

GCE

Physics B (Advancing Physics)

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

Advanced Subsidiary GCE

Mark Scheme for June 2014

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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.

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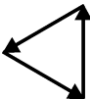
1. These are the annotations, (including abbreviations), including those used in scoris, which are used when marking

Annotation	Meaning
	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Follow through
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures Penalised only in 14(b)(iii)
	Correct response
	Arithmetic error
	Wrong physics or equation

2. 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

3. The following questions should be annotated with ticks , crosses and carets to show where marks have been awarded in the body of the text:
- 8bii
 - 10bii
 - 12c
 - 12d
 - 13aii
 - 13aiv
 - 14biii
 - 14c
4. Do not penalise excessive significant figures anywhere except Q14(b)(iii). Unit errors are covered in Q9(a)(i).

Question	Answer	Marks	Guidance
1 (a)	J s^{-1}	1	
(b)	kg m s^{-2}	1	
2 (a)	B	1	
(b)	C	1	
(c)	A	1	
(d)	C	1	
3 (a)	1	1	
(b)	10^{-4}	1	
4	2 nd box and no others	1	
5 (a)	B and H	1	
(b)	E : arrow at 3 o'clock (1); G : arrow between 10 and 11 o'clock (1)	2	allow one mark if both E and H are mirror images of correct arrows
(c)	 or clockwise combination.	1	Needs to show the addition of three tip-to-tail arrows forming equilateral triangle (by eye). Reject a right-angled triangle; reject 3 arrows in star formation.
6 (a)	speed: evidence of scale drawing or trig. / Pythagoras (1); answer of 61 m s^{-1} (1); direction: angle of 35° or 55° correctly indicated (1); E of S (1) or equivalent, e.g. bearing 145° ;	4	a bald 61 m s^{-1} gets both marks (± 3 for scale drawing) labelled angle on diagram in range $33 - 37^\circ$ gets both marks 4 th mark not awarded if no angle/incorrect angle given ecf from speed
(b)	35 m s^{-1} (1); (towards the) west or equivalent, e.g. bearing 270° (1)	2	(If wind not E-W, any southerlyish wind with westerly component of 35 m s^{-1} is acceptable) allow ecf from part (a)
7 (a)	$1 \times 590 \times 10^{-9} \text{ m} = d \sin(18.2^\circ)$ (1); $d = 590 \times 10^{-9} \text{ m} / \sin(18.2^\circ) = 1.89 \times 10^{-6} \text{ m}$ ($\approx 2 \times 10^{-6} \text{ m}$) (1)m; (1)e	2	Watch for $590 \times 10^{-9} \text{ m} \times \sin(18.2^\circ) = 1.84 \times 10^{-7} \text{ m}$ which gets 0.
(b)	largest $\theta = 90^\circ / \sin \theta = 1$ so $\lambda = d \sin \theta / 3 = 1.89 \times 10^{-6} \text{ m} / 3 = 630 \text{ nm}$	1	$d = 2 \times 10^{-6} \text{ m}$ gives 667 nm
Section A total		22	

