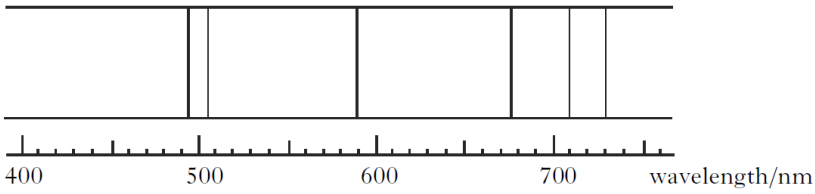


Figure 15(*a*)

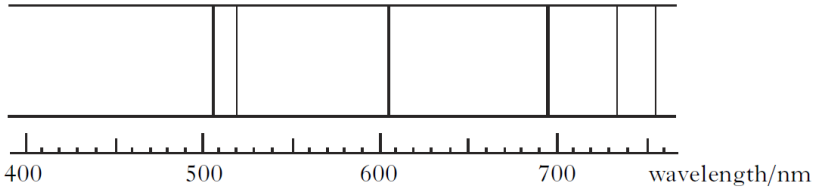


Figure 15(*b*)

a) **Calculate the approximate Red Shift Ratio Z for this star**.

b) **Calculate the approximate speed of the star relative to Earth**.

12. An X-ray binary system consists of a **star in a circular orbit around a black hole** as shown in Figure 3A.

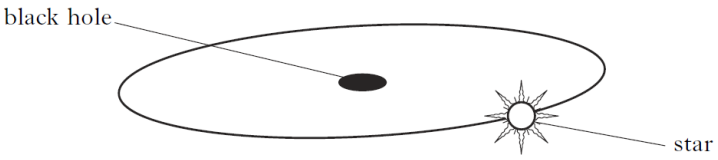


Figure 3A

The binary system orbits in the same plane as an earth-based telescope as shown below in figure 3B.

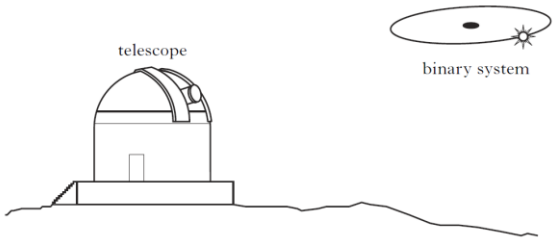


Figure 3B

Light from the star is analysed and found to contain the emission spectrum of hydrogen gas. The frequency of a particular line in the spectrum is monitored and a periodic variation in frequency is recorded. **Explain this periodic variation in frequency.**