

Mark Scheme STANDARDISATION VERSION Summer 2007

GCE

GCE Physics (6736/01)

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	Paper PHY6		PHY6 Synoptic	June 2007	
			Mark scheme		
1.	(a)	(i)	(a piezo-electric material) bends / deforms	\checkmark	
			when a p.d. / voltage is applied	\checkmark	2
		(ii)	top: heater drawn and labelled anywhere left of ink chamb	er 🗸	
			middle: bubble in ink to left of nozzle and on same level	\checkmark	
			bottom: no bubble / shrunk bubble with some escaped ink	~	3
	(b)	(i)	(on graph) solid at left	\checkmark	
			liquid above and gas / vapour below right part of curve	\checkmark	2
		(ii)	critical point: where there is no distinction between L and above which a gas or vapour cannot be liquefied by pressu only (<i>not</i> simply when L to G transition temp)	G / ire ✓	1
	(c)	(i)	(surface tension) pulls ink into a drop / droplet(s) / sphere	\checkmark	
		(ii)	(ink droplets) are deflected by an electric field / charged p	lates 🗸	
			ink / droplets / they are (electrically) charged	\checkmark	3
	(d)	(i)	$100\ 000\ /\ 10^5$ drops per second		
			means 10^{-5} s per drop / between drops	\checkmark	
			i.e. $10\times 10^{-6}~s$ / 10 μs / 10 microseconds between drops	\checkmark	
			so heating for <u>less</u> than 10 microseconds is consistent	\checkmark	max 2
		(ii)	use of $\frac{4}{3}\pi r^3$ with $r = 5.5 (\times 10^{-6} \text{ m} / \mu\text{m}) (\Rightarrow 6.96 \times 10^{-10} \text{ m})$	(m^3)	
			use of number of drops = frequency (in Hz) \times 180 s	\checkmark	
			should be $(620 \times 10^3 \text{ Hz})(180 \text{ s})$ but accept other frequence	ies	
			$\Rightarrow \text{ volume} = 7.8 \times 10^{-8} \text{ m}^3$ (accept <i>r</i> and <i>d</i> confusion $\rightarrow 6.2 \times 10^{-7} \text{ m}^3$ for 2 out of 3 m	narks) 🗸	

(e) (i) (each step must be shown)

		electric field / $E = V \div x$	\checkmark	
		force on droplet = $qE / -qE / qV \div x$	\checkmark	
		use of Newton's second law/ <i>ma</i> = force on droplet [e.c.f.]	\checkmark	2
		$\Rightarrow a = as given qV/mx$ (no mark)		3
		(proofs involving energy conservation are only valid when charged droplet explicitly moves from lower to upper plate, but might get the Newton's Law mark.)		
	(ii)	(direction is) upwards / towards positive	\checkmark	
		(assume that) <i>either</i> weight / air resistance has no effect or <i>E</i> -field is uniform (<i>not E</i> -field is constant)	\checkmark	2
	(iii)	 parabolic / parabola (curve - 1 mark only) 	$\checkmark\checkmark$	
		2. a straight line / linear / continues in the same direction	✓	3
(f)	(i)	correct substitution in $t = s/v$ ($t = 0.015 \text{ m} \div 220 \text{ m s}^{-1}$)	\checkmark	
		$= 6.8 \times 10^{-5} \text{ s} / 68 \ \mu \text{s} \pmod{10^{-5}}$		
	(ii)	substitute in $s = \frac{1}{2}at^2$ i.e. $\frac{1}{2}(2.0 \times 10^5 \text{ m s}^{-2})(\text{above } t)^2$	\checkmark	
		$= 4.65 \times 10^{-4} \text{ m} / 0.465 \text{ mm} \text{ (no e.c.f.)}$	✓	3
(g)	(i)	correct substitution in $\Delta p = 2\gamma/r$ (no mark)		
		giving magnitude of $\Delta p = 2.65 \times 10^4 / 26500$	\checkmark	
		unit: Pa / N m ⁻² (do not accept J m ⁻³)	\checkmark	
	(ii)	use of normal atmospheric pressure p_A from 95 to 110 (kPa)	\checkmark	
		giving $\Delta p/p_A$ from 28 % to 24% (e.c.f. Δp by eye)	\checkmark	4

(Total 31 marks)

2. (a) (i) method 1

either	≥ 2 values of ratio $A_1 \div A_2$ at fixed <i>t</i> intervals	✓
	A values to be ≥ 2 Gs apart	\checkmark
	(e.g. $3.00/2.70 = 2.70/2.45 = 2.45/2.23$ etc)	
	values shown to be approximately equal	\checkmark
or	for 2 fixed ratios of $A_1 \div A_2$ find <i>t</i> intervals	\checkmark
	t to be ≥ 2 Gs	✓
	show to be approximately equal	✓
	(i.e. inverse of above method)	
method	12	

use $A = A_0 e^{-\lambda t}$ to calculate two values of λ	\checkmark
A values to be ≥ 2 Gs apart	\checkmark
showing that they are approximately equal	\checkmark
(ignore units throughout)	

method 3

for any one of the above:

assume exponential decay and predict a second value of A or t

3

3

3

(ii) use of $A = A_0 e^{-\lambda t}$ ($\lambda \approx 5 \times 10^{-11} s^{-1}$) use of $\lambda t_{\frac{1}{2}} = \ln 2$ ($t_{\frac{1}{2}} = 1.3 / 1.4 \times 10^{10} s$) $t_{\frac{1}{2}} = 440$ years (iii) measure activity A

