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 2015

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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:
4, 10ai & 12cii

Question	Answer	Marks	Guidance
1 (a)	force	1	
(b)	displacement (1); force (1)	2	either order. 1 mark max for both correct plus a third variable.
2 (a)	$\frac{hc}{\lambda}$ (1); $F\Delta s$ (1)	2	either order
(b)	$d \sin\theta$ (1); $\left(\frac{u+v}{2}\right)t$ (1)	2	either order
3 (a)	$\sin\theta = n\lambda/d = (590 \times 10^{-9}\text{ m})/(2.8 \times 10^{-6}\text{ m})$ (1); = 0.211 θ = arcsin (0.211) = 12.2 ° = 12 ° (1)	2	1st mark for correct substitution into the equation allow rounding 0.211 to 0.21, giving θ = 12.1 ° a bald 12° gets both marks. Allow 2 or 3 s.f. and reject 4 s.f.
(b)	$n = (2.8 \times 10^{-6}\text{ m}) \times \sin(57.4°)/(590 \times 10^{-9}\text{ m}) = 3.998$ (1); so n = 4 (1)	2	allow 4.0 as evidence of rounding to an integer Bald answer of 4 gets both marks.
4	Peak intensity (and all others) increased (1); Width of the central peak is half what it was (1);	2	The two marks are independent. Both minima need to be at the first scale marking from the origin (by eye)
5	magnitude=$\sqrt{\{(2.4\text{ m s}^{-1})^2+(2.8\text{ m s}^{-1})^2\}}=3.69\text{ m s}^{-1}=3.7\text{ m s}^{-1}$ (1); direction = N arctan(2.8 m s^{-1}/ 2.4 m s^{-1}) E = N 49.4 ° E = N 49 ° E (1)m; (1)e	3	rounding 3.69 to 3.7 & using cos ⇒ 49.6°/using sin ⇒ 49.2° so a bald answer of 49.2° or 49.4° or 49.6° gets both marks. allow bearing = 49 °/049 ° or any correct, clearly labelled angle. Correct angle gets 1 mark, correct indication of direction (NOT just NE) gets the 2nd mark. Ignore excessive s.f.
6	assumption: negligible/no air resistance/only force is gravity/weight/ constant acceleration/ constant deceleration(1); $v^2 = u^2 + 2as \Rightarrow 0 = (12\text{ m s}^{-1})^2 + 2(-9.8\text{ m s}^{-2})s$ $s = (12\text{ m s}^{-1})^2/2(9.8\text{ m s}^{-2}) = 7.35\text{ m} = 7.3\text{ m}$ (1)m; (1)e 7.4 m is a rounding error	3	if g not opposite in sign to u, no calculation marks (gross error of Physics) allow alternative valid approaches using more than one *suvat* equation, e.g. $a = \Delta v/t \Rightarrow t$ = (0-12)m s^{-1}/-9.8 m s^{-2} = 1.224 s (1); average velocity = (0+12)m s^{-1}/2 = 6 m s^{-1} so s = 6 m s^{-1} × 1.224 s = 7.34 m = 7.3 m
7	symmetrical parabola (1); ball goes higher and hits the ground nearer the launch point (1)	2	by eye; SSU to decide both points needed for the second mark.
	Section A total	**21**	

