Question Number	Answer	Acceptable answers	Mark
1(a)	D		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(b)	A description including **two** of the following • (bat) emits /sends /makes (ultra)sound /it / signal/wave(1) • signal/wave /(ultra)sound reflects/bounces(back)/ rebounds (off moth/prey) (1) • bat's (ears) detect reflected (ultra)sound (1) • reflection is used to estimate distance (to moth) (1)	On diagram idea of something emitted e.g. line (with arrow) from anywhere on /near bat or outgoing waves On diagram idea of something reflected e.g. line with arrow from anywhere on /near moth or reflected waves (from moth) idea of reflection detected e.g. bat hears the reflected (ultra)sound/wave/signal idea of bat analyses data e.g. bat times how long (it takes) for reflected wave to get back **Ignore** idea that it listens for noises from prey	**(2)**

Question Number		Indicative content	Mark
QWC	***1(c)**	A description linking some of the following • ultrasound does not cause damage to (healthy) cells / ORA • idea of real-time image with ultrasound • ultrasound uses non-ionising radiation • idea that (consultant) can change image position during ultrasound scan • 3D image possible with ultrasound • ultrasound safer for consultant • ultrasound machines more portable • ultrasound can be used to measure blood flow rates • ultrasound gives detail of soft tissue • X-rays are more suitable for bony structures • X-rays produce higher resolution images • X- rays are more suitable for parts of body containing gas (lungs, intestines) This list is not exhaustive. Give credit for other plausible suggestions	**(6)**
Level	**0**	No rewardable material	
1	**1-**	• a limited description with no comparison or contrast ie describes a use/fact about ultrasound OR X-rays eg Ultrasound can be used to look at a foetus (unborn child) • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3-**	• a description giving some attempt at comparison or contrast ie describes a use of ultrasound AND X-rays eg Ultrasound can be used to look at a fetus. X-rays are used to detect broken bones OR Ultrasound can be used to look at a fetus because it's safer (than X-rays) • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed description with clear comparison and/or contrast ie describes a use of ultrasound AND X-rays, one of which is detailed, AND a clear comparison Ultrasound can be used to monitor a fetus. In ultrasound the waves reflect off soft tissue. X-rays (are used to look at bones because they) are absorbed by bones OR Ultrasound can be used to monitor a fetus. In ultrasound the waves reflect off soft tissue. X-rays are used to look at bones but not used for fetus because they can damage DNA/cause mutations of cells • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Question Number	Answer	Acceptable answers	Mark
1 (d)	substitution (1) 5000 x 0.000 003 evaluation (1) 0.015 (m) evidence of dividing by 2 (1) (5000 ÷2) x 0.000003 7.5×10^{-3} (m) scores 3 marks	ignore powers of 10 until evaluation e.g. 5000 x 0.0003 etc gains 1 mark or .15 /1.5/15 etc gains 1 mark 1.5×10^{-2}/ 0.015 gains 2 marks 7.5/0.75/0.075 etc gains 2 0.0075 (m) scores 3 marks give full marks for correct answer, no working	**(3)**

Question Number	Answer	Acceptable answers	Mark
2(a)	D		**(1)**

Question Number	Answer	Acceptable answers	Mark
2(b)(i)	(sudden) decrease in speed	refraction / change direction	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(b)(ii)	a description linking • the (speed) increases (1) with any one of • as depth increases (1) • linearly (1) • from 11.8 to 14 (km/s) (1) • by 2.2	 accelerates travels further into the mantle / material becomes more dense steadily / evenly from >11 and < 12 to >13 and <14 2 to 3	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(b)(iii)	substitution (1) 12 = 5800 ÷ t transposition (1) t = 5800 ÷ 12 evaluation (1) 480 (s)	Substitution and transposition can be in either order 8 minutes A value which correctly rounds to 480 give full marks for correct answer, no working	**(3)**

Question Number	Answer	Acceptable answers	Mark
2(c)	an explanation linking • impossible to predict earthquakes (1) with one of • (because) no pattern to {results/forces} (1) • (because) not able to predict force needed to make block start sliding (1) • the movement of (tectonic) plates is similar to the movement of the block (over the rough surface) (1)	difficult to predict results {(very) different/not (very) close/not concordant} as force needed for plates to start sliding is unpredictable (ignore references to strength of earthquake)	**(2)**