(iii) measure activity A \checkmark of sample of known N/known m and nucleon number \checkmark use $A = \lambda N$ and $\lambda t_{\frac{1}{2}} = \ln 2$ \checkmark (method involving measuring the ratio A_0/A_1 no marks)

(b) (i) y-axis:
$$l/10^n A and x-axis: l/10^m s$$

(any or no powers of 10)
with $n + m = -3$ to -6 (e.g. mA and ms = -6)
(but not mA and Gs = $+6$)
(ii) radioactive decay is random *or* capacitor discharge is
not random / capacitor discharge can be controlled *or*
radioactive decay can not be controlled / capacitors
can be recharged *or* radioactivity cannot be replaced \checkmark
(c) (i)
 $241 \over 95} \rightarrow \frac{4}{2} He + \frac{237}{93} Np$
4 and 2 with He / α
237 and 93 with Np
(allow γ and/or energy on right of equation)
(ii) use of $1.6 \times 10^{-19} \text{ J eV}^{-1}$
use of $E = hc/\lambda$ (often in two steps)
 $\lambda = 2.5 / 2.48 \times 10^{-11} \text{ m, an X-ray or gamma photon}$

(Total 17 marks)

3.	(a)	(i)	circuit either: p.d. across wire	✓	
			A in series and V across wire / wire + A	\checkmark	
			deduce $R = V \div I$ / from graph	\checkmark	
			or : mention of ohmmeter	✓	
			ohmmeter correct in diagram (no cell)	✓	
			repeat for various l	\checkmark	
			(circuits may show sliding / crocodile connections to manganin wire)		
			use a micrometer / digital callipers (maybe on diagram)	✓	
			measure <i>d</i> in more than 2 places	✓	
			calculate $\rho = R\pi r^2/l$ (beware $2\pi r^2 / \pi d^2$)	✓	-
				,	max 5
		(ii)	(suitable as) the wire will warm up	\checkmark	
			but R (not ρ) manganin wire constant / does not vary	\checkmark	2
	(b)	(i)	$R = \rho d/A$ (no mark)		-
		(ii)	1. either $t_{\frac{1}{2}}$ for discharge = $RC\ln 2$ or $t_{\frac{1}{2}}$ depends on RC	\checkmark	
			substitute in $RC = \rho d/A \times \varepsilon A/d$ [e.c.f. R]	\checkmark	
			continue e.c.f. to show result independent of A and d	\checkmark	
			2. substitute values into $t_{\frac{1}{2}} = \rho \varepsilon \ln 2$	\checkmark	
			$\Rightarrow \epsilon = 5.2 \times 10^{-11}$	\checkmark	
			unit s Ω^{-1} m ⁻¹ / F m ⁻¹	\checkmark	max 5
		(iii)	connected in parallel	✓	
			same p.d. / voltage (across adjacent pairs of foils)	\checkmark	
			capacitance = $4C$ [e.c.f. 1 mark for $C/4$ series] (Tot	√ al 15 n	3 narks)

4.	(a)	(i)	oscillations / B / E / fields are perpendicular / at right angles to the direction of propagation / c / travel / motion / energy transfer	✓	
		(ii)	place coil so that <i>B</i> / magnetic field goes through coil / so that axis of coil is parallel to <i>B</i> field / coil is perpendicular to <i>B</i> field (<i>not</i> cutting <i>B</i> -field / lines of flux)	√	
		(iii)	<i>either</i> \uparrow for polarised and $\uparrow \leftrightarrow$ plus other arrows in between for unpolarised (i.e. all on diagrams)	√	
			<i>or</i> oscillations (of B / E) are in one plane / direction if polarised and / but lots of / many / all if unpolarised	√	
			<i>both</i> (mention of particles loses mark)		3
	(b)	(i)	(do <i>not</i> look at the algebra; try to pick out the following three main features plus any one of the fourth)		
			N C ⁻¹ / V m ⁻¹ for the unit of E_0	\checkmark	
			W = $J s^{-1} / kg m^2 s^{-3} (W m^{-2} \equiv kg s^{-3})$	\checkmark	
			$F \equiv C V^{-1} / C^2 J^{-1} (F \equiv kg^{-1} m^{-2} s^4 A^2)$ (beware N as unit for farad)	✓	
			$V \equiv J C^{-1} / J \equiv N m / W \equiv A V / A \equiv C s^{-1} / C \equiv A s (accept base units for these e.g. J \equiv kg m^2 s^{-2})$	√	4
		(ii)	use of $I = \frac{1}{2}acE_0^2$ with $c = 3.0 \times 10^8 \mathrm{m s^{-1}}$	\checkmark	
			$\Rightarrow E_0 = 1030 \text{ N C}^{-1} / 1000 \text{ V m}^{-1}$ (beware 1.05×10^6 i.e. not square rooted)	✓	
		(iii)	use of inverse square law / $I \propto 1/r^2$	\checkmark	
			$\Rightarrow I = (1.40 \times 10^3 \text{ W m}^{-2}) \div 20^2 = 3.5 \text{ W m}^{-2}$	\checkmark	4

(c)	(i)	addition / combination of in phase <u>waves</u> (suitable diagrams acceptable)	\checkmark	
	(ii)	measurement of S_1P as 35 or 36 mm and S_2P as 28 or 29 mm	\checkmark	
		path difference = $S_1P - S_2P$ calculated	\checkmark	
		their p.d. $\approx \lambda$ / wavelength (<i>not</i> 7 mm)	\checkmark	
	(iii)	mention of stationary / standing waves	\checkmark	
		nodes / antinodes separated by $\lambda/2$	\checkmark	6

(Total 17 marks)