Answer on Question #69377-Physics / Mechanics | Relativity

A stationary sonar station sends out a sound pulse at $f_0 = 40.000$ MHz. It receives a pulse back from an object directly below it with a time delay of $t = 80$ ms at a frequency of 39.958 MHz. Assume the speed of sound in seawater is $c = 1.54$ km/s.

(a) Determine the depth of the object.

(b) Determine the vertical speed of the object.

Solution

(a)

$$2l = ct,$$

$$l = \frac{ct}{2} = \frac{1540 \times 80 \times 10^{-3}}{2} = 61.6 \text{ m}.$$

(b) In terms of a Doppler effect, the change of frequency

$$\Delta f = f_0 \frac{v}{c}.$$

So, the vertical speed of the object is

$$v = \frac{\Delta f}{f_0} c = \frac{40.000 - 39.958}{40.000} \times 1540 = 1.617 \frac{\text{m}}{\text{s}}.$$

Answer:

(a) 61.6 m.
(b) $1.617 \frac{\text{m}}{\text{s}}$.