

## Solutions

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### 2.1

: transverse.: vertical oscillation is perpendicular to horizontal propagation.

### 2.2

:  $v = f\lambda$ .:  $v = 5.0 \text{ Hz} \times 0.40 \text{ m} = 2.0 \text{ m/s}$ .

### 2.3

:  $T = 1/f$  and crest-to-trough difference =  $2A$ .:  $T = 1/5.0 = 0.20 \text{ s}$ .: difference =  $2 \times 0.030 = 0.060 \text{ m}$ ; it is not wavelength.

### 2.4

: point moves up and down about equilibrium.: disturbance/energy moves along the string.: this does not imply a permanent rightward transport of that point with the wave.

### 3.1

each: spring example is longitudinal from parallel coil motion/propagation; direction on a page alone does not determine wave type; amplitude differs from frequency; no supplied observation establishes that changing amplitude changes frequency; electromagnetic waves share a vacuum speed under stated conditions; mechanical waves depend on their medium and are not all light-speed waves.

### 3.2

Local analytic rubric, 8  $\times$ : classify string as transverse; distinguish directions; state 2.0 m/s; state 0.20 s; distinguish 0.060 m height from wavelength; explain point oscillation; keep amplitude distinct from frequency; avoid universal-light-speed claim; coherent truthful 80–110 word response. Example: “The string wave is transverse because its marked point oscillates vertically while the disturbance propagates horizontally. Its supplied frequency and wavelength give a speed of 2.0 metres per second and a period of 0.20 seconds. The amplitude is 0.030 metres, so crest-to-trough height is 0.060 metres; neither height is the wavelength. The marked point oscillates about equilibrium rather than moving permanently along with the disturbance. Amplitude and frequency describe different properties, and no change linking them was measured here. The spring example is longitudinal. Electromagnetic vacuum speed does not establish the speed of every mechanical wave.”