GCE MARKING SCHEME

PHYSICS
AS/Advanced

JANUARY 2013

INTRODUCTION

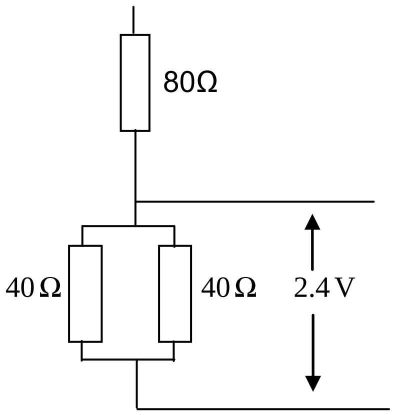
The marking schemes which follow were those used by WJEC for the January 2013 examination in GCE PHYSICS. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference 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.

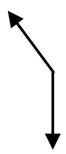
It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

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

GCE Physics - PH1

Mark Scheme - January 2013

Question			Marking details	Marks Available
1	*(a)*	(i)	Decelerating (1) Gradient changes/decreases **or** correct use of values from the graph (1)	[2]
		(ii)	0.75 m s^{-1} (**unit** mark)	[1]
		(iii)	Any tangent at 6 s (1) Speed: 0.55 – 0.75 [m s^{-1}] (1)	[2]
		(iv)		
		(I)	No- infinite speed (or equiv) don't accept very large speed	[1]
		(II)	Yes- stopped	[1]
	(b)		$Velocity = \dfrac{Displacement}{Time}$ (1); Displacement = 0 [over 1 complete lap] (1)	[2]
			Question 1 total	**[9]**
2	*(a)*	(i)	$Resistance = \dfrac{pd}{current}$ (accept: voltage / if *V* and *I* written must be qualified)	[1]
		(ii)	$V = \text{J C}^{-1}$ (1); $I = \text{C s}^{-1}$ (1); Convincing working (1) Don't accept use of t -award **ecf** for 3rd mark. Alternative route using power formulae is acceptable.	[3]
	(b)	(i)	$I = \dfrac{V_{in}}{R_1 + R_2}$	[1]
		(ii)	$V_{out} = IR_2$ (1); *I* (from (i)) used correctly (1)	[2]
	(c)	(i)	Any parallel combination shown (1); 40 [Ω] used correctly (1)	[2]
		(ii)	 Resistor combination shown (1) **ecf** from *(c)*(i) 2.4 [V] or V_{out} labelled correctly (1)	[2]
			Question 2 total	**[11]**

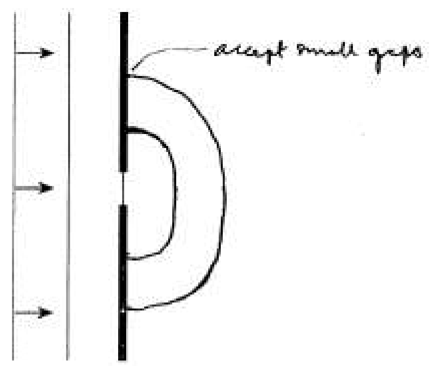
Question			Marking details	Marks Available
3	*(a)*	(i)	Straight line through origin. Accept $F \alpha x$.	[1]
		(ii)	Area = ½ Fx (1); $F = kx$ and clear substitution/manipulation (1)	[2]
	(b)	(i)	F = 8.0 [N] (1) **or** k = 100 [N m^{-1}] (1) Use of ½ Fx / Use of ½ kx^2 (i.e ½ x 8.0 x 80 x 10^{-3}) (1) / (i.e ½ x 100 x (80 x 10^{-3})^2) (1) = 0.32[J] (1) **(ecf** for *F)* / = 0.32[J] (1) (**ecf** for derived value of *k*)	[3]
		(ii)	0.32 = ½ mv^2 (**ecf**) (1); v = 4.0 [m s^{-1}] (1)	[2]
	(c)		$\Delta E_k = Fd$ understood (1) d =(0.8 + 0.4 + (2π(0.2))) **or** 2.46 [m] (1) ΔE_k = 0.03[J] **or** (½ x 0.04 x (4^2 – 3.8^2)) (1) (**ecf** from *(b)* (ii)) F = 0.013 [N] (1) (**ecf** for *d*) Alternative method using equations of motion and $F = ma$ acceptable.	[4]
			Question 3 Total	**[12]**
4	*(a)*	(i)	**<u>Correct use</u>** of $v^2 = u^2 + 2ax$ (i.e. 0 = 6^2 – 2 x 9.81 x x) (1) x = 1.8 [m] (1) Total height = 12.8 [m] (1) (**ecf** for x)	[3]
		(ii) (I)	v^2 = 2 x 9.81 x 12.8 (**ecf**) (1) or suitable alternative v = 15.9 [m s^{-1}] (1)	[2]
		(II)	$t_{up} = \left(\frac{0-6}{-9.81}\right)$ = 0.6 [s] (1) $t_{down} = \left(\frac{15.9(ecf)-0}{9.81}\right)$ = 1.6 [s] (1) Total time = 2.2 [s] (1) (other solutions possible)	[3]
	(b)	(i)	 (1) Ball only acted upon by **<u>force due to gravity / weigh</u>**t is the only force acting (1) Only award 2nd mark if 1st mark correct.	[2]
		(ii)	 (1) (1) Marks are independent. If additional arrows present deduct 1 mark for each extra arrow.	[2]
			Question 4 Total	**[12]**

