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 2016

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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

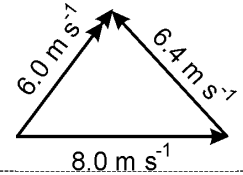
Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

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

The following questions should be annotated with ticks in the body of the text to show where marks have been awarded: 10d & 14aiii.

Question	Answer	Marks	Guidance
1 (a)	force..... acceleration	1	both needed, in that order
(b)	kinetic energy and work	1	both needed, in either order
(c)	acceleration and force	1	both needed, in either order
2 (a)	**B**	1	
(b)	**D**	1	
(c)	**C**	1	
(d)	**A**	1	
3 (a)	10^{-2}	1	
(b)	10^{-4}	1	
4 (a)	θ clearly smaller than Fig 4.1	1	
(b)	λ clearly smaller than original in λ Fig 4.1	1	Need to see at least 3 wave fronts, equally spaced (by eye)
5 (a)	E_k = 0.5× 0.025 kg × (60 m s^{-1})^2 = 45 J (1)m (1)e	2	
(b)	$F = E_k/d$ = 45 J/0.60 m = 75 N(1)m (1)e	2	accept use of 50J => 83 N or via *suvat* & *F=ma*
6	either sharper/better contrast/less fuzzy/clearer (1); because other wavelengths (with different fringe separations) removed/single wavelength/monochromatic (1) ***or*** dimmer (1); because filter absorbs (most of) the light (1)	2	first mark for correct description second mark for correct linked explanation
7 (a)	For long λ, k/λ is small (1); compared with $g\lambda/2\pi$ so 2nd term under the $\sqrt{}$ is negligible (1)	2	1st marking point is for recognising that k/λ is small; 2nd marking point is for the comparison with $g\lambda/2\pi$ evaluation of k/λ for suggested λ is (1) without similar for $g\lambda/2\pi$
(b)	longer λ waves arrive first (because they are faster)(1) longer λ are faster because v is proportional to λ (1);	2	accept valid calculations for second mark
	Section A total	**21**	

Question	Answer	Marks	Guidance
8 (a) (i)	1.0×10^{-3} m / 8.0×10^{-6} m = 125 (1)m; (1)e	2	
(a) (ii)	maximum possible angle = 90° (1); so λ_{max} = d sin (90°) = d (8.0×10^{-6} m) (1)	2	attempt to calc θ gives sin θ > 1 (1); so not possible (1)
(b)	Apparent d = component of d perpendicular to IR owtte (1); Evidence of resolution / trig to get d cos A (1)	2	acceptable diagram and trig can score both marks
(c)	Need to have large d *(compared to others)* to produce max. for 300 μm (1); would result in very small angle for 0.74 μm / resolution would be poor due to large range of angles (1)	2	accept for one mark correct explanation that relates λ to d accept valid calculations for both marks
	Total	**8**	
9 (a)	f = 2.998×10^{8} m s^{-1}/ 1064×10^{-9} m = 2.818×10^{14} Hz (1); E = 6.626×10^{-34} J s × 2.818×10^{14} Hz =1.867×10^{-19} J (1)m (1)e	3	or use $E = hc/\lambda$; equation recall = (1); then (1)m; (1)e evaluation mark dependent on 4 s.f.; intermediate rounding gives same result to 4 s.f.
(b) (i)	P = 100×10^{-6} J /10×10^{-9} s = 10 000 W	1	
(b) (ii)	N = 100×10^{-6} J /1.867×10^{-19} J = 5.4×10^{14} (1)m; (1)e	2	2×10^{-19} J $\Rightarrow$ 5×10^{14}
(c) (i)	λ halves (1) reasoning/evidence for f doubling (1)	2	Can calculate both frequencies for both marks
(c) (ii)	Total energy must remain the same (1); There must be fewer photons as photon energy is higher for green (1)	2	
(c) (iii)	Any sensible suggestion based on the idea that it is now visible light / radiation of higher photon energy	1	
	Total	**11**	

