WTS TUTORING

WTS

DOPPLER EFFECT

GRADE : 12

COMPILED BY : PROF KWV KHANGELANI SIBIYA

: WTS TUTORS

CELL NO. : 0826727928

EMAIL : KWVSIBIYA@GMAIL.COM

FACEBOOK P. : WTS MATHS & SCEINCE TUTORING

WEBSITE : WWW.WTSTUTOR.COM

PAST PAPERS

QUESTION 6 (Start on a NEW page.)

An ambulance moves away from an accident scene at a constant speed with its siren producing sound waves at a frequency of 890 Hz. A detector at the scene measures 90% of the frequency of sound waves produced by the siren as the ambulance moves away.

6.1 What phenomenon is being described above? (1)

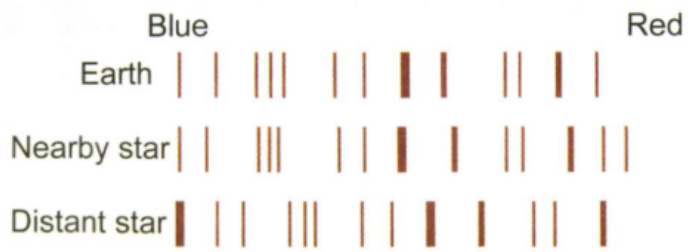
6.2 Explain, in terms of wave motion, why the detector measures 90% of the frequency of sound waves emitted by the ambulance. (2)

Assume that the speed of sound in air is 340 $m \cdot s^{-1}$.

6.3 Calculate the speed of the ambulance. (5)

6.4 What is the use of the Doppler flow meter in the medical field? (1)

6.5 The diagram below shows spectral lines for a nearby star and a distant star as observed from Earth.



6.5.1 Is the nearby star moving towards or away from Earth? (1)

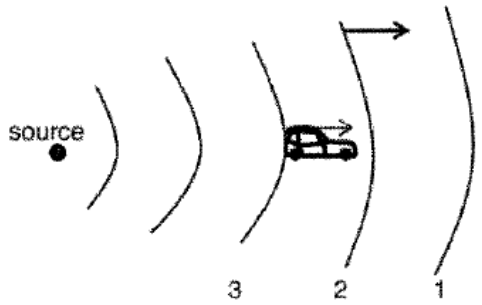
6.5.2 Compare the motion of the nearby star and the distant star as observed from Earth. Which ONE of them is moving faster? (2)

[12]

QUESTION 6 (Start on a new page.)

Use the ANSWER SHEET at the end of the question paper to answer Question 6.2.

6.1 A fire truck has just stopped at an accident scene with its siren of frequency 380 Hz still on. The driver of an ambulance driving away from the accident scene hears the fire truck's siren as 360 Hz. This is shown in the diagram below. Take the speed of sound in air as 340 $m \cdot s^{-1}$.



6.1.1 Define the *Doppler effect.* (2)

6.1.2 Calculate the speed of the ambulance in $km \cdot h^{-1}$. (5)

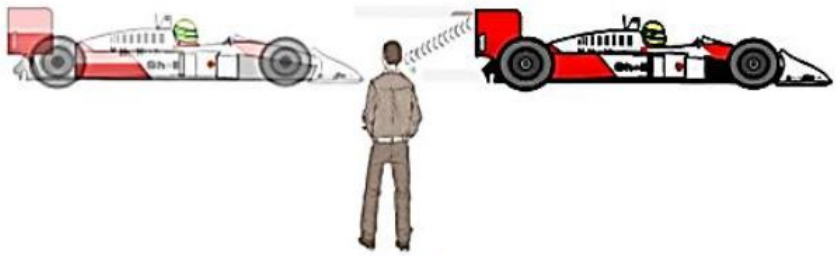
6.2 The wave fronts 3,2,1 and others shown on the diagram above, originate from the sound source.

On the ANSWER SHEET provided, draw the new relative positions of the wave fronts 2 and 1 as encountered by the car's driver, which would explain why the driver hears a lower frequency. Hand in the ANSWER SHEET with your ANSWER BOOK. (4)

6.3 Give TWO real-life examples where the Doppler effect is applied. (2)
[13]

QUESTION 6 (Start on a new page)

A man standing on the sidewalk notices that the sound of a racing car changes when the car moves towards him at a constant speed of 200 km.h^{-1} compared to when the car is moving away from him.



