GCE

Physics B

Unit **H157/01:** Foundations of physics

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 or repeated 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

Section A: MCQs

Question	Answer	Marks	Guidance
1	A	1	
2	C	1	
3	D	1	
4	D	1	
5	C	1	
6	B	1	
7	B	1	
8	C	1	
9	C	1	
10	B	1	
11	B	1	
12	D	1	
13	B	1	
14	C	1	
15	B	1	
16	C	1	
17	A	1	
18	A	1	
19	C	1	
20	D	1	
	Total	20	

SECTION B

Question			Expected Answer	Mark	Rationale/Additional Guidance
21	(a)		$I_T = I_1 + I_2$	1	**Allow** if expressed in words e.g. "sum of I_1 and I_2 is I_T". Any subject.
	(b)		*V* same *R* halved (for I_2)	1 1	**NOT** voltage = 12V across both. Can be implied by equations, or calculations. e.g. $I_1 = V/2R$ and $I_2 = V/R$. Allow *R* doubled for I_1. No mark for resistors are doubled / twice as many resistors.
	(c)		$1/R_{parallel} = 1/R_1 + 1/R_2 = 1/100 + 1/200 = 3/200$ $R_{parallel} = 67\ \Omega$ $R_{total} = 100 + R_{parallel} = 167\ \Omega$ (<170 Ω)	1 1	Evaluation of parallel resistance Evaluation of 167 Ω. Both marks for bare 167 Ω. Accept 166 Ω if working shown. Accept evaluation of (100 + clear incorrect parallel calculation) for 2nd mark. One mark for showing full correct working leading to incorrect final answer.
	(d)		Power = (V^2/R =) $12^2/167 = 144/167$ = 0.86 (W)	1 1	Method **accept** other working method e.g. by finding current = 72 mA. Accept use of 170 Ω in place of their answer from (c) leading to 0.85 (W). Accept 0.9 (W). Evaluation **allow** ecf from part c.
			Total	**7**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
22			$1/v = 1/u + 1/f = 1/(-0.5) + 1/0.02$ $= 48$ $v = 1/48 = 0.021$ m	1 1 1	method and correct substitution Correct evaluation from their equation. Allow ecf on one error (eg sign/POT) from their calculation. answer must be to 2 SF **not** 0.0208 cm. 0.019 m from sign error 2/3 Negative value in final answer loses one mark
			Total	**3**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
23	(a)		stiffness decreases initially and starts to increase again ; after (strain) in range 2.5 to 3.5	1 1	Allow stiff<u>er</u> at low and high strains
	(b)		result in range 16 to 28 MPa construction of tangent above 48 MPa and correct method to find gradient	1 1	 Stress range drawn over at least 20 MPa
			Total	**4**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
24			Algebraic expression for $L = (4/3\ \pi\ r^3)/(\ \pi\ R^2)$ with any appropriate symbols, with or without π. OR correct substitution into equal volume e.g. $4/3\pi(0.25)^3 = \pi(100)^2 \times L$	1	Ignore POT errors on radii at this point. Allow volume of sphere $4/3\pi\{0.25\}^3 = 0.0654$ (or 0.021 π) (mm^3) for first mark. .
			$L = 2.08 \times 10^{-9}$ (m)	1	Evaluation. Allow 2.1 or 2nm. Use of diameter in either calculation will lose this mark
			Assumption: about shape of drop or slick; *or* volume of drop = volume of disc	1	**not** assumption about thickness as this is given in the stem i.e. all the drop ends up in the film and none goes into the water / talc; none is left on wire etc.
			Total	**3**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
25	**(a)**		sin(42°) / sin(27°) OR sin(27°) / sin(42°)	**1**	Use of Snell's law
			leading to 1.47 OR 0.68 AND relating to ratio of speeds.	**1**	Accept 1.5 e.g. $c_{glass} = c_{air} \times 0.68$ or evaluation of speed of light in glass = 2×10^8 ms^{-1}
	(b)		Light travels faster in water than glass	**1**	OR in terms of water and air: Light travels slower in water than air. If air and water described, both must be correct for this mark.
			light bends away from the normal on entering water / *r* > *i* for glass into water	**1**	Must have comparison or change of specific angle for *r* and *i* OR as the angle between the ray and the normal in water is smaller than the angle between the ray and the normal in air
			Total **Total Section B**	**4** **20**	

