2017 Ph H2 Q1

Section: Our Dynamic Universe
Topic: Motion, Equations and Graphs; Doppler Effect

(a) (i) Question Summary

What is meant by an acceleration of $\mathbf{0.32\,m\,s^{-2}}$?

✅ Answer:

The train's velocity increases by $\mathbf{0.32\,m\,s^{-1}}$ **each second**.

(a) (ii) Question Summary

The train accelerates uniformly at $\mathbf{0.32\,m\,s^{-2}}$ for $\mathbf{25\,s}$.
Find the distance travelled.

✅ Answer:

$$s = 100\,\text{m}$$

Working

$$s = ut + \frac{1}{2}at^2$$

Initial velocity $u = 0$.

$$s = 0 + \frac{1}{2}(0.32)(25^2) = 0.16 \times 625 = 100\,\text{m}.$$

(b) (i) Question Summary

The train horn has a frequency of $\mathbf{270\,Hz}$.
An observer on a bridge hears $\mathbf{290\,Hz}$.
The speed of sound is $\mathbf{340\,m\,s^{-1}}$.
Find the train's speed.

✅ Answer:

$$v_s = 23\,\text{ms}^{-1}$$

Working

Doppler equation:

$$f_o = f_s \frac{v}{v - v_s}$$

Rearrange for v_s:

$$v_s = v\left(1 - \frac{f_s}{f_o}\right) = 340\left(1 - \frac{270}{290}\right) = 23\,\text{ms}^{-1}.$$

(b) (ii) Explanation

As the train passes and moves away, the **wavefronts are spread out** relative to the observer, so the observed frequency **decreases**. The source frequency remains constant; only the relative motion changes the frequency.
