OCR
Oxford Cambridge and RSA

GCE

Physics A

Unit **H156/02:** Depth in physics

Advanced Subsidiary GCE

Mark Scheme for June 2016

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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

Annotation	**Meaning**
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
TE	Transcription error
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
SF	Error in number of significant figures
	Correct response
	Wrong physics or equation
BP	Blank Page

Abbreviations, annotations and conventions

Annotation	**Meaning**
/	alternative and acceptable answers for the same marking point
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

CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

If the data given in a question is to 2 sf, then allow to 2 or more significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Guidance.

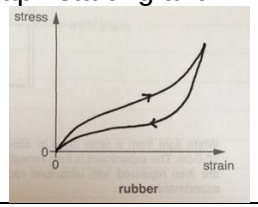
Question			Answer	Marks	Guidance
1	(a)		Transverse: vibrations /oscillations are perpendicular / right angles to the direction of travel / energy transfer (AW) Longitudinal: vibrations /oscillations are parallel to / in the same direction as the direction of travel / energy transfer (AW)	B1 B1	**Allow** 1 mark for 'For one of the waves, the oscillations / vibrations are at right angles and for the other they are parallel to the direction of travel' (AW) **Not** move for vibrations / oscillations **Allow** 1 mark for transverse (waves) can be polarised ORA
	(b)	(i)	40 (mV)	B1	
		(ii)	(T =) 3 x 0.5 = 1.5 (ms) f = 670 (Hz)	C1 A1	 **Note**: Answer to 3 SF is 667 (Hz) **Note**: 0.67 or 0.667 scores 1 mark
		(iii)	(330 = 670 × λ) λ = 0.49 (m)	 B1	**Possible** ECF from **(b)(ii)** **Note**: λ = 0.495 (m) if 667 Hz is used, therefore allow 0.50 or 0.5 (m) here
	(c)		Amplitude / height (of trace / signal) is smaller $I \propto A^2$ and amplitude (of sound or signal) is halved / amplitude is 2 div / amplitude is 20 (mV)	B1 B1	 **Note** this will also score the first B1 mark
			Total	**8**	

Question			Answer	Marks	Guidance
2	(a)	(i)	(When two or more waves meet at a point) the resultant <u>displacement</u> is equal to the sum of the <u>displacements</u> of the (individual) waves.	B1	**Allow**: net / total for 'resultant' **Not** amplitude
		(ii)	There is a constant / fixed phase difference (between the waves)	B1	**Allow** constant / fixed phase relationship **Ignore** 'the frequency / wavelength is the same' **Not** the same phase difference **Not** zero phase difference
	(b)		1. λ 2. $\frac{3\lambda}{2}$ or 1.5λ	B1 B1	
	(c)		$\lambda = \frac{ax}{D}$ stated <u>and</u> D and λ are constants. Separation decreases (AW)	M1 A1	**Allow** $x \propto a^{-1}$ **Allow** other correct answers, e.g. in terms of path difference and angles
			Total	6	

Question			Answer	Marks	Guidance
3	(a)	(i)	$(t =)\frac{6.3}{9.8(1)}$ (t =) 0.6(42….s)	M1 A0	**Allow** other correct methods, e.g: $(t) = \sqrt{\frac{2\times 2.0}{9.8(1)}}$ or $(t) = \frac{2\times 2.0}{6.3}$ **Not** a = 10 m s^{-2} **Note** t must be the unknown
		(ii)	(v_H =) $\frac{18}{0.64}$ or $\frac{18}{0.6}$ (v_H =) 28 (m s^{-1}) or 30 (m s^{-1})	M1 A0	**Note** v must be the unknown
		(iii)	$v = \sqrt{6.3^2 + 30^2}$ v = 31 (m s^{-1})	C1 A1	$v = \sqrt{6.3^2 + 28^2}$ **Allow** trigonometry methods v = 29 (m s^{-1}) **Note** 940 scores one mark
	(b)	(i)	$(E_k = \frac{1}{2}mv^2 = \frac{1}{2}\times 0.16 \times 30.7^2)$ E_k = 75 (J)	B1	Possible ECF from **(a)(iii)**
		(ii)	$(E_p = mgh = 0.16 \times 9.81 \times 2.0 =)$ 3.1 (J)	B1	**Allow** $(E_k = \frac{1}{2}mv^2 = \frac{1}{2}\times 0.16 \times 6.3^2) = 3.2(\text{J})$
		(iii)	**(b)(i)** – **(b)(ii)** ; (75 – 3.1) or $(E_k = \frac{