A-LEVEL

PHYSICS B: PHYSICS IN CONTEXT

PHYB1 – Harmony and Structure in the Universe

Mark scheme

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Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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COMPONENT NAME: Unit 1 – Harmony and Structure in the Universe

COMPONENT NUMBER: PHYB1

Question	Part	Sub Part	Marking Guidance	Mark type	Mark	Comments
1	a		Minimum intensity (of 1000 Hz sound) which can be detected (by (normal) human ear) Allow quietest /faintest/lowest volume	B1	1	Answer must clearly refer to loudness
1	b		Sound intensity doubles for every 3 dB increase 15 dB = 2^5 or equivalent Intensity = 32 x 10^{-12} (W m^{-2}) (or 3.2 x 10^{-11}) or 10 log (P/P_m) = 15 10 log Intensity = 32 x 10^{-12} W m^{-2} Intensity = 32 x 10^{-12} (W m^{-2})	C1 C1 A1	3	
2	a		440 Hz	B1	1	General marked

2	b		Wave length = 430 mm (fundamental λ=1290 mm) Substitute into $v = f\lambda$ (irrespective of powers) Using corresponding *f* andλ) Allow ecf from (a) i.e (their (a) x 1290) 5.7 (5.68) x 10^2 (m s^{-1})	C1 C1 A1	3	Allow 4 sf answers

3	a		Period = 100±10 ms (Condone powers of 10 here) Frequency 10±1(Hz) 2 or 3 sf	C1 A1	2	

3	b		Less susceptible to (e-m) noise/interference by e-m waves) Easier to remove noise Better quality since higher bandwidth/transmit more detail/higher range of frequencies in signal Less power wasted in carrier wave (more used in side band)	B1	1 max	'transmit more information ' is ambiguous. Not just better quality – need a reason or just more bandwidth

4	a		Most alpha particles passed through undeviated/ went <u>straight</u> through (Very) few (1 in 8000) were deviated through more than 90^o (back scattered)	B1 B1	2	

4	b		Evidence of cubing diameters/radii 4/3 π cancelled or values calculated 3.7 x 10^{-15}	C1 C1 A1	3	2.7 x 10^{14} scores 2 2.4x10^{-10} scores 1 if $\frac{4}{3}\pi r^3$ quoted

5	a		Star classification/Star Class/Class of star/Star type/Type of star/Spectral class of star/ wavelength for maximum intensity/λ_{max}/λmax/peak wavelength/Wien peak wavelength	B1	1	General marked Not just Class Ignore OBA etc Not maximum wavelength or max λ
5	b		A – white dwarf B – main sequence /the Sun C – super giant /red giant/giant/red supergiant	B1 B1 B1	3	General marked
6	a		Analogue continuous digital signals with two values/binary signals	B1	1	Varying –not enough
6	b	i	$2^2 = 4$ and $2^3 = 8$ (levels) OR $2^2 = 4$ or $2^3 = 8$ plus more bits gives more levels	B1	1	
6	b	ii	A – 6 (mV) B – 7 (mV)	B1 B1	2	
6	b	iii	Advantage – regenerated/recorded signal more faithful/accurate reproduction of original source Disadvantage – more space/ memory/data storage or greater bandwidth needed	B1 B1	2	Not just 'more accurate' 'better quality'

6	c		The marking scheme for this question includes an overall assessment for the quality of written communication (QWC). There are no discrete marks for the assessment of QWC but the candidate's QWC in this answer will be one of the criteria used to assign a level and award the marks for this question. **Descriptor** – an answer will be expected to meet most of the criteria in the level descriptor. **Level 3 – good** -claims supported by an appropriate range of evidence -good use of information or ideas about physics, going beyond those given in the question -argument well-structured with minimal repetition or irrelevant points -accurate and clear expression of ideas with only minor errors of grammar, punctuation and spelling **Level 2 – modest** -claims partly supported by evidence, -good use of information or ideas about physics given in the question but limited beyond this the argument shows some attempt at structure -the ideas are expressed with reasonable clarity but with a few errors of grammar, punctuation and spelling **Level 1 – limited** -valid points but not clearly linked to an argument structure -limited use of information about physics -unstructured -errors in spelling, punctuation and grammar or lack of fluency **Level 0** -incorrect, inappropriate or no response		6	

