SKILL 54: Other Phenomena

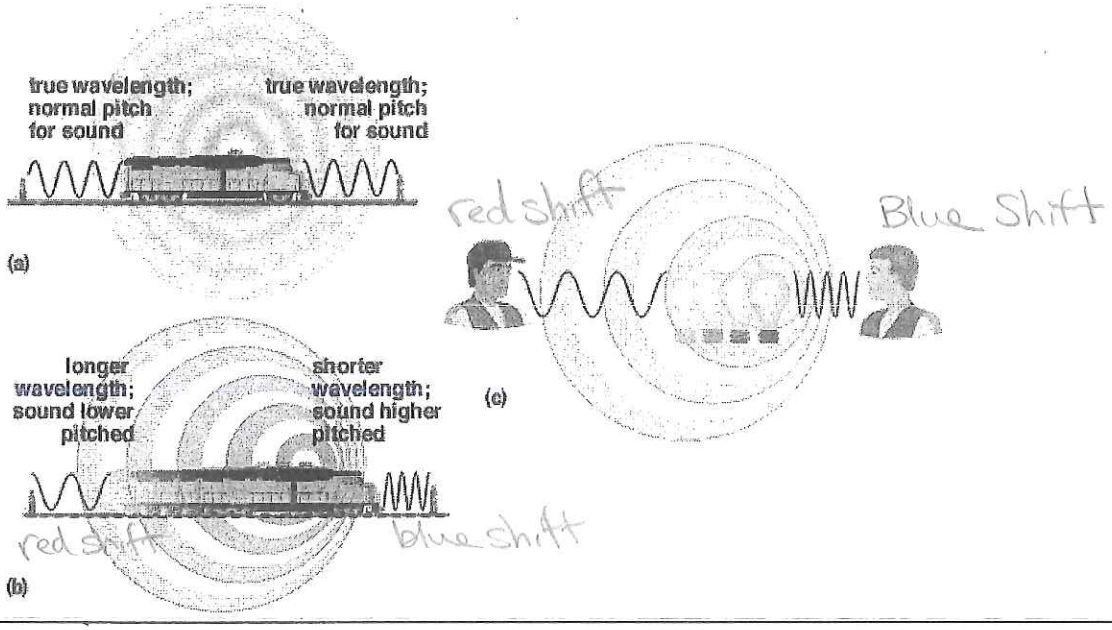
272. **Doppler Effect**: Apparent shift in the frequency of a wave due to the relative motion of the source and or observer

If the object is getting closer the frequency will increase in relation to the speed (constant speed will be constant frequency, increasing speed will be increasing frequency, decreasing speed will be decreasing frequency)

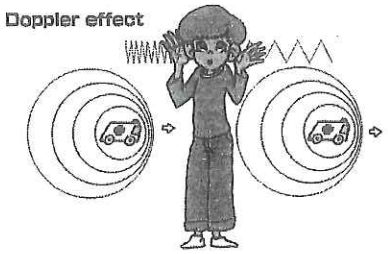
If the object is getting further away the frequency will decrease in relation to the speed

For SOUND the Doppler Effect will be observed as a change in pitch

For LIGHT the Doppler Effect will be observed as a shift in the color. A shift toward high frequency is called blue shift. A shift toward low frequency is called red shift.



273. Doppler Effect



If the wave source and the observer are approaching one another the perceived frequency will increase

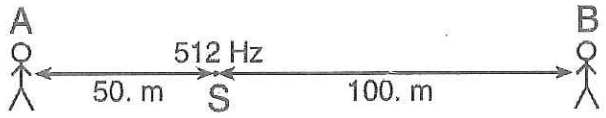
If the wave source and the observer are moving further apart the perceived frequency will decrease

We use the Doppler Effect to analyze sound, light and the motion of objects. Analyzing light from distant celestial objects allows us to determine their relative motion to Earth and satellites. If a planetary object is moving away from us the spectrum of light will be red shifted. If a planetary object is moving toward us the spectrum of light will be blue shifted.

274. Moving from one substance to another is called transmission. If waves change speed as they enter a new medium they bend. This is known as refraction
Some waves can't move from one boundary to the other and they bounce off the boundary. This is called reflection
Some waves are absorbed when they interact with a boundary.

Topic 5C: Doppler Effect
Skill 54

275. In the diagram below, a stationary source located at point S produces sound having a constant frequency of 512 hertz. Observer A, 50. meters to the left of S, hears a frequency of 512 hertz. Observer B, 100. meters to the right of S, hears a frequency lower than 512 hertz.



Which statement best describes the motion of the observers?

