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General Certificate of Education (A-level)
January 2012

Physics B: Physics in Context PHYB1

(Specification 2455)

Unit 1: Harmony and structure in the universe

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner 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 examiners 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 examiner understands and applies it in the same correct way. As preparation for standardisation each examiner 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, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

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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NOTES

Letters are used to distinguish between different types of marks in the scheme.

M indicates OBLIGATORY METHOD MARK
This is usually awarded for the physical principles involved, or for a particular point in the argument or definition. It is followed by one or more accuracy marks which cannot be scored unless the M mark has already been scored.

C indicates COMPENSATION METHOD MARK
This is awarded for the correct method or physical principle. In this case the method can be seen or implied by a correct answer or other correct subsequent steps. In this way an answer might score full marks even if some working has been omitted.

A indicates ACCURACY MARK
These marks are awarded for correct calculation or further detail. They follow an M mark or a C mark.

B indicates INDEPENDENT MARK
This is a mark which is independent of M and C marks.

ecf is used to indicate that marks can be awarded if an error has been carried forward (ecf must be written on the script). This is also referred to as a 'transferred error' or 'consequential marking'.

Where a correct answer only (**cao**) is required, this means that the answer must be as in the marking scheme, including significant figures and units.

cnao is used to indicate that the answer must be numerically correct but the unit is only penalised if it is the first error or omission in the section (see below).

Marks should be awarded for **correct** alternative approaches to numerical question that are not covered by the marking scheme. A correct answer from working that contains a physics error (PE) should not be given credit. Examiners should contact the Team Leader or Principal Examiner for confirmation of the validity of the method, if in doubt.

GCE Physics, Specification B: Physics in Context, PHYB1, Harmony and Structure in the Universe

Question 1			
a	**max 2 from** in progressive waves, all points have the same amplitude (in turn), in stationary waves, they do not in stationary waves, points between nodes are in phase, in progressive waves, all points within one wavelength are out of phase with each other in stationary waves, there is no energy transfer along the wave, in progressive waves, there is stationary waves have nodes and antinodes but progressive waves do not where there are single relevant statements but no clear comparison between stationary and compressive waves, award 1 mark for two such statements	**B1** **B1** **B1** **B1**	**max 2**
b	f α 1/l or $f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$ or fl = const 657/660 (Hz)	**C1** **A1**	**2**
		Total	**4**

Question 2			
a	curved path – always curving towards centre line with no abrupt reflection and with ray only in the core	**B1**	**1**
b	cladding- lower than core max in centre and reducing towards outside of the fibre	**B1** **B1**	**2**
c	all rays paths take same length of time (approximately)/rays travel faster near edge/rays travel slower in the centre idea that pulses do not overlap as much/reduces pulse broadening or dispersion/allows more frequent pulses to be sent	**B1** **B1**	**2**
		Total	**5**

Question 3			
	line 2: radiation (era)/electromagnetic **wave** era line 3: atoms formed/stars begin to form/CMB appears line 5: 1×10^{10} y to 2×10^{10} y/approximately 4×10^{17} second	**B1** **B1** **B1**	**3**
		Total	**3**

Question 4			
	electrons high energy scattering/inelastic/KE not conserved… demonstrated substructure of proton	**M1** **M1** **A1**	**3**
		Total	**3**

Question 5			
	clearly interference with regular fringes of even width and separation – seen in either blue or red blue fringes narrower than red	**M1** **A1**	**2**
		Total	**2**

Question 6			
	boron numbers correct: A = 11; Z = 5 β^+ correct: A = 0; Z = (+)1 ν_e (not anti neutrino) with numbers correct: 0,0	**B1** **B1** **B1**	**3**
		Total	**3**