			Level 3 Response will address **A B and C** Two of these should be covered in some detail whilst the other may be more superficial. The coherence of the response will determine 5 or 6 **Level 2** The response may address one of **A B and C** in detail with the others superficially covered or two of these in reasonable detail with the other not addressed. Superficial coverage of **A B and C** will not likely be worth more than 3. **Level 1** This is likely to be superficial remarks about one or two of **A B and C** **A Reasons for digital transmission** • digital techniques avoid e-m interference, signal loss and noise • multiple copies made with not loss of quality • encryption possible • data sharing easy – pros and con • compression techniques possible • sender uses TDM to service more users **B Factors that affect the quality of music** • Need to transmit wide range of frequencies in original sound to retain quality • higher quantization and sampling rate produces better quality • increasing these increases bandwidth **C Why MP3 and MP4 are used** • Designed to eliminate transmission of frequencies(high and low) that cannot be heard • compression can make the data very bandwidth efficient • requires less storage space/memory • eliminate low volume frequencies that do not affect overall volume • quicker file transfer			

7	(a)		Photons provide the energy energy provided releases electrons and provides KE energy has to be provided to release electrons/provide work function impurities change work function(at different parts of the surface) Electrons liberated from the surface have E_{kmax} Electrons come from/liberated from deeper in the metal some electrons need more energy than work function some electrons need more energy than others to be liberated Require more energy to bring them to the surface/release them/remove them less photon energy available to provide KE KE of electrons is photon energy – work function – energy to bring them to the surface	B1 B1	2	1 sensible statement about the PE effect 2detail relating the 'other' electrons Reference to atoms/energy levels =0

7	(b)		Values correctly read [370±5] and (2.5±0.5) x 10^{-19} Photon energy substitution from hc/λ (ignore incorrect power of 10 in λ) 5.4 x 10^{-19} seen Their photon energy - (2.5±0.5) x 10^{-19} [(2.8–3.0) x 10^{-19} (J) if completely correct]	C1 C1 C1 A1	4	

8	(a)		d = 2.5 x 10^{-5} (m) $\theta = 1.79(1.8)(^{o})$ or sinθ = (780 x10^{-9})/(2.5 x 10^{-5}) (condone incorrect powers of 10) or 2 x their θ $2\theta = 3.58$ (3.6) (^{o})	C1 C1 A1	3	Note scores 1 correct final answer by PE sinθ = $\frac{(2 \times 780 \times 10^{-9})}{(2.5 \times 10^{-5})}$

8	(b)		195 nm = $\lambda/4$ Reflections from pit and land interfere destructively/waves from pit and land are antiphase Allowing detection of change from pit to land or vice versa (owtte) Producing binary 0 (implying originally 1)	B1 B1 B1	3	

8	(c)		Equal intensity/amplitude beams mean reflection occurs from same surface (owtte) Reflected beams should have equal intensity/amplitude If one beam overlaps with pit/goes off track there will be different intensities/amplitude (so error/re-tracking initiated)	B1 B1	2	

9	(a)		Restricting vibration of transverse wave to one plane	B1	1	Not 'removing one of the planes of vibration' 'travelling in one plane'

9	(b)	(i)	The receiver is picking up a maximum signal when the grille is removed (owtte)	B1	1	

9	(b)	(ii)	Microwaves are reflected /absorbed by the wire/do not pass through The grille must have vertical wires Electric field must be vertical to accelerate electrons by absorbing microwaves	B1 B1 B1	3	

9	(c)		Sound is longitudinal wave Vibrations parallel to direction of propagation so polarisation not possible Oscillate in the same direction that they travel in Only transverse waves can be polarised	B1 B1	2	Not Travel in one plane/one direction- must refer to the oscillations1
10	(a)	(i)	Similarity: same (rest) mass/ 3 quarks Difference <u>opposite</u> charge / opposite spin/ **etc**	B1 B1	2	Allow correct quark structure for both marks Not 'both charged' as a similarity Charge alone
10	(a)	(ii)	$\bar{d}\,\bar{d}\,\bar{u}$	B1	1	Auto marked
10	(a)	(iii)	Antiproton, positron/antielectron neutrino /electron neutrino (Allow correct symbols)	B3	3	
10	(b)	(i)	Baryon/ hadron	B1	1	
10	(b)	(ii)	*Q*: +2 = +1 + 1 *B*: 1 = 1 + 0 *L*: 0 = 0 + 0	B1 B1 B1	3	
11	(a)		Doppler effect One star moves towards Earth so shorter wavelength/ blue shift an one away so longer wavelength/red shift	B1 B1	2	

11	(b)		$\Delta\lambda$ = 0.2(nm) or 654.6 (nm) used Use of $v = \frac{\Delta\lambda}{\lambda}c$ wih c substituted correctly allow 0.4 nm for $\Delta\lambda$ 92 (91.7) (km s^{-1})	C1 C1 A1	3	condone incorrect powers of 10 for nm 183 or 184 gets 2

11	(c)		Conversion to pc (8.3 x 10^{-3} Mpc or 8.3 x 10^{3} pc) or (65 x 8.3) seen or (65 x 27000/3.26) 0.54 (km s^{-1})	C1 A1	2	Note: May convert 65 km s^{-1} to m s^{-1} and distances to m