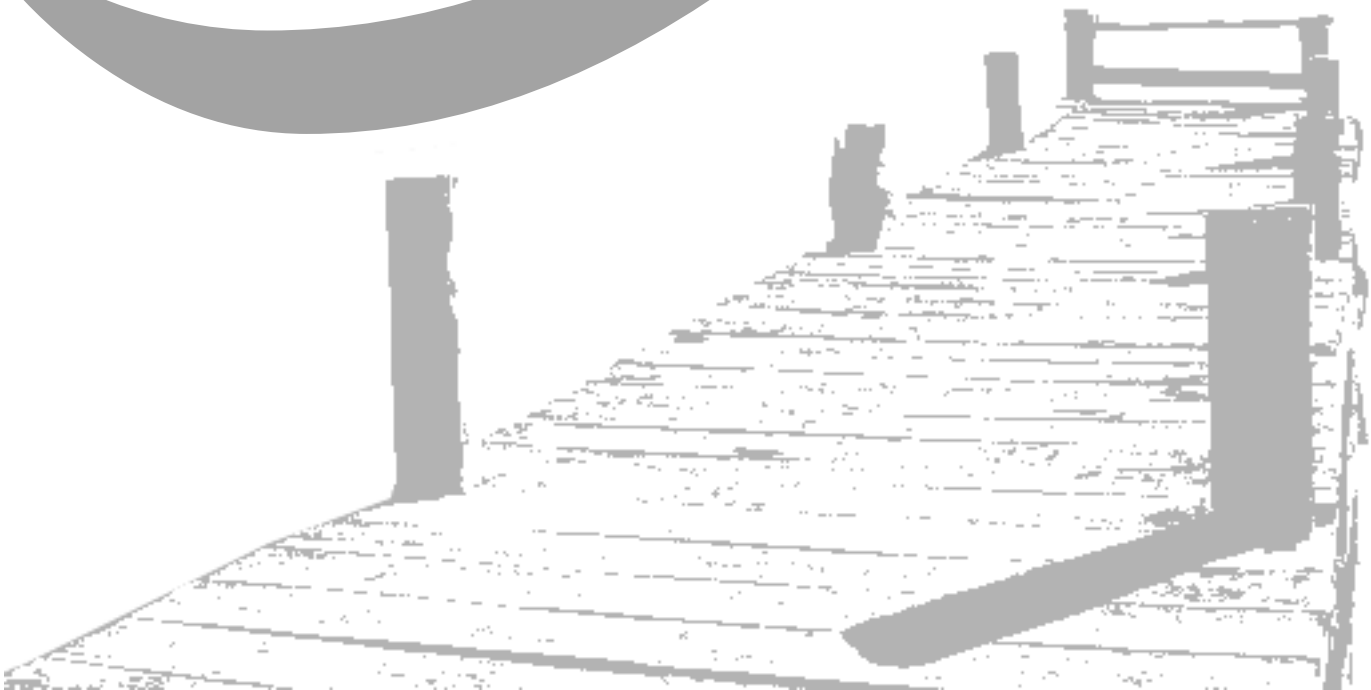
GCE
AS and A Level

Physics A

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 5D: Approved specimen mark scheme

Version 1.1



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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 2450

Specification A

PHA5D Turning Points in Physics

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

PHA5D: Turning Points in Physics

Question 1			
(a)	(i)	current heats the wire ✓ electrons (in filament) gain sufficient k.e. (to leave the filament) ✓	**3**
	(ii)	electrons would collide (or be absorbed or scattered) by gas atoms (or molecules) ✓	
(b)	(i)	k.e. ($= eV$) $= 1.6 \times 10^{-19} \times 3900$ ✓ $= 6.2 \times 10^{-16}$ (J) ✓	**4**
	(ii)	(rearrange ½ $m v^2 = eV$ to give) v ($= (2eV/m)$ ½) $= \left(\frac{2 \times 1.6 \times 10^{-19} \times 3900}{9.1 \times 10^{-31}}\right)^{½}$ ✓ $= 3.7 \times 10^{7}\,\mathrm{m\,s^{-1}}$ ✓	
		Total	**7**

