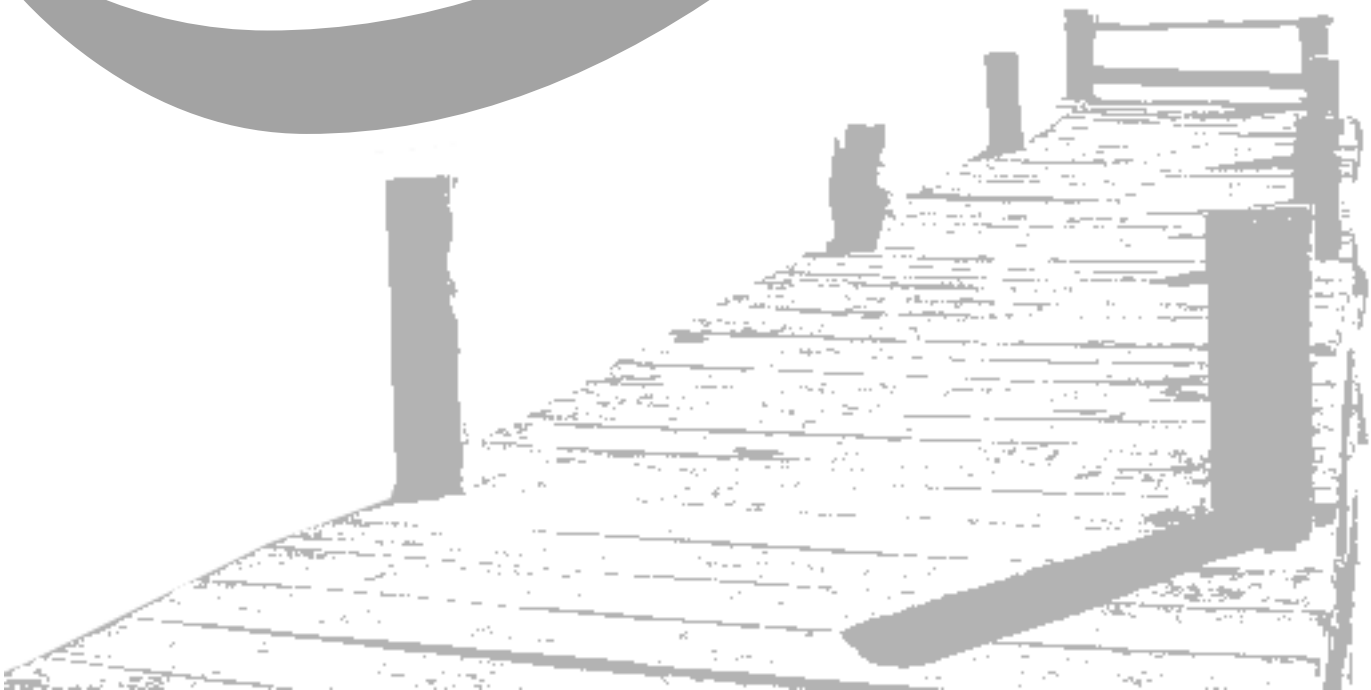
GCE
AS and A Level

Physics A

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 1451

Specification A

PHYA1 Particles, Quantum Phenomena and Electricity

Mark Scheme

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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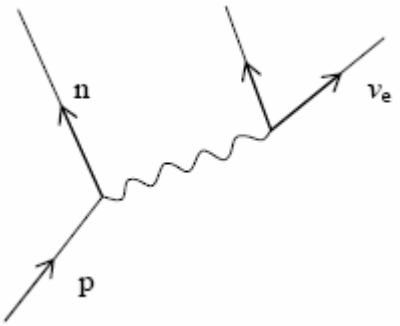
Dr Michael Cresswell Director General

PHYA1: Particles, Quantum Phenomena and Electricity

Question 1			
(a)		55 protons 55 electrons ✓ 82 neutrons ✓	**2**
(b)	(i)	same number of protons ✓ different number of neutrons ✓	**3**
	(ii)	$^{134\rightarrow154}_{55}Cs$ ✓	
(c)		specific charge (= charge/mass) = $55 \times 1.6 \times 10^{-19}/137 \times 1.67 \times 10^{-27}$ ✓ 3.85×10^{7} ✓ C kg^{-1} ✓	**3**
		Total	**8**

Question 2			
(a)	(i)	$q\bar{q}$; qqq; $\bar{q}\bar{q}\bar{q}$ ✓✓ (✓ for just two combinations)	**4**
	(ii)	$\pi^{+} = u\bar{d}$ ✓ $\bar{p} = \bar{d}\bar{u}\bar{u}$ ✓	
(b)	(i)	strangeness = -3 charge = -1 baryon number = +1 lepton number = 0 ✓✓✓ if all correct – lose one for each error	**4**
	(ii)	the proton ✓	
		Total	**8**

Question 3			
(a)		n ✓ p ✓ ν_e ✓ 	**3**
(b)	(i)	γ photon ✓	
	(ii)	γ is massless γ has infinite range γ does not carry charge ✓✓ any two	**3**
(c)	(i)	all properties/quantum numbers (e.g. charge, strangeness) are opposite ✓ but the masses are the same ✓	
	(ii)	π^o ✓ $\overline{K}^\circ$ ✓ γ ✓	**5**
		Total	**11**

