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General Certificate of Education (A-level)
June 2011

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 candidates' 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 candidates' 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 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.

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

Question 1			
a	one named hadron or obvious symbol	**B1**	**1**
b	$d\bar{d}/u\bar{u}/u\bar{d}/\bar{d}u$ or words	**B1**	**1**
		Total	**2**

Question 2			
a	correct numbers for beta$^+$ (0, (+)1) and chromium (52) (electron) neutrino with correct numbers (0,0)	**B1** **B1**	**2**
b	W^+/W/(intermediate vector) boson (not Z boson)	**B1**	**1**
		Total	**3**

Question 3				
a		use of c/c_s = n (condone inversion of c and c_s) 1.9×10^8 (m s^{-1})	**C1** **A1**	**2**
b	i	path difference = 120 m or 0.12 km/finds two times and subtracts (allow incorrect speed with working) (condone power of ten error) (penalise use of different speeds) 6.4×10^{-7} s (ecf from (a))	**C1** **A1**	**2**
b	ii	refractive index varies across (graded-index) core/refractive index maximum at **centre** of core ray travels slower in centre/rays travel faster at edge/ray B travels faster/ray A travels slower	**B1** **B1**	**2**
			Total	

Question 4				
a	i	S placed correctly (5800,1)	**B1**	**1**
a	ii	correct shape lying close to S mark	**B1**	**1**
a	iii	O at hot end between 40000 K and 20000 K	**B1**	**1**
b		red giant	**B1**	**1**
			Total	**4**

Question 5				
a		correct sub into $I = P/(4\pi r^2)$	**C1**	**3**
		2.6×10^{-6} (W)	**A1**	
		answer to 2 sf/any 2 sf answer with working	**B1**	
b	i	intensity ratio = 1×10^{-6} ($1 \times 10^{-12}/1 \times 10^{-6}$ seen)/(attempts to use) intensity proportional to amplitude^2	**C1**	**2**
		so amplitude ratio = 0.001	**A1**	
b	ii	decrease in (audible) **frequency** range/can not hear higher frequencies/poor high frequency response	**B1**	**1**
			Total	**6**

Question 6				
a		pair production	**B1**	**1**
b	i	(Einstein predicted) relationship between energy and mass/$E = mc^2$/ conversion of energy to mass/creation of mass or matter/converted into mass	**B1**	**2**
		minimum energy is equivalent to (combined) mass of both particles	**B1**	
b	ii	excess energy is released as kinetic energy (condone more ke)	**B1**	**1**
c		any named particle and its antiparticle (allow use of recognised symbols)	**B1**	**1**
			Total	**5**

Question 7				
a		**reflection** at end of string mentioned	**B1**	**2**
		reflected wave **interferes**/**superposes** with incident wave	**B1**	
b	i	one half wavelength shown (ANA)	**B1**	**2**
		displacement antinodes labelled at ends of pipe **and** node labelled in middle (allow on loose ANA diagram)	**B1**	
b	ii	frequency halves	**B1**	**2**
		fixed end has to be (displacement) node/(wavelength now 4 times length so) wavelength doubles/length (originally ½ λ) is now ¼ λ/ speed is constant/λ changes from 2L to 4L	**B1**	
b	iii	even harmonics	**B1**	**1**
c		use of $f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$ correct substitution	**C1**	**3**
		rearrangement (T =) $4 \times (0.64)^2 \times 262^2 \times 8.8 \times 10^{-3}$/correctly rearranged $T = 4L^2f^2\mu$	**C1**	
		990 (N)	**A1**	
			Total	**10**

Question 8			
a i	recognition that h is slope of graph/E_k = hf – φ linked to y = mx + c/ attempts to find gradient readings from graph (eg (1.44 – 0.0)/(6.8 – 4.6)) (or (1.64 – 0/(7.1 – 4.6)) with correct powers of 10 6.55×10^{-34}	**M1** **M1** **A1**	**3**
a ii	intercept = 4.6×10^{14}/E = hf used (for frequency in range)/correct reading of point from graph (to feed into hf = φ + E_k) min energy = hf = $4.6 \times 10^{14} \times 6.63 \times 10^{-34}$/use of hf = φ + E_k (correct sub including h) 3.0×10^{-19} (J) range 3.0 to 3.3 (upper limit is 3.33×10^{-19} (J))	**C1** **C1** **A1**	**3**
b	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 or 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 of lack of fluency **Level 0** ● incorrect, inappropriate or no response		**5-6** **3-4** **1-2** **0**

	Examples of the sort of information or ideas that might be used to support an argument: **Photon nature of light** ● light consists of photons/stream of particle ● photon energy = hf/photon energy is proportional to frequency **Process** ● photons collide with electrons ● absorbed by electrons as quanta ● photon gives all its energy to electron (or reflected with no loss of energy) ● electron must overcome binding forces/minimum energy required is work function ● there is a minimum energy required to eject an electron ● one electron one photon/no sharing/no accumulation/ independent of time **Links** ● frequency below minimum means that photon energy below work function ● frequency below minimum means electrons gain insufficient energy to be liberated from surface ● independent of intensity, below threshold frequency increase intensity means more photons but each with energy below work function		
		Total	**12**

Question 9			
a	total power emitted/energy per second output	**B1**	**1**
b	star A appears brighter/brighter a star appears to be then the lower its apparent magnitude stars are at the same (average) distance from Earth infers brightest star radiates most (condone incorrect reference to apparent magnitude along with brightness)	**B1** **M1** **A1**	**3**
c i	(wavelength changes) due to relative motion of source/mention of Doppler effect shorter wavelength when moving towards/increased wavelength when moving away diagram/explanation of waves occupying smaller or greater distance (allow stretching/compressing)	**B1** **B1** **B1**	**3**

c ii	use of $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ (condone power of 10 error)/determines $\Delta\lambda$ = 0.2 (nm)	**C1**	**3**
	correct substitution	**C1**	
	9.2(1) × 10^4 (m s^{-1}) condone 1.8 × 10^5 (m s^{-1})	**B1**	
		Total	**10**

Question 10			
a	explanation of interference in terms of **superposition** of waves/path difference identified on diagram	**B1**	**3**
	(maximum due to) path difference of nλ (or λ)	**B1**	
	(maximum due to) arriving in phase – constructive interference/ (maximum due to) phase difference = 0 – constructive interference	**B1**	
b	halves angle (0.95°)	**C1**	**3**
	sub into nλ = d sin(θ) (condone power of 10 error) condone use of 1.9° in sub	**C1**	
	4.7 × 10^{-5} (m) condone 2.35 × 10^{-5} (m)	**B1**	
c	track widths on DVD smaller/wavelength used by DVD smaller/tighter spiral	**B1**	**2**
	so tolerance in system must be smaller to maintain accurate tracking owtte	**B1**	
d i	lossy (compression)/predictive (coding) or lossless/MP3/masking/ other named	**B1**	**2**
	loses physiologically unimportant info/only transmits changing data	**B1**	
d ii	**any two from**		**2**
	less data needs to be sorted/files (songs etc) require less storage space/more info stored in same space/cheaper fewer discs	**B1**	
	more channels can be streamed per connection	**B1**	
	quicker uploads/downloads/speed up transmission of data increased/easier sharing supported by reason/cheaper to download supported by reason	**B1**	
		Total	**12**

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