WJEC
CBAC

GCE MARKING SCHEME

PHYSICS
AS/Advanced

SUMMER 2011

INTRODUCTION

The marking schemes which follow were those used by WJEC for the Summer 2011 examination in GCE PHYSICS. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

Notes on the interpretation of these marking schemes

The marking schemes, whilst reasonably complete do not give **all** the answers which were credited by the examiners. It is hoped that the schemes are self-explanatory, though they will need to be read alongside the question papers. The following clarifications may be of use:

Statements in brackets [ ] are exemplification, alternatives, acceptable ranges, e.g. 3.8 [± 0.3] × 10^{-19} J **or** statements which, whilst desirable in an answer were not required on this occasion for full marks. [accept….] indicates that, whilst not a good answer, it was accepted on this occasion.

The numbers in parentheses ( ) are the marks, usually 1, for each response.

e.c.f. stands for *error carried forward,* and indicates that the results of a previous (incorrect) calculation will be treated as correct for the current section. i.e. the mistake will only be penalised once.

The expression [or by impl.] indicates that the mark is credited when subsequent credit-worthy working or answer demonstrates that this idea/equation has been used.

In general the physics of the answer needs to be correct but specific expressions or methods are often not required. The expression [or equiv.] emphasises that the particular idea, could be expressed in several different ways.

Incorrect or absent units are not always penalised, but they are present in the mark scheme for completeness. Where ((**unit**)) appears it indicates that the unit is required for the mark to be awarded but attracts no separate mark. A (1) following the unit, in addition to a (1) following the numerical part of the answer, indicates that the unit itself attracts a mark.

Example: 25 GPa (1) ((**unit**)) indicates that the unit (or correct alternative. e.g. 2·5 × 10^{10} N m^{-2}) is a requirement for the mark;

25 (1) GPa (1) indicates that the numerical part of the answer [2·5 × 10^{10}] and the unit Pa each attract a mark. In this case, an answer of 25 GN would be awarded the first mark but not the second, it being considered that the SI multiplier is numerical.

Unless otherwise stated, no penalties for excessive significant figures are applied in these papers. Significant figures are usually assessed only in the practical units.
N.B. This Mark Scheme is not a set of Model Answers.

Question			Marking details	Marks Available
1	*(a)*	(i)	Longitudinal waves: Directions of [particle **or** molecule or air] oscillations and direction of travel of wave [or energy] [NB **not** particles travelling](1) are parallel [or parallel / antiparallel or the same] (1) [Independent marks]	2
		(ii)	Wavelength: [Shortest] distance [along the direction of propagation] between air layers [or particles or molecules or points] oscillating in phase (✓) **or** distance between [the centre of successive] compressions [or rarefactions]. [NB **not** 'peaks' and 'troughs']	1
	(b)	(i)	Interference between [or superposition of] [progressive] waves (1) travelling <u>in opposite directions</u>. (1) [Not 'constructive' or 'destructive' interference only]	2
		(ii)	N.B. Working must be shown. $\lambda = 0.44$ m (1) $v = f\lambda$ correctly applied (1) [**or** $v = \lambda/T$ correctly applied] $v = 330$ m s^{-1} ((**unit**)) (1) [Correct answer only → 1 mark] [No ecf unless wrong answer commented upon!]	3
		(iii)	$\frac{\lambda}{2} = 3.3$ m or $\lambda = 6.6$ m (1). So nodes must be further apart than 2 m [or equiv] (1) [ecf from incorrect v]	2
				[10]
2	*(a)*	(i)	$v_{air} > v_{glass}$ (1), $f_{air} = f_{glass}$ **and** $\lambda_{air} > \lambda_{glass}$ (1)	2
		(ii)	Cycles [or oscillation] can't appear or disappear [at boundary] **or** equiv. / frequency determined by the source [**not** just f is constant]	1
	(b)	(i)	$[1.00]\sin 40^\circ = 1.52\sin\phi$ [where ϕ = angle of refraction] (1) $\phi = 25°$ (1); $\theta = 90° - 25°$ (1) = [65°]	3
		(ii)	$\sin c = \frac{1}{1.52}$ [or equiv] $c = 41°$ (1) $65° > 41°$ or remark (1)[free standing] **or**: $\sin^{-1}(1.52\sin 65^\circ)$ gives "error" (1), so refraction not possible (1)	2
		(iii)	I. Diagram: Reasonable path drawn [no gross departure from law of reflection] with emergent ray in correct quadrant (1) II. 2 sensible parallel paths inside block labelled (1) Emergent ray labelled as parallel to incident ray. (1)	1 2
	(c)		Any 2× (1) from: • minimises <u>multimode</u> dispersion [or equiv](✓) • cuts down range of path lengths (✓) • less pulse broadening **or** less likelihood of overlapping **or** more rapid data [allow: smearing and jumbling] sequence possible (✓) [not interfere or distorted]	2 **[13]**

