Physics 20 - Lesson 32
The Doppler Effect – Answer Key

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1)

$$v_{train} = v_s = 100 km/h = 27.8 m/s$$

a) Toward

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$$f_o = f_s\left(\frac{v}{v-v_s}\right) = 400 Hz\left(\frac{344 m/s}{344 m/s - 27.8 m/s}\right)$$

$$\boxed{f_o = 435 Hz}$$

b) Away

$$f_o = f_s\left(\frac{v}{v+v_s}\right) = 400 Hz\left(\frac{344 m/s}{344 m/s + 27.8 m/s}\right)$$

$$\boxed{f_o = 370 Hz}$$

2)

$$\lambda = 0.38 m$$
$$v = 340 m/s$$
$$v_o = 20 m/s$$

$$f = \frac{v}{\lambda} = \frac{340 m/s}{0.38 m} = 895 Hz$$

b) $v_o(+)$

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a) $v_o(-)$ $\quad f_o = f_s\left(\frac{v-v_o}{v}\right)$ $\qquad f_o = f_s\left(\frac{v+v_o}{v}\right)$

$$f_o = 895 Hz\left(\frac{340 m/s - 20 m/s}{340 m/s}\right) \qquad f_o = 855\left(\frac{340 m/s + 20 m/s}{340 m/s}\right)$$

$$\boxed{f_o = 842 Hz} \qquad\qquad \boxed{f_o = 948 Hz}$$

3)
$$f_s = 2150 Hz$$
$$v = 339 m/s$$

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$$v_s = -25 m/s (toward)$$
$$f_o = ?$$

$$f_o = f_s\left(\frac{v}{v-v_s}\right)$$

$$f_o = 2150 Hz\left(\frac{339 m/s}{339 m/s - 25 m/s}\right)$$

$$\boxed{f_o = 2321 Hz}$$

4)
$$f_s = 1200 Hz$$
$$v_s = {}^{(+)}30.0 m/s$$

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$$v_o = -{}^{(-)}18 m/s$$
$$f_o = ?$$
$$v = 340 m/s$$

$$f_o = f_s\left(\frac{v-v_o}{v+v_s}\right)$$

$$f_o = 1200 Hz\left(\frac{340 m/s - 18 m/s}{340 m/s + 30 m/s}\right)$$

$$\boxed{f_o = 1044 Hz}$$

5)

$f_s = 5.17 \times 10^{14} \, Hz$

$f_o = 4.70 \times 10^{14} \, Hz$

$v = 3.00 \times 10^8 \, m/s$

/6 $v_s = ?$

$$f_o = f_s \left(\frac{v}{v \pm v_s} \right)$$

$$vf_o \pm v_s f_o = vf_s$$

$$\pm v_s = \frac{v(f_s - f_o)}{f_o}$$

$$\pm v_s = \frac{3.00 \times 10^8 \, m/s (5.17 \times 10^{14} \, Hz_s - 4.70 \times 10^{14} \, Hz)}{4.70 \times 10^{14} \, Hz}$$

$$\boxed{v_s = 3.0 \times 10^7 \, m/s \ (away)}$$