Question	Answer	Marks	Guidance
8 (a)	(identical) waves (in opposite directions) superpose/ interfere/ standing waves are produced (1); both constructive interference/ antinodes **and** destructive interference/nodes occur (at different places) (1); **X** is an antinode/constructive interference (1) ; loudspeakers are in phase (1);	3	Can credit mp1 within explanations below mentioning the key word(s) Can explain in terms of phasors
(b)	$\lambda = v/f$ = 340 m s^{-1}/2000 Hz = 0.17 m (1); distance = ½λ = 0.085 m (1)	2	ecf own wavelength
(c) (i)	wavelength is half that in Tom's experiment (1); (speed is same, so) frequency must be doubled/ 4000 Hz. (1)	2	A bald 'frequency doubled' gets the 2nd marking point only
(c) (ii)	they are in antiphase/exactly 180° out of phase (**as they leave the loudspeakers)**	1	Reject answers treating only the situation **at X**. NOT just 'out of phase';
(d)	In the room, reflections/echoes off walls/floor/ceiling (to give extra superposition) (1); Extra reflections add noise/ interference (1)	2	Outside, minima are lower and maxima higher
	Total	**10**	
9 (a) (i)	each LED has a power of 5W/22 = 0.227 W (1); photon energy $E = hf$ = 6.6 × 10^{-34} J s × 5.0 × 10^{14} Hz = 3.3 × 10^{-19} J (1); number of photons/second = 0.227 W / 3.3 × 10^{-19} J =6.88 or 6.89 × 10^{17} s^{-1} (1)	3	rounding 0.23 W ⇒ 6.97 × 10^{17} s^{-1} = 7.0 × 10^{17} s^{-1} unrounded 0.22727…W ⇒ 6.88 × 10^{17} s^{-1} ecf incorrect power or photon energy Bald correct answer with no working gets 3 marks Missing ÷ 22 LEDs gives 1.5 × 10^{19} s^{-1} = 2 marks.
(a) (ii)	most /45W of the output of the filament lamp is not visible (1); emits photons of lower frequency/lower energy/ infrared (1)	2	a bald 'emits mostly infrared' gets both marks
(b)	The given value 5.0×10^{14} Hz corresponds to λ =3.0 ×10^{8} m s^{-1}/5.0×10^{14} Hz = 600 nm (1); Compares with mean λ (520 to 580 nm) deduced from the graph OR justifies that 600 nm cannot be the mean (1)	2	Or estimate mean λ (in the range 520 to 580 nm) (1); and then calculates the corresponding value of f = 5.2 to 5.8 ×10^{14} Hz and compares with the given 5.0×10^{14} Hz (1)
(c)	will look pinker/redder/more orangey (due to increased longer wavelengths & reduced higher ones) (1); suggestion for use (1)	2	Allow 'view though a diffraction grating/spectrometer/prism' Must justify in terms of appearance. could refer to red and blue ends of the spectrum Must be a specific environment, e.g. more comfortable/relaxing/less harsh light/ darkroom/nightlight for child's room/different horticultural uses e.g. photosynthesis, ripening fruit
	Total	**9**	

Question	Answer	Marks	Guidance
10 (a) (i)	tangent drawn at t = 30 s (1); acceleration calculated e.g. = (400-70 m s^{-1})/45 s = 7.0 m s^{-2} (1)	2	Please annotate graph with a tick Must have $\Delta t \geq 20$ s Allow a tolerance of $6 \leq a \leq 9$ m s^{-2}
(a) (ii)	$F_{resultant}$ = 95 kg × 7 m s^{-2} = 665 N (1); upward force = mg - $F_{resultant}$ (1); = (95 kg × 9.8 m s^{-2}) - 665 N = 931 – 665 N = 266 N (1)	3	ecf own value of a allow $F = m(g-a)$ Bald answer of 266 N with no working gets 3 marks
(b)	velocity reaches a maximum and then starts to drop (1); (or acceleration followed by deceleration) decelerating/drag/frictional force on FB is increasing (1); caused by the air becoming denser (1)	3	Ignore 'reaches terminal velocity of 350 m s^{-1} /at ≈ 48 s' Reject positive gradient followed by negative gradient. Allow change body shape to increase area
(c)	Use of clear and appropriate method of finding area under graph (1); Total areas of triangles/trapezia calculated (and compared with 35 km) (2)	3	Scroll back to the bottom of 10 b to see method used. Accuracy marks: Answer in range 34 – 36 km get 2 marks Answer in range 32 – 38 but not 34 – 36 km gets only 1 mark
	Total	11	