Question			Marking details	Marks Available
5	*(a)*	(i)	Point where entire **<u>weight</u>** of object acts. Don't accept mass.	[1]
		(ii)	Tan θ = 40/60 (1); θ = 33.7° (1)	[2]
	(b)	(i)	V = 0.6.x 0.4 x 0.1 (1); $M = \rho$ x V used correctly (1)	[2]
		(ii)	T sinθ or equivalent (1) x 1.2 (1) = 9.6 x 9.81 x 1.8 (1) T = 220 [N] (1)	[4]
		(iii)	F = 220 (**ecf**) cos40° or equivalent (1) F = 169 [N] (1) Accept Pythagoras solution.	[2]
			Question 5 Total	**[11]**
6	*(a)*	(i)	Correct and convincing use of $\rho = \dfrac{RA}{l}$ (including unit conversion)	[1]
		(ii)	$\left(\dfrac{2000}{11.2}\right)$ = 179 A **unit** mark	[1]
		(iii)	$v = \dfrac{I}{nAe}$ rearranged (or shown numerically) (1) n = 6.0 x 10^{28} x 3 (1) v = 1.55 x 10^{-5} [m s^{-1}] (**ecf** on I and n) (1)	[3]
	(b)	(i)	Same (or equivalent)	[1]
		(ii)	v increased (1) because…; A decreased, I,n,e unchanged by implicaton (1)	[2]
		(iii)	Increased frequency / more collisions **<u>between electrons and lattice</u>** / atoms / ions **or** electrons carry greater kinetic energy (1) leading to **<u>increased vibrational / kinetic energy of lattice atoms</u>** (1)	[2]
			Question 6 Total	**[10]**

Question			Marking details	Marks Available
7	*(a)*		*V*- energy (per coulomb) used in [external] resistor / circuit. (1) *E*- energy (per coulomb) transferred / supplied by source / in the whole circuit (1) *Ir*- energy (per coulomb) wasted / lost in source / cell / internal resistance (1) Use of 'per coulomb / unit charge' once. (1)	[4]
	(b)	(i)	4 [Ω]	[1]
		(ii)	Gradient attempted e.g. 60/10 (1) (or use of equation **ecf** from *(b)* (i)) emf = 6 [V] (1)	[2]
		(iii)	$1/I$ = 4 [A^{-1}] or by implication (1) R = 20 [Ω] (1) Use of I^2R i.e. $(0.25)^2$ x 20 (**ecf**) (1) or correct substitution into both $V = IR$ and $P = IV$ or V^2/R P = 1.25[W] (1)	[4]
	(c)	(i)	emf = 12.0 [V] (**ecf**) **<u>and</u>** r = 8.0 [Ω] (**ecf**)	[1]
		(ii)	R = 52.0 [Ω] (**ecf**)	[1]
		(iii)	y intercept (r→8.0 Ω (**ecf**)) (1) Precise gradient e.g. through (5,52) (**ecf**) (1)	[2]
			Question 7 Total	**[15]**

