

Answer on Question #43419 – Physics – Other

An airplane is moving toward you at a speed of 75 m/s. The sound of the motor that you hear from the plane has an apparent frequency of 296 Hz. If the true frequency of the sound sources is 231 Hz, then the speed of the sound is?

Solution:

c – velocity of waves in the medium (speed of the sound);

$v_r = 0$ – velocity of the receiver relative to the medium;

positive if the receiver is moving towards the source (and negative in the other direction);

$v_s = -75 \frac{m}{s}$ – velocity of the source relative to the medium;

positive if the source is moving away from the receiver (and negative in the other direction)

$f_0 = 231$ Hz – emitted frequency;

$f = 296$ Hz – observed frequency;

In classical physics, where the speeds of source and the receiver relative to the medium are lower than the velocity of waves in the medium, the relationship between observed frequency f and emitted frequency f_0 is given by:

$$f = \left(\frac{c + v_r}{c + v_s} \right) f_0$$
$$fc + fv_s = f_0 c + f_0 v_r$$
$$c = \frac{f_0 v_r - fv_s}{f - f_0} = \frac{231 \text{ Hz} \cdot 0 + 296 \text{ Hz} \cdot 75 \frac{m}{s}}{296 \text{ Hz} - 231 \text{ Hz}} = 341.5 \frac{m}{s}$$

Answer: speed of the sound is equal to $341.5 \frac{m}{s}$.