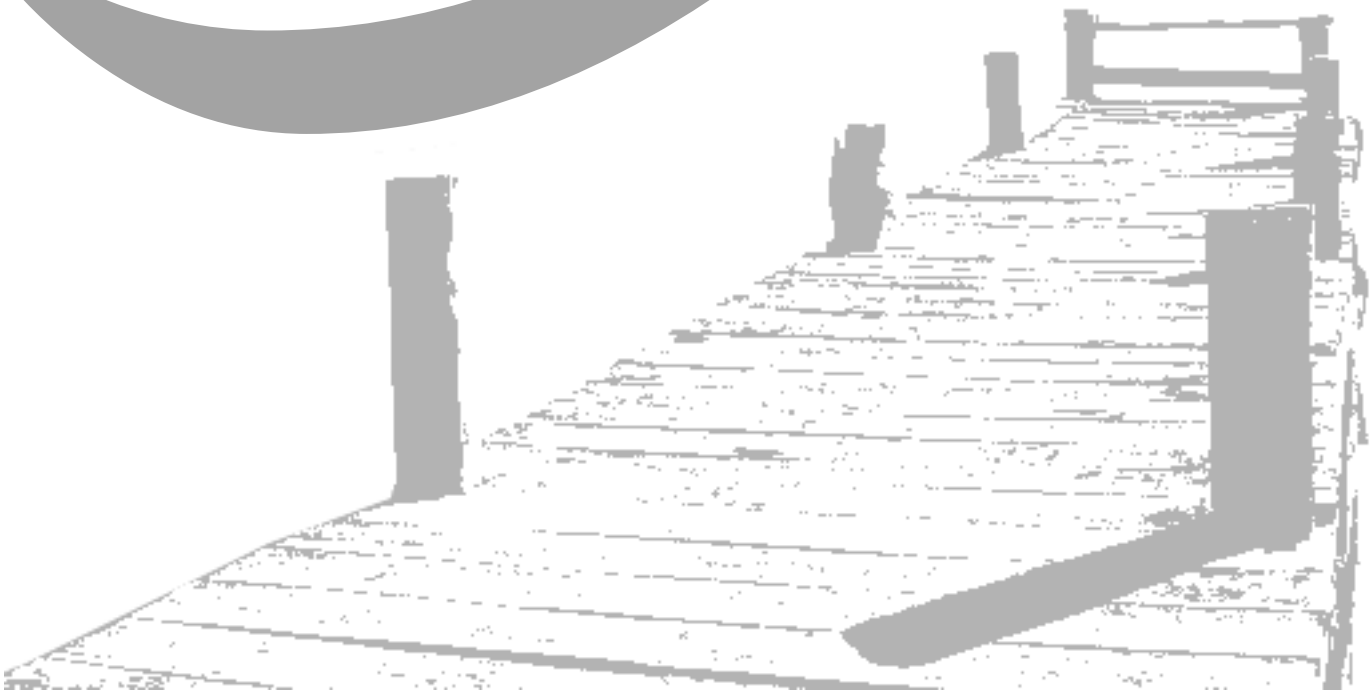
GCE
AS and A Level

Physics B: Physics In Context

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 1:
Approved specimen mark scheme

Version 1.1



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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

Specimen Draft

The specimen assessment materials are provided to give centres a reasonable idea of the general shape and character of theplanned question papers and mark schemes in advance of the first operational exams.

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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Dr Michael Cresswell Director General

PHYB1: Harmony and Structure in the Universe

Section A

Question 1			
(a)	the Big Bang ✓	AO1	**1**
(b)	the immense size of the Universe means that it takes light millions of years to reach us from distant galaxies (owtte) ✓ we are thus seeing light that left galaxies millions of years ago (owtte) ✓	AO3 AO3	**2**
		Total	**3**

Question 2			
	use of inverse-square law ✓ 3 × distance so 1/9 × intensity (or equivalent calc) ✓ $1.9 \times 10^{-8}/9 = 2.11 \times 10^{-9}$ (Wm^{-2}) ✓	AO1 AO2 AO2	**3**
		Total	**3**

Question 3				
(a)		lepton fundamental meson, baryon not fundamental allow underline or crossing out wrong options ✓	AO1	**1**
(b)	(i)	baryon/hadron ✓	AO1	**3**
	(ii)	u u d ✓ $+\frac{2}{3}+\frac{2}{3}-\frac{1}{3}=+1$(e) ✓	AO2 AO2	
			Total	**4**

Question 4			
(a)	frequency modulation ✓ amplitude modulation ✓	AO1 AO1	**2**
(b)	limitations on the speed/range of sound waves ✓ means that the signal must be piggy-backed on radio frequency wave ✓	AO2 AO2	**2**
		Total	**4**