Assume that the speed of sound in air is 340 m.s^{-1}.

6.1 Name and state the phenomenon illustrated above. (3)

6.2 Convert 200 km·h^{-1} to m·s^{-1}. (2)

6.3 If the frequency of sound that the man will hear when the car is approaching him is 298,84 Hz, calculate the frequency of sound produced by the car. (5)

6.4 State TWO uses of the Doppler flow meter in medical field. (2)
[12]

QUESTION 6 (Start on a new page)

A car sounds its horn as it travels at a steady speed of 15 m·s^{-1} along a straight road between two stationary observers, **X** and **Y**. Observer **X** hears a frequency of 538 Hz whilst observer **Y** hears a lower frequency.
The phenomenon observed by **X** and **Y** is called the Doppler Effect. Take the speed of sound in air as 340 m·s^{-1}.

6.1 State ONE condition necessary for the Doppler Effect wave phenomenon to be observed. (1)

6.2 Is the car travelling TOWARDS **X** or TOWARDS **Y**? Explain the answer by referring to **speed of sound**, **wavelength** and **frequency**. (4)

6.3 Calculate the:

6.3.1 Frequency of the car's horn (4)

6.3.2 Frequency heard by **Y** as the car travels at 15 m·s^{-1}. (4)

6.4 State ONE application of the Doppler Effect in the medical field. (1)
[14]

QUESTION 6 (Start on a new page)

A sound source emits sound waves with a frequency of 945 Hz. The sound source moves towards a stationary listener at a constant velocity. The listener measures the frequency of the sound waves as 980,6 Hz. Take the speed of sound in air as 340 $m \cdot s^{-1}$. Ignore the effects of wind.

6.1 Define the term *frequency*. (2)

6.2 Explain why the listener observes a higher frequency than the frequency of the sound source. (2)

6.3 Calculate the speed of the sound source. (4)

6.4 Draw a graph of the observed frequency versus time as the sound source moves towards the listener, passing it and then moves away from the listener. Clearly indicate the frequency of the sound source (945 Hz) on the graph. (3)
[11]

QUESTION 6

The siren of a police car produces a sound of frequency 420 Hz. A man sitting next to the road notices that the pitch of the sound changes as the car moves towards and then away from him.

6.1 Name and state in words the phenomenon described above. (3)

6.2 Calculate the frequency of the sound of the siren observed by the man, when the car is moving towards him at a constant speed of 16 $m \cdot s^{-1}$. Assume that the speed of sound in air is 340 $m \cdot s^{-1}$. (5)

6.3 The police car moves away from the man at a constant velocity, then slows down and finally comes to rest.

6.3.1 How will the observed frequency **compare** with the original frequency of the siren when the police car moves away from the man at constant velocity? Write only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

6.3.2 How will the observed frequency CHANGE if the car moves at a lower speed away from the observer? Write only INCREASES, DECREASES or REMAINS THE SAME. (1)

6.4 Light from a star undergoes a red shift when observed from Earth.

6.4.1 Explain the term *red shift*. (2)

6.4.2 What can be concluded about the Universe from this red shift? (1)
[13]

QUESTION 6 (Begin on a new page.)

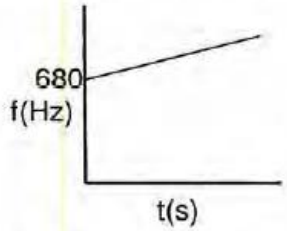
6.1 The siren of a stationary police car emits sound at a frequency of 650 Hz. An observer travelling in a car at constant velocity measures the frequency of the detected sound from the siren for two different situations. The results obtained are presented in graphs **A** and **B** below.

6.1.1 Define the *Doppler effect.* (2)

6.1.2 Which graph demonstrates the results obtained when the observer was travelling towards the siren. Give a reason for your answer. (2)

6.1.3 Calculate the speed of the observer using the data from graph **A**. (Take the speed of sound in air as 340 $m \cdot s^{-1}$) (5)

The observer now conducts a new investigation and from the results obtained draws the graph shown below.