Question	Answer	Marks	Guidance
11 (a)	distance travelled = vt, so volume swept out, $V = Avt$ (1); $m = \rho V = \rho Avt$ (1)	2	
(b)	$E_k = \frac{1}{2}mv^2$ $= \frac{1}{2}(\rho Avt)v^2 = E_k = \frac{1}{2}\rho Av^3t$ (1)	1	quoting $m = \rho Avt$ and $E_k = \frac{1}{2}mv^2$ implying combination into $E_k = \frac{1}{2}\rho Av^3t$ is enough for the mark.
(c)	$P = \frac{1}{2}\rho Av^3 = 0.5 \times 1.2\ \text{kg m}^{-3} \times 9.0\ \text{m}^2 \times (20\ \text{m s}^{-1})^3$ = 43 200 W (= 43 000 W) (1)s (1)e	2	A bald correct answer with no evidence of calculation gets both marks Attempt to use $E_k = \frac{1}{2}\rho Av^3t$ gets 0 unless t = 1 s
(d)	***Energy arguments*** *Three of:* energy losses (to air) more for coach (1); because A is larger for coach (1); if travelling at same speed (1); energy loss/fuel consumed by coach is greater (1); energy loss/fuel consumed per traveller is less for coach (1); car is streamlined, while coach is like model which reduces losses from car but not coach (1); ***Social/economic/environment arguments:*** *One of:* Can argue either coach or car is cheaper as cost per person depends on number of passengers (1); convenient to use a car: e.g. shorter total journey time, can leave when you like, goes where you want to get to (1); coaches more environment-friendly; less pollution (CO_2/particulates) per person (1); cars offer privacy (1)	4	Three marks for energy arguments and one for social/ economic/environment arguments. Ignore arguments based on mass of vehicles unless justified by greater mass → greater weight → more rolling friction or GPE needed in climbing hills Credit attempts to quantify argument ignore 'car travels faster' QWC ('form and style appropriate to purpose') requires a consideration of both energy consumption and social factors; the mark scheme will not allow 4/4 unless both aspects are covered .
	Total	9	

Question	Answer	Marks	Guidance
12 (a) (i)	**C B**	**1**	both needed, in that order
(a) (ii)	**A C**	**1**	both needed, in that order
(b)	$\Delta V/\Delta\theta$ =(1.6 - 0.4)/50 = 0.024 / 2.4 x 10^{-2} (1);m (1);e units of V $^{o}C^{-1}$ (1)	**3**	must have p.d./temp. to get either of these marks accept 0.02 allow e.g. mV $^{o}C^{-1}$ if conversion made
(c) (i)	If C is chosen: Statement about response time **so** newborn is has smallest possible time overheating/staff are alerted more quickly(1); and states that sensitivity is adequate (1) If A is chosen Statement about sensitivity **so** sensor responds more reliably/reaches a triggering voltage more easily (1) and states that response time is OK (1)	**2**	either **C** or **A** can be the final choice: the candidate needs to recognise the advantage of the small response time (**C**) and the greater sensitivity (**A**).
(c) (ii)	Starts at the same point (0,0.4) (1); levels off above 1.6 V (1); Hits maximum at a value of *t* between A & B (1)	**3**	Annotate with ticks.
	Total	**10**	

