Question	Answer	Marks	Guidance
1	**Level 3: (5 – 6 marks)** **Describes the nature of laser beam AND explains where and how information is stored AND explains how information is read from the disc.** Quality of written communication does not impede communication of the science at this level. **Level 2: (3 – 4 marks)** **Describes any two from:** **the nature of laser beam OR** **explains where and how information is stored OR explains how information is read from the disc.** Quality of written communication partly impedes communication of the science at this level. **Level 1: (1 – 2 marks)** **Describes any one from:** **the nature of laser beam OR** **explains where and how information is stored OR** **explains how information is read from the disc.** . Quality of written communication impedes communication of the science at this level. **Level 0: (0 marks)** Insufficient or irrelevant science. Answer not worthy of credit.	6	**This question is targeted up to grade A*** **Indicative scientific points may include:** **Nature of a laser beam** • **EITHER** laser beam is coherent • **OR** is in phase or in sync **AND** has same frequency / wavelength / is monochromatic **Where and how information is stored** • storage by pits and bumps / lands **How information is read from the disc** • read by reflection of laser from pits and / or bumps or lands (collected by receiver) **Use the L1, L2, L3 annotations in Scoris; do not use ticks.**
	Total	**6**	

Question	Answer	Marks	Guidance
2 a	P wave (no mark) because they are faster [1]	1	**Allow** primary / pressure / longitudinal wave **Ignore** 'powerful / stronger' S wave …etc scores [0]
b	can measure lag time / time between waves [1] idea that distance is determined by lag time [1] **but** difference in time can be used to calculate the distance from earthquake [2] determine wave direction **/** direction that the wave(s) have come from / AW [1] idea of triangulating the results [1] compare results from different sites [1]	2	**maximum 2 marks** find time taken by waves [1] **Eg** readings taken from different points on Earth [1]
c	(can't get through because) **outer** core is liquid [1]	1	**Ignore** S-waves can't get through liquid Eg. S-waves can't get through liquid **inner** core scores [0]

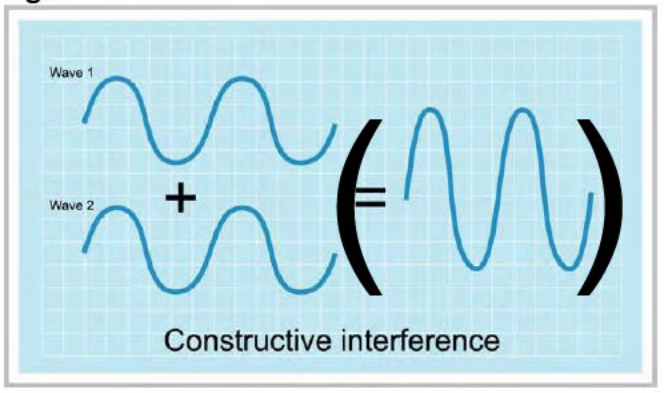
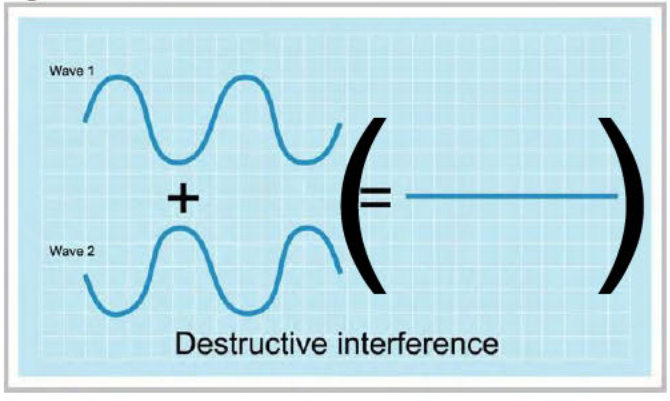
d i	speed = 0.96 (m/s) [2] **but if answer is incomplete then** 0.80 x 1.2 [1]	2	**allow** correct substitution of a reasonable wavelength **only acceptable alternatives allowed are:** 1.92 [1] (i.e. 1.60 x 1.2) [1] 0.48 [1] (i.e. 0.4 x 1.2) [1] **but** ignore other wavelengths when awarding this mark
ii	0.11(m) [1]	1	if not answer on line allow correct answer indicated in list
	Total	**7**	