SECTION C

Question			Grid	Expected Answer	Mark	Rationale/Additional Guidance
26	**a**			(Force in direction of motion =) 1.5 cos20° (=1.41) Work done = force x distance = 1.41 x 1 = (1.41 kJ)	**1** **1**	Do not credit incorrect use of cos20° If answer given in J, need to see unit (e.g. 1409 J)
	b			($P = Fv$ = 1409 x 40) = 5.6 x 10^4 W	**1**	Ecf from (a). No credit for 1500 x 40 = 6.0 x 10^4 W unless ecf.
	c	**i**		$A = \pi r^2 = \pi \times 0.006^2 = 1.13 \times 10^{-4}$ (m ^{2}) stress = 1500 N / cross sectional area 1.3(3) x 10^7 (Pa)	**1** **1** **1**	Ignore POT error but penalise incorrect use of diameter CSA for their value; allow 1.5 for force Evaluation consistent with unit; apply POT error Allow 2/3 for use of 1.4kN leading to 1.2 x 10^7. Allow 2/3 for use of diameter leading to 3.3 x 10^6.
		ii		safe because working stress is about 3% / a lot lower than breaking stress	**1**	safety comment with explanation **e.g.** sensible suggestions about dangers of landing with flag deployed, cracks in wire reducing CSA, sudden additional force (e.g. wind, snagging) Sense of difference must be clear, ie stress is less than breaking stress allow ecf on stresses close to or above 460MPa Not just difference in values
		iii		(Strain = stress / E) = 1.33 x 10^7 / 210 x 10^9 6.32 x 10^{-5}	**1** **1**	Method **allow** ecf from stress in **i** POT error loses 1 mark Evaluation **accept** 0.0063 % if symbol given
				Total	**9**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
27	(a)		Any 3 from: Sample (the signal) at regular intervals The sample rate should be at least twice the highest frequency There are a limited number of levels of pd (stated or shown e.g. by several equally spaced horizontal lines on the figure). Assign (the sampled pd) to the nearest level.	**3**	Could be shown on figure by at least 4 equally spaced vertical lines from x axis to curve (This point scores two marks, including the regular interval mark) Accept "quantisation levels" in place of "levels of pd". Could be shown on figure by several equally spaced horizontal lines. Allow indication on figure of equally spaced vertical and horizontal sample-and-hold stepped line. This could be awarded marking points 1 and 3 and 4 if clear. Ignore any references to binary coding.
	(b)	i	2 points plotted correctly best fit line (with intercept)	**1** **1**	Points plotted to within half square tolerance Expect intercept with ½ small square of 10. Penalise line which clearly goes through origin. Line should be clean and straight.
		ii	(positive) non-zero intercept (at ≈ 10 kbytes/their intercept) when message time is zero	**1**	**Accept** line does not pass through origin
		iii	Gradient calculation leading to gradient in range 14 to 16 kbyte / s Bit rate due to sound = 8 x gradient ≈ answer in range 1.12 to 1.28 x 10^5bit / s	**1** **1**	 Inaccurate gradient x 8 correctly evaluated gets 1 mark
			Total	**9**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
28	**a**	**i**	Hard to judge the point when it is quietest (consistently) / intensity will have a broad minimum	**1**	**Expect** answers which relate to a judgement of where the minimum is **Allow** answers referring to hearing **Allow** any reference to stray signals / reflections / difficulty in reading small changes in oscilloscope trace
	a	**ii**	(Difficult to produce consistent results because of) placement of ruler / measuring tape may sag / uncertain where centre of microphone or speaker is	**1**	**Allow** suggestions relating to unknown location of detection of sound on microphone or speaker Allow suggestions which would improve the precision e.g position marker at centre of each speaker
	b	**i**	Path difference = 4.17 - 3.56 (=0.61m) Wavelength is the path difference (at this point for waves to be in phase) = 0.61m	**1** **1**	 Full credit for 0.61m on answer line
	b	**ii**	It will reduce (percentage) uncertainty in the measurement of speaker / microphone distances But the uncertainty in the microphone position (at minimum) is unchanged / more significant (so there is no/little change in the percentage error of the wavelength)	**1** **1**	Ignore reference to accuracy of measurement.
	c		v = (f λ = 560 x 0.61) = 342 (m s^{-1}) Largest smallest method: Either largest estimate 590 x 0.65 = 384 (m s^{-1}) or smallest estimate 530 x 0.57 = 302 (m s^{-1}) OR percentage uncertainty method: Finding percentage in f (30/560 = 5.4%) AND percentage in λ (0.04/0.61 = 6.6%)	**1** **1**	Evaluation. Accept 340. Allow ecf from (b)(i) throughout. **accept** max = 590 x 0.63 = 372 for using ± 0.02 **accept** min = 530 x 0.59 = 313 for using ± 0.02 Accept 3.3% for λ (0.02/0.61)

			Largest smallest method: Uncertainty is difference e.g (384-340) = 44 Or (340-302) = 38 OR Percentage uncertainty method: Adding percentage errors (leading to 12%) AND conversion to uncertainty (12% x 340 = 41 ms^{-1}). Uncertainty place value equal to or fewer than place value of speed	**1** **1**	Accept half the range leads to 41. Accept half the range = 30 from using ± 0.02 Accept 8 or 9% if 0.02 used and conversion leading to 30ms^{-1}. No decimal places allowed in either answer. e.g 340 ± 40 or 342 ± 40 or 342 ± 44
	d		(Both) now become minima Because one source is in antiphase with other / have added phase difference of π rad / 180°	**1** **1**	Accept maxima become minima or vice verse. Not out of phase
			Total **Total Section C** **Total Sections B & C**	**12** **30** **50**	

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