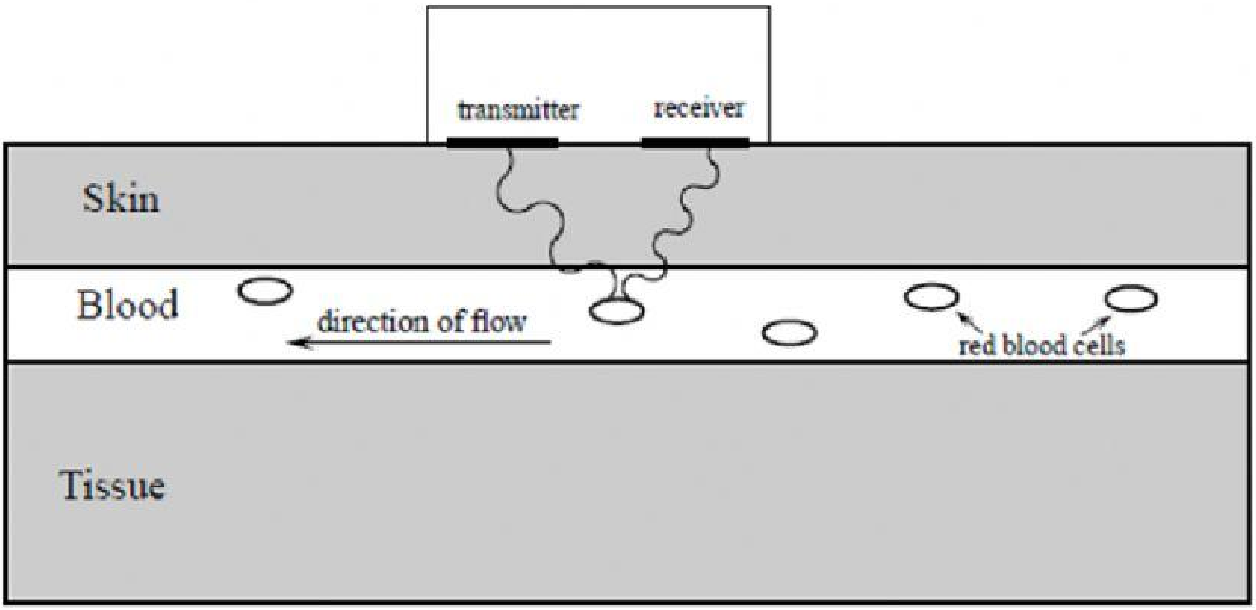
Applications of the Doppler effect: (this is important to go over and is usually tested in the multiple choice)

Ultrasound and the Doppler Effect

Ultrasonic waves (ultrasound) are sound waves with a frequency greater than 20 000 Hz (the upper limit of human hearing). These waves can be used in medicine to determine the direction of blood flow. The device, called a Doppler flow meter, sends out sound waves. The sound waves can travle through skin and tissue and will be reflected by moving objects in the body (like blood). The reflected waves return to the flow meter where its frequency (received frequency) is compared to the transmitted frequency. Because of the Doppler effect, blood that is moving towards the flow meter will change the sound to a higher frequency and blood that is moving away from the flow meter will cause a lower frequency.



Ultrasound can be used to determine whether blood is flowing in the right direction in the circulation system of unborn babies, or identify areas in the body where blood flow is restricted due to narrow veins. The use of ultrasound equipment in medicine is called sonography or ultrasonography.

The Expanding Universe

Stars emit light, which is why we can see them at night. Galaxies are huge collections of stars. An example is our own Galaxy, the Milky Way, of which our sun is only one of the millions of stars! Using large telescopes like the Southern African Large Telescope (SALT) in the Karoo, astronomers can measure the light from distant galaxies. The spectrum of light can tell us what elements are in the stars in the galaxies because each element emits/absorbs light at particular wavelengths (called spectral lines). If these lines are observed to be shifted from their usual wavelengths to shorter wavelengths, then the light from the galaxy is said to be *blueshifted*. If the spectral lines are shifted to longer wavelengths, then the light from the galaxy is said to be *redshifted*. If we think of the blueshift and redshift in Doppler effect terms, then a blueshifted galaxy would appear to be moving *towards* us (the observers) and a redshifted galaxy would appear to be moving *away* from us.