A) Observer A is moving toward point S, and observer B is stationary.
B) Observer A is moving away from point S, and observer B is stationary.
C) Observer A is stationary, and observer B is moving toward point S.
D) Observer A is stationary, and observer B is moving away from point S.

decrease in frequency is away

276. Astronauts traveling toward Earth in a fast-moving spacecraft receive a radio signal from an antenna on Earth. Compared to the frequency and wavelength of the radio signal emitted from the antenna, the radio signal received by the astronauts has a

A) lower frequency and a shorter wavelength
B) lower frequency and a longer wavelength
C) higher frequency and a shorter wavelength
D) higher frequency and a longer wavelength

toward = higher f

f & λ are inverse

277. A car's horn produces a sound wave of constant frequency. As the car speeds up going away from a stationary spectator, the sound wave detected by the spectator

A) decreases in amplitude and decreases in frequency
B) decreases in amplitude and increases in frequency
C) increases in amplitude and decreases in frequency
D) increases in amplitude and increases in frequency

amplitude = loudness

away means decrease in f

278. A car's horn is producing a sound wave having a constant frequency of 350 hertz. If the car moves toward a stationary observer at constant speed, the frequency of the car's horn detected by this observer may be

A) 320 Hz
B) 330 Hz
C) 350 Hz
D) 380 Hz

toward = higher

279. A police car traveling at a speed of 30.0 meters per second sounds its siren, which has a frequency of 1.00×10^3 hertz. As the police car approaches a stationary pedestrian, the pedestrian detects a siren frequency of

A) 30.0 Hz
B) 9.19×10^2 Hz
C) 1.00×10^3 Hz
D) 1.10×10^3 Hz

toward = higher f

280. A train sounds a whistle of constant frequency as it leaves the train station. Compared to the sound emitted by the whistle, the sound that the passengers standing on the platform hear has a frequency that is

A) lower, because the sound-wave fronts reach the platform at a frequency lower than the frequency at which they are produced
B) lower, because the sound-wave travels more slowly in the still air above the platform than in the rushing air near the train
C) higher, because the sound-wave fronts reach the platform at a frequency higher than the frequency at which they are produced
D) higher, because the sound-wave travels faster in the still air above the platform than in the rushing air near the train

281. A radar gun can determine the speed of a moving automobile by measuring the difference in frequency between emitted and reflected radar waves. This process illustrates

A) resonance
B) the Doppler effect
C) diffraction
D) refraction

282. An astronomer on Earth studying light coming from a star notes that the observed light frequencies are lower than the actual emitted frequencies. The astronomer concludes that the distance between the star and Earth is

A) decreasing
B) increasing
C) unchanging

moving away

283. An astronomical body emitting high-intensity pulses of green light is moving toward Earth at high velocity. To an observer on Earth, this light may appear

A) red
B) blue
C) orange
D) yellow

284. The driver of a car blows the horn as the car approaches a crosswalk. Compared to the actual pitch of the horn, the pitch observed by a pedestrian in the crosswalk is

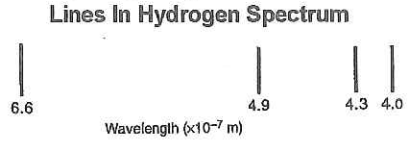
A) lower
B) higher
C) the same

285. Light from the star Betelgeuse displays a Doppler red shift. The shift is best explained by assuming that Betelgeuse is

A) decreasing in temperature
B) increasing in temperature
C) moving toward Earth
D) moving away from Earth

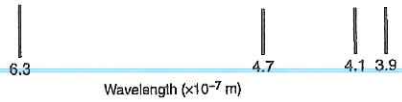
Red = lower f = away

286. The four-line Balmer series spectrum shown below is emitted by a hydrogen gas sample in a laboratory. A star moving away from Earth also emits a hydrogen spectrum.

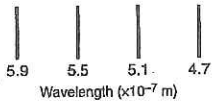


Which spectrum might be observed on Earth for this star?

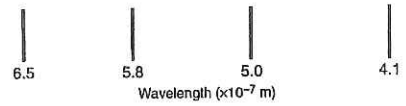
A)



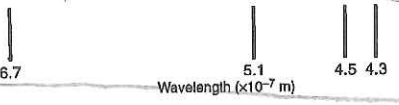
B)



C)



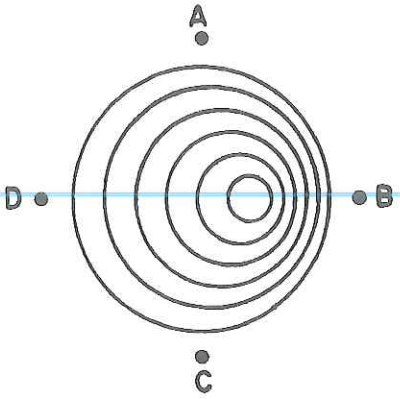
D)



- wavelength is inverse of frequency
- for a star moving away frequency would decrease
- if frequency decreases, wavelength increases

→ shift to lower f means bigger λ

Base your answers to questions **287** and **288** on the diagram below which represents the wave pattern produced by a vibrating source moving linearly in a shallow tank of water. The pattern is viewed from above and the lines represent wave crests.



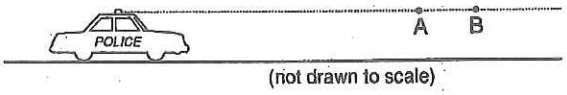
287. The velocity of the source is increased. The wavelength of the waves observed at point *D* will

A) decrease B) increase
C) remain the same

288. The wave pattern is an illustration of

A) diffraction B) interference
C) dispersion D) the Doppler effect

289. Base your answer to the following question on the diagram below which shows a parked police car with a siren on top. The siren is producing a sound with a frequency of 680 hertz, which travels first through point *A* and then through point *B*, as shown. The speed of the sound is 340 meters per second.



(not drawn to scale)

If the car were to accelerate toward point *A*, the frequency of the sound heard by an observer at point *A* would

A) decrease
B) increase
C) remain the same