Question Number	Answer	Acceptable answers	Mark
1 (a)	• below 20 Hz (1) • above {20 000 Hz / 20 kHz} (1) If Hz or kHz is not seen somewhere, the maximum score is 1 mark.	infrasound ultrasound (in either order) (no units needed for the names)	**(2)**

Question Number	Answer	Acceptable answers	Mark
1 (b)(i)	C it is a longitudinal wave travelling faster than an S wave		**(1)**

Question Number	Answer	Acceptable answers	Mark
1 (b)(ii)	Explanation linking the following:- MP1 refraction /changing speed (1) MP2 (due to) changing {material/medium /rock type / density} (1)	ignore changes in direction/ bending (in this case) rock becomes {more / less} {dense / compact}	**(2)**

Question Number	Answer	Acceptable answers	Mark
1 (b)(iii)	Explanation linking the following:- MP1 (S / transverse waves) they cannot travel through liquid (1) MP2 Earth's core is (at least part) {liquid/molten} (1) MP3 (so) (S waves) they cannot travel through core (to other side of Earth) (1)	Check diagram for creditworthy points. they can only travel through solids may be stated in part (ii) (S / transverse waves) they cannot be detected on opposite side of the Earth to (collision site / earthquake)	**(3)**

Question Number	Answer	Acceptable answers	Mark
1 (b)(iv)	Suggestion to include any two from: MP1 idea that {kinetic energy/force/ momentum} of meteor might cause the earthquake (1) MP2 (earthquakes happen where) plates slide {past/over/under/away from/against} each other (1) MP3 (plates move) suddenly MP4 (meteor collision) starts seismic waves /P/S (1)	(meteor) it has large amount of kinetic energy (earthquakes happen where) plates collide rub/move for slide (earthquakes happen when) large amount of energy released in / near Earth's surface (plates) jolt/jerk vibrations passing through the Earth condone earthquake waves {kinetic energy/force /momentum} of meteor can cause the plates to slide past each other = 2	**(2)**

(Total for Question 4 = 10 marks)

Question Number	Answer	Acceptable answers	Mark
2(a)(i)	☒ **A** ultrasound waves have a frequency above 20 000 Hz		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(ii)	☒ **C** sonar		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(iii)	a description including any **two** of the following: • (ultrasound waves / pulses) go down (through the water) (1) • (ultrasound waves are) reflected **off fish** (1) • (reflected ultrasound waves) are received by boat (1) • time delay (shows how deep fish are) (1)	 on diagram, wave or ray indicated as downwards idea of wave moving towards or hitting fish on diagram, waves or rays reflected **off fish** idea of wave bouncing **off fish** signal is timed **ignore** fish emitting ultrasound	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(b)(i)	(number of waves =) 5 (1)		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(b)(ii)	60 ÷ 5 (1) **or** 60 ÷ (their answer to 2(b)(i)) (1)	12 (cm) **or** ecf from number of waves	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(c)	Substitution 1.7 x 8 (1) Evaluation 14 (cm/s) (1)	 13.6 (cm/s) give full marks for correct answer, no working Power of 10 error max. 1 mark.	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(a)	☒ **D** both transverse and longitudinal waves		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(b)	A description including **three** of the following points • molten rock/magma (in mantle) (1) • convection currents (in mantle) (1) • plates move (1) • build up of pressure/force/energy (when plates (not) sliding over/under/past (each other)) (1) • sudden movement when pressure becomes too great/is released (1) • This sudden movement of plates is an earthquake (1)	Marks can be awarded on a labelled diagram Description of convection currents or arrows on diagram plates rub together Jolt/jerk when pressure becomes too great/ is released	**(3)**

