DOPLEROV EFEKAT

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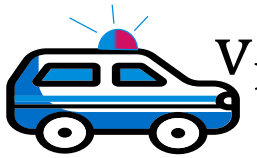
$$\nu = \nu_i$$

ν_i



$v_P = 0\,\frac{m}{s}$

prijemnik

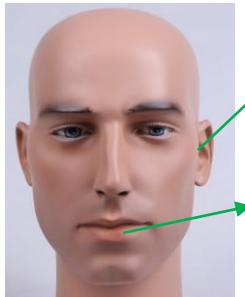
$v_i = 0\,\frac{m}{s}$

izvor zvuka

$$\nu = \nu_i \frac{v \pm v_P}{v \mp v_i}$$

PRIBLIŽAVAJU

UDALJAVAJU



prijemnik

izvor zvuka

Kada bi se kretali izvor i prijemnik

$$\nu = \nu_i \frac{v \pm v_P}{v \mp v_i}$$

ν – frekvencija koju registruje prijemnik

ν_i – frekvencija koju emituje izvor

v – brzina zvuka u nekoj sredini

v_P – brzina prijemnika

v_i – brzina izvora zvuka

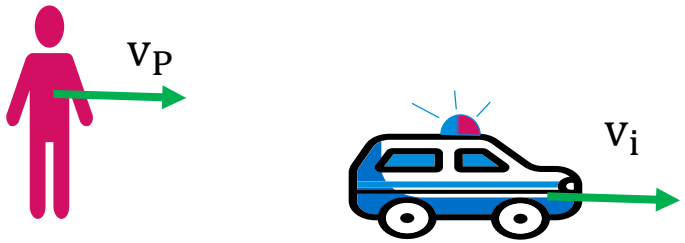
$+v_P$ – prijemnik se približava izvoru

$-v_P$ – prijemnik se udaljava od izvora

$-v_i$ – izvor se približava prijemniku

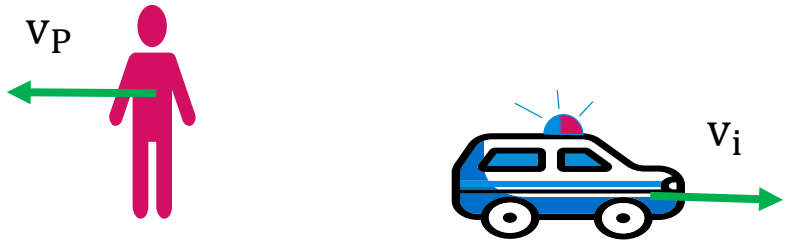
$+v_i$ – izvor se udaljava od prijemnika

$$\nu = \nu_i \frac{v \pm v_P}{v \mp v_i}$$



$$\nu = \nu_i \frac{v + v_P}{v + v_i}$$

$$\nu = \nu_i \frac{v + v_P}{v - v_i}$$

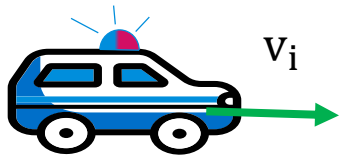


$$\nu = \nu_i \frac{v - v_P}{v + v_i}$$

$$\nu = \nu_i \frac{v - v_P}{v - v_i}$$

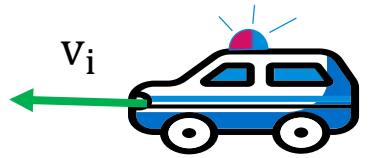
$$\nu = \nu_i \frac{v \pm v_P}{v \mp v_i}$$