Question 5			
(a)	40 kHz ✓	AO1	**1**
(b)	number of bits required per second for each station = 40000 × 8 ✓ total channels = 1.5×10^8/bits per second required for each station ✓ (answer 468 gets both marks **n.b.** not 469) (e.c.f. from (a) 1.875×10^7/their (a), rounded down) **allow 1 mark only for use of 20 kHz and arriving at 937 stations**	AO2 AO2	**2**
(c)	makes files smaller ✓ increased bandwidth ✓ reduced quality ✓ many frequencies unnecessary for acceptable quality ✓ credit comments about lossless compression ✓	AO2 AO2 AO2 AO2 AO2	**max 3**
		Total	**6**

Section B

Question 6			
(a)	reflection implied/2 waves in opposite directions/fixed end (not ends) ✓ similar amplitude/little energy loss at wall ✓ frequency constant **or** same frequency/wavelength **or** correct wavelength condition specified ✓	AO1 AO1 AO1	**3**
(b)	displacement perpendicular to rest/average/mean position of string **or** string displacement perpendicular to energy propagation direction owtte ✓	AO1	**1**
(c)	A larger than B ✓ A 180º (or π rad) out of phase with B (owtte) ✓	AO2 AO2	**2**
(d)	$\lambda = 1.2$ ✓ $c = f\lambda$; allow e.c.f from wrong λ ✓ $f = 6.2/1.2 = 5.2$ Hz ✓	AO2 AO1 AO2	**3**
(e) (i)	diagram correct (6 loops) ✓	AO2	**2**
(ii)	Q and R correctly in phase with P; must be a position where movement occurs ✓	AO1	
		Total	**11**

Question 7			
(a)	H-S diagram to show:		
	absolute magnitude scale from +15 to -11 ✓	AO1	
	temperature from 50 000 to 2500 (K) ✓	AO1	**4**
	main sequence drawn correctly ✓	AO1	
	giants and dwarfs shown in correct areas ✓	AO1	
(b)	Alnitak: helium absorption	AO2	
	Sirius: hydrogen (Balmer) absorption lines	AO2	
	Sun: metals (absorption)	AO2	**max 2**
	Antares: molecular bands	AO2	
	four correct (max two) two or three correct (max 1) ✓✓		
(c)	reference to principle of brightness increasing with temperature ✓	AO1	
	class M (Antares) cooler than O (Alnitak) ✓	AO2	**max 3**
	these stars are the same brightness hence cooler star bigger ✓	AO2	
	so Antares has larger surface ✓	AO2	
		Total	**9**

Question 8			
(a)	use of $\Delta f/f = v/c$ ✓	AO1	
	Δf = 160 (159) Hz ✓	AO2	**3**
	observed frequency = 3600 Hz ✓	AO2	
(b)	wavelength of light observed, λ, is measured ✓	AO1	
	compare wavelength of light from similar terrestrial source λ_0 ✓	AO1	**4**
	difference ∝ speed of astronomical source ✓	AO2	
	If $\lambda > \lambda_0$, source is receding ✓	AO3	
		Total	**7**

Question 9			
(a)	mention of total internal reflection ✓ outer medium must be of lower refractive index ✓ so that critical angle attainable ✓	AO2 AO1 AO2	**3**
(b) (i)	angle of acceptance should be as large as possible ✓ this results from a smaller critical angle ✓ larger apex cone of light trapped in fibre ✓	AO2 AO2 AO2	**5**
(ii)	substitution into equation seen and written correctly ✓ 9.8(9) seen and approximated to 10 ✓	AO1 AO2	
(c)	link between refractive index and speed of e-m waves ✓ idea that multiple paths will mean pulse broadening ✓ grading means that those rays travelling further travel faster ✓	AO1 AO2 AO2	**3**
		Total	**11**

Question 10		
(a)	The marking scheme for this part of the question includes an overall assessment for the Quality of Written Communication (QWC). There are no discrete marks for the assessment of QWC but the candidates' QWC in this answer will be one of the criteria used to assign a level and award the marks for this part of the question.	
Level	**Descriptor** an answer will be expected to meet most of the criteria in the level descriptor	**Mark range**
Good **3**	- 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	**5-6**
Modest **2**	- claims partially 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	**3-4**
Limited **1**	- valid points but not clearly linked to an argument structure - limited use of information or ideas about physics - unstructured - errors in spelling, punctuation and grammar or lack of fluency	**1-2**
0	- incorrect, inappropriate or no response	**0**

(a)		examples of the sort of information or ideas that might be used to support an argument:		
		blackbody radiation	AO3	
		idea that intensity increases with frequency	AO3	
		in ultraviolet region this disagrees with experiment	AO3	
		disagreement with classical physics requires Planck's postulation of quanta to account for discrepancies	AO3	**max 6**
		wave/particle paradox	AO3	
		interference phenomena require wave idea	AO3	
		photoelectric effect requires particle idea	AO3	
		resulting paradox only resolved by considering light to be both wave and particle	AO3	
(b)	(i)	recognition that work function = hf_0 or hc/λ_0 ✓	AO1	
		rearrangement or correct substitution of values ✓	AO2	
		4.3×10^{-7} m ✓	AO2	**6**
	(ii)	Einstein's equation seen or used ✓	AO1	
		work function subtracted from energy of incident photon ✓	AO2	
		$1.0(1) \times 10^{-19}$ J ✓	AO2	
			Total	**12**