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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 1456

Specification B: Physics in Context

PHYB1 Harmony and Structure in the Universe

Mark Scheme

2009 examination - June series

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 meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting 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 candidates' 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.

Quality of Written Communication

Skill Level	Marks
Excellent to good (i) the answer provides a well-structured and logical explanation, procedure or argument which • answers the question in a piece of extend prose • has only minor inadequacies of grammar, spelling and punctuation (ii) the answer contains in-depth and relevant key physics as identified in the detailed mark scheme which is • correctly explained or applied in the context of the question, and • supported by relevant evidence of physics theory and presented in a logical sequence	5 or 6
Modest to adequate (i) the answer provides some structure and some explanation, procedure or argument **but** • is incomplete or not logically organised • has some significant errors of grammar, spelling or punctuation (ii) the answer contains most of the essential and relevant physics **but** • some key points are omitted or • the evidence or theoretical basis is incomplete	3 or 4
Poor to limited (i) the answer lacks structure and coherence and • the explanations, procedures or arguments are very limited and • there are many significant errors or grammar, spelling and punctuation (ii) the answers contains only limited relevant physics and little evidence of understanding, explanation of physics principles	1 or 2
No answer/totally irrelevant or incorrect answers	0

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

Question 1			
(a)	**A** – digital **and B** - analogue	**B1**	**1**
(b)	**figure 1**/digital signal/signal **A** (could have noise removed most effectively) for digital signal it's only necessary to recognise on/off – signal 1 if above certain voltage and 0 when below certain voltage for analogue signal continuously varying – difficult to determine which part of composite is signal and which part is noise	**B1** **B1** **B1**	**3**
		Total	**4**

Question 2			
	transverse yes transverse yes longitudinal no	**B1** **B1** **B1**	**3**
		Total	**3**

Question 3			
	any **three** from: possible avoidance of royalties copyright issues/'free' downloads (compression or low sampling rate) may mean music is not heard at its best increased profitability – ability to present large catalogue; no warehousing/distribution costs; ready access promotes casual purchases; no artwork printed; increased range of players phones etc offer greater potential profit raise profile of musicians/leads to more revenue from merchandise/marketing/concerts/fast distribution to public (rapid response to advert/performance)/international dimension/no middle man musician can sell directly to public	 **B1** **B1** **B1** **B1**	**max 3**
		Total	**3**

Question 4			
(a)	$w = \lambda D/s$	**C1**	**3**
	correct substitution – condone wrong powers of ten	**C1**	
	cao 11(.3) mm or equivalent; **unit required**	**A1**	
(b)	same frequency or wavelength	**C1**	**2**
	constant phase (relationship)	**A1**	
		Total	**5**

Question 5			
	luminosity axis: 1, 100, 10000, 1000000 – pattern clear min of two consecutive values	**B1**	**5**
	temperature axis: 10000, 5000, 2500 – pattern clear min of two consecutive values	**B1**	
	S at approx (6000, 1) ecf	**B1**	
	R to right of giants line (short line on right)	**B1**	
	W anywhere on the white dwarf line (short line at bottom)	**B1**	
		Total	**5**

Question 6				
(a)	(i)	1 loop	**B1**	**4**
	(ii)	0.578 (m) ecf	**B1**	
	(iii)	$v = f\lambda$	**C1**	
		381 m s^{-1} ecf	**A1**	
(b)		$656 = \frac{1}{2\times 0.33}\sqrt{\frac{T}{3.78\times 10^{-4}}}$	**C1**	**3**
		$T = 4l^2 f^2 \mu$	**C1**	
		70.9 (N) cao to 3 sf **only**	**A1**	
(c)	(i)	beats superposition of waves/interference of waves	**B1**	**5**
		rising and falling of loudness	**B1**	
		frequency of beats is 4 Hz	**B1**	
	(ii)	adjust tension/turn tuning pegs etc	**B1**	
		until best frequency is zero/no beats are heard	**B1**	
			Total	**12**

Question 7			
(a)	**any two + two**		
	diffraction around Earth's surface/ground waves	**M1**	
	long wave (-length) (radio)/AM radio	**A1**	
	reflection/refraction by ionosphere/sky waves	**M1**	**4**
	vhf/hf/medium wave (radio)	**A1**	
	fibre optic	**M1**	
	visible or ir	**A1**	
(b) (i)	reflector correctly labelled **not** 'dish'	**B1**	
	dipole correctly labelled accept antenna/aerial	**B1**	
(ii)	**any two of**		
	penetrates or not absorbed by ionosphere (condone atmosphere)	**B1**	**4**
	can use small diameter dish	**B1**	
	small footprint therefore reasonable intensity	**B1**	
	high bandwidth/greater capacity for data transmission	**B1**	
		Total	**8**

Question 8			
	generic marking scheme for QWC applies **examples of the physics points made in the response** • data stored in binary (0s and 1s) • series of pits or bumps (and lands) • ¼ λ deep/high • arranged in a spiral track (that laser shines on) • laser kept on tracks by tracking mechanism • when reflected from pit/bump or misses surface, beam misses a light sensor • when reflected from surface or misses pit, beam falls on a light sensor • ideas of constructive and destructive interference • phase of path difference • DAC produces analogue signal • amplified and output from loudspeaker/earphone		**max 6**
		Total	**6**

Question 9				
(a)		$\frac{\Delta f}{f} = \frac{v}{c}$ change of frequency is 150 (or 148) new frequency is 2900 or 2950 (Hz)	**C1** **A1** **B1**	**3**
(b)	(i)	red shift is the increase in wavelength/reduction in frequency of light from distant sources shows that the Universe is expanding/other bodies are moving away from us/each other	**B1** **B1**	**3**
	(ii)	(Ω = density parameter) determines whether flat, open or closed (Big Crunch)	**B1**	
			Total	**6**

Question 10				
(a)	(i)	moves between one object and another/carrier acting on two particles	**B1**	
		gives rise to the force between the particles	**B1**	
		gluon(s) (accept pions)	**B1**	**5**
	(ii)	gluons light**er**/(w) bosons more massive	**B1**	
	(iii)	gluons have long**er** range/(w) bosons have shorter range **not** distance	**B1**	
(b)		$^{1}_{1}\mathrm{p}$	**B1**	**2**
		$^{0}_{0}\bar{\nu}$ in either order	**B1**	
(c)		baryon 0 → 0 + 0 + 0	**B1**	
		lepton 1 → 1 + (-1) + 1	**B1**	**3**
		charge -1 → (-1) + 0 + 0	**B1**	
			Total	**10**

Question 11				
(a)	(i)	-0.66 to -0.72 keV line marked as **B** downward arrow	**B1**	
	(ii)	uses 7.06 (eV) (condone negative sign)	**B1**	
		attempts to multiply by 1.6×10^{-16} (condone incorrect power of 10) and to divide by 6.63×10^{-34}	**B1**	**4**
		$1.7(0) \times 10^{18}$ (Hz) cao	**B1**	
(b)	(i)	$\lambda = h/mv$ or $\lambda = h/p$ or correct substitution	**C1**	
		$4.4(2) \times 10^{6}$ ($\mathrm{m\,s^{-1}}$) [4.8(5) with h to 2 sf]	**A1**	**4**
	(ii)	same order of magnitude as atomic spacing	**B1**	
		produces wide **diffraction** angle/good **diffraction**	**B1**	
			Total	**8**