Question	Answer	Marks	Guidance
10 (a)	accelerates at start, due to **gravity** (1); air resistance increases to balance weight (so constant velocity) (1)	**2**	unbalanced force for 'curved at start' balanced force for straight line
(b)	distance = area under curve (1); appropriate method for finding area carried out (1); comparison with 0.63 m (1)	**3**	indicated on graph or stated explicitly e.g. counting squares, drawing horizontal line at mean v accept answers 0.60 to 0.65 m
(c)	tangent drawn and $\Delta t \geq 0.5$ s used (1); answer between 0.6 & 0.9 m s^{-2} (1)	**2**	tangent to *s-t* graph at 0.5 s found correctly = (1)
(d)	(Weight same) but air resistance will be less (at any particular speed) (1); line is always above the original line (1) Initial slope of *v-t* graph similar (= *g*) (1); Slope declines more gradually than previous graph/steeper (1); higher terminal velocity (1) takes longer to reach terminal velocity (1)	**3**	An appropriate graph can be evidence for a number of the marking points. QWC is 'organise information'. Do not award 3 marks unless the whole argument is coherent and includes a correct reference to the forces.
	Total	**10**	
11 (a)	Estimates: extra height required = 0.5 m (±0.2 m) and mass between 40 and 100 kg (1); Extra energy = $mg\Delta h$ = 70 kg × 9.8 m s^{-2} × 0.3 m = 206 J (1)m; (1)e	**3**	Likely to calculate $mgh_{old} - mgh_{new}$ ignore references to specific jump heights if final difference is valid (i.e. 0.3 to 0.7 m)
(b)	Centre of mass further off the ground to start with, so less high to raise it	**1**	
(c) (i)	$v^2 = 2as$ = 2× 9.8 m s^{-2} × 1.1 m (1)m v = 4.6 m s^{-1} (> 4 m s^{-1}) (1)e	**2**	$v^2 = 2gh$ *method also acceptable for both marks*
(c) (ii)	 vector triangle as shown or equivalent (e.g. parallelogram) (1); result in range 6.2 – 6.6 m s^{-1}	**2**	Allow reverse working from Δv = 6.0 m s^{-1}. Allow algebraic treatment (not needed on spec) 8.0 m s^{-1} - (6.0 m s^{-1})cos(53°) =(8.0-3.6) m s^{-1} =4.4 m s^{-1} (1); (6.0 m s^{-1})sin(53°) =4.8 m s^{-1} $\lvert\Delta v\rvert = \sqrt{[(4.4 \text{ m s}^{-1})^2 + 4.8 \text{ m s}^{-1})^2]}$ = 6.5 m s^{-1} (1)
(c) (iii)	$a = \Delta v/\Delta t_{max}$ = 6.5 m s^{-1}/0.18 s = 36 m s^{-2} F = 82 kg ×36 m s^{-2} = 2960 N = 3000 N (1)m; (1)e	**2**	ecf own Δv: reject use of 8.0 m s^{-1} accept the use of 6.0 m s^{-1} (2733) to get full marks accept the use of 6.0x sin 53 (gives 2183 N) to get full marks
	Total	**10**	
	Section B total	**39**	

Question	Answer	Marks	Guidance
12 (a)	2.4 (1); ± 0.3 (1)	**2**	2.39 ± 0.3 (0.30) (0.31) gets (1) If 2.1 value incorrectly omitted as outlier, answer is 2.4 ± 0.2 which gets (1)
(b) (i)	Percentage or fractional uncertainty in standard laboratory kg is much less than for extension	**1**	'Standard mass is accurately calibrated' can gain the mark
(b) (ii)	9.8 x 1/ 2.4 (1)(m) = 4.1 (1); ± 0.5 (1);	**3**	ecf own answer to (a). No sf penalty. uncertainty can be calculated as % or from max/min values
(c)	Using minimum k =(3.2-0.6) N cm^{-1} = 2.6 N cm^{-1} (1); gives x = 24 N/(2.6 N cm^{-1}) = 9.2 cm and so will be at risk of deforming (1)	**2**	accept reverse argument 2.6 x 9 = 23.4 N as the minimum force.
	Total	**8**	
13 (a) (i)	systematic errors are consistently different from the true value (by a given amount all in the same direction) (1); random uncertainties have no discernible pattern (1)	**2**	e.g. constant difference
(a) (ii)	Systematic errors are inherent in the system/ taking more results just repeats the same error (1);	**1**	Or taking more results only allows better analysis of random uncertainties
(b)	stretched tape means measured distance is LESS than actual distance(1); this would lead to a lower calculated value for speed (1)	**2**	
(c)	linear graph, positive gradient, x-axis intercept >0 (1); valid explanation of **this** example (1)	**2**	line should cross y-axis e.g. line shifted downwards/all currents too small
	Total	**7**	

