A- LEVEL

Physics B

PHYB1 – Harmony and Structure in the Universe
Mark scheme

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Version/Stage: Final v1

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.

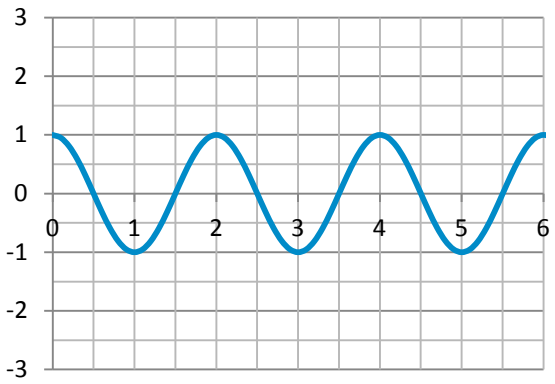
Further copies of this mark scheme are available from aqa.org.uk

Question	Part	Sub Part	Marking Guidance	Mark Type	Mark	Comments
1	a		110 Hz	B1	1	
1	b		(Use finger on the fret so that) a ¼ length of the string is used to sound the note or hold string down on 24th fret	B1	1	
1	c		Mention or description of beats or description of rising and falling amplitude/louder and quieter Beat frequency 10(.0 Hz) Allow beat frequency = 430 - 420	B1 B1	2	regular rising and falling of loudness owtte
2	a		Balances the relative strength/voltages/currents/intensity/signal/loudness/output from the two microphones/combines the signals to form one signal	B1	1	Condone power Not 'sorts the relative strengths Allow merges
2	b		CD or named digital recorder (A to D converter means) digital recorder is needed	B1 B1	2	only allow magnetic media if clear mention of digital Computer/mobile phone/ipad/MP3 because it processes digital data
2	c		Noise reduction when recovering of original digital signal during playback or Less storage per file or shorter download time per file due to compression of digital signal	B1 B1	2	allow for 1 mark • concept of restoring the original signal more easily • 'faithful' multiple copies • ease of manipulation of data Not easier to store

3	a		Prevents (physical) damage to fibre/strengthen the fibre/protect the fibre Prevent crosstalk	B1	1	allow named physical damage e.g., scratching
3	b		(Relative) refractive index =1.03 or Use of sin$c$ = n_2/n_1 76.0° or 76.8°	C1 A1	2	Calculating the refractive indices and rounding before dividing gives 76.8.
4	a		(Constructive) interference/superposition occurs or Waves arrive in phase so produce maximum intensity	B1	1	Diffraction alone is not enough
4	b		Correct substitution of numerical value in h/mv irrespective of powers of 10 2.1×10^{-11} (m)	C1 A1	2	
5			dark matter mentioned Actual velocity of a star does not agree with the observable mass (OWTTE) or The observed velocity requires a larger gravitational force (than that calculated from the observable mass)(OWTTE).	B1 B1	2	

6			Correct substitution ignoring powers of10 in hc/λ Photon energy = 3.0(3) x 10^{-19}J Conversion of -3.4 eV to J (5.44 x 10^{-19} seen) Answer −2.4 x 10^{-19} J (must have negative sign)	C1 A1 C1 A1	4	Photon energy in eV = 1.9 eV gets 3 marks -8.4(8.5) x 10^{-19} J gets 3 marks

7	a	i	250 Hz	B1	1	

7	a	ii	 Start at +1 Twice frequency or half amplitude throughout Correct cosine shape by eye and minimum two periods	 B1 B1 B1		 Condone minor errors in cosine shape

7	b	i	6.4×10^{-5} $W\,m^{-2}$	B1 B1	2	condone 6.3×10^{-5}

7	b	ii	Ratio of distances 4 Ratio of intensities =16 Halving means drop of 3 dB or doubling means and increase of 3dB 4 x 3 dB = 12 dB cnao	C1 C1 C1 A1	4	Allow calculation of intensity at 80 m by method consistent with 7(i) for first mark Ratio of intensities consistent with their intensities i.e condone minor arithmetical differences Candidates may calculate the dB level to the threshold at each distance and subtract.