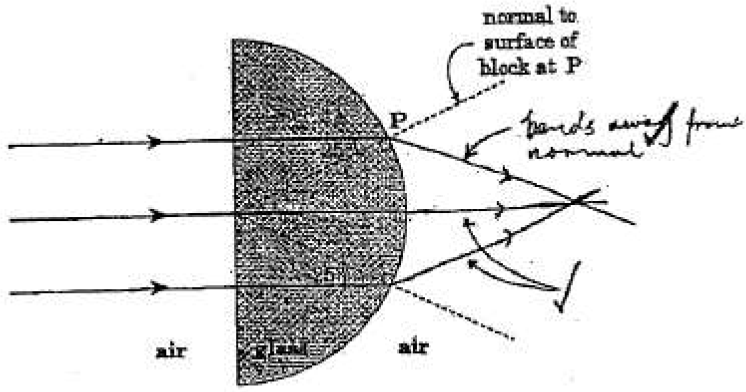
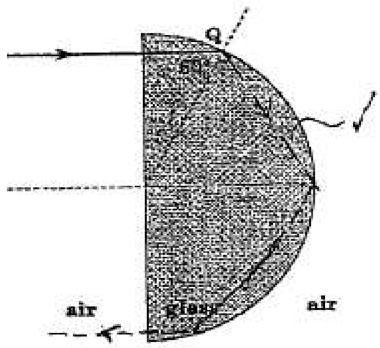
Mark Scheme - January 2013

Question			Marking details	Marks Available
1	*(a)*	(i)	3.0 [cm] [accept 3 cm]	[1]
		(ii)	v = 3.0 x 5.0 (1) [cm s^{-1}] or by implication. **Full ecf on λ** $t = \frac{d}{v}$ applied (1) t = 0.70 s (**ecf** on λ) (1) OR $d = \frac{10.5}{3.0}$ (1) T = 0.20 [s] (1) [$t = 0.20x\frac{10.5}{3.0}$] t = 0.70 [s] (1)	[3]
		(iii)	B in phase, C not in phase (in antiphase not acceptable), D in phase - irrespective of explanations. (1) Correct answer and understandable explanation or 'in phase' explained, for one of B, C or D. (1) Correct answer and understandable explanation for another of B, C, or D. (1)	[3]
	(b)	(i)	Diffraction	[1]
		(ii)	Rounded and (almost) semicircular (Accept gaps of <=3 mm) (1) λ constant (1) (within about 30%)	[2]



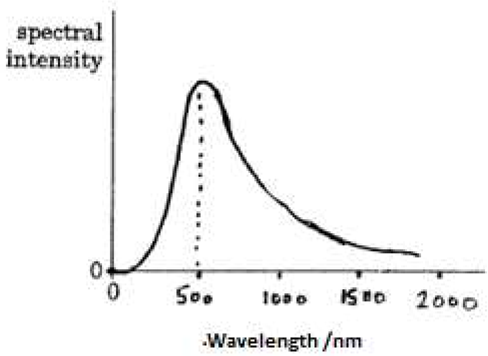
		(iii)	Any 2 x (1) from: • λ decreased [No penalty for (say) 'halved'] • less spreading • side beams	[2]
			Question 1 total	**[12]**

Question			Marking details	Marks Available
2	*(a)*	(i)	Constructive interference at P / waves arrive in phase at P (1) Same path length from sources / AP = BP / no path difference (1)	[2]
		(ii)	52.2 **and** 50.2 (1) λ = 2.0 [cm] (1) **ecf on slips** OR 56.8 **and** 52.8 (1) λ = 2.0 [cm] (1) **ecf on slips**	[2]
		(iii) (I)	$\lambda = \frac{10.0x10.0}{50}$ (1) = 2.0 cm (1) **UNIT** OR $\lambda = \frac{10.0x12.0}{50}$ (1) = 2.4 cm (1) **UNIT**	[2]
		(II)	AB or SP not very small compared with D OR maxima not evenly spaced	[1]
	(b)	(i)	*d* = 2.0 x 10^{-6} [m] (1) or by implication 3λ = *d** sin72.3^{o} (1) [*d** needs to be related to *d*, even 5.0 x 10^{5} would do] λ = 6.35 x 10^{-7} [m] (1)	[3]
		(ii)	Up to 3rd order visible, 1 + 3x2 beams seen OR diagram (1) $\frac{d}{\lambda}$ = 3.15 (1) so only 3 orders (1) not a freestanding mark OR $\frac{4\lambda}{d}$ >1 (1) so only 3 orders (1) not a freestanding mark	[3]
			Question 2 total	**[13]**