$v_P = 0\,\frac{m}{s}$

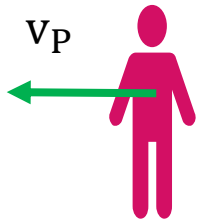


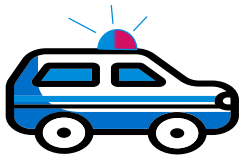
$$\nu = \nu_i \frac{v}{v + v_i}$$

$v_P = 0\,\frac{m}{s}$



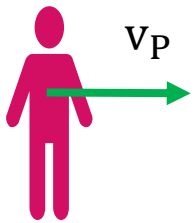
$$\nu = \nu_i \frac{v}{v - v_i}$$



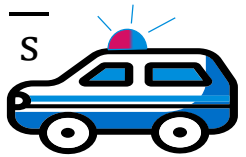


$v_i = 0\,\frac{m}{s}$

$$\nu = \nu_i \frac{v - v_P}{v}$$



$v_i = 0\,\frac{m}{s}$



$$\nu = \nu_i \frac{v + v_P}{v}$$

Auto se kreće po pravom putu brzinom 54 km/h. Za njim juri policijski auto brzinom 72 km/h sa uključenom sirenom frekvencije 750 Hz. Koliku frekvenciju čuje vozač prvog auta ako je brzina zvuka u vazduhu 340 m/s?

$$\mathrm{v_P} = 54\frac{km}{h} = 15\frac{m}{s}$$

$$\mathrm{v_i} = 72\frac{km}{h} = 20\frac{m}{s}$$

$$\nu_i = 750Hz$$

$$\mathrm{v} = 340\frac{m}{s}$$

$$\nu = \nu_i \frac{\mathrm{v} \pm \mathrm{v_P}}{\mathrm{v} \mp \mathrm{v_i}}$$

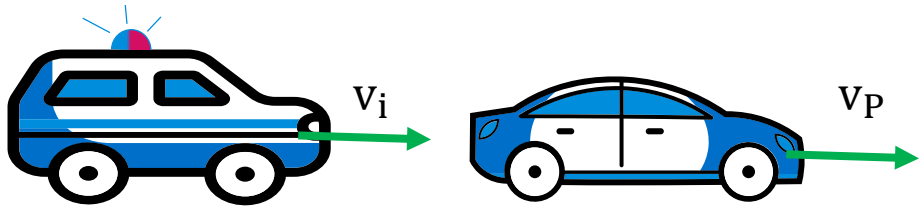
$$\nu = \nu_i \frac{\mathrm{v} - \mathrm{v_P}}{\mathrm{v} - \mathrm{v_i}}$$

$$\nu = 750Hz \frac{340\frac{m}{s} - 15\frac{m}{s}}{340\frac{m}{s} - 20\frac{m}{s}}$$

$$\nu = 750Hz \frac{325\frac{m}{s}}{320\frac{m}{s}}$$

$$\nu = 750Hz \cdot 1{,}015625$$

$$\nu = 761{,}72Hz$$



Slepi miš leti brzinom 6 m/s i emituje ultra zvuk frekvencije 45 kHz koji se odbija od stene. Koju frekvenciju će čuti slepi miš? Brzina zvuka je $340\frac{m}{s}$. Razlikovati slučajeve:

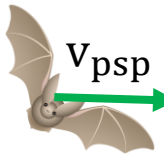
a) kada se slepi miš približava steni,
b) kada se slepi miš udaljava od stene

$$\nu = \nu_i \frac{\mathrm{v} \pm \mathrm{v_P}}{\mathrm{v} \mp \mathrm{v_i}}$$

a)

$\mathrm{v_{ism}} = 6\frac{m}{s}$

$\nu_i = 45000Hz$



$\mathrm{v_{psp}} = 6\frac{m}{s}$

prijemnik

stena

$\mathrm{v_p} = 0\frac{m}{s}$

$\nu_s = \nu_i \frac{\mathrm{v}}{\mathrm{v} - \mathrm{v_{ism}}}$

izvor

$\nu_1 = \nu_s \frac{\mathrm{v} + \mathrm{v_{psp}}}{\mathrm{v}}$

$$\nu_1 = \nu_i \frac{\cancel{v}}{\mathrm{v} - \mathrm{v_{ism}}} \frac{\mathrm{v} + \mathrm{v_{psp}}}{\cancel{v}} = \nu_i \frac{\mathrm{v} + \mathrm{v_{psp}}}{\mathrm{v} - \mathrm{v_{ism}}}$$

$$\nu_1 = 45000Hz \frac{340\frac{m}{s} + 6\frac{m}{s}}{340\frac{m}{s} - 6\frac{m}{s}} = 45000Hz \frac{346\frac{m}{s}}{334\frac{m}{s}}$$

$$\nu_1 = 45000Hz \cdot 1{,}03593 = 46616{,}85Hz \approx 46{,}62kHz$$

b)

