**Core Waves Review MARKSCHEME**

**1.** (a) ray: direction in which wave (energy) is travelling;
wavefront: line joining (neighbouring) points that have the same phase / displacement /
Or suitable reference to Huygen's principle;
ray is normal to a wavefront; 3

(b) (i) wavefront parallel to D; 1

(ii) frequency is constant;
since $v = f\lambda$, $v \propto \lambda$;
wavelength larger in medium I, **hence** higher speed in medium I; 3

*Allow solution based on angles marked on diagram or speed of wavefronts.*

(iii) ratio = $\frac{v_I}{v_R} = \frac{\lambda_I}{\lambda_R}$ (or based on Snell's law);

$= \frac{3.0}{1.5} = 2.0$ *allow ± 0.5*; 2

(c) (i) velocity / displacement / direction in (+) and (–) directions;
idea of periodicity; 2

(ii) period = 3.0 ms;
frequency = $\frac{1}{T}$ = 330 Hz; 2

(iii) *Accept any one of the following.*
at time $t$ = 0, 1.5 ms, 3.0 ms, 4.5 ms, *etc*; 1

(iv) area of half-loop = 140 ± 10 squares / mean $v = 4.0\ \text{m s}^{-1}$ *accept ± 0.2*;
$= 140 \times 0.4 \times 0.1 \times 10^{-3}$ / $4.0 \times 1.5 \times 10^{-3}$;
$= 5.6 \times 10^{-3}$ m / $6.0 \times 10^{-3}$ m; 2

*Award **[1]** for area of triangle.*

(v) (twice) the amplitude; 1

*Allow distance moved in 1.5 m s.*

**[17]**

**2.** (a) (i) distance travelled per unit time;
by the energy of the wave / by a wavefront; 2

(ii) velocity has direction; but light travels in all directions; 2

(b) (i) distance in a particular direction; *(accept in terms of energy transfer)*
(of a particle) from its mean position; 2

(ii) *longitudinal*: displacement along;
*transverse*: displacement normal to;
direction of transfer of wave energy / propagation, **not** motion; 3
*Award **[0]** for left / right and up / down for longitudinal / transverse.*

(c) (i) $\left(\frac{700}{75}\right) = 9.3 \text{ km s}^{-1}$; (±0.1) 1

(ii) $\left(\frac{700}{120}\right) = 5.8 \text{ km s}^{-1}$; (±0.1) 1

*Award **[1 max]** if the answers to (i) and (ii) are given in reversed order.*

(d) (i) P shown as the earlier (left hand) pulse; 1

(ii) laboratory $L_3$; 1

(iii) *eg* pulses arrive sooner;
smaller S-P interval;
larger amplitude of pulses; 3

*Allow any feasible piece of evidence, award **[1]** for each up to **[3 max]**.*

(iv) *distance from* $L_1$ = 1060 km; (± 20)
*distance from* $L_2$ = 650 km; (± 20)
*distance from* $L_3$ = 420 km; (± 20)

*Accept 3 significant digits in all three estimates.*

some explanation of working; 4

(v) position marked, consistent with answers to (iv);
to the right of line $L_2L_3$, closer to $L_3$; 1 max

*If the answers given in (iv) means that the point cannot be plotted, then only allow the mark if the candidate states that the position cannot be plotted / does not make sense.*

(e) (i) illustration showing node at centre, antinode at each end; 1

(ii) wavelength of standing wave = (2 × 280) = 560 m / ecf

*or* $\frac{3.4 \times 10^3}{6}$ = 570 m;

frequency = $\frac{(3.4 \times 10^3)}{560}$ ≈ 6Hz

*or* wavelength of standing wave = (2 × 280) = 560 m;
earthquake frequency is natural frequency of vibration of building / mention of resonance / multiple / submultiple if ecf; 3

**[25]**

3. Wave properties

(a) (i) direction in which energy is travelling / locus of one point on a wavefront; 1

(ii) speed at which energy is propagated along the wave; 1

(b) (i) frequency $\left(= \left\{6.0 \times 10^{-3}\right\}^{-1}\right) = 170\,\text{Hz}$; 1

(ii) at $t$ = 1.0ms , displacement (= 1.7 + 0.7) = 2.4mm;
at $t$ = 8.0ms, displacement = 1.7 − 0.7;
= 1.0mm; 3

**[6]**

4. (a) Transverse
the particles (of the medium) vibrate at right angles;
to the direction of energy transfer;

Longitudinal
the particles (of the medium) vibrate in the same direction as the direction of energy transfer; 3

(b) (i) time period = 0.13 s;
$\left(f = \frac{1}{T} = \frac{1}{0.13}\right)$ = 7.7(±0.3) Hz; 2
*Award full marks for bald correct answer.*

(ii) 8 mm; 1

(c) $\lambda = \frac{v}{f}$;

$\frac{15}{7.7}$;

$\lambda = 1.95 \text{ cm} \approx 2.0 \text{ cm}$ 2

(d) start at (–1.2 → –2.0) on *y*-axis;
sine curve of amplitude 8 mm;
wavelength 2 cm; 3

(e) use of $\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2}$

$\sin\theta_2 = \frac{v_2}{v_1}\sin\theta_1$;

$= \frac{20}{15}\sin 30$ to give $\theta_2 = 42°$;

angle = 48°; 3

**[14]**

**5.** A **[1]**

**6.** C **[1]**

**7.** C **[1]**

**8.** A **[1]**

**9.** B **[1]**

**10.** A **[1]**

**11.** A **[1]**

**12.** C **[1]**

**13.** B **[1]**

**14.** D **[1]**

**15.** B **[1]**