Question Number	Answer	Acceptable answers	Mark
3 (ai)	D ultrasound waves (1)		**(1)**

Question Number	Answer	Acceptable answers	Mark
3 (aii)	Any 3 from • emits (high frequency/ultra) (sound)(1) • (sound is) reflected (off fish) (1) • (reflection) detected by Dolphin (1) • dolphin (estimates) time between (sending and receiving) sounds (1) • dolphin is able to change time into (estimate of) distance (1)	Makes/sends out/produces (ultra sound/signal/wave) Uses 'high frequency sound' is insufficient (sound) bounces off (fish) or echoes towards dolphin 1st three marks can be scored on the diagram. ie unless stated otherwise, assume any waves/rays starting at dolphin are ultrasound. Rays do not need to be straight	**(3)**

Question Number	Answer	Acceptable answers	Mark
3 (b)	An explanation including: • Infrasound (1) Plus one from: • Decrease/change in amplitude is least (1) • can be detected/'heard' further away (1)	 Marks are independent Stays the biggest/stays high. Has a bigger amplitude would travel the furthest/further	**(2)**

Question Number	Answer	Acceptable answers	Mark
3 (ci)	B seismic waves (1)		**(1)**

Question Number	Answer	Acceptable answers	Mark
3 (cii)	(there is a) difference/change in density (1)	more/less/too dense (reach a) boundary (between different materials) Ignore 'the waves cannot travel through liquids/oil'	**(1)**

Question Number	Answer	Acceptable answers	Mark
3 (d)	Substitution into correct equation(1) v = 15 x 125 Evaluation (1) 1875 Unit (1) m/s	 Power of 10 error max 1 mark for numerical answer 2 marks for correct numerical answer even with no working shown ms^{-1} **not** mps 1.875 km/s or 6750 km/h gain 3 marks If numerical answer incorrect, accept any correctly-written unit of speed: eg **k**m/s or km/hr or miles per hour / mph	**(3)**

Total for Question 4 = 11 marks

Question Number	Answer	Acceptable answers	Mark
4(a)(i)	D		**(1)**

Question Number	Answer	Acceptable answers	Mark
4(a)(ii)	moons (1) heliocentric (1)	must be in correct order	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(a)(iii)	A description including two of the following points Reflecting telescope has mirror(s) (1) Galilean telescope has only lenses (1) Reflecting telescope can gather more light / can have a larger objective (1) Image viewed from the side of reflecting telescope (1) Image viewed from end of Galilean telescope. (1)	refracting telescope reverse argument	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b)(i)	5 (cm) (1) 8 (cm) (1)	+5 -5 0.08 m 80 mm	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b)(ii)	B		**(1)**

Question Number	Answer	Acceptable answers	Mark
5(ai)	A		**(1)**

Question Number	Answer	Acceptable answers	Mark
5(aii)	A description linking plates move / slip / separate (relative to each other) (1) sudden (release of energy) (1)	 plate rubs against each other friction between plates plate boundary shifts jerk / jolt	**(2)**

Question Number	Answer	Acceptable answers	Mark
5(bi)	substitution (1) 0.65 = 80 / t transposition (1) t = 80 / 0.65 (123 seconds)	transposition and substitution can be in either order . Allow reverse calculations eg speed = 80/120 (1) = 0.67 (about 0.65) (1) or distance = 0.65 x 120 (1) = 78 km (about 80) (1).	**(2)**

Question Number	Answer	Acceptable answers	Mark
5(bii)	A description linking any three detection of arrival of P and S waves (1) measurement of difference in arrival times (1) calculation of distance (from epicentre to station) (1) triangulation/using three / several stations (1)	Reward suitable labelled diagram	**(3)**

Question Number	Answer	Acceptable answers	Mark
5(b)(iii)	A suggestion including any two of the following Infrasound (1) some animals can hear waves below human frequency range / 20 Hz (1) they could hear P waves arriving before the (stronger) S waves arrive (1)	 Some animals have greater audio / tactile sensitivity than humans	**(2)**