Solutions

Each answer shows the steps, then the **result**.

2.1

- the change in the **observed frequency** when the source **moves relative to** the observer

2.2

- it **increases**

2.3

- **minus** $(-)$ in the denominator when the source moves **towards** the observer

2.4

- each new wavefront is emitted from slightly **closer** to the observer, so the wavefronts ahead are **closer together** (shorter λ)

3.1

- source moving **towards** $\Rightarrow$ minus sign

$$f_{\mathrm{o}} = \frac{v f_{\mathrm{s}}}{v - v_{\mathrm{s}}} = \frac{(340\ \frac{\mathrm{m}}{\mathrm{s}})(800\ \mathrm{Hz})}{340\ \frac{\mathrm{m}}{\mathrm{s}} - 30\ \frac{\mathrm{m}}{\mathrm{s}}} = \frac{2.72 \times 10^{5}\ \mathrm{m\ s^{-2}}}{310\ \frac{\mathrm{m}}{\mathrm{s}}} = \mathbf{877}\ \mathrm{Hz}$$

3.2

- source moving **away** $\Rightarrow$ plus sign

$$f_{\mathrm{o}} = \frac{v f_{\mathrm{s}}}{v + v_{\mathrm{s}}} = \frac{(340\ \frac{\mathrm{m}}{\mathrm{s}})(800\ \mathrm{Hz})}{340\ \frac{\mathrm{m}}{\mathrm{s}} + 30\ \frac{\mathrm{m}}{\mathrm{s}}} = \frac{2.72 \times 10^{5}\ \mathrm{m\ s^{-2}}}{370\ \frac{\mathrm{m}}{\mathrm{s}}} = \mathbf{735}\ \mathrm{Hz}$$

3.3 B

- moving **away** stretches successive wavefronts, so λ rises; v is fixed by the medium, so f **falls**
- **A** is an *approaching* source (why a passing siren drops in pitch)

3.4

- as the ambulance approaches, the wavefronts ahead are **bunched closer together**
- shorter $\lambda \Rightarrow$ **higher frequency** (higher pitch)

3.5

(a)

- approaching: $f_{\mathrm{o}} = \dfrac{v f_{\mathrm{s}}}{v - v_{\mathrm{s}}} = \dfrac{(340)(500)}{340 - 25} = \mathbf{540}\ \mathrm{Hz}$
- moving away: $f_{\mathrm{o}} = \dfrac{(340)(500)}{340 + 25} = \mathbf{466}\ \mathrm{Hz}$

(b)

- 500 Hz: with no relative motion the wavefronts are evenly spaced, so the wavelength and frequency are unchanged

3.6

- moving away: $450 = \dfrac{(340)(480)}{340 + v_{\mathrm{s}}}$, so $340 + v_{\mathrm{s}} = \dfrac{(340)(480)}{450} = 362.7$
- $v_{\mathrm{s}} = \mathbf{23}\ \mathrm{m\,s^{-1}}$