6.1.4 Explain the change in the shape of the graph when compared to graph **B**. (2)

6.2 State ONE use of the Doppler effect in medicine. (1)
[12]

QUESTION 6 (Start on a new page.)

6.1 A flying bat emits sound waves at a frequency of 75 Hz. A stationary observer detects the frequency of the sound waves emitted as 73 Hz. The speed of sound in air is 340 $m \cdot s^{-1}$.

6.1.1 State the Doppler Effect in words. (2)

6.1.2 Is the bat flying TOWARDS or AWAY from the observer? (1)

6.1.3 Calculate the speed at which the bat is flying. (4)

6.2 Briefly explain the observations that enable scientists to tell that the universe is expanding. (4)

6.3 State TWO applications of the Doppler Effect in medicine. (2)
[13]

QUESTION 6

A traffic official is stationary on the side of a road where the speed limit is set at 100 $km.hr^{-1}$. He hears the hooter of car that is travelling at constant velocity on this road. The hooter emits sound waves of frequency 433,64 Hz.

The wavelength of the sound detected by the traffic official is 0,72 m. The speed of sound in is 340 $m.s^{-1}$.

6.1 State the Doppler effect in words. (2)

6.2 Calculate the frequency of the waves detected by the traffic official. (3)

6.3 Is the car travelling towards or away from the traffic official? Give a reason for your answer. (2)

6.4 Perform a calculation to determine whether the car is exceeding the speed limit. (6)

6.5 If the car travels at a lower constant velocity, how will this affect the frequency detected by the traffic official?
Write down GREATER THAN, LESS THAN or THE SAME AS. (1)
[14]

QUESTION 6 (Start on a new page)

6.1 A bird, flying at a constant speed, emits sounds with a frequency of 90 Hz. A stationary observer hears the sounds from the bird at 88 Hz.

6.1.1 State the Doppler Effect in words. (2)

6.1.2 Is the bird moving TOWARDS or AWAY from the observer? (1)

6.1.3 Calculate the speed with which the bird is flying. (5)

6.2 The velocities of galaxies relative to the earth can be determined by studying the red shift observed in their spectrums. The table below shows the velocities of three galaxies, **D**, **E** and **F**, relative to the earth.

Galaxies	**D**	**E**	**F**
Speed ($x10^7$) $m{\cdot}s^{-1}$	0,15	1,52	2,44

6.2.1 What is meant by the term '*red shift*'? (2)

6.2.2 State the type of spectrum observed for the different galaxies. (1)

6.2.3 Which galaxy **D**, **E** or **F** shows the greatest red shift? Give a reason for your answer. (2)

[13]

QUESTION 6

6.1 A police car moves away from an accident scene at a constant speed with its siren on. A paramedic at the accident observes a 7% drop in the frequency of the sound of the siren in comparison to when the car was standing still. Speed of sound in air on that day is 335 $m{\cdot}s^{-1}$.

6.1.1 State in words, the *Doppler effect*. (2)

6.1.2 Calculate the speed of the car. (4)

6.2 An astronomer on Earth observes the missing frequencies in a line spectrum from a distant galaxy. The frequencies associated with specific elements are all lower than expected.

6.2.1 With what kind of line spectrum is the astronomer working? Answer only ABSORPTION or EMISSION. (1)

6.2.2 Identify the type of shift seen by the astronomer. (1)

6.2.3 Is the distant galaxy moving towards or away from our Solar System. (1)

[9]

QUESTION 6 (Start on a new page.)

A traffic officer is standing on the side of a road where the speed limit is 100 $km \cdot h^{-1}$.
He hears the hooter of a car that is travelling at constant velocity on this road. The hooter emits sound waves of frequency 433,64 Hz.

The wavelength of the sound waves detected by the traffic officer is 0,72 m. The speed of sound in air is 340 $m.s^{-1}$.

6.1 Calculate the frequency of the detected sound wave. (3)

6.2 State the Doppler-effect in words. (2)

6.3 Is the car travelling towards or away from the traffic officer? Give a reason for the answer (2)

6.4 Is the car exceeding the speed limit? Support your answer by means of a calculation. (6)

6.5 How will the frequency of the sound waves detected by the traffic officer be affected if the car travels at a lower constant velocity? Choose from GREATER THAN, LESS THAN or THE SAME AS. (1)

[14]

MERCY!!!!!

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