OCR
Oxford Cambridge and RSA

GCE

Physics B (Advancing Physics)

Unit **G492**: Understanding Processes/Experimentation and Data Handing

Advanced Subsidiary GCE

Mark Scheme for June 2017

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Annotations available in Scoris

Annotation	Meaning
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
FT	Follow through
NAQ	Not answered question
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
RE	Rounding error
SF	Error in number of significant figures
	Correct response
AE	Arithmetic error
	Wrong physics or equation

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ecf	Error carried forward
AW	Alternative wording
ORA	Or reverse argument
(1)m	a method mark, awarded if a correct method is used
(1)e	an evaluation mark, awarded for correct substitution and evaluation

The following questions should be annotated with ticks to show where marks have been awarded in the body of the text:

Question			Answer	Marks	Guidance
1	a		force	1	
	b		force and velocity	1	both needed for the mark
	c		power…(force)….velocity	1	In correct order. Both needed for the mark.
2	a		A	1	
	b		A	1	
	c		B or D	1	Accept D due to similarity to graph B
3			Use of $x = \lambda L/d$ (1) $= 630\times10^{-9}$ x 3.2 / 0.65×10^{-3} (1) $= 3.1 \times 10^{-3}$ m (1)	3	$\sin\theta \approx \tan\theta = \lambda/d$ = [630×10^{-9} m]/[0.65×10^{-3} m] (1)m ; $\sin\theta = 0.000969 \Rightarrow \theta = 0.0555°$ (1) ; $x/L = x/3.2$ m = $\tan\theta$ = = 0.000969 = 3.1×10^{-3} m (1)
4				2	tip-to-tail (1) ; equilateral triangle (by eye (1)
5			Identify resultant forces 0.8 N & 0.3 N (1) $[1.8\text{ N} - 1.5\text{ N}]^2 + [2.4\text{ N} - 1.6\text{ N}]^2 = 0.85(4)$ N (1) m = 1.5 N / [9.8 m s^{-2}] = 0.153 or 0.15 kg (1) ; $a = F/m$ = 0.854 N / 0.153 kg = 5.58 or 5.6 m s^{-2} (1)	4	Allow ecf from part 1 A bald 5.58/5.6 m s^{-2} with no working gets all 4 marks
6	a		½ × (5 s × 10 m s^{-1}) + 1 s × 10 m s^{-1} (1)m ; = 35 m (1)	2	A bald 35 m with no working gets both marks
	b		gradient to curve drawn at 8.5 s (1) ; gradient calculated including minimum Δt of 1s (1)m ; acceptable range 1.3 to 2.0 m s^{-2} (1)	3	No drawn gradient = not shown.
			Section A Total	**20**	

Question			Answer	Marks	Guidance
Section B					
7	a	(i)	Waves reflect off the closed end/back of tube (1) incoming waves and reflected waves superpose /interfere (1)	2	
	a	(ii)	becomes much louder and then quiet again at certain precise frequencies(1); where standing wave for those λs fits the tube / demonstrate understanding of nodes & antinodes (1)	2	
	b	(i)	$\lambda = c/f = 340 \text{ m s}^{-1} / 1.7 \times 10^3 \text{ Hz} = 0.20 \text{ m}$	1	
	b	(ii)	N and A equally spaced (judged by eye) (1); N at closed end, A at open end (1); Exactly 3 Ns and 3 As (1)	3	Zero marks if labels N and A not used
	c		$\lambda = 920 \text{ m s}^{-1} / 1.7 \times 10^3 \text{ Hz} = 0.54 \text{ m}$ (1); $^5/_4\lambda = {}^5/_4 \times 0.54 \text{ m} = 0.68 \text{ m}$ (1)	2	ecf (b)(ii)
			Total	**10**	
8	a	(i)	$E = hf = 6.6\times10^{-34} \text{ J s} \times 1.7\times10^{15} \text{ Hz} = 1.12 \times10^{-18} \text{ J}$ (1); number of photons $= 25 \times 10^{-3} \text{ J} / 1.12 \times 10^{-18} \text{ J}$ $= 2.2 \times 10^{16}$ (1)	2	
	a	(ii)	number per second $= P_{mean} / E_{pulse}$ $= 4.5 \text{ W} / 25 \text{ x } 10^{-3} \text{ J} = 180 \text{ s}^{-1}$(1)	1	
	a	(iii)	$t_{pulse} = 1.2 \times 10^7 \times (1/1.7\times10^{15} \text{ Hz}) = 7.06\times10^{-9} \text{ s}$ $P_{pulse} = 25\times10^{-3} \text{ J} / 7.06\times10^{-9} \text{ s} = 3.54\times10^6 \text{ W}$ (1) ; $P_{pulse}/P_{mean} = 3.54\times10^6 \text{ W} / 4.5 \text{ W} = 7.9\times10^5$ (1)	2	Credit any correct method calculation of more precise value is evidence of 'show that'
	b	(i)	$1.12 \times10^{-18} \text{ J} - 8.3 \times 10^{-19} \text{ J}$ (1)	1	Error on question paper means that only need to see the correct working to award mark. Calculation not needed. e.c.f own photon energy
	b	(ii)	λ greater $\Rightarrow$ (f smaller) $\Rightarrow$ E smaller (1) Energy $= 3.74\times10^{-19} \text{ J} < 8.3 \times 10^{-19} \text{ J}$ / a third of the energy is less than the energy per photon required to release electron (1) ;	2	accept photon energy less than the work function of nickel correct calculation required for second mark or direct reference to 3 x smaller energy and stating that this is less than the energy required to release an electron.
	c		unable to see beam (1) ; so damage (to eyes/skin) from very powerful beam possible (1)	2	must combine ideas of high power, invisibility and damage to person for second mark.

