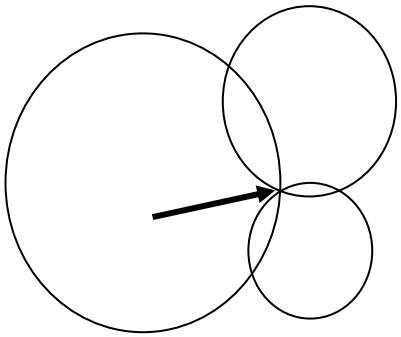
| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **1(a)** | C | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **1(b)(i)** | An explanation linking the following<br><br>• the earthquake will be one of the points of intersection (1)<br><br>• (but) there are two points (of intersection) (1) | (might implies) further evidence needed<br>possibly at a different place (NOT places)<br><br>50:50 chance | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **1(b)(ii)** |  | any arrow clearly indicating the common point of intersection<br>ignore ambiguous arrows<br><br>a small circle or cross at the common intersection | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **1(c)** | • S- wave arrives at 17 minutes<br>P-wave arrives 9.5 minutes<br>(1 for both)<br><br>• difference in arrival time = 7.5 (minutes) (1) | 7.0 to 8.0 inclusive<br>7.30/7:30<br>give full marks for correct answer, no working<br><br>e.c.f from readings marked on graph or stated for a different distance on graph | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **1(d)** | A description including the following<br><br>• vibration (1)<br><br>• in same direction as wave/energy moves (1) | up and down/side to side/shake<br><br>backwards and forwards/back and forth scores 2 | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(a)** | A | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(b)(i)** | (number of waves =) 7 (1)<br><br>(distance between floats =)7 × 0.8 (1) | **Accept**<br>5.6 (m)<br>give full marks for correct answer, no working<br>e.c.f from number of waves if clear<br><br>6.4 (m) for 1 mark | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(b)(ii)** | C | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(b)(iii)** | Any **one** from the following points<br>• size (1)<br>• mass (1)<br>• speed (1)<br>• direction of travel (1) | small<br>light<br>slow<br>fast<br>momentum<br>how far away<br>weight<br>power<br>ke | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(c)** | • change of direction (1)<br>• towards the normal (1)<br>• λ shorter than in deep water (1) | Ignore reflection<br><br>of EITHER ray or wave<br><br>must not reach normal<br>if ray and wave contradict then no mark<br><br>λ shorter for all complete waves in shallow water, at least 2 λ drawn, judge by eye | **(3)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(a)** | C | | **(1)** |

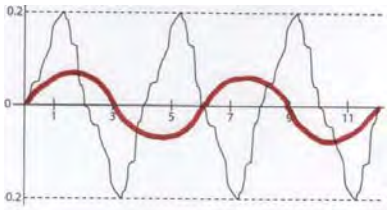
| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(b)** | 5 (cm) | 5.0, +5, -5, ±5 ignore unit | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(c)** | • A difference in f or λ (however described) (1)<br><br>This difference correctly qualified by one of<br>• Relationship to each other (1)<br>• Relationship to audible sound (1)<br>• Frequency or wavelength data (1) | Accept pitch for frequency<br><br>IS has longer λ than audible (1)<br><br>US>20kHz (1)<br><br>IS has lower f (than US) (2 marks)<br><br>information shown on a labelled sketch of the sound spectrum | **(2)** |

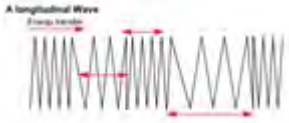
| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(d)** | An explanation linking the following points<br><br>• corks as plates / water as mantle (1)<br><br>• water heated (underneath) (1)<br><br>• convection currents mentioned(1) | labels on diagram<br><br>corks as crust / water as magma /lava<br><br>reference to heat in the Earth<br><br>arrow on diagram | **(3)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(e)** | An evaluation linking the following points<br><br>• (a)statement about either distance travelled or arrival times of any two waves (1)<br><br>• (b)statement comparing any pair of S-P times (1)<br><br>• correct comparison between (a) and(b)leading t conclusion (1) | quantitative or qualitative<br><br>quantitative or qualitative<br><br>quantitative<br><br>e.g.<br><br>station M is twice as far as station L, the S-P time is double, suggestion is OK. 3 marks<br><br>e.g.<br><br>station N is (about) 3½ times as far as station L, but S-P time is 3⅓ times, so maybe not. 3 marks | **(3)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **4(a)(i)** | 12/3 (1)<br><br>4 (m) (1) | the wave shown is for 3 wavelengths<br>any correct ratio<br><br>give full marks for correct answer, no working | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **4(a)(ii)** | all amplitudes smaller (1)<br><br>all wavelengths longer (1) | Accept smaller peak to trough distance wherever it is drawn<br><br>all wavelengths shown must be longer than original<br>can be any shape<br>must be at least half a wavelength shown<br>  | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **4(b)(i)** | {P-wave / ultrasound / infrasound / shock} (1) | P/primary/pressure (wave)<br><br>**IGNORE** slinky/spring/push-pull | **(1)** |

| Question Number | Answe | | Mark |
|---|---|---|---|
| **4(b)(ii)** | Any two from:<br><br>vibrations different direction (1)<br><br><br><br><br><br><br><br>In longitudinal (vibrations) move in same direction as {wave/energy} moves (1)<br><br><br><br><br><br><br>In transverse (vibrations) move at right angles to direction {wave/energy} moves (1) | In one is up and down, other is backwards and forwards / any two different motions<br> <br>**AND**<br> <br><br><br>in longitudinal (particles) move backwards and forwards<br>  <br><br><br>in transverse (particles) move up and down/ side to side<br> | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **4(c)(i)** | B | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **4(c)(ii)** | substitution (1)<br>ie 340 / 1047<br><br>evaluation (to at least 2 sf) (1)<br>ie between 0.32 and 0.33 (m) inclusive<br><br><br><br><br><br><br><br>conversion of m to cm (1) | No **RA**<br><br>If incorrect value chosen for frequency cannot get substitution mark but can get evaluation mark and conversion mark<br>frequency (Hz) evaluation(m)<br>1290 0.26<br>1245 0.27<br>1200 0.28<br>1174 0.29<br>1109 0.31<br>960 0.35 | **(3)** |

| Question Number | Answ | | Mark |
|---|---|---|---|
| **5(a)(i)** | B | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **5(a)(ii)** | An explanation linking two of the following:<br>• (uneven) heat (from the core) (1)<br>• convection (currents) (1)<br>• (that are in) the mantle (1) | | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **5(b)** | C | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **5(c)(i)** | Description to include:<br>• (they can be) reflected (1)<br>• (and/or) refracted (1) | bounce off/back<br>change direction/speed | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **5(c)(ii )** | Substitution (1)<br>1200/200<br>Evaluation (1)<br>6 (km/s) | Power of 10 error max 1 mark<br>give full marks for correct answer, no working | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **5(d)** | An explanation linking<br>• tsunamis are caused by underwater earthquakes / volcanic eruption (1)<br>• are random/irregular (1) | Underwater movements of the plates / landslip into the sea / meteorite strike into the sea<br>can happen at any time / do not know when it will happen | **(2)** |