Question 2		
(a)	particles of light (or corpuscles) ✓ attracted towards glass surface ✓ (*on entry to glass (or leaving glass)*) velocity (or momentum) parallel to surface unchanged ✓ velocity (or momentum) perpendicular to surface increased (or decreased on leaving) ✓ direction (or velocity or momentum) same after leaving glass as before entry to glass ✓	**max 4**
(b)	named experiment ✓ observational evidence ✓ how it supports Huygens' theory ✓ (e.g. Young's double slits ✓ shows interference ✓ which is a wave property ✓ or measurement of the speed of light ✓ speed of light is less than in air ✓ as predicted by wave theory ✓)	**max 3**
	Total	**7**

Question 3			
(a)	(i)	speed of light in free space independent of motion of source ✓ and of motion of observer ✓	**max 4**
	(ii)	laws of physics have the same form in all inertial frames ✓ inertial frame is one in which Newton's 1st law of motion is obeyed ✓ laws of physics unchanged in coordinate transformation ✓ from one inertial frame to another ✓	
(b)	(i)	$m\ (= m_0\ (1 - v^2/c^2)^{-½})$ $= 1.9 \times 10^{-28} \times (1 - 0.995^2)^{-½}$ (kg) ✓ $= 1.9 \times 10^{-27}$ kg ✓	**6**
	(ii)	$E\ (= mc^2)$ $= 1.9 \times 10^{-27} \times (3.0 \times 10^8)^2$ ✓ $= 1.7 \times 10^{-10}$ J ✓	
	(iii)	$E_K\ (= E - m_0\ c^2)$ $= 1.7 \times 10^{-10}\ (1.9 \times 10^{-28} \times (3.0 \times 10^8)^2)$ ✓ $= 1.5 \times 10^{-10}$ J ✓	
		Total	**10**

Question 4		
(a)	**one feature** (1 mark for one of the following) • there is a threshold (minimum) frequency (of light) for photoelectric emission from a given metal • photoelectric emission is instant **explanation** • light consists of photons (or wavepackets) ✓ • energy of a photon = hf where f is the light frequency ✓ • work function ϕ of metal is the minimum amount of energy it needs to escape ✓ • 1 electron absorbs 1 photon and gains energy hf ✓ • electron can escape if energy gained $hf > \phi$ ✓	**6**
(b) (i) (ii)	an electron requires 2.2 eV of energy to escape from the metal surface ✓ photon frequency, f ($= c/\lambda = \frac{3.0\times10^{8}}{5.2\times10^{-7}}$) $= 5.77 \times 10^{-19}$ J ✓ photon frequency ($= hf$) $= 6.63 \times 10^{-34} \times 5.77 \times 10^{14} = 3.83 \times 10^{-19}$ J✓ $E_{K\ max}$ ($= hf - \phi$) $= 3.83 \times 10^{-19} - (2.2 \times 1.6 \times 10^{-19})$ ✓ $= 3.1 \times 10^{-20}$ J ✓	**5**
	Total	**11**

		Assessment Objectives	
Question No		*Ability tested*	*Marks*
1	(a)	AO1	**3**
	(b)	AO2	**4**
		Question Total	**7**
2	(a)	AO2/AO3	**4**
	(b)	AO2/AO3	**3**
		Question Total	**7**
3	(a)	AO1	**4**
	(b)	AO2	**6**
		Question Total	**10**
4	(a)	AO2/AO3	**6**
	(b)	AO1	**5**
		Question Total	**11**
		Total	**35**

	Summary	
Marks	*Ability tested*	*%*
12	AO1 Knowledge and Understanding	34
21	AO2 Application	60
2	AO3 How Science Works	6

	Summary Common Section & Section D Turning Points in Physics	
Marks	*Ability tested*	*%*
25	AO1 Knowledge and Understanding	33
45	AO2 Application	60
5	AO3 How Science Works	7