Question			Marking details	Marks Available
3.	(a)	(i)	(I)  	[2]
			(II) 1.58 sin25^{o} = [1.00] sin *a* (1) or equivalent or by implication *a* = 42^{o} (1)	[2]
		(ii)	(I) Either *c* = 39^{o} (1) 60^{o}>39^{o} or equivalent (1) OR 1.58 sin 60^{o} gives error (1) So refraction not possible or TIR [needs *attempt* to justify] (1)	[2]
			(II) TIR at Q and at least one more instance of TIR with subsequent **ecf** (1) As drawn with reflected ray at Q going off East of South, eventually emerging through diameter face ,with at least one more TIR event.(1)  	[2]
	(b)	(i)	Thinner	[1]
		(ii)	Monomode: parallel to axis (accept straight) Multimode: zig-zag paths as well (1) or some paths involve reflections	[1]
		(iii)	Only one route for data (1) [no zig-zag routes] Each pulse [data element etc] arrives [at other end of fibre] at same time (1) No overlapping of pulses (1) [even over long distances]	[3]
			Question 3 Total	**[13]**

Question			Marking details	Marks Available
4	*(a)*		Any 4 x (1) from: • light [energy] in discrete packets • one electron ejected by one photon OR photons don't co-operate • energy not accumulated [by electron] over time or emission from instant light shines • intensity has no effect on $E_{k\max}$ or accept intensity affects number emitted per second • wave theory doesn't predict Einstein's equation or doesn't predict threshold frequency	[4]
	(b)	(i)	$E_{k\max} = (6.63 \times 10^{-34} \times 8.7 \times 10^{14} - 3.8 \times 10^{-19})$ (1) $E_{k\max} = 1.97 \times 10^{-19}$ [J] (1)	[2]
		(ii)	These photons eject electrons with smaller $E_{k\max}$ (1) $E_{k\max}$ same as previously with some explanation given (1)	[2]
		(iii)	Correct use of $c = f\lambda$ (1) e.g. to give $\lambda_{thresh} = 523$ [nm] OR $f_{400\text{ nm}} = 7.5 \times 10^{14}$ [Hz] OR $f_{700\text{ nm}} = 4.3 \times 10^{14}$ [Hz] Comparison of 400 [nm] with λ_{thresh} (1) or 7.5×10^{14} [Hz] with f_{thresh} (5.73×10^{14} [Hz]) or substitution of 7.5×10^{14} [Hz] into Einstein's equation. Conclusion : It can (1) [if reasoned]	[3]
			Question 4 Total	**[11]**

Question			Marking details	Marks Available
5	*(a)*		$E = \frac{hc}{\lambda}$ (1) or equivalent e.g. $E = hf$ and $f = \frac{c}{\lambda}$ λ = 880 [nm] (1)	[2]
	(b)	(i)	Photon disappears and the electron gains its energy **or** electron promoted from G to U	[1]
		(ii)	1. [Passing] photon 2. Of energy 2.26 x 10^{-19} [J] or λ = 880 [nm] or equivalent 3. Causes electron to drop [from U to G] 4. Releasing additional photon 5. Identical to or in phase or polarised in the same direction or travelling in the same direction with the incident photon Award (1) mark for each of statements 1, 3 and 4 Award the 4^{th} mark for either statement 2 or 5.	[4]
		(iii)	Electron drops [from U to G] by itself (or randomly or without stimulation...), with emission of photon	[1]
	(c)	(i)	Raising electrons to higher level or causing population inversion	[1]
		(ii)	So more electrons in higher level than lower (1). So stimulated emission more probable than absorption (1).	[2]
			Question 5 Total	**[11]**

