Worksheet: Doppler Shift

Q1: A wave is emitted from a source that moves relative to astationary observer at a velocity v_s,where a positive value of $v_s$corresponds to the motion of the source toward the observer. The wave propagateswith a velocity v. Which of thefollowing formulas correctly relates the frequency f, measured at the wave's source, and the frequency f' of the wave measured by the observer?

A $f' = \frac{f(v + v_s)}{(v - v_s)}$

B $f' = \frac{f(v - v_s)}{(v + v_s)}$

C $f' = \frac{fv}{(v - v_s)}$

D $f' = \frac{fv}{(v + v_s)}$

Q2: A fire alarm activated on one floor of a building where a fire drill is occurring emits sound waves that propagate at 343 m/s. A person leavingthe building accidentally drops their phone down a stairwell during aconversation, and the listener hears the fire alarm at the instant the phone hitsthe ground as having a frequency of 12.3 kHz. The phone is dropped from the floorof the building where the alarm is active, and it hits the ground traveling at 18 m/s. What is the frequency of the alarm? Give your answer to three significantfigures.

A 11.7 kHz

B 12.9 kHz

C 13.0 kHz

D 11.1 kHz

E 13.7 kHz

Q3: A wave is emitted from a stationary source and propagateswith a velocity v. Which of thefollowing formulas correctly relates the frequency f, measured at the wave's source, and the frequency f' of the wave measured by an observer moving relative to the source at a velocity v_0, where a positive value of v_0 corresponds to the motion of the observertoward the source?

A $f' = \frac{f(v + v_0)}{(v - v_0)}$

B $f' = \frac{f(v - v_0)}{v}$

C $f' = \frac{f(v + v_0)}{v}$

D $f' = \frac{f(v - v_0)}{(v + v_0)}$

Q4: Sound waves with a frequency of 1.86 kHz are emitted by a man shouting to a passing cyclist. The cyclist is moving at −11 m/s relative to the man. The sound waves propagate at 343 m/s. What is the frequency of the soundwaves from the man perceived by the cyclist? Give your answer to three significantfigures.

A 1.86 kHz

B 1.74 kHz

C 1.80 kHz

D 1.85 kHz

E 1.98 kHz

Q5: Sound waves propagating at 343 m/s are emitted from a vibratingjackhammer used on a maintenance site at the side of a road. A car on the roadis moving toward the jackhammer at 24 m/s. The frequency of the sound waves from the jackhammer perceived by the driver of the car is 972 Hz. What is thefrequency of vibration of the jackhammer? Give your answer to three significant figures.

A 972 Hz

B 931 Hz

C 908 Hz

D 904 Hz

E 845 Hz

Q6: An airport worker listens to an airliner landing, with itsengines emitting sound waves with a frequency of 444 Hz as it approaches the worker at a velocity of 45.5 m/s. The sound waves propagate at 341 m/s.

What frequency of sound is perceived by the worker to beemitted from the airliner? Answer to three significant figures.

A 444 Hz

B 392 Hz

C 512 Hz

D 503 Hz

E 385 Hz

What frequency of sound is perceived by another worker to beemitted from the airliner, assuming that the other worker is on the oppositeside of the airliner to the first worker and the airliner moves along a linethat intersects both workers? Answer to three significant figures.

A 503 Hz

B 444 Hz

C 392 Hz

D 385 Hz

E 512 Hz

Q7: A traveler on a train station platform hears a train approaching. The train produces a sound of frequency 7.44 kHz, which the traveler perceives as having a frequency of 6.98 kHz. The sound waves from the train propagate at 344 m/s. At what speed is the train approaching the platform?

A 3.44 m/s

B 123 m/s

C 21.3 m/s

D 22.7 m/s

E 23.5 m/s

Q8: A bungee jumper jumps from a bridge and then begins torise up toward it due to the contraction of the bungee cord. The jumperperceives the cheering of some onlookers on the bridge as having a frequency of 3.21 kHz at an instant t. Thecheering onlookers perceive the frequency of their cheers as 3.19 kHz. Thesound of the cheering propagates at 343 m/s. What is the speed at which thebungee jumper is moving at the instant t?

A 4.00 m/s

B 1.79 m/s

C 1.00 m/s

D 3.25 m/s

E 2.15 m/s

Q9: Sound waves with a frequency 2.25 kHz are emitted from a loudspeakerused in a public-address system at a motor sports event. A car participating ina race is moving toward the speaker at 33 m/s. The sound waves propagate at 343 m/s. What is the frequency of the sound waves from the speaker perceived by thedriver of the car? Answer to three significant figures.

A 2.05 kHz

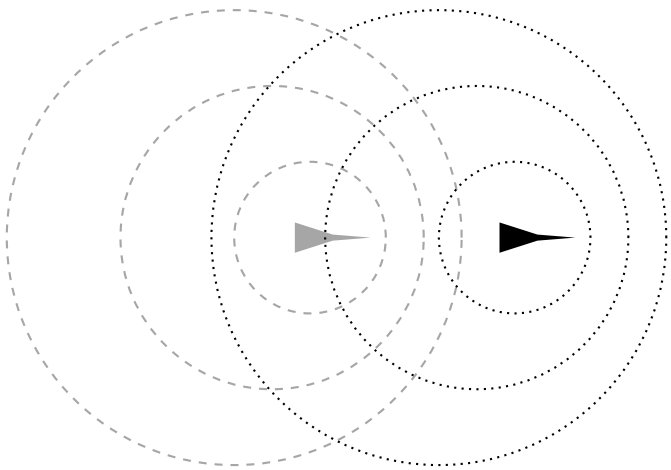
B 2.47 kHz

C 2.03 kHz

D 2.25 kHz

E 2.89 kHz

Q10: Two aircraft are traveling in the same direction as each other,with the leading aircraft directly ahead of the following aircraft, as shown inthe diagram. The diagram is not drawn to scale. The leading aircraft istraveling at 288 m/s. The frequency of the sound waves from the followingaircraft as measured by the leading aircraft is 1.11 times the frequency of thesound waves of the following aircraft as measured by the following aircraft itself. Soundwaves in the air between the two aircraft propagate at 350 m/s. What is the speedof the following aircraft?



