1. (a)(i) R.I. = speed of light in air/speed of light in medium   **B1 [1]**
{allow sin i / sin r if i and r correctly identified e.g. on a sketch}

(b)(i) $_g n_a = 1/1.49$ **C1**
correct substitution into $n = \sin i/\sin r$: $\sin r = 1.49 \times \sin 30$ **C1**
$\Rightarrow r = 48°$ **A1 [3]**
{If n = 1.49 is used, allow 2 marks for r = 19.6° (or 19.9°) i.e. 2 ecf marks}

(ii) REFRACTED RAY correctly drawn on Fig 1.1 (i.e r>30°)   **B1**
{allow ecf from (i) for r=19.6° i.e. for refracted ray bending towards normal}
(partially) reflected ray drawn at 30° (roughly judged by eye)   **B1 [2]**
{N.B. allow this mark if partially reflected ray is shown either here OR in (iv)}

(iii) correct substitution into $\sin C = 1/n$: $\sin C = 1/1.49$ **C1**
$\Rightarrow C = 42°$L   **A1 [2]**

(iv) RAY drawn to the right of X with C (or 42°) correctly labelled   **B1**

REFRACTED RAY along interface   **B1 [2]**
{ignore partially reflected ray unless mark in (b) (ii) was not gained}

(c)(i) recall of $n = c_a / c_g$ OR $c_g = (1/1.49) \times 3.0 \times 10^8$ **C1**
$c_g = 2.01 \times 10^8$ (m/s)   **A1 [2]**

(ii) time = dist. /vel. OR $t = (50 \times 10^3)/(2.01 \times 10^8)$ {allow ecf from (i)}   **C1**
= 2.49×10^{-4} s   **A1 [2]**

(iii) some light travels further because of T.I.R (WTTE)   **B1 [1]**

QUESTION TOTAL = 15

2. (a)(i) λ = distance between neighbouring crests/ troughs (WTTE)   **B1**
{do not accept 'length of one wave'}

(ii) f = number of waves/ cycles/ vibrations per second (WTTE)   **B1**
passing a point OR produced by the wave source (WTTE)   **B1**

(iii) v = distance travelled by the wave per second (WTTE)   **B1 [4]**
{do not accept v = 'distance / time' OR v=fλ}
{allow labelled diagrams used to define terms}

(b) In 1 second f waves are produced each of length λ (WTTE)   **B1**
(hence) distance travelled by first wave in 1 second = $f \times \lambda$ **B1**
(hence) $v = f \times \lambda$ **B1 [3]**
{allow any other valid proof:
e.g. $v = d/t$ ── B1; where d = wavelength AND t = period AND
and since $t = 1/f \Rightarrow v = f\lambda$}

(c)(i) valid scales labelled on displacement axis AND time axis   **B1**
smooth sinusoidal {generously judged} wave drawn   **B1**
amplitude correctly shown: 1.2 cm above and below time axis   **B1**
period (0.04s) correctly shown with at least 2 full cycles drawn   **B1 [4]**

(ii) wave source vibrates in the same direction as the wave (WTTE)   **B1 [1]**
{allow 'vibrates/moves backwards and forwards' but not just 'source vibrates}

(iii) Frequency = 1/period   **C1**
$\lambda = v/f = 340 \times 0.02$ **C1**
$\lambda = 6.8$ m   **A1 [3]**

QUESTION TOTAL = 15

3. (a)(i) 1. constructive: waves meet in phase (WTTE)   **B1**
producing a resultant of maximum amplitude (WTTE)   **B1**
{allow producing "a bright spot" or "a loud sound"}

2. destructive: waves meet in antiphase OR out of phase   **B1**
{allow "waves cancel each other out"}
producing a resultant of minimum amplitude (WTTE)   **B1**
{allow producing "a black spot" OR "no light" OR "no sound"}
   [4]
{Full marks may be scored for correct and fully labelled diagrams}

(ii) coherence: constant phase difference   **B2**
{allow a B1 mark for "same frequency" OR "identical waves}   **[2]**

(b)(i) maxima: where path difference = whole number of wavelengths   **B1**
minima: where path difference = odd number of half-wavelengths   **B1 [2]**

(ii) required path difference for maxima/minima now shorter   **B1**
hence separation would DECREASE   **B1 [2]**

QUESTION TOTAL = 10

4. (a)(i) (transverse) waves travel out from the centre   **B1**
are reflected (by the supports) AND interference occurs (WTTE)   **B1 [2]**
{allow answers based on a diagrams/graphical methods}

(ii) correct shape {not a single sine wave type shape}   **B1**

NODES (N) shown at both ends   **B1**
an ANTINODE (A) shown at the centre   **B1**
{allow correct labelling of Ns and As for incorrect wave shape i.e treat as ecf}   **B1 [3]**

(iii) L = half wavelength (for fundamental) {OR 0.4 = (1/2) λ}   **C1**
$\lambda = 0.80$ m   **A1 [2]**
{allow ecf for cand's standing wave drawn in (ii) for both marks}

(b)(i)   any valid suggestion: eg node required at centre
       touch centre while bowing at ¼ pt   B1
       OR increase tension   B1   by a factor of 4   B1
       OR shorten length   B1   by a factor of 2   B1   B1 [2]

(ii)   correct wave drawn {do not allow 'sine wave' unless ecf from (ii)}
      {allow ecf from (ii) –i.e if wave drawn has double freq.ʸ of cand.'s wave
      in (ii)}   B1 [1]

                        QUESTION TOTAL = 10

5. (a)   the spreading out of wavefront/waves
       {do not allow "spreading out of light/sound" "bending of light/waves}
                                      B1

       when they pass through a gap (OR pass an obstacle)   B1 [2]

(b)(i)   a straight strip (OR bar OR ruler)   B1
       is vibrated vertically OR up and down (in the water)   B1 [2]

(ii)   increase the frequency (of the waves/wave source)   B1
      OR use a shallower depth of water   B1 [1]

(c)(i)   semicircular wavefronts drawn   B1
       no change in λ : i.e approx. same λ before & after gap   B1 [2]

(ii)   less diffraction occurs   B1
      wavefronts only slightly curved at edges (WTTE) (OR diagram)   B1 [2]
      { full marks may be scored from a valid diagram}

(iii)   Wavelength of light much smaller than most normal gaps   B1 [1]

                       QUESTION TOTAL = 10

OCR
RECOGNISING ACHIEVEMENT

Waves

24 + E
30 + D
3L + C
4L + B
48 + A