Question Number	Answer	Acceptable answers	Mark
3(c)	relevant values 110 and 10 seen anywhere(1) 100 (s) (1) **acceptable range 95 to 105** (s)	(could be on chart) tolerance +/- 5 s give full marks for correct answer, no working	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(d)	any vertical line of 10 squares on graph between P- wave and S-wave (1) OR times eg 52 (s) – 32(s) Range (48 to 56) – (29 to 35) 220 (km) (1)	Range 9 to 11 squares range 200 to 240 (km) give full marks for correct answer, no working	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(e)	a description including **two** of the following: • longitudinal / sound (wave) (1) • (frequency) less than 20 Hz (1)	Frequency below range/too low for (normal) human ear	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(a)	**A** 23 000 Hz		**(1)**

Question Number	Answer	Acceptable answers	Mark
4(b)	Any one from the following points • sonar / ranging (1) • (medical) scanning(1) • medical treatment (1) • animal communication (1) • cleaning(1)	**Accept** foetal/tumours shattering kidney stones /destroying cancer cells dog whistles	**(1)**

Question Number	Answer	Acceptable answers	Mark
4(c)	An explanation linking the following points • a reference to frequency/pitch/hearing range (1) • (frequency/pitch) is high(er) for cats RA (1) [The points must be linked for the second mark]	Accept Hz Cat detects high(er) frequency/pitch for 2 mark ignore incorrect value of frequency for ultrasound if a comparison made (tested in 1a) cat can hear >20000 Hz (2) humans cannot hear > 20000 Hz / ORA (2) amplitude too low / too quiet is 1 mark only if no other marks awarded	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(d)(i)	substitution (1) 340 x 0.047 evaluation (1) 16 (m)	 15.9(8) (m) give full marks for correct answer, no working	 **(2)**

Question Number	Answer	Acceptable answers	Mark
4(d)(ii)	Any two from the following points • Idea of speed (1) • correct difference identified e.g. sound slower RA (1)	 It/ infrared/light/em waves travel(s) faster/quicker scores 2 marks Ignore references to time	 **(2)**

Question Number	Answer	Acceptable answers	Mark
5(a)	A description including the following points • (Particles) vibrate/oscillate (1) • (vibration) parallel to direction of wave / propagation (1)	Both marks may be awarded for a clear diagram move backwards and forwards/to and fro/ push and pull Accept idea of (a series of) compressions and rarefactions in the same direction as wave travel /energy transfers **Accept** they vibrate in the same direction that the wave is going (for 2 marks)	**(2)**

Question Number	Answer	Acceptable answers	Mark
5(b)	**B** the frequency of infrasound is too low		**(1)**

Question Number	Answer	Acceptable answers	Mark
5(c)(i)	transposition (1) t = distance ÷ speed substitution (1) (2 x)2500 ÷ 340 evaluation (1) 14.7 (s)	**This is a "show that" question, there must be evidence of calculation** **Ignore** factor of 2 until final evaluation 2500 ÷ 340 = 2 marks 14.7 is evidence of calculation = 3 marks There are other ways to use the data e.g. 5000 ÷15 = 333 (m/s) (which is about 340 m/s) 2500 ÷7.5 = 333 (m/s) (which is about 340 m/s) **OR** 340 x 15 = 5100 (m) (which is about 5000 m) Give marks for transposition, substitution and evaluation clearly shown	**(3)**

Question Number	Answer	Acceptable answers	Mark
5(c)(ii)	Any **one** of the following points • idea of a conversation (1) • (4000 m is) a longer distance taking a longer time (to reach other elephant) (1) • time needed for waves to travel is about 24 s (1) • time gap between calls (sufficient) for elephant to hear a reply (1) • call lasts long enough to be identified by other elephants (OWTTE) (1)	longer distance and call takes (some) time waiting to see if there is a reply/response (from another elephant)	**(1)**

Question Number	Answer	Acceptable answers	Mark
5(d)	A description linking the following points • detecting/ locating/ monitoring (infrasound) (1) • volcanic eruptions / underground explosions / earthquakes /nuclear explosions / meteor strikes (1)	Ignore references to ultrasound and infrared idea of need for a detecting instrument (1) idea of infrasound (waves) travelling through a medium (1)	**(2)**