A 294 m/s

B 230 m/s

C 930 m/s

D 188 m/s

E 406 m/s

Q11: A child on a roller coaster in an amusement park passesanother joyride. The other ride is stationary and is emitting a musical note witha frequency of 1,024 Hz. The child perceives the note's frequency as 1,002 Hz.The sound waves propagate at 343 m/s. At what speed does the roller coaster moveaway from the other ride? Give your answer to three significant figures.

A 7.37 m/s

B 79.3 m/s

C 55.3 m/s

D 12.2 m/s

E 335 m/s

Q12: Two objects that emit 425 Hz sounds move directly away from each other, both moving at 72.5 m/s. The ratio of the frequencies of the soundwaves of each object from itself and from the other object is 1.55. What speeddo the sound waves propagate at in the air around the objects?

A 75.5 m/s

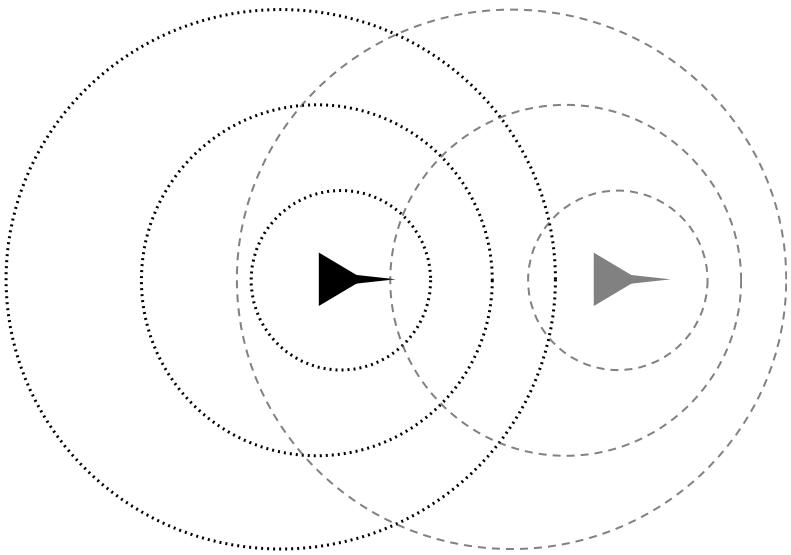
B 425 m/s

C 336 m/s

D 350 m/s

E 16.3 m/s

Q13: Two aircraft travel in the same direction,with the leading aircraft directly ahead of the following aircraft, as shown inthe diagram. The diagram is not drawn to scale. The leading aircraft is traveling at 296 m/s.The frequency of the sound waves from the following aircraft as measured by theleading aircraft is 0.750 times the frequency of the sound waves of thefollowing aircraft as measured by the following aircraft itself. Sound waves in the airbetween the aircraft propagate at 350 m/s. What is the speed of the followingaircraft?



A 422 m/s

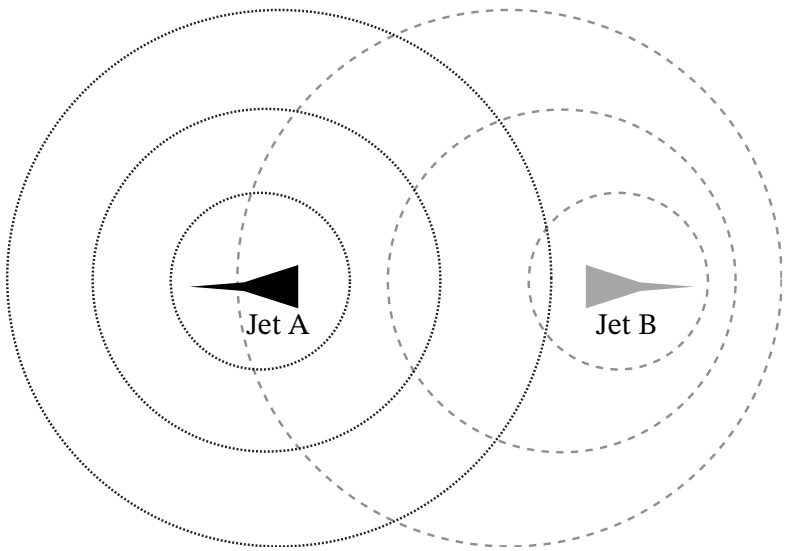
B 161 m/s

C 511 m/s

D 278 m/s

E 72 m/s

Q14: Two jet fighters, jet A and jet B, are flying directly away from each other, as shown in the diagram. The diagram is not drawn to scale. Each of them emits a sound with a frequency of 4.42 kHz as measured by the pilots ofthe jets. Jet A travels at 233 m/s and jet B travels at 256 m/s. Sound wavesmove in the air around the jets at 349 m/s.



At what frequency does the pilot of jet A hear the sounds from jet B?

A 4, 250 Hz

B 5, 510 Hz

C 847 Hz

D 452 Hz

E 2, 770 Hz

At what frequency does the pilot of jet B hear the sounds fromjet A?

A 232 Hz

B 4, 590 Hz

C 706 Hz

D 2, 310 Hz

E 3, 540 Hz