8			Marking of QWC Points that may be included Radio: Ground waves • long wavelength • diffraction around surface of Earth • follow Earth's curvature • hills and buildings limit signal area • mention of orientation of aerials: alignment, E-vertical to reduce losses by producing currents in the Earth Sky waves • short wavelength • Reflection from ionosphere • Refraction by atmosphere • Skip distances limit area covered • Radio aerials require alignment for maximum signal strength • Signal can fluctuate or disappear altogether • Movement of ionosphere Satellite • microwave/UHF • geosynchronous orbits needed for constant communication • transmitter uses large diameter dishes to provide maximum power at the satellite. • small diameter on satellite dishes give large footprint but low power per m^2 at the Earth's surface • receiver dishes have parabolic reflectors and need to be within satellite's footprint	B6	6	

			May also mention use of Optical fibre cable and/or copper cable Maximum signal strength need repeaters/generation of signal along the path Area of reception needs distribution points with further methods of transmission radio or fibre/copper cable 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/discussion 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/discussion 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 **In addition to the QWC** criteria above the following describes the relevant physics that defines each level.**:** **5/6** should mention least three channels of communication Candidates either Give substantial descriptions that include most of the points mentioned of two of the channels listed and say something sensible about the other. OR Give some relevant points about each of them Discussion should be clear/ not repetitive and the discussions should relate to the appropriate channel **3/4** should mention three channels and discuss **two** of the channels listed giving some relevant points about each of them at least two points about each of them Or discuss one in more detail and refer to the others superficially **1/2 2** will discuss one superficially and give some relevant mention one of the others, **1** may give two channels with little/no relevant discussion			

9	a		(90,39) (0,-1) $\bar{\upsilon}e$	B1 B1 B1	3	
9	b		d→u or number of u quarks increases by 1 and number of d quarks decreases by 1	B1	1	
9	c	i	Meson	B1	1	Do not allow hadron
9	c	ii	Negative box ticked	B1	1	
9	c	iii	Characteristic of particles with strange quarks/they contain the strange quark/they have strangeness	B1	1	
9	c	iv	Gluon, W ($^+$ or $^-$) (boson) or Z^o	B1	1	
10	a		Gives the ratio of the (recessional) velocity (of galaxies) to distance from Earth	B1	1	accept equation with terms defined not *v* depends on *d,* the relationship between them, shows the relationship between them

10	b		*d* changed to Mpc (2.45×10^2) or 1.8×10^4/their attempt to convert distance (*H*=) 73.35 or 73.47 seen to at least 3 sf	B1 B1	2	or d change to m and v to m s^{-1}

10	c	i	*T*= 1/*H* or *H* = 2.4×10^{-18} s seen Value in s calculated (4.2×10^{17}) Correct conversion to years 1.3×10^{10}	C1 A1 B1	3	e.g. 3.08×10^{-19}/73 Allow their value in s

10	c	ii	Universe is expanding at constant/steady rate	B1	1	

11	a		**Any two** Brownian motion (Gaseous) diffusion Constant composition: ratio of masses of elements a compound is always the same Compounds of the same two elements have ratios of elements in simple proportions	 B1 B1	2	Or description of

11	b		Most pass straight through, little/no deviation Suggesting most of atom is empty space Suggesting a small nucleus Scattering through angles of more than 90^o (back scattering) Suggested small/dense/nucleus of positive charge	M1 A1 M1 A1	4	two observations and two inferences

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11	c	i	Electron loses (some of its) kinetic energy/momentum	B1	1	
11	c	ii	Electron needs momentum Electron needs short wavelength(comparable with proton size)	B1 B1	2	
11	c	iii	Electrons have large scattering angle/suffer inelastic collisions with the protons	B1	1	scattered more than 90°
12	a	i	Node and antinode both correctly marked	B1	1	
12	a	ii	Node at centre, antinode at each end – half wavelength	B1	1	Node ±2 mm from centre
12	b		λ = 0.50 m Distance between antinodes = 0.25 m	C1 A1	2	
12	c	i	Appreciation that different harmonics/overtones are present or Quality of the sound depends on the harmonics/overtones that are present Detail: Open pipe all harmonics OR Closed pipe only odd harmonics	C1 A1	2	
12	c	ii	Intensity is the power per metre squared of the sound emitted/only depends on the amplitude^2 of the wave Loudness – is a subjective property that depends on the listener's ability to hear sound	B1 B1	2	