GCE

Physics B (Advancing Physics)

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

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.

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

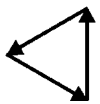
1. These are the annotations, (including abbreviations), including those used in scoris, which are used when marking

Annotation	**Meaning**
BP	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.
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 **Penalised only in 14(b)(iii)**
✓	Correct response
AE	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 ° 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)	$1 \times 590 \times 10^{-9}$ m = $d \sin(18.2°)$(1); $d = 590 \times 10^{-9}$ m / $\sin(18.2°) = 1.89 \times 10^{-6}$ m ($\approx 2 \times 10^{-6}$ m) (1)m; (1)e	2	Watch for 590×10^{-9} m × $\sin(18.2°) = 1.84 \times 10^{-7}$ m which gets 0.
	(b)	largest θ = 90 ° / $\sin\theta$ = 1 so $\lambda = d \sin\theta /3 = 1.89 \times 10^{-6}$ m/3 = 630 nm	1	$d = 2 \times 10^{-6}$ m gives 667 nm
		Section A total	**22**	

Question			Answer	Marks	Guidance
8	(a)	(i)	From diagram, radius = 14mm/70mm x 35 = 7 m (1); Area = 3 × π × 7^2 = 462 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 m s^{-1} × 500 m^2 = 1250 m^3 (1); $m = V\rho$ = 1250 m^3 × 1030 kg m^{-3} = 1.29 × 10^6 kg (1)	2	Accept ecf own area in (a) 462 m^2 gives 1155 m^3 (1); and 1.19 × 10^6 kg (1)
	(b)	(i)	E_k = ½ ×1.29 × 10^6 kg × (2.5 m $s^{-1})^2$ = 4.03 × 10^6 J (4 MJ) (1);	1	Needs evidence of calculation E = ½×1.29×10^6×$(2.5)^2$ = 4×10^6 J or a calculated answer (with no working) of 3.1 MJ (from 1× 10^6 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 × 10^{-15} J/6.6 × 10^{-34} J s = 4.55 × 10^{18} Hz (1); $\lambda = c/f$ = 3.0 × 10^8 m s^{-1}/ 4.55 × 10^{18} Hz = 6.6 × 10^{-11} m = 66 pm(1)	2	Or: recall of $E = hc/\lambda$ (1); substitution & evaluation (1)
	(a)	(ii)	output energy in 1 s = 0.5/100 × 12 × 10^3 J = 60 J(1); N = 60 J/3 × 10^{-15} J = 2.0 × 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)	$v = \sqrt{(2E/m)} = \sqrt{(2×7.0 × 10^{-17} J/9.1× 10^{-31} kg)}$ = $\sqrt{(1.54× 10^{14} J kg^{-1})}$ = 1.24× 10^7 m s^{-1} (1)m; (1)e	2	Watch for incorrect use of λ from ai gives1.09 x 10^7
	(b)	(ii)	$\lambda = h/mv$ = 6.6 × 10^{-34} J s/(9.1 × 10^{-31} kg×1.24× 10^7 m s^{-1}) = 5.85 × 10^{-11} m = (58 × 10^{-12} m) (1)	1	Using 1× 10^7 m s^{-1} gives 73 pm
	(b)	(iii)	$E_k \propto v^2 \Rightarrow v^2\downarrow$ 4× $\Rightarrow v\downarrow \sqrt{4}$× = 2× (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 = ½ λ and so λ = 1.32 m (1); *f* = *v*/ λ = 340 m s^{-1}/1.32 m = 258/260 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); λ ∝ *v* (both increase) so flute needs to be longer (1)	2	no mark for 'longer flute' without explanation
	(b)	(ii)	*v* must become 340 m s^{-1} × √(298/283) = 349 m s^{-1} (1); percentage increase in *v* = 100% × (9/340) = 2.6% (1); use of *f* α *v* (λ is unchanged) (1)	3	or ratio of *v*s = √(ratio of *T*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 =½ base × height (1)m; ½×9.2 m s^{-1}×(1.64s - 0.7 s) = 4.3 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* ⇒ 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 ⇒ T = 8 ms (1) ; f=1/T = 125 Hz (1)	2	If '8' seen assume 8 ms meant and award mp1
	(b)		0.1 × 20 ns = 2 x 10^{-9}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 explanations 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 because large amounts of data captured by cro sweep(1); sensors with rapid response times (1); needed because cro signal changes rapidly/has small time resolution (1) memory/processors with rapid response times (1); needed because sensor output changes rapidly/has small time resolution (1)	4	Any two pairs. 1st mark is for describing a necessary development, which could be quoted from the article. 2nd 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 Wh / 35 Wh kg $^{-1}$ = 686 kg (> 500 kg) (1)m; (1)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% of 50kW = 10kW = 10 000 J in 1 s (1)m; (1)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 m s $^{-1}$ / 15.4 s = 1.75 m s $^{-2}$ (1); $F = ma$ = 1170 kg × 1.75 m s $^{-2}$ = 2050 N (≈ 2 kN) (1)	2	
	(b)	(ii)	$\Delta E_k = ½mv^2$ = 0.5×1170 kg×(27 m s $^{-1}$) ^{2} = 426 000 J (1); P = 426 000 J / 15.4 s = 27 700 W (≈½ of 49 kW) (1)	2	or v_{mean} = 27 m s $^{-1}$ / 2 =13.5 m s $^{-1}$ (1); $P = Fv$ = 2050 N × 13.5 m s $^{-1}$ = 27 700 W (1) but must use mean velocity otherwise zero marks Using 2 kN gives 27 000 W with this approach.
	(b)	(iii)	t = 120 km / 80 km hour $^{-1}$ = 1.5 hours (1); 16 kWh / 1.5 hours = 10.67kW = 11 kW (1)	2	
			Total	**15**	