Question	Answer	Marks	Guidance
13 (a)	Total energy consumption is lower /each month the energy consumption is lower (1); Savings in the winter months are more significant than the summer(1); Any valid quantitative comparison : must show manipulation of the data (1)	3	any three points, but QWC ('organise information') requires a quantitative comparison for 3 marks. Do not credit answers based on data using the number of people in the house.
(b)	5280 – 3311 = 1969 kWh (1) 1969 kWh × 1000 × (60×60)s = 7088 MJ (1)	2	7088 MJ or 7 GJ both marks
(c) (i)	More people use more energy/ORA (which can make the comparison fairer) (1); The house has certain requirements which are the same however many people live there (1)	2	e.g. showering, heating extra rooms e.g. heating living room, cooking
(c) (ii)	April does not fit the trend Feb – Jun in 2000 (1); Highest consumption months in each year are different (1); Lowest consumption months in each year are different (1); Energy usage pattern between named months is different (1)	2	Any two points from the list (Feb 1996 & Apr 2000) (Oct 1996 & Nov 2000) Last marking point can gain credit twice if applied to different month ranges
(c) (iii)	Either 1996 or 2000 may have been untypical (1); Outside temperature affects how much heating/cooling is needed (1); If this is not taken into account then it is not valid to make the monthly comparison (1)	2	
(d)	There is correlation; increase in temperature (in summer months) leads to lower energy usage (1); low values in summer suggest little energy demand by air conditioning (in this year) (1); There is considerable variation in the data (wide spread) around the best-fit line (1); There are large energy differences between months with very similar temperatures (1); values are more consistent at higher temperatures/ higher temperatures probably more consistent over the 30 year period (1)	3	any three points 'inversely proportional' loses the 1st m.p Accept weak negative correlation for 2 marks e.g. Mar, Nov
	Total	**14**	

Question	Answer	Marks	Guidance
14 (a) (i)	Newton was the great authority in Physics/his ideas carried more weight (1); wave theory was thought of as foreign, not British (1); lack of experimental evidence(1); light travelling in straight lines/particle model could explain phenomena well enough (1)	2	Any two from four.
(a) (ii)	In order to produce a narrow beam (that was of the correct width) / slightly wider than the thickness of the card (1)	1	accept need for source to be coherent
(a) (iii)	Lasers are monochromatic / coherent (1)	1	allow 'lasers are high intensity/very bright/collimated' allow sensible statement about phase here
(b)	Same (absolute) uncertainty in the measurement/device (1); The % uncertainty is therefore reduced (by a factor of 40) (1)	2	Accept 'easier to measure/'easier to read' for one mark max. 2nd mp is dependent on the 1st mp as stated left
(c) (i)	9% for *d* (1); 4% for *x* (1); So uncertainty in λ is much greater than that in *x*(1) Therefore statement should either have said 'percentage uncertainty in the wavelength is roughly equal to the percentage uncertainty in the thickness of the card' **or** 'uncertainties in *x* and *L* are negligible compared with that in *d*'. (1)	3	Accept other valid calculations justifying % uncertainty using correct values for *d, L*,& *x* respectively May compare %uncertainty in *d* with that in *x*, or with a total combining all uncertainties
(c) (ii)	2.4 m $\times 10^{-2}$ × 0.11 × 10^{-3} m /6.4 m = 4.13 × 10^{-7} m (1)m (1)e	2	
(c) (iii)	(use of maximum values for *x* & *d*) **2.5 $\times 10^{-2}$** & **0.12 × 10^{-3}** (1); λ_{max} = 2.5 $\times 10^{-2}$ × 0.12 × 10^{-3} /6.35 = 4.72 $\times 10^{-7}$ m (1)	2	Allow approaches involving adding percentage fractional uncertainties in both *d* and *x* (& L) which give $\Delta\lambda/\lambda$ = 0.13 (0.14) and so λ_{max} = 4.6 $\times 10^{-7}$ m (4.7 $\times 10^{-7}$ m)
(c) (iv)	Numerical comparison of the systematic error with the uncertainty from the values in cii & ciii (1); If paper is at an angle to the beam, the beam is blocked by a value > thickness of paper (1); value of *d* substituted in the equation is too small, giving too small a value of λ (1)	3	systematic error is about 200 nm, while uncertainty quoted is about 60 nm. Allow ecf from values in (c)(ii) and (c)(iii). Accept valid diagram for showing link between increased angle and *d.* Recalculating the 'true' value of *d* from 635 nm can get this marking point.
	Total	**16**	

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