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General Certificate of Education (A-level)
January 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)	correct substitution into formula, condone power of ten error 8.7×10^{-10} (m)	**C1** **A1**	**2**
		Total	**2**

Question 2			
	GU/heavy particle accept Planck/GUT/fundamental particle/electroweak/inflationary/quark matter accept galaxy era/star era/atomic penalise wrong position/allow 1 mark for one correct one incorrect	**B1** **B1**	**2**
		Total	**2**

Question 3			
(a)	(sheath) to protect fibre (and cladding)/to add strength (to cladding)/prevent loss of signal from **scratches** at least sense of protecting fibre/cladding disallow anything that could infer that it is cladding [eg prevent signal loss/protects info] treat extra as neutral cladding explanation **zero** marks	**B1**	**1**
(b)	use of $\sin c = n_2/n_1$ (condone ratio inverted) $\sin 60 = n_2/1.6$ (condone lack of subscript) 1.4/1.39 (condone units) **or** sub for *c* and an *n* or 1.85/1.9/1.8 seen (1st) **alternative** use of $n_1 \sin\theta_1 = n_2 \sin\theta_2$ with a θ=90 (1st) correct sub (2nd)	**C1** **C1** **A1**	**3**
(c)	different wavelengths different speeds/different wavelengths different refractive indices/different paths/different angles/different distances spreading of pulse/spreading into different wavelengths	**B1** **B1**	**2**
		Total	**6**

Question 4			
	apparent magnitude is brightness observed at Earth (not luminosity)	**B1**	**3**
	absolute magnitude is brightness observed (at Earth) if all stars at constant distance or some specified distance (not luminosity)	**M1**	
	of 10 parsecs/32.6 light years	**A1**	
		Total	**3**

Question 5			
(i)	strong (nuclear)/electromagnetic/gravitational/(allow production of particles/creation of particles)	**B1**	**1**
(ii)	weak (nuclear)	**B1**	**1**
		Total	**2**

Question 6			
(a)	either recorder or mixer mentioned	**C1**	**2**
	correct order	**A1**	
(b)	evidence of multiplying a frequency difference by 2	**C1**	**2**
	30 (kHz)	**A1**	
		Total	**4**

Question 7			
	(galactic) **mass** is much greater than visible **mass** (of galaxy)/mass observed does not match that required for observed orbital speed/orbital speed does not match predicted	**B1**	**2**
	there must be dark matter/WIMPs/present	**B1**	
		Total	**2**

Question 8			
(a)	sub into $c = f\lambda$ (condone power of 10 error)	C1	4
	sub into $\sin\theta = \lambda/a$ (condone power of 10 error)	C1	
	radius (footprint) = 3.8×10^8 (m)/condone 3.8×10^5 (m) **or** diameter = 7.7×10^8 (m)/condone 7.7×10^5 (m)	A1	
	diameter = 2 × radius (allow any radius based on working)	B1	
(b)	because waves will not leave earth/not penetrate (from Moon)/ weakens	B1	max 2
	this frequency is reflected by the ionosphere/atmosphere (allow absorbed/attenuated/refracted for process)	B1	
	larger footprint (needs much power)/beam width too large/diffracts too much/too spread out	B1	
(c) (i)	mention of Doppler effect/movement of source towards observer	B1	2
	wave fronts compressed/wavelength decrease	B1	
(c) (ii)	use of $v = \Delta f \times c/f$	C1	4
	substitution (condone power of ten error)	C1	
	$1.3(2) \times 10^3$ (ms^{-1})	A1	
	3 sf on any answer based on working	B1	
		Total	**12**

Question 9			
(a)	(height is) 1/4 wavelength	C1	2
	5.2×10^{-7} (m)	A1	
(b)	constant phase difference/coherent	B1	2
	same frequency/monochromatic/wavelength is 4 × bump height	B1	
(c) (i)	wavelength of light decreased/frequency increased	B1	max 2
	tighter spiral/track width decreased/longer track	B1	
	shorter bumps/more bumps/smaller distance between bumps	B1	
	bumps not as high	B1	
	dual layer/more tracks/double sided	B1	
	more efficient tracking system/more powerful lens	B1	
(c) (ii)	store more data/more memory/more information	B1	2
	store video/store more music/fewer discs required/store higher quality/harder to scratch	B1	
		Total	**8**

Question 10			
(a)	alpha with 4, 2 carbon with 12 neutron 1, 0	**B1** **B1** **B1**	**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		**5-6**
	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		**3-4**
	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		**1-2**
	Level 0 ● incorrect, inappropriate or no response		**0**

		Examples of the sort of information or ideas that might be used to support an argument: **experimental method** ● new particle incident on paraffin wax, rich in hydrogen nuclei (accept protons) ● protons are emitted from wax, detected by Geiger counter ● Geiger counter, low reading without wax present and high reading with wax present ● neutron in expansion chamber, recoil of nitrogen **observation and conclusion** ● protons knocked out, incident particle similar mass/head on collision/transfer of momentum ● weakly ionising, more penetrating/neutral/Geiger counter not detect new particle directly (low reading) ● can not be gamma, violate laws of conservation of energy and momentum ● unknown particle is neutral, electric or magnetic field not deflect new particle/Geiger counter low reading		
(c)	(i)	(electron) antineutrino (do not accept symbol)	**B1**	**1**
(c)	(ii)	lepton	**B1**	**1**
(c)	(iii)	weak (nuclear)	**B1**	**1**
			Total	**12**

Question 11				
(a)		release of electrons from (metal) surface when electromagnetic radiation is incident on the surface	**B1**	**1**
(b)	(i)	use of $c = f\lambda$/or $f = 7.9 \times 10^{14}$ seen (condone power of ten) correct sub into $E = hf$ (condone power of ten error) 5.2(3) × 10^{-19} (J)	**C1** **C1** **A1**	**3**
(b)	(ii)	work function = 2.3 × 1.6 × 10^{-19} (3.7 × 10^{-19}) **or** converts 5.2 × 10^{-19} to 3.27 eV allow conversion to frequency if comparison made less than answer to (b) (i) so yes (based on comparison of **cna**) (allow **ecf** from (b) (i))	**M1** **A1**	**2**
(c)		surface attracts negative electron back to positive surface photons have insufficient energy/energy required increased	**B1** **B1**	**2**
			Total	**8**

Question 12			
(a)	read off time between pulses = 3.8 **ms** (range 3.7 to 3.8) speed = 1.2/3.8 × 10^{-3} (condone power of ten error) (allow wider range for time 3.6 to 3.9) 307 – 333 (m s^{-1})	**B1** **M1** **A1**	**3**
(b) (i)	reads off at 6 units and 1.5 units 0.25 (allow ¼)	**C1** **A1**	**2**
(b) (ii)	6 (dB)	**B1**	**1**
(b) (iii)	quotes inverse square law/attempts to use $I = P/4\pi r^2$ doubling the distance quarter the intensity or values/correct sub into equations or 2.4 m/0.6 m seen balloon at X = 1.2 (m)	**C1** **C1** **A1**	**3**
		Total	**9**