Question	Answer	Marks	Guidance
3 a i	ideas of: (**for test group**) inaccurate or unreliable measurement(s) [1] (**for test group**) small(er) sample in group / [1] (**for test group**) group not representative / research more representative [1]	3	 Eg. Equipment may be faulty [1] Eg. method may be flawed [1] Eg. large(r) sample in research [1] **allow** example of how the group is not representative eg. **Test group**, some have a hearing impairment [1] eg. All aged16 in test group / AW [1] eg. (**test group**) result(s) look anomalous [1]
ii	19 000 [2] **but if answer is incorrect or incomplete then:** evidence of multiplying average by 5 [1] **or** $\frac{80\,000 + \text{Dionne}}{5}$ [1]	2	**If no answer on answer line check table**

Question	Answer	Marks	Guidance
b i	**any 2 from:** greater hearing loss with ageing [1] greater hearing loss with greater frequency [1] rate of hearing loss increases with ageing [1] rate of hearing loss increases with increasing frequency [1]	2	Eg. as you get older your ability to hear reduces [1] **BUT allow** as you get older your ability to hear higher frequencies reduces [2]
ii	hearing aid lowers (6000Hz) sounds to 3000(Hz) [1] (with hearing aid) less hearing loss at 3000(Hz) / lower frequency sounds heard more easily [1] (at age 60) hearing aid reduces hearing loss by 10 - 15(dB) / AW [1]	3	**Look for use of data in answers.** **Allow** other value of frequency correctly halved [1] **ignore** just frequency halved Eg better hearing (range) at 3000(Hz) **Eg.** (at 60) aid reduces hearing loss from 27 to 13 (dB **Allows** halves hearing loss [1]
	Total	**10**	

Question	Answer	Marks	Guidance
4 a i	(area) where the lines / particles / molecules / layers are close(r) together [1]	1	**allow** area higher density / pressure [1] **allow** correct compression indicated on diagram [1] Ignore waves / wavelength / frequency.
ii	simple comparison of movement [1] **longitudinal waves** (particles or vibrations) move in the same direction as wave movement / AW [1] **transverse waves** (particles or vibrations) move at right angles to the direction of movement of the wave / AW [1]	3	**allow** all marking points from labelled diagrams eg one moves up and down and the other moves side to side [1] **Allow** backwards and forwards / to and fro **allow** (idea that) (particles or vibrations) move side to side along (the wave) [1] **allow** (idea that) (particles or vibrations) move up and down across (the wave) [1] **Allow** 90^0 / perpendicular [1] Longitudinal and transverse waves explained fully scores [3]
b	no (no mark) (idea that) we can't hear high pitched sounds [1] **BUT** We cannot hear 20 000 (Hz) (or above) scores [2]	2	'yes' scores [0] **Allow** (idea that) 25 000 (Hz) is higher than we can hear [1] **Allow** frequencies above a threshold: eg. Can't hear above 18 000 (Hz) [1] **Allow** 20kHz **Allow** correct references to wavelength for [1]
	Total	**6**	

Question	Answer	Marks	Guidance
5 a	(idea of) angle of incidence = angle of reflection / AW [1]	1	**Eg.** reflects at same angle [1]
b	Particles do **not** undergo • diffraction [1] • interference [1] Waves undergo • diffraction [1] • interference [1]	2	Assume the answer refers to the particle theory unless indicated otherwise.

Question	Answer	Marks	Guidance
c	Constructive interference – peaks on both waves add / in phase / AW [1]	2	**allow** 'in sync' for in phase **Allow** marks from suitable diagrams. **Eg.**  [1]
	Destructive interference – peak and trough on waves cancel / out of phase / AW [1]		**allow** 'out of sync' for out of phase Eg.  [1]
	Total	**5**	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>(a)</td><td>(i)</td><td>1.5 x 10^{14} (Hz) (2)

but if answer is incorrect

2.2 x 10^{8} ÷ 1.5 x 10^{-6} (1)</td><td>2</td><td>1.47 x 10^{14} (2)
allow other Hz prefixes eg 1.5 x 10^{8} MHz/150THz
if multiple clearly shown on answer line

allow 1.4666 x 10^{14} (1)
allow 146666660000000 (1)</td></tr>
<tr><td></td><td></td><td>(ii)</td><td><table><tr><th></th><th>> i fibre</th><th>= in fibre</th><th>< in fibre</th></tr><tr><td>speed of IR in air</td><td>✓</td><td></td><td></td></tr><tr><td>wavelength of IR in air</td><td>✓</td><td></td><td></td></tr><tr><td>frequency of IR in air</td><td></td><td>✓</td><td></td></tr></table></td><td>2</td><td>all 3 correct (2)