Question			Answer	Marks	Guidance
14	(a)	(i)	(variation in) human reaction time is the limiting factor	1	accept other reasonable suggestions Repeats are varying at the first decimal place
	(a)	(ii)	uncertainty in end and start time is now divided by 10/reduces % uncertainty in T values	1	Allow 'can measure longer time interval with greater accuracy'
	(a)	(iii)	same percentage uncertainty/divide 0.1 by 10 (1)	1	
	(a)	(iv)	T_{min} = 1.09 s & = 1.11 s so 1.188 < T^2 < 1.232 (1); T^2_{mean} = 1.21 and ΔT^2 = 1.232 – 1.21 = 0.02 (1)	2	both are method marks accept T^2_{mean} to upper or lower limit T^2 accept doubling **percentage** error in *T*; percentage error in *T* = 0.91 (1); ⇒ percentage error in T^2 doubles to 1.8 ⇒ΔT^2 = (1.8× 1.21)/100 = 0.022 = 0.02 to 1 s.f. (1)
	(b)	(i)	T^2 values of 0.36 s^2 & 0.62 s^2 (1); correct plotting (1)	2	Ignore incorrect / absent values for *T*
	(b)	(ii)	$T^2 = \frac{4\pi^2}{g} L$ (1); relate to line equation *y* = *mx* (+ *c*) (1)	2	First mark for algebraic manipulation. Allow 2nd mp for showing gradient = T^2/L (= $4\pi^2/g$)
	(b)	(iii)	best-fit line drawn (1); gradient correctly determined using triangle with Δ*L* at least 0.1 m (1); *g* = $4\pi^2$/gradient calculated (1)	3	if data for points not on line used, this mark is not awarded Penalise > 3 sf
	(c)		advantages: (much) longer *T* reduces uncertainty Δ*T* (1); % uncertainty in L decreases (1) more precise determination of e.g. central point of swing (1); greater range of lengths to increase reliability/validity (1); disadvantages: practical difficulty of working with 3m pendulum in lab.(1); uncertainty in length Δ*L* will increase as *L* longer than metre rule (1); long pendulum more susceptible to draughts/air resistance/wobble (1)	3	any 3 allow all advantages or all disadvantages 'Wobble' includes departure from 2D motion, i.e. acting as conical pendulum
			Total	**15**	

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