Question	Answer	Marks	Guidance
8 (a) (i)	From diagram, radius = 14mm/70mm $\times$ 35 = 7 m (1); Area = $3 \times \pi \times 7^2 = 462 \text{ m}^2$ (1)	2	accept radius range 6 – 9 m Ecf own radius for 2 nd mark but watch out for incorrect method using area of triangular base which gets 0.
(a) (ii)	In 1 s, $V = 2.5 \text{ m s}^{-1} \times 500 \text{ m}^2 = 1250 \text{ m}^3$ (1); $m = V\rho = 1250 \text{ m}^3 \times 1030 \text{ kg m}^{-3} = 1.29 \times 10^6 \text{ kg}$ (1)	2	Accept ecf own area in (a) 462 m ² gives 1155 m ³ (1); and $1.19 \times 10^6 \text{ kg}$ (1)
(b) (i)	$E_k = \frac{1}{2} \times 1.29 \times 10^6 \text{ kg} \times (2.5 \text{ m s}^{-1})^2 = 4.03 \times 10^6 \text{ J}$ (4 MJ) (1);	1	Needs evidence of calculation $E = \frac{1}{2} \times 1.29 \times 10^6 \times (2.5)^2 = 4 \times 10^6 \text{ J}$ or a calculated answer (with no working) of 3.1 MJ (from $1 \times 10^6 \text{ kg}$) or 4.023 MJ (from unrounded answer to aii)
(b) (ii)	friction / electrical resistance in turbine/generator & wiring (1); causes turbines/generators/some energy dissipated as heat/sound (1); turbine blades don't trap all water/water passing through turbine circle not slowed down to 0 (1); so water retains some kinetic energy (1); front turbines will disturb flow to one at back (1); so less energy extracted at back (1)	4	QWC: 4 marks not awarded unless two separate factors are clearly and separately discussed. This means that 4 marks does require a clear structure, e.g. columns, paragraphs.
Total		9	
9 (a) (i)	$f = E/h = 3 \times 10^{-15} \text{ J} / 6.6 \times 10^{-34} \text{ J s} = 4.55 \times 10^{18} \text{ Hz}$ (1); $\lambda = c/f = 3.0 \times 10^8 \text{ m s}^{-1} / 4.55 \times 10^{18} \text{ Hz}$ $= 6.6 \times 10^{-11} \text{ m} = 66 \text{ pm}$ (1)	2	Or: recall of $E = hc/\lambda$ (1); substitution & evaluation (1)
(a) (ii)	output energy in 1 s = $0.5/100 \times 12 \times 10^3 \text{ J} = 60 \text{ J}$ (1); $N = 60 \text{ J} / 3 \times 10^{-15} \text{ J} = 2.0 \times 10^{16}$ (1)	2	Watch for use of 50% which loses 1 st mark but can get 2 nd mark for FT (gives 2.0×10^{18})
(a) (iii)	most of the 12 kW is dissipated inside the instrument and would damage it/start a fire (1)	1	answer needs to recognise that this power would damage the tube
(b) (i)	$v = \sqrt{(2E/m)} = \sqrt{(2 \times 7.0 \times 10^{-17} \text{ J} / 9.1 \times 10^{-31} \text{ kg})}$ $= \sqrt{(1.54 \times 10^{14} \text{ J kg}^{-1})} = 1.24 \times 10^7 \text{ m s}^{-1}$ (1)m; (1)e	2	Watch for incorrect use of λ from ai gives 1.09×10^7
(b) (ii)	$\lambda = h/mv = 6.6 \times 10^{-34} \text{ J s} / (9.1 \times 10^{-31} \text{ kg} \times 1.24 \times 10^7 \text{ m s}^{-1})$ $= 5.85 \times 10^{-11} \text{ m} = (58 \times 10^{-12} \text{ m})$ (1)	1	Using $1 \times 10^7 \text{ m s}^{-1}$ gives 73 pm
(b) (iii)	$E_k \propto v^2 \Rightarrow v^2 \downarrow 4 \times \Rightarrow v \downarrow \sqrt{4} \times = 2 \times$ (to half of answer in (i)) (1); $\lambda \propto 1/v \Rightarrow \lambda \uparrow$ by the same ratio as the velocities (1)	2	Accept recalculation (b) (i) (1) & (ii) (1) $E_k \downarrow \Rightarrow v \downarrow \Rightarrow \lambda \uparrow$ without numbers gets (1) Reject a bald answer 'doubles' without explanation..
Total		10	

Question	Answer	Marks	Guidance
10 (a) (i)	66 cm = $\frac{1}{2}\lambda$ and so $\lambda = 1.32$ m (1); $f = v/\lambda = 340 \text{ m s}^{-1}/1.32 \text{ m} = 258/260 \text{ Hz}$ (1)	2	accept 132 cm for first marking point no ecf on λ
(a) (ii)	N and A labelled and alternating (1); Antinode at each end of drawing/list (1); 3 'loops' e.g. ANANANA or NANANAN (1)	3	Candidates may intend equal spacing which is hard to draw so do not penalise inequality here. e.g. a correct unlabelled diagram would get mp2 & mp 3
(b) (i)	same f needed (1); $\lambda \propto v$ (both increase) so flute needs to be longer (1)	2	no mark for 'longer flute' without explanation
(b) (ii)	v must become $340 \text{ m s}^{-1} \times \sqrt{(298/283)} = 349 \text{ m s}^{-1}$ (1); percentage increase in $v = 100\% \times (9/340) = 2.6\%$ (1); use of $f \propto v$ (λ is unchanged) (1)	3	or ratio of v s = $\sqrt{(\text{ratio of } T\text{s})} = 1.026$ (1); which is a 2.6% increase (1); watch for stage-by-stage calculation with rounding between stages resulting in e.g. 2.3% which is OK
Total		10	
11 (a)	Gradient is steepest at the origin (1); therefore greater acceleration and so greater force (1)	2	Must refer to gradient at the start/at the origin
(b) (i)	board has stopped accelerating the diver upwards/starts to decelerate due to gravity/has maximum (upwards) velocity	1	recognising that this is the end of the upwards push earns this mark
(b) (ii)	this is the highest point because $v = 0$ / changes direction at this point	1	
(c) (i)	distance risen (from board) to highest point of dive	1	allow 'distance between B and C'/'distance travelled in this time'
(c) (ii)	area above CD = $\frac{1}{2}$ base $\times$ height (1)m; $\frac{1}{2} \times 9.2 \text{ m s}^{-1} \times (1.64\text{s} - 0.7 \text{ s}) = 4.3 \text{ m}$ (1)e	2	allow equivalent using equations of uniformly accelerated motion, with (1)m (1)e
(d)	force most at start and drops all the time (1); larger $v \Rightarrow$ larger resistive force (1)	2	Mp1 describes the change in a or F Mp2 is a mechanism in terms of resistance
Total		9	