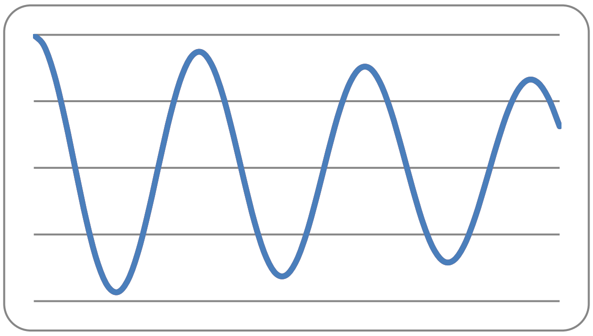
Question			Marking details	Marks Available
6	*(a)*	(i)	$A = 4\pi(8.54 \times 10^{8}\ [\text{m}])^{2}$ (1) [9.16×10^{18} [m^2]] $P = 5.67 \times 10^{-8} \times$ area attempt $\times 5790^{4}$ (1) [W] $P = 5.84 \times 10^{26}$ [W] and consistency **ecf on slips** (1) [One mark to be lost for slips e.g. powers of 10, factors of 2, 4, π] Or alternative solution using Stefan's law is acceptable.	[3]
		(ii)	$I = \frac{power}{4\pi(4.1x10^{16})^{2}}$ (1) $I = 2.76 \times 10^{-8}\ \text{Wm}^{-2}$ **UNIT (1)** [penalty of 1 mark for slips of 10^{n}, 4, π etc no penalty if same slip as in (i)]	[2]
		(iii)	$\lambda_{pmax} = \frac{2.9x10^{-3}}{5790}$ (1) = 5.01×10^{-7} [m] (1) GRAPH - Goes through origin and doesn't hit the axis (1) Peak at ~ 500 nm (Apply **ecf**) (1)  	[4]
	(b)		*P* goes up and *T* goes down and then *A* goes up (1) Because $A = \frac{P}{\sigma T^{4}}$ or any convincing explanation (1)	[2]
			Question 6 Total	**[11]**

Question			Marking details	Marks Available
7	*(a)*		Name (1) [e.g. antiproton, antineutron] Quarks (1) [e.g. $\bar{u}\,\bar{u}\,\bar{d}$, $\bar{u}\,\bar{d}\,\bar{d}$	[2]
	(b)	(i)	Must be neutral or lepton number conserved (1) ν_e by considering charge and lepton number (1)	[2]
		(ii)	1st mark : π^+ (1) Either 2 x (1) from: • y can't be a lepton [violates lepton conservation] • y must be positive • y can't be a baryon OR y must have u quark number [2-1] = 1 (1) and d quark number [1-2] = -1 (1)	[3]
		(iii)	In (i) Yes – quark flavour changes or neutrino (1) In (ii) No – quark flavours conserved (1) [accept no neutrino]	[2]
			Question 7 Total	**[9]**

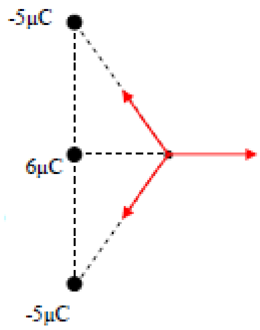
GCE Physics - PH4

January 2013 - Markscheme

Question			Marking details	Marks Available
1	*(a)*	(i)	$T = \frac{1}{f} = 1.6$ **or** $\omega^2 = \frac{k}{m}$ (1) algebra i.e. $m = \frac{T^2 k}{4\pi^2}$ **or** $\omega = 2\pi f$ (1) $m = \frac{1.6^2 \times 2640}{4\pi^2}$ (1) = [171 kg]	[3]
		(ii)	$\frac{1}{2}mv^2 = 2150$ (1) v = 5.01 [m s^{-1}] (1) **ecf** on m	[2]
		(iii)	2.15 [kJ] (1) conservation of energy stated or implied / **all** KE transferred to PE (1) (accept energy cannot be created or destroyed)	[2]
		(iv)	$v = \omega A$ (1) or suitable alternative A = 1.28 [m] (1) **ecf**	[2]
		(v)	$x = \pm A\sin(2\pi ft)$ (1) For 1st mark ω must be substituted. $a = -\omega^2 x$ used **(1)** 13.9 [m s^{-2}] (1) **ecf**	[3]
	(b)		Resonance / maximum amplitude (1) since natural frequency / $\frac{1}{0.625} = 1.6$ (1)	[2]

