

Our Dynamic Universe

The Doppler Effect for Sound

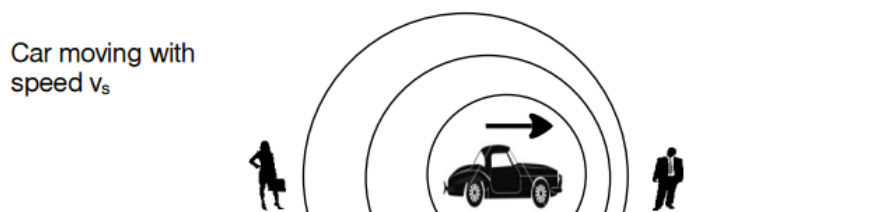


- 1) A car with a speed of 50 m s^{-1} is approaching a pedestrian who is standing at the edge of the pavement. The car sounds its horn which has a frequency of 600 hertz.
- a) Determine the frequency observed by the pedestrian as the car approaches
 - b) Determine the frequency observed by the pedestrian as the car is moving away.

[703 Hz, 523 Hz]

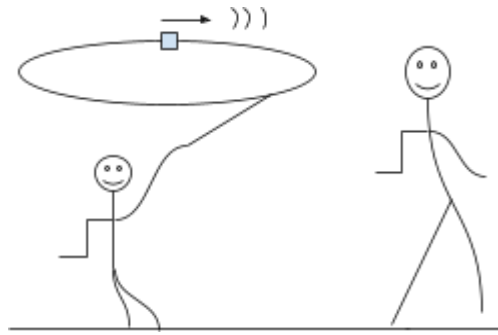
- 2) A jet aircraft travelling at 200 m s^{-1} approaches a crowd at an airshow. The sound of the aircraft's engines has a frequency of 950 Hz.
- a) Determine the frequency of engines that the crowd hears when the jet approaches. [2,307 Hz]
 - b) Determine the frequency of the engines when the jet moves away from the crowd at a speed of 200 m s^{-1} . [598 Hz]

- 3) The diagram below shows two pedestrians on a pavement as a car passes them. The diagram shows the sound waves being emitted by the car's engine



- a) Use your knowledge of physics to describe why the man hears the car's engine at a higher frequency than the woman.
- b) The car's engine emits sound at a frequency of 150 Hz and is moving at a speed of 30 m s^{-1} . Determine the observed frequency which
 - i) the man hears [165 Hz]
 - ii) the woman hears [138 Hz]

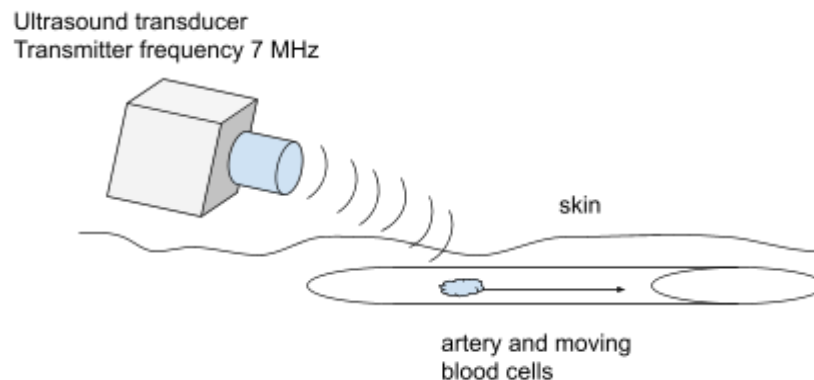
- 4) A child swings a buzzer around his head with a speed of 70 m s^{-1} . The buzzer makes a sound of frequency 1000 Hz .



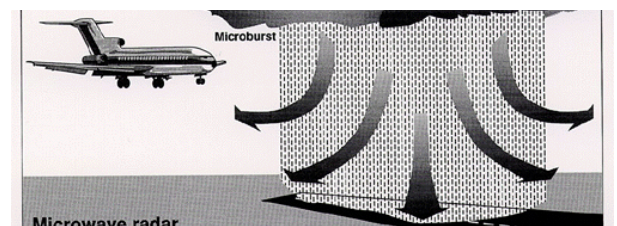
- a) Determine the frequency of buzzer as it approaches the adult.
b) Calculate the frequency of the buzzer as it moves away from the adult.
[$1,259 \text{ Hz}$, 829 Hz]
- 5) The observed frequency of the sound a jet's engine makes as it moves away from an observer is found to be $1,600 \text{ Hz}$. The actual frequency of sound the jet engine makes is 2000 Hz .
Show that the speed of the jet is 85 m s^{-1} .
- 6) A fast moving object makes a sound of frequency 14 kHz . An observer she measures the observed frequency to be $17,000 \text{ Hz}$.
- a) Determine whether the object is moving towards or away from the observer.
b) Show that the speed of the object is 60 m s^{-1}
- 7) A siren on an ambulance emits a sound of $3,700 \text{ hertz}$. A nearby physicist measures the frequency to be $3,400 \text{ hertz}$.
- a) Determine if the ambulance is approaching or moving away from the physicist.
b) Show that the speed of the ambulance is 30 m s^{-1}
- 8) A fast moving object emits a sound of a certain frequency. Determine the speed the object must approach an observer for her to hear the sound with double the frequency.
[170 m/s]

- 9) A policeman aims radar gun at a car travelling at 22 m s^{-1} towards him.
The radar gun emits ultrasound of frequency $25,000 \text{ Hz}$. Ultrasound travels at 340 m s^{-1} .
Determine the frequency of the reflected ultrasound. [26730 Hz]

- 10) The doppler effect can be used in medicine to calculate the speed of blood flowing in a patient's arteries.



- a) Copy and complete this sentence choosing the correct word.
*The transducer is a device that transmits ultrasound. The ultrasound waves reflect off the moving blood cells. The frequency of the reflected ultrasound will be **less** / **more** than the transmitted frequency. This frequency **decrease/increase** is used to calculate the speed of the blood cells.*
- b) The speed of the blood cells is found to be 30 cm s^{-1} . Determine the frequency of the reflected ultrasound.
- 11) Aircraft are prone to danger when they encounter heavy rain showers that create wind shear. This is when there is a burst of downward wind which strikes the ground suddenly changes the wind speed.



- a) Explain how by transmitting microwaves into the downpour the pilot can find the wind speed of the downpour.
- b) The transmitted frequency of the microwaves is $1.5 \times 10^{10} \text{ Hz}$ and the reflected frequency is $1.50000025 \times 10^{10} \text{ Hz}$.
Calculate the speed of the wind coming from the downpour. [50 m s^{-1}]