Question 4		
(a)	The marking scheme for this part of the question includes an overall assessment for the quality of written communication. There are no discrete marks for the assessment of written communication but the quality of written communication will be one of the criteria used to assign the answer to one of three levels.	
Level	**Descriptor** an answer will be expected to meet most of the criteria in the level descriptor	**Mark range**
Good **3**	- answer supported by appropriate range of relevant points - 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 spelling, punctuation and grammar	**6-7**
Modest **2**	- answer partially supported by relevant points - 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 spelling, punctuation and grammar	**3-5**
Limited **1**	- valid points but not clearly linked to an argument structure - limited use of information or ideas about physics	**1-2**
0	- unstructured - errors in spelling, punctuation and grammar or lack of fluency - incorrect, inappropriate or no response	**0**
	physics points: • the energy of each photon/the light increases with frequency ✓ • electrons need a minimum amount of energy to leave the metal ✓ • the amount of energy required is equal to the work function ✓ • (this suggests) the electrons are given energy in one discrete event or one electron interacts with one photon ✓ • (so the) light energy is not spread out it is concentrated (into quanta) ✓ • the electron does not build up energy over time or photoelectricity occurs immediately light falls on the metal ✓	
(b) (i)	$E = hf = 6.63 \times 10^{-34} \times 2.10 \times 10^{15} = 1.39 \times 10^{-18}$ (J) ✓	**5**
(ii)	$\phi = hf - E_k$ ✓ $= 1.39 \times 10^{-18} - 6.20 \times 10^{-19}$ $= 7.72 \times 10^{-19}$ J ✓	
	Total	**12**

Question 5		
(a) (i)	positive current showing increasing gradient ✓ (starting) any value in the range 0.6 – 0.7 V ✓ negative current zero or near zero for negative pd ✓	**6**
(ii)	diode is in the forward (bias) direction this occurs when the current is high so the current by passes the ammeter ✓✓✓ any 3 lines	
(b)	pd across diode = any value in the range 0.6 – 0.7 V ✓ pd across 4Ω = (12 V – diode pd) = value consistent with above in the range 11.3 to 11.4 V ✓ for 6Ω resistor, I (= V/R = 12/6) = 2.0 A ✓ for 4Ω resistor, I (= pd across 4Ω resistor/4Ω) = value consistent with above in the range 2.82 to 2.85 A ✓ ammeter current (= sum of above currents) = value consistent with above in the range 4.82 to 4.85 A ✓	**5**
	Total	**11**

Question 6		
(a) (i)	R (= V^2/P) = $12^2/45$ ✓ R = 3.2Ω ✓	**4**
(ii)	(resistive strips are in parallel) $1/R_T = 1/R_1 + 1/R_2 \ldots = 5/R$ ✓ R_T (= 5 × 3.2) = 16Ω ✓	
(b)	(using $R = pl/A$ and $A = wt$) thickness = pl/wR ✓ = $3 \times 10^{-5} \times 0.80/2.5 \times 10^{-3} \times 16$ ✓ = 0.60 mm ✓	**3**
(c)	I (= P/V) = 45/12 = 3.75 A ✓ t (Q/I) = $1.44 \times 10^{-5}/3.75 = 3.84 \times 10^4$s ✓ $3.84 \times 10^4/60 \times 60$ = 10.7 hr ✓	**3**
	Total	**10**

Question 7			
(a)		$V_0 = \sqrt{2}\ V_{rms} = \sqrt{2} \times 4.2$ V ✓ (5.94 V) $V_{p\text{-}p}$ ($= 2 \times V_0$) $= 2 \times 5.94 = 11.8$ V ✓	**2**
(b)	(i)	voltage sensitivity $= 11.8/5.9 = 2.0$ V div^{-1} ✓	**3**
	(ii)	T ($=1/f = 1/2500$) $= 4.0 \times 10^{-4}$ s ✓ time base $= 4.0 \times 10^{-4}/8 = 5.0\ 10^{-5}$ s div^{-1} ✓	
(c)	(i)	spot at $(1.75/0.5) = 3.5$ div ✓	**5**
	(ii)	(use of sum of emf = sum of pd) $1.75 = I\ (3.5 + 10)$ ✓ $I = 0.13$ A ✓	
	(iii)	V ($= RI = 10 \times 0.13$) $= 1.3$ V ✓ [or $V = \varepsilon - Ir = 1.75 - 0.13 \times 3.5 = 1.3$ V] spot at $(1.3/0.5) = 2.6$ div ✓ (accept 2.5 to 2.75 div)	
		Total	**10**

		Assessment Objectives	
Question No		*Ability tested*	*Marks*
1	(a)	AO1	**2**
	(b)	AO2	**3**
	(c)	AO1	**3**
		Question Total	**8**
2	(a)	AO1	**4**
	(b)	AO2	**4**
		Question Total	**8**
3	(a)	AO1	**3**
	(b)	AO2	**3**
	(c)	AO1/AO3	**5**
		Question Total	**11**
4	(a)	AO2	**7**
	(b)	AO1	**5**
		Question Total	**12**
5	(a)	AO1	**6**
	(b)	AO2	**5**
		Question Total	**11**
6	(a)	AO1	**4**
	(b)	AO2	**3**
	(c)	AO2	**3**
		Question Total	**10**
7	(a)	AO1	**2**
	(b)	AO1/AO3	**3**
	(c)	AO2	**5**
		Question Total	**10**
		Total	**70**

	Summary	
Marks	*Ability tested*	*%*
33	AO1 Knowledge and Understanding	47
33	AO2 Application	47
4	AO3 How Science Works	6