Question			Marking details	Marks Available
3	*(a)*		Electrons are emitted [from tin] (1). Electrons are negatively charged [**or** plate originally neutral] **or** electrons knocked out by photons (1) Plate left with a positive charge (1)	3
	(b)	(i)	Work function: [Minimum] energy [or work] needed for an electron to escape [from metal surface]	1
		(ii)	$hf_{min} = \phi$ [or by impl.] or $0 = 6.63 \times 10^{-34} f_{min} - 7.1 \times 10^{-19}$ (1) $f_{min} = 1.07 \times 10^{15}$ Hz (1)	2
		(iii)	$1.5 \times 10^{-19} = hf - 7.1 \times 10^{-19}$ [or equiv. or by impl.] (1) $f = 1.3 \times 10^{15}$ Hz (1)	2
	(c)	(i)	number per second = $\frac{0.64 \times 10^{-6}[\text{C s}^{-1}]}{1.6 \times 10^{-19}[\text{C}]}$	1
		(ii)	Number of photons per second = $4.0 \times 10^{12} \times 1200$ Multiplication by 1200 at any stage [or by impl.](1) Photon energy = 8.6×10^{-19} J [or by impl.] (1) UV energy per second = 4.1 m(1)W(1) [4.1×10^{-3} J s^{-1} ✓✓]	4
				[13]
4	*(a)*	(i)	Ground state to level T labelled I or *pumping* (1) Level U to level L labelled II or *stimulated emission* (1)	2
		(ii)	$E_{phot} = \frac{hc}{\lambda}$ [or $E_{phot} = hf$ **and** $f = \frac{c}{\lambda}$] [or by impl.](1) $E_{phot} = 1.9[0] \times 10^{-19}$ J (1) Energy of level U $= 2.2 \times 10^{-19}$ J (1)	3
		(iii)	I. [Stimulated emission is triggered by an incident] photon (1) with energy 1.9×10^{-19} J [ecf but **not** 2.2×10^{-19}] **or** equal to the difference between levels U and L (1) [no ecf from incorrect identification of transition in *(a)*(i)]	2
			II. Photon emitted together with the original photon [accept: there are now 2 photons where there was previously 1; also accept correct answer given in I.]	1
			III. Stimulated photon and incident photon <u>in phase</u>.	1
		(iv)	Promotes population inversion [between levels U and L] (1) **Either** less pumping needed, **or** population inversion needed so that stimulated emission predominates over absorption (1)	2
	(b)		Less energy input needed for a given [light] energy output (1) [**or** more efficient]	1
				[12]

Question			Marking details	Marks Available
5	*(a)*	(i)	Diffraction	1
		(ii)	[Slit width much] greater than the wavelength (1) [Angular] spread [of central maximum] is small. (1)	2
		(iii)	[Width of] spread decreases (1) [accept: less diffraction] Peak intensity increases (1)[**or** intensity increases because more light is let through].	2
	(b)	(i)	1.25 mm	1
		(ii)	Use of $\lambda = \frac{ay}{D}$ with symbols correctly interpreted (1) λ = 625 nm [ecf on *y*] (1)	2
		(iii)	When path difference is a whole number of wavelengths [not just: path difference = 0] (1), waves from the slits arrive [or equiv.] in phase (1) and interfere constructively (1)	3
		(iv)	Less light diffracted at greater angles / intensity envelope the same as the diffraction graph.	1
	(c)		Any 2 × (1) from: • Light from laser may be brighter ✓ [not just collimated] • Light from laser coherent / no need for single slit / light source need not be distant ✓ • light [more nearly] monochromatic ✓	2
				[14]

Question			Marking details	Marks Available
6	*(a)*	(i)	Quark-antiquark combination [or equiv.]	1
		(ii)	Only $\bar{u}d$ combination [in the 1st generation] gives a charge of +e [or $\frac{2}{3}+\frac{1}{3}=1$]	1
	(b)	(i)	I. [$u\bar{d}$ + uud + udd $\rightarrow$ uud + uud] u numbers: LHS = 4; RHS = 4, so conserved	1
			II. d numbers: LHS = 2; RHS = 2, so conserved	1
		(ii)	Strong force (1) Any 1 × (1) of: • 'high energies' suggests strong ✓ • separate conservation of u and d ✓ • no neutrino / lepton involvement ✓ • quark regrouping / only quarks involved ✓	2
	(c)	(i)	Any intelligible method [e.g. baryon and charge conservation **or** u and d numbers conservation, **or** quark counting to give 9u+9d in X, **or** comparison with equation in *(b)* noting that $\pi^+ + n \rightarrow p$] (1) [or by impl.]	
			A = 6 **and** Z = 3 (1)	2
		(ii)	Proton number / atomic number [accept: chemical element]	1
				[11]
7	*(a)*	(i)	$T = \frac{W}{260\times10^{-9}}$ (1 – trans) [or by impl.][allow this mark even if 10^{-9} omitted]	
			= 11 × 10^3 K (1) ((**unit**))	2
		(ii)	Black body [accept: non-reflecting surface / radiates <u>equally</u> in all directions]	1
	(b)		Radius is × 70 so area is × 70^2 [or equiv, or by impl.] (1) Temperature is × 2, so T^4 is 2^4 [or equiv. or by impl.] (1) [So] Power is × 80 000 (1)	3
	(c)		Absorption [by atoms in the stellar atmosphere or in interstellar gas] of specific wavelengths from the star's continuous spectrum [or from star's radiation / star's light] (1) Any 2 × (1) from: • ….. because photons of specific <u>energy</u> abso rbed ✓ • Photon energies correspond to transitions between [atoms'] energy levels ✓ • Absorbed radiation re-emitted but in all directions ✓	3
				[9]

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