Question	Answer	Marks	Guidance
14 (a) (i)	$[f]$= Hz= s^{-1} and $[\lambda]$ = m so $[f\lambda]$ = m s^{-1} = $[v]$	1	*ora*
(a) (ii)	Left tube contains ½' loop' / ¼λ (1); Right tube contains 1½ 'loops' / ¾λ (1); All nodes & anti-nodes correctly labelled (1)	3	Loops which do not include the end correction *c* are limited to 1 mark out of the first two marks Labelling mark is independent of first two marking points.

(a) (iii)	sound waves travel down tube from loudspeaker (1);
	reflected/returned/bounces back at end (1);
	idea of superposition / interference (of these 2 waves) (1);
	node = zero amplitude/destructive interference (1);
	antinode = maximum amplitude/ constructive interference (1);
		3	Any 3 points
			
			QWC: Need to see at least two of the following words used and spelled correctly: superposition, interference, node, antinode, frequency, wavelength
			If QWC is not met then do not award more than 2 marks

(b) (i)	correct algebraic manipulation	1	
(b) (ii)	end correction is the same for both L_2 and L_1 / is constant	1	accept the diameters of the tubes are equal
(c) (i)	suggestion (1); explanation (1)	2	L_2 note is quieter (1); so harder to define resonance position (1) Allow other sensible reasons e.g. related to difficultly of using much greater length of tube
(c) (ii)	percentage uncertainties of 600Hz for L_2 and L_1 are greater (1); resulting in greater % uncertainty in v (1)	2	allow calculation of Δv in each case.
(c) (iii)	can compare all data together visually (1); more data available (1); Can identify/remove outliers (1); allows averaging over whole data (1); can see unexpected patterns e.g. departure from linearity (1)	2	Any 2 points Allow other valid reasons

Question	Answer	Marks	Guidance
(d) (i)	gradient = $(L_2 - L_1)/ (1/f) = (L_2 - L_1)f$ *(1)* substituting $f = v/\lambda$ and $(L_2 - L_1) = ½\lambda \Rightarrow ½v$ *(1)*	**2**	can make comparison with $y = mx + c$: Combining the two equations identifying $L_2 - L_1$ as y and $(1/f)$ as x (1); stating $c = 0$ & $m = ½v$ (1)
(d) (ii)	use of gradient with $\Delta(1/f) \geq 1$ ms (1); gradient = 170 m s^{-1} (1) so $v = 2 \times$ gradient = 340 m s^{-1} (1)	**3**	acceptable range 328 to 360 m s^{-1} Ecf own gradient for 2nd mark
(d) (iii)	use of uncertainty bar on $(L_2 - L_1) = \pm 0.04$ m (1); % uncertainty in 0.86 value gives 5% uncertainty (1) converting % uncertainty into final value = ± 17 m s^{-1}(1) or calculation of extreme values of v (1) m; subtraction of/from (d)(ii) (ecf own value) or ½($v_{max} - v_{min}$) (1) m (1) e	**3**	accept working from any $(L_2 - L_1)$value $L_2 - L_1$ in range 0.82 to 0.90 m. Steepest/shallowest straight line through origin is equivalent v_{max} = 360 m s^{-1} v_{min} = 328 m s^{-1} ½($v_{max} - v_{min}$) = 16 m s^{-1} or accept largest difference from own value
(e)	$(L_2 - L_1) \uparrow \Rightarrow \lambda \uparrow$(1); for constant $f \Rightarrow v\uparrow$ (therefore this is consistent for increased temperature) (1)	**2**	
	Total	**25**	
	Section C total	**40**	

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