Question 7				
a		refers to or describes reaction time (not human error) distance or time very small/estimates time taken/comments on high percentage error	**B1** **B1**	**1**
b	i	use of 5% of 500 J/eg 25 (J) seen **uses** $P=E/t$ eg $25/t=200$ 130 (125) ms	**C1** **C1** **A1**	**3**
b	ii	$200/4\pi r^2/I = P/A$ *or* $I = P/4\pi r^2$ with some substitution 7.07×10^{-4} $W\,m^{-2}$	**C1** **A1** **B1**	**3**
			Total	**7**

Question 8			
a i	vary continuously with time/can have any value	**B1**	**1**
a ii	has discreet values (usually 2)/allow reference to binary	**B1**	**1**
b	changing analogue to digital (analogue signal) is sampled digital signal is (a sequence of) binary numbers	**B1** **B1** **B1**	**max 2**
c i	the idea of not using all of the information/losing some information/only sending changes of data/predictive/lossy/MP3	**B1**	**1**
c ii	need to store less information/fewer bits or bytes/more films in same space **not** can store more data	**B1**	**1**
d	not losing any of the original signal detail/fidelity stated or explained	**B1**	**1**
		Total	**7**

Question 9			
a i	445 nm ± 5	**B1**	**1**
a ii	uses 0.0029/450 or their ai condone powers of ten 6440 or 6170 K (allow °C if they have clearly converted their answer)	**C1** **A1** **A1**	**3**
b i	**any 3 from** absorption … …by (cool) gas at edges of star explains why particular frequencies/wavelengths are affected/ characteristic of make-up of star reradiated in all directions, (so intensity in our direction reduced)	 **B1** **B1** **B1** **B1**	**max 3**
b ii	485 nm ± 5 $6.6 \times 10^{-34} \times 3 \times 10^{8}$/their λ condone powers of ten 4.08×10^{-19} (J)/divides by 1.6×10^{-19} 2.55 (eV) (allow reasonable rounding errors)	**C1** **C1** **C1** **A1**	**4**
		Total	**11**

Question 10			
	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		**5-6** **3-4** **1-2**

	Examples of the sort of information or ideas that might be used to support an argument • mediate or transmit forces • by being interchanged between interacting particles • not detected during exchange • vary in mass and range • massive = short range • different particles for each type of force • strong: gluons (pions) • weak: bosons (W, Z) • electromag: photons • gravity: gravitons (?) • gravitons not yet confirmed		
		Total	**6**

Question 11				
a		distance travelled by light in 1 y	**B1**	**1**
b	i	quasi-stellar radio source (allow star)/black hole in centre of a galaxy	**B1**	**1**
b	ii	v = H d *and* some clear substitution of a value of H (in any units) multiplied by a distance (in any units) – condone powers of ten conversion to parsec/divides by 3.26 4.87×10^4	**C1** **C1** **A1**	**3**
c		$\Delta\lambda = \frac{v_s}{c}\lambda$ or $\frac{5 \times 10^4}{3 \times 10^5} \times 485$ (condone 3×10^8) change in wavelength is 79/81 nm new wavelength is 564 nm	**C1** **C1** **A1**	**3**
d	i	(radiation produced soon) after big bang	**B1**	**1**
d	ii	originally high energy or short wavelength explanation of increase in wavelength eg cooling or expansion of universe/Doppler shift **or** statement that wavelength is appropriate to current temperature of universe	**B1** **B1**	**2**
			Total	**11**

Question 12				
a		curved dish with something looking like a dipole at an appropriate position (parabolic) reflector and dipole both labelled correctly	**M1** **A1**	**2**
b	i	0.95(5) (°)	**B1**	**1**
b	ii	$b = \lambda/\sin\theta$ in symbols or numbers $\frac{2.9 \times 10^{-2}}{\sin(0.955) \text{or } 0.0167}$ 1.75 m ecf	**C1** **A1**	**2**
b	iii	central maximum falling to zero and of approximate correct shape (hump), condone/ignore other maxima 1st minima on both sides at 600 km on each side	**M1** **A1**	**2**
			Total	**7**

	UMS conversion calculator www.aqa.org.uk/umsconversion		