1 or 2 correct (1)</td></tr>
<tr><td></td><td>(b)</td><td></td><td>max one from standard demand marks:
rapid (high rate) of transmission of data (1)
idea that it is easier to remove noise (1)

any two from higher demand marks:
multiple signals / more information transmitted / multiplexing (1)
output signal / sound / picture is clearer (1)

noise not recognised or amplified (1)</td><td>2</td><td>ignore interference can be removed

ignore less interference in signal

allow interference is not recognised (1)</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>6</td><td></td></tr>
</table>

Question			Answer	Marks	Guidance
7	(a)		a compression is a region of high(er) pressure / region where (air) particles are close(r) together / AW (1) a rarefaction is a region of low(er) pressure / region where (air) particles are far / further apart / AW (1)	2	ignore reference to waves / wavelengths / frequency **allow** where lines are close(r) together / more concentrated (1) **allow** area of high(er) density (1) **allow** layers or molecules for particles (1) **ignore** particles more dense **allow** where lines are far / further apart / less concentrated (1) **allow** area of low(er) density (1) **allow** layers or molecules for particles (1) **ignore** particles less dense if no marks scored allow [1] mark for correct labelling of both the compression and rarefaction on the diagram.
	(b)	(i)	(idea that) ultrasound causes **vibrations / oscillations** (in the stone) (1)	1	**allow** resonate (1) NOT gamma rays
		(ii)	able to produce images / scans of soft tissue / does not damage living cells / tissue (1)	1	**allow** non-ionising radiation (1) allow reverse arguments for X-rays. Eg X-rays cannot show soft tissue (1) Eg X-rays only show bones / hard tissues(1) But X-rays show bones (0) Ignore unqualified references to dangers. Eg. ultrasound safer / X-rays more damaging
			Total	**4**	

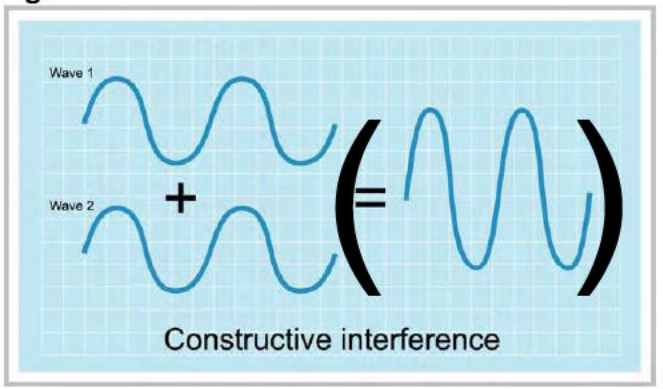
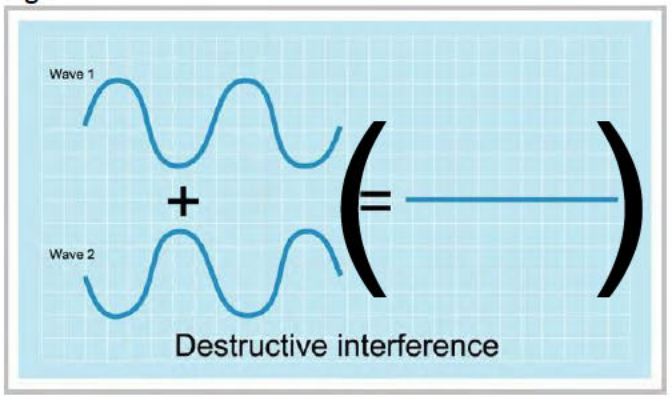
Question			Answer	Marks	Guidance
8			<table><tr><td></td><td>reflection</td><td>interference</td></tr><tr><td>particle model</td><td>✓</td><td></td></tr><tr><td>wave model</td><td>✓</td><td>✓</td></tr><tr><td></td><td>(1)</td><td>(1)</td></tr></table>	2	**one mark for each correct column**
			Total	**2**	

Question			Answer	Marks	Guidance
9			5 (m/s) (2) **but if the answer is incorrect** 20 x 0.25 (1)	2	**allow** 1 mark for correct calculation using a wrong wavelength ie (wavelength = 40 m) speed = 10 (m/s) (1) (wavelength = 10m) speed = 2.5 (m/s) (1)
			Total	**2**	