Question			Answer	Marks	Guidance
			Total	**10**	

Question			Answer	Marks	Guidance
9	**a**		horiz. component of *v* constant/ no horizontal force (1) vert. component of *v* increases/ gravity acts vert. (1)	2	
	b		Horizontally : spacing becomes less and less (1) ; because air resistance is slowing the sphere down (1) ; Vertically: increase in spacing becomes less and less (and eventually spacings become equal) (1) ; because air resistance opposes weight owtte (1)	4	QWC is 'Select and use a form and style of writing appropriate to purpose'. For full marks, answer should be clearly laid out. Use of bullet points and/or subheadings is acceptable.
	c		$t^2 = 2y/g \Rightarrow t = \sqrt{[2y/g]}$ (1) ; $x = vt = v\sqrt{\frac{2y}{g}}$ (1)	2	*t = x / v substituted into equation fully followed through gains 2 marks*
	d		$t = \sqrt{\frac{2y}{g}} = \sqrt{\frac{2 \times 1.5\ \text{m}}{9.8\ \text{m s}^{-2}}} = 0.55(3)$ s (1) ; $v = x / t = 2.6\ \text{m} / 0.553\ \text{s} = 4.7\ \text{m s}^{-1}$ (1)	2	
			Total	**10**	

10	**a**		choice of *suvat* equation: $v^2 = u^2 + 2as$ (1);
			substitution with $u = 0$, $a = g$ and $s = h$ (1);
			$v = \sqrt{[2 \times 9.8\ \text{m s}^{-2} \times 25\ \text{m}]} = 22.1$ or $22\ \text{m s}^{-1}$ (1)
				3	Can use combination of equations. Correct answer with no working gets 3 marks. Accept GPE to KE calculations.

	b	**(i)**	$E_k = ½ \times 2.8\ \text{kg} \times [22\ \text{m s}^{-1}]^2 = 680$ to 670 J	1	Correct answer with no working gets the mark
	b	**(ii)**	the initial **gravitational** potential energy of the bird (at a height of 25 m)	1	Accept work done by gravity
	c	**(i)**	decreases with ΔFs getting less as it goes deeper (1); decreases as it moves slower (relative to the water) (1)	2	Must describe non-linear nature for the mark accept reasonable alternative
	c	**(ii)**	identifies that area under curve = work done (1) ; Reasonable method to find area (1); answer in range 660 – 715 N (1)	3	correct answer with no working gets (3)

