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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 - January 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)	up, down, strange (allow charm, top, bottom) any two ✓ any three ✓✓ (not u, d, s etc)	**B2**	**2**
(b)	udd ✓ +2/3(e) -1/3(e) -1/3(e) ✓	**B1** **B1**	**2**
		Total	**4**

Question 2				
(a)		15-23 kHz ✓	**B1**	**1**
(b)	(i)	$v = f\lambda$ ✓	**C1**	**3**
		9.4(3) Hz	**A1**	
	(ii)	building ✓	**B1**	
			Total	**4**

Question 3			
(a)	stored in binary ✓ as series of pits (or bumps) and lands ✓	**B1** **B1**	**2**
(b)	DVDs store more data (on the same area) ✓ **or** DVD use higher frequency **or** DVD has tighter spiral **or** pits and lands shorter on DVD etc	**B1**	**1**
		Total	**3**

Question 4			
(a)	sin c = n_c/n_f ✓ 78.6° ✓	**B1** **B1**	**2**
(b)	required for total internal reflection ✓ avoids signal loss ✓ avoids cross-talk (owtte) ✓	**B1** **B1** **B1**	**max 2**
		Total	**4**

Question 5			
(a)	force carrier ✓ for (four) fundamental forces ✓	**B1** **B1**	**2**
(b)	gravity/gravitation ✓	**B1**	**1**
(c)	W ✓ Z ✓ (allow 'boson' as one alternative)	**B1** **B1**	**2**
		Total	**5**

Question 6				
(a)		intensity = power per unit area per second ✓ loudness = perception of intensity depending on ear of observer ✓	**B1** **B1**	**2**
(b)	(i)	minimum sound level/pressure/loudness/intensity of pure tone that can be heard by human ear (in noiseless environment) ✓	**B1**	**2**
	(ii)	0 (dB) ✓	**B1**	
(c)	(i)	attempted use of or quoting inverse square ✓ constant found or evidence of $I_1d_1^2 = I_2d_2^2$ ✓ 4.24 (m) ✓	**C1** **C1** **A1**	**6**
	(ii)	ratio of intensities = 8 ✓ intensity needs doubling three times or 3 × 3 dB (or idea of 3 dB doubling) ✓ 9 dB increase ✓	**C1** **C1** **A1**	
			Total	**10**

Question 7			
(a)	energy in uv is greater than work function of zinc ✓ photoelectrons emitted so electroscope discharges ✓	**B1** **B1**	**2**
(b) (i) (ii)	uv ✓ (visible has) lower frequencies **or** (visible energy) less than work function ✓	**B1** **B1**	**2**
(c)	higher voltage means harder for electrons to leave zinc (owtte) ✓	**B1**	**1**
(d)	use of photoelectric equation ✓ correct selection of h, c and m_e ✓ correct ½ mv^2 (3.1×10^{-19}) ✓ 8.3×10^5 ✓	**C1** **C1** **C1** **C1**	**4**
		Total	**9**

Question 8			
(a)	**generic marking scheme for QWC applies** **examples of the physics points made in the response** • BB evidence comes from observations suggesting that universe expanding • and cooling • very short wavelength photons produced in early stages of formation of universe lose energy as universe expands • lower energy photons have longer wavelength • these would now be in microwave region • distribution of microwaves consistent with black body • 2.7 K • oldest signal now detected • red shift from visible produced to microwave • since decoupling occurs at 3000 K • cooled factor of 1000 • meaning wavelength increases by factor of 1000 • equal strength in all directions		**max 6**

(b)	quasi-stellar radio sources ✓ black hole at centre of a galaxy ✓ most distant visible objects ✓ extremely luminous object with very large red shift ✓	**B1** **B1** **B1** **B1**	**max 2**
(c)	use of Hubble's law ✓ substitution of H and c ✓ d calculated in Mpc (3.59×10^3) ✓ conversion of d to ly (1.17×10^{10}) ✓	**B1** **B1** **C1** **A1**	**4**
		Total	**12**

Question 9				
(a)	(i)	blue ✓	**B1**	**3**
	(ii)	O ✓	**B1**	
	(iii)	G ✓	**B1**	
(b)	(i)	580-620 ✓	**B1**	**6**
	(ii)	$\lambda_{max} T = 0.0029\,\text{m K}$ ✓	**B1**	
		4900 K ✓	**B1**	
	(iii)	**P** has greater intensity than **Q** ✓	**B1**	
		Q could be closer (to the observer) than **P** ✓	**B1**	
		Q could have a much larger emitting surface than **P** ✓	**B1**	
			Total	**9**

Question 10			
(a) (i)	microwaves ✓	**B1**	**3**
(ii)	**max 2 from**		
	must be able to pass through ionosphere ✓	**B1**	
	relatively short wavelength – small dish needed ✓	**B1**	
	large bandwidth ✓	**B1**	
	any other sensible response ✓	**B1**	
(b)	region in which strong signal received ✓	**B1**	**max 2**
	corresponding to principal maximum ✓	**B1**	
	signal diffracts from satellite dish ✓	**B1**	
(c)	statement or use of sin $\theta = \lambda/b$ ✓	**C1**	**3**
	$\theta = 2.42°$ ✓	**C1**	
	angle of spread = 4.84° ✓	**A1**	
(d)	avoid collisions between satellites or satellites and space debris ✓	**B1**	**2**
	avoid interference between signals ✓	**B1**	
		Total	**10**