Question	Answer	Marks	Guidance
12 (a) (i)	2.1 to 2.3 squares = 4.2 to 4.6 V	1	
(a) (ii)	1 cycle in 4 divisions $\Rightarrow T = 8 \text{ ms}$ (1) ; $f = 1/T = 125 \text{ Hz}$ (1)	2	If '8' seen assume 8 ms meant and award mp1
(b)	$0.1 \times 20 \text{ ns} = 2 \times 10^{-9} \text{ s}$ (1)	1	
(c)	Advantages: Great range of voltages can be used for many different input p.d.s (1); Excellent time resolution can analyse fast-changing signals (1); Values of amplitude and period can be easily obtained wave form easy to see and (1) Can plot rapid changes owtte because electrons have small mass (1) Disadvantages: Only repeated signals can be displayed because it needs the signal to be redrawn on the screen continually (1); Screen resolution limited because lacks minor divisions (1)	2	Award marks only for correct <u>explanations</u> of advantages & disadvantages Must have one advantage and one disadvantage. Do not award marks for unexplained quotes from the article, e.g. 'screen display has limited precision' NOT 'low inertia' (In article)
(d)	large computer memory (1); needed <u>because</u> large amounts of data captured by cro sweep(1); sensors with rapid response times (1); needed <u>because</u> cro signal changes rapidly/has small time resolution (1) memory/processors with rapid response times (1); needed <u>because</u> sensor output changes rapidly/has small time resolution (1)	4	Any two pairs. 1 st mark is for describing a necessary development, which could be quoted from the article. 2 nd mark must be an interpretation of the article, not a straight quote; it. must be an explanation in terms of what a cro trace could capture and which the digital storage oscilloscope must copy.
Total		10	

Question	Answer	Marks	Guidance
13 (a) (i)	$24000 \text{ Wh} / 35 \text{ Wh kg}^{-1} = 686 \text{ kg} (> 500 \text{ kg}) (1)\text{m}; (1)\text{e}$	2	
(a) (ii)	Car: mass increase will reduce the acceleration/increase the force needed for the (same) acceleration (1); also increases energy required to accelerate / climb hills (1); Forklift: makes it more stable / less prone to tip (1) Idea of low centre of mass (1)	3	Do NOT credit any reference to fuel Accept increasing braking distance / increasing friction Accept correct discussion of moments. 3 out 4 marking points QWC is clear organisation and use of appropriate terms
(a) (iii)	$20\% \text{ of } 50\text{kW} = 10\text{kW} = 10\,000 \text{ J in } 1 \text{ s} (1)\text{m}; (1)\text{e}$	2	
(a) (iv)	decreased range or increased frequency of re-charging (1); battery will overheat (1); this will increase self-discharge (1)	2	2 from 3 marking points
(b) (i)	$a = 27 \text{ m s}^{-1} / 15.4 \text{ s} = 1.75 \text{ m s}^{-2} (1);$ $F = ma = 1170 \text{ kg} \times 1.75 \text{ m s}^{-2} = 2050 \text{ N} (\approx 2 \text{ kN}) (1)$	2	
(b) (ii)	$\Delta E_k = \frac{1}{2}mv^2 = 0.5 \times 1170 \text{ kg} \times (27 \text{ m s}^{-1})^2 = 426\,000 \text{ J} (1);$ $P = 426\,000 \text{ J} / 15.4 \text{ s} = 27\,700 \text{ W} (\approx \frac{1}{2} \text{ of } 49 \text{ kW}) (1)$	2	or $v_{\text{mean}} = 27 \text{ m s}^{-1} / 2 = 13.5 \text{ m s}^{-1} (1);$ $P = Fv = 2050 \text{ N} \times 13.5 \text{ m s}^{-1} = 27\,700 \text{ W} (1)$ but must use mean velocity otherwise zero marks Using 2 kN gives 27 000 W with this approach.
(b) (iii)	$t = 120 \text{ km} / 80 \text{ km hour}^{-1} = 1.5 \text{ hours} (1);$ $16 \text{ kWh} / 1.5 \text{ hours} = 10.67\text{kW} = 11 \text{ kW} (1)$	2	
Total		15	

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