

Doppler effect

$$f' = f \left(\frac{1 \pm \frac{v_{obs}}{v}}{1 \mp \frac{v_{source}}{v}} \right)$$

14.78 Obstetricians use ultrasound monitor fetal heart beat. If 5 MHz ultrasound reflects off moving heart wall with 100 Hz freq shift; what is speed of heart wall?



mat'l receives sound wave

moving receiver "hears"

$$f' > f$$

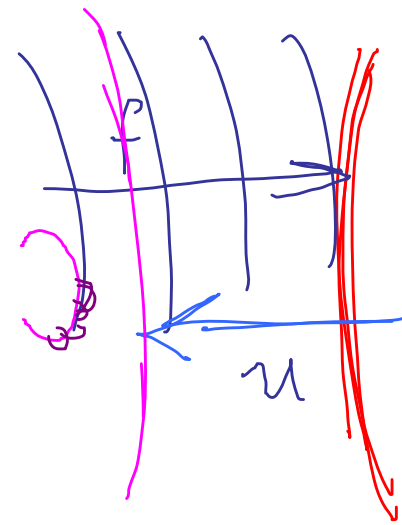
mat'l itself sends back wave
at f' .

moving source, to outside $f'' > f'$

Find f' $f' = f \left(1 + \frac{u}{v}\right)$

$$f'' = f' \left(\frac{1}{1 - \frac{u}{v}} \right)$$

f'' is what's heard:



$$f = 5 \text{ MHz}$$

v = speed of sound in medium.

$$= v_{\text{water}} = 1440 \frac{\text{m}}{\text{s}}$$

$$f'' = f \left(\frac{1 + \frac{u}{v}}{1 - \frac{u}{v}} \right)$$

$$\frac{u}{v} = x, \quad x \text{ small.}$$

$$f'' = f \left(\frac{1+x}{1-x} \right)$$

$$\approx f(1+x)(1+x)$$

$$f'' \approx f + 2xf$$

$$f'' - f = 100 \text{ Hz} = 2 \frac{u}{v} f$$

$$f = 5 \text{ MHz}$$

$$f'' - f = 100 \text{ Hz}$$

$$f = 5,000,000$$

$$f'' = 5,000,100$$

$$\Delta f$$

1.5 $\frac{\text{cm}}{\text{s}}$
 ??
check

$$\frac{1}{1-x} \approx 1+x$$