Important:

- If the light source is moving away from the observer (positive velocity) then the observed frequency is lower and the observed wavelength is greater (redshifted).
- If the source is moving towards (negative velocity) the observer, the observed frequency is higher and the wavelength is shorter (blueshifted).

Remember R O Y G B I V

RED ORANGE YELLOW GREEN BLUE INDIGO VIOLET

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The frequency increases

Thus wavelength decreases $f \propto \frac{1}{\lambda}$

(The energy of the light increases)

Multiple choice questions:

1.

The Doppler effect will occur when:

A A listener moves around a stationary source of sound in a circle.

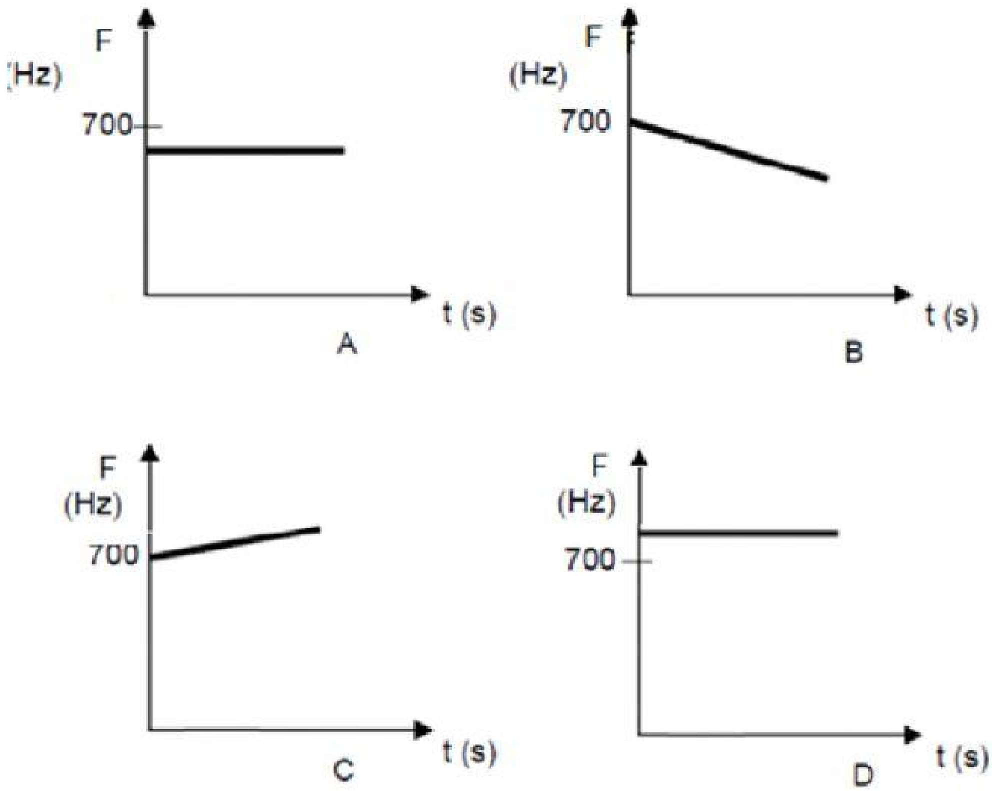
B A listener moves in a straight line towards a stationary source of sound.

C A listener and a source of sound are both stationary.

D A source of sound moves around a stationary listener in a circle.

2.

The siren of an ambulance travelling down a road at constant speed emits sound waves of 700 Hz. A man sitting next to the road notices that the pitch (frequency) of the sound changes as the ambulance moves towards him. Which ONE of the following frequency vs time graphs best shows the frequency of the sound observed (heard) by the man?



3.

In which direction will the visible spectrum shift during a red shift?

A towards the blue end of the spectrum.
B to light of a shorter wavelength.
C to light of a lower frequency.
D. to light of a higher energy.

4.

If a star gazer on earth noticed a red shift in the light emitted from a star, this would mean

A. The star is moving away from earth

B. The star is moving toward the earth

C. The star is at rest

D. The earth is expanding