Question			Answer	Marks	Guidance
10	(a)		**total internal reflection / TIR** [1]	1	**allow** correct description of TIR not merely 'reflection' **ignore** just waves **ignore** diagrams unless TIR is shown in a label
	(b)		more information capacity / higher transmission rate / transmits information or data or signal more quickly / AW [1] less (chance of) interference / tapping / hacking / idea of interference can be removed [1]	2	**allow** carry more than one signal (at the same time) **allow** higher level answers eg multiplexing **allow** its quicker / AW **ignore** damage **ignore** no interference in fibres **allow** less heating or energy loss or attenuation or less need for amplification **as an addition marking point**
	(c)		(narrow) beam of single coloured / monochromatic light [1] but (narrow or intense) beam of light that • is same frequency / wavelength [1] • is in phase [1] • has low divergence [1]	2	**allow** one / single colour or pure colour **max 2 can be gained from higher level answers in second part of M.S.** **allow** coherent [2] **allow** in sync. (for in phase) **ignore** idea of (low) dispersion **ignore** more focused **ignore** light from a torch spreads out
			Total	**5**	

Question	Answer	Marks	Guidance
11 a	**gamma** **X-ray** (1) (ultraviolet) **(visible) light** **infrared** **microwave** (1) (radio)	2	top two rows correct (1) rows 4 to 6 correct (1)
b	number of waves / oscillations / cycles **in a second / unit of time** / AW (1)	1	**allow** number of times a crest / trough / peak / wave passes a point each second (1) **NOT** peaks **AND** troughs
c	**evidence of any correct calculation** 3 X 10^8 / wavelength value (1) 4.05 x 10^{14} (1) 0.01 x 10^{14} (1) **evidence of subtracting** 4.05 x 10^{14} - 0.01 x 10^{14} = 4.04 x 10^{14} (1)	4	**N.B. this is not a calculation so do not merely award 4 marks for correct answer** **Must calculate frequency not wavelength** **look** for candidates who subtract wavelengths first. Then use this value to calculate frequency. This can only score the first mark .
	Total	**7**	

Question	Answer	Marks	Guidance
12 a	(idea of) angle of incidence = angle of reflection / AW [1]	1	**Eg.** reflects at same angle [1]
b	Particles do **not** undergo • diffraction [1] • interference [1] Waves undergo • diffraction [1] • interference [1]	2	Assume the answer refers to the particle theory unless indicated otherwise.

Question	Answer	Marks	Guidance
c	Constructive interference – peaks on both waves add / in phase / AW [1]	2	**allow** 'in sync' for in phase **Allow** marks from suitable diagrams. **Eg.**  [1]
	Destructive interference – peak and trough on waves cancel / out of phase / AW [1]		**allow** 'out of sync' for out of phase Eg.  [1]
	Total	**5**	

Question			Answer	Marks	Guidance
13	(a)	(i)	radiation (1)	1	Ignore 'Infra red' **but** infrared radiation (1)
		(ii)	idea or description of convection (1) (warm water rises because) water expands or density falls (1)	2	e warm water rises / ora (1) **not heat rises** **ignore** water circulates **ignore** conduction eg warm water rises when it expands and becomes less dense (2)
	(b)	(i)	170 000 (2) **but if answer is incorrect** 200 000 x 0.85 (1)	2	 **allow** 200 000 x 85 / 100 (1)
		(ii)	**any one from:** double glazed top traps air / is a good insulator / reduces convection (1) black surface of cylinder is a good absorber (of radiation) (1) idea of shiny surface reflects (radiation back in) (1)	1	**ignore** 'double glazing traps heat' **allow** reduces energy loss by conduction (1) eg shiny surfaces reflects heat back in (1) **ignore** light
	(c)	(i)	$3 \times 10^8 \div 0.001$ / AW (2) **but if answer is incorrect** $3 \times 10^8 \div 1$ (1)	2	e $\frac{3 \times 10^8}{1 \times 10^{-3}}$ (2) eg $3 \times 10^8 = 3 \times 10^{11} \times 0.001$ (2) eg $3 \times 10^8 = 3 \times 10^{11} \times 1 \times 10^{-3}$ (2) **allow** $3 \times 10^8 / 3 \times 10^{11} = 0.001$ (2) **allow** $3 \times 10^8 / 3 \times 10^{11} = 1 \times 10^{-3}$ (2)

Question			Answer	Marks	Guidance
		(ii)	shorter wavelength means higher frequency (1) **but** higher frequency has greater energy (2)	2	**allow** shorter waves have higher energy (1)
			Total	**10**	