Question			Marking details	Marks Available
	(c)		Basic shape (decreasing to 1.4 m with a cos or –cos shape) (1) period = 1.6 s (accept 1.5 – 1.7 s) (1) period constant (1) 	[3]
			Question 1 total	**[17]**
2	*(a)*		$\frac{1}{2}m\overline{c^2}$ **<u>KE of a particle</u>**/atom/molecule	[1]
			$\frac{3}{2}\ nRT$ internal energy (accept total KE)	[1]
	(b)	(i)	$N_A \times \frac{1}{2}m\overline{c^2} = \frac{3}{2} \times 1 \times RT$ (1) (or equivalent) e.g. $\frac{1}{2}m\overline{c^2} = \frac{3}{2}kT$ $\overline{c^2} = \frac{3RT}{mN_A}$ (1) (i.e. algebra) rms speed = 1350 [m s^{-1}] (1)	[3]
		(ii)	$p = \frac{1}{3}\rho\overline{c^2}$ (1) p = 1.16x10^{5} Pa / Nm^{-2} (1) **ecf <u>UNIT mark</u>** Or suitable alternative method	[2]
			Question 2 total	**[7]**

Question			Marking details	Marks Available
3	*(a)*		The [vector] sum of the momenta [of bodies in a system] stays constant [even if forces act between the bodies], (1) provided there is no external [resultant] force. (1)	[2]
	(b)	(i)	$1.78\text{x}10^{-25}$ x u = $5.62\text{x}10^{5}$ x $1.71\text{x}10^{-25}$ $\pm$ $1.36\text{x}10^{7}$ x $6.64\text{x}10^{-27}$ (1) i.e. attempt at conservation of momentum u = {$5.62\text{x}10^{5}$ x $1.71\text{x}10^{-25}$ - $1.36\text{x}10^{7}$ x $6.64\text{x}10^{-27}$ }/$1.78\text{x}10^{-25}$ i.e. correct algebra and sign (1) u = 32 600 [m s^{-1}] (1)	[3]
		(ii)	$E = \frac{hc}{\lambda}$ {or E = hf and c = f λ} (1) Algebra and $p = \frac{h}{\lambda}$ (1) (Use of both $E = mc^2$ and $p = mc$ award 1 mark only.)	[2]
		(iii)	$p = \frac{E}{c}$ attempted (1) 5.62 $\text{x}10^{5}$ x 1.71 $\text{x}10^{-25}$ used as a denominator (1) $\frac{6.93\times10^{-22}}{5.62\text{x}10^{5}\text{ x }1.71\text{x}10^{-25}} \times 100 = 0.72\%$ (1) (accept: 4.5 x 10^{18}%)	[3]
			Question 3 Total	**[10]**

Question			Marking details	Marks Available
4	*(a)*		horizontal arrow to right at P (1) both other arrows correct direction (1)  	[2]
	(b)		$E = \frac{Q}{4\pi\varepsilon_0 r^2}$ used (1) e.g. $\frac{6\times9\times10^9}{3^2}$ E = 6 000 N C^{-1} (1) **UNIT mark**	[2]
	(c)		$E = \frac{Q}{4\pi\varepsilon_0 r^2}$ used for negative charge (1) (answer = 1 800) e.g. $\frac{5\times9\times10^9}{5^2}$ but not $\frac{5\times9\times10^9}{3^2}$ x 2 and x cosθ (1) [= 2 160] resultant = 3 840 [N C^{-1}] [to the right] (1) **ecf** on arrows	[3]
	(d)	(i)	correct equation used (1) e.g. $\frac{5\times9\times10^9}{5}$ Attempt at adding 3 potentials (1) e.g. $\frac{(6-5-5)\times9\times10^9}{5}$ $\frac{1}{4\pi\varepsilon_0}\left\{\frac{6}{3}-\frac{5}{5}-\frac{5}{5}\right\}$ (1) or equivalent obviously giving zero	[3]
		(ii)	(Energy) - final total energy must be zero or final potential is also zero (1) (any implied dissipation of energy loses this mark) Initially (resultant) force / field is to the right (1) Then (resultant) force / field is to the left or deceleration (1)	[3]
			Question 4 Total	**[13]**