Question			Answer	Marks	Guidance
			Total	**10**	

Question			Answer	Marks	Guidance
Section C					
11	**a**	**(i)**	Excluding 11.0 N, spread = 1.5 (1) ; 11.0 + (2 × 1.5) = 15.5 > 13.5 so not outlier (1)	2	'Not far enough away from middle of peak' owtte gets 1/2
	a	**(ii)**	For whole set, mean = 13.34 & spread = 2.0 (1) ; ΔF expressed to 1 s.f. (= 2 N) (1) F_{mean} expressed to same number of decimal places as spread (1)	3	Both correct values needed(1) / accept fractional uncertainties incorrect ΔF expressed to 1 s.f. scores (1) allow ecf 13 ± 2 N scores all three marks
	b		For F, percentage uncertainty = 100%×(2 N/13 N) = 15% (1) ; For d, percentage uncertainty ≤ 100%×(0.005 mm/0.46 mm) = 1 % (1) ; so the error in F will dominate (1)	3	
	c		$A = \pi r^2 = \pi[0.23\times10^{-3}\ m]^2 = 1.66\times10^{-7}\ m^2$ (1) ; $\sigma = F/A$ = 13 N/$6.65\times10^{-7}\ m^2$ = 78 to 81 MPa (1) ; Calculation of $\Delta\sigma$ using max/min method or fractional uncertainties gives values in the range ± 8 MPa to ± 12 MPa (1)	3	
			Total	**11**	

Question			Answer	Marks	Guidance
12	a		comparison of percentage/fractional uncertainties or [range/mean] for all three lenses (1) ; Need the one with smallest percentage uncertainty (1) 9.0 D is the choice (1)	3	percentage uncertainties: 3.7% = 4% for 3 D, 4.6% = 5% for 6 D, 1.5% = 2% for 9 D. range/mean: 0.074 for 3 D, 0.092 for 6 D, 0.031 for 9 D.
	b	i	$u_{min} = v_{min} - d_{max}$ (1)m ; = 39.2 cm – 12.9 cm = 26.3 (cm) (1)e ; $u_{max} = v_{max} - d_{min}$ = 40.8 cm – 12.1 cm = 28.7 cm (1)e ;	3	award method mark for first correct use of idea repeat calc., so no method mark
	b	ii	Use of lens equation requires curvature/ powers in D and so distance in m /if cm are used, answer will not be in D (but in cD).	1	
	c		$P_1=[1/v_{max} - 1/u_{min}]$= 1/0.408 m –1/0.263 m= -1.35 D(1) $P_2= [1/v_{min}–1/u_{max}]$=1/0.392 m –1/0.287 m= -0.93 D (1) P = [-1.35 D -0.93 D]/2 = - 1.14 D (1) Use of max/min values to calculate $\Delta P = \pm$ 0.21D (1)	4	1 method mark for using $v_{max} - u_{min}$ for one extreme value of P or for mean value of P calculated Penalise missing negative sign Allow adding percentage uncertainties in u and v
			Total	**11**	

Question			Answer	Marks	Guidance
13	a		Easier for the eye to judge/reduces uncertainty in the measurement owtte (1)	1	Accept answer based on getting the eye dark-adapted or similar
	b		Advantages: quicker (1) ; can get measurements for a larger range of LEDs made in the same time (a lesson) if repeats are not made (1) ; Disadvantages: ΔV_s may not be constant for all colours (1) ; because sensitivity of eye varies with colour of light (1)	4	Allow other valid responses. QWC is 'organise info. clearly & coherently' - do not award 4 marks unless advantage(s) and disadvantage(s) both present with at least 1 explanation.
	c	i	$E = V_s e$ (from article) $E = hf$ and $c = f\lambda$ (1) ; $V_s e = hf = h[c/\lambda]$ (1)m ; rearrange to $V_s = \frac{hc}{e\lambda}$ (1)	3	
	c	ii	relates $V_s = \frac{hc}{e\lambda}$ to $y = mx$ $(+c)$	1	or equivalent, i.e. indentifies direct proportion and constant of proportionality
	d	i	1.67& 1.74 in table (1) ; both correctly plotted (1); best-fit line drawn (1)	3	line should go through all uncertainty bars.
	d	ii	Gradient triangle of base > 1 major unit (0.1 x 10^6 m^{-1}) (1); calculation of gradient (1)m ; (1)e	3	expect answers in the range 1.12×10^{-6} V m to = 1.21×10^{-6} V m Accept answers 1.12×10^{6} V m to = 1.21×10^{6} V m due to error on the x -axis
	d	iii	h = gradient× e/c (1) ; = 1.17×10^{-6} V m × 1.6×10^{-19} C /3.0×10^{8} m s^{-1} (1)m&s = 6.24×10^{-34} J s (1)e	3	e.c.f. own gradient
			Total	**18**	
			Section C Total	**40**	

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