$\mathrm{v_{isp}} = 6\frac{m}{s}$

$\mathrm{v_p} = 0\frac{m}{s}$

$\nu_s = \nu_i \frac{\mathrm{v}}{\mathrm{v} + \mathrm{v_{ism}}}$

$\mathrm{v_{psp}} = 6\frac{m}{s}$

izvor

$\nu_2 = \nu_s \frac{\mathrm{v} - \mathrm{v_{psp}}}{\mathrm{v}}$

prijemnik

$$\nu_2 = \nu_i \frac{\cancel{v}}{\mathrm{v} + \mathrm{v_{ism}}} \frac{\mathrm{v} - \mathrm{v_{psp}}}{\cancel{v}} = \nu_i \frac{\mathrm{v} - \mathrm{v_{psp}}}{\mathrm{v} + \mathrm{v_{ism}}}$$

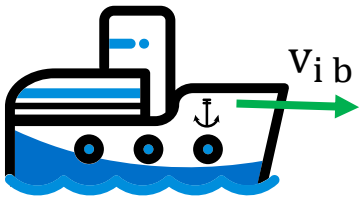
$$\nu_2 = 45000Hz \frac{340\frac{m}{s} - 6\frac{m}{s}}{340\frac{m}{s} + 6\frac{m}{s}} = 45000Hz \frac{334\frac{m}{s}}{346\frac{m}{s}}$$

$$\nu_2 = 45000Hz \cdot 0{,}9653 = 43438{,}5Hz \approx 43{,}44kHz$$

Brodska sirena emituje zvuk frekvencije 300 Hz. Zvuk nailazi na vertikalni stenu, odbija se i stiže do broda. Kapetan registruje frekvenciju 310 Hz. Brzina zvuka je 330 m/s. Koliko je udaljena stena ako brodu treba 2 minuta da stigne do nje krećući se stalnom brzinom?

$$\nu = \nu_i \frac{v \pm v_P}{v \mp v_i}$$

$\nu_i = 300Hz$



$v_{i\,b}$

stena

$v_p = 0\frac{m}{s}$

$\nu_s = \nu_i \frac{v}{v - v_{i\,b}}$

$\nu = \nu_i \frac{\cancel{v}}{v - v_{i\,b}} \frac{v + v_{p\,b}}{\cancel{v}} = \nu_i \frac{v + v_{p\,b}}{v - v_{i\,b}}$

$v_{p\,b} = v_{i\,b} = v_b$

$\nu = \nu_i \frac{v + v_b}{v - v_b}$

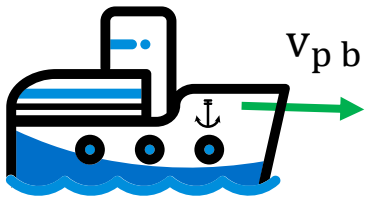
$\nu(v - v_b) = \nu_i(v + v_b)$

$\nu \cdot v - \nu \cdot v_b = \nu_i \cdot v + \nu_i \cdot v_b$

$\nu \cdot v - \nu_i \cdot v = \nu \cdot v_b + \nu_i \cdot v_b$

$v \cdot (\nu - \nu_i) = v_b.(\nu + \nu_i)$

$v_b = \frac{v \cdot (\nu - \nu_i)}{(\nu + \nu_i)} = \frac{330\frac{m}{s} \cdot (310\text{Hz} - 300Hz)}{(310\text{Hz} + 300Hz)} = \frac{330\frac{m}{s} \cdot 10Hz}{610Hz} = 5{,}41\frac{m}{s}$



$v_{p\,b}$

izvor

$\nu = \nu_s \frac{v + v_{p\,b}}{v}$

$\nu = 310\text{Hz}$

$v = 330\frac{m}{s}$

$t = 2min = 120s$

$S = v_b \cdot t$

$S = 5{,}41\frac{m}{s} \cdot 120s$

$S = 649{,}2m$