Question			Marking details	Marks Available
5	*(a)*		$\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ used (1) $\Delta\lambda = \frac{9.4x10^5}{3x10^8}x656 = 2.06$ [nm] (1) $\Delta\lambda = \frac{6.6x10^5}{3x10^8}x656 = 1.44$ [nm] (1)	[3]
	(b)		$F = \frac{GMm}{r^2}$ used **<u>or</u>** $g = \frac{GM}{r^2}$ (1) $F = 2.37 \times 10^{-11}$ [N] (1)	[2]
	(c)	(i)	$\frac{mv^2}{r} = \frac{GMm}{r^2}$ (1) convincing algebra (1)	[2]
		(ii)	$v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{6.67\times10^{-11} 8\times10^{39}}{1.5\times10^{20}}}$ **<u>or</u>** calculating *M* using *v* (1st mark algebra) (1) $v = 60\,000$ [m s^{-1}] **<u>or</u>** $M = 4.4 \times 10^{40}$ or $G = 3.675 \times 10^{-10}$ (1) Comment: (1) allow **ecf** If *v* - suggests dark matter since actual *v* is greater If *M* – yes If *G* – yes because larger *G* or stronger gravity	[3]
			Question 5 Total	**[10]**

Question			Marking details	Marks Available
6	*(a)*		period = 44 [days] ± 2 days (1) correct conversion to seconds (allow **ecf**) (1) (= $3.83\text{x}10^6$ s)	[2]
	(b)		$v = \frac{2\pi r}{T}$ or equivalent e.g. $v = \omega r$ *and* $\omega = \frac{2\pi}{T}$ (1) $r = \frac{vT}{2\pi} = \frac{18xa}{2\pi}$ (1) (=1.097 x 10^7) **ecf** on *T*	[2]
	(c)		$d^3 = \frac{T^2 G(M_1+M_2)}{4\pi^2}$ i.e. algebra nearly complete (1) $(M_1 + M_2) \approx M_1$ either written or worded (1) $d = 3.6\text{x}10^{10}$ [m] (1) **ecf**	[3]
	(d)		Values substituted correctly into a correct equation (1) $M_2 = 5.9\text{x}10^{26}$ [kg] (1) **ecf** on *d* and *r* i.e. 100 times / [much] larger than the Earth (1) (allow **ecf** on *M*)	[3]
			Question 6 Total	**[10]**

Question			Marking details	Marks Available
7	*(a)*		$T = \frac{pV}{nR}$ or implied (1) $T = \frac{84000 \times 2}{49.3 \times 8.31}$ = 410 [K] **and** $T = \frac{104000 \times 1.2}{49.3 \times 8.31} = 305$ [K] (1)	[2]
	(b)	(i)	*U* = 190 [kJ] allow **ecf**	[1]
		(ii)	*U* = 250 [kJ] allow **ecf**	[1]
	(c)		no area under graph or no change in volume	[1]
	(d)		temp constant / internal energy only depends on temperature / because they are isotherms	[1]
	(e)	(i)	A **clear** valid method (remember **show that...**) e.g. trapezium (1) (counting squares ok) DA= $\frac{1}{2}$(140 000 + 84 000) x 0.8 = 89.6 [kJ] (1) or better $\frac{1}{2}$(140 000 + 105 000) x 0.4 (no penalty for mysterious -ve sign or +ve sign) + $\frac{1}{2}$(105 000 + 84 000) x 0.4 = $\pm$ 86.8 [kJ]	[2]
		(ii)	BC = $\frac{1}{2}$(104 000 + 64 000) x 0.8 = 67.2 [kJ] (1) or better $\frac{1}{2}$(104 000 + 78 000) x 0.4 (sign penalised here!) $\frac{1}{2}$(78 000 + 64 000) x 0.4 = 64.8 [kJ]	[1]
	(f)		**Allow ecf**	[4]

	AB	BC	CD	DA	ABCDA
W	0	67[kJ]	0	-90 kJ	-23[kJ]
ΔU	-60 [kJ]	0	60 [kJ]	0	0
Q	-60 [kJ]	67[kJ]	60 [kJ]	-90 kJ	-23[kJ]
	(1)	(1)	(1)		(1)

Question 7 Total **[13]**

WJEC
245 Western Avenue
Cardiff CF5 2YX
Tel No 029 2026 5000
Fax 029 2057 5994
E-mail: exams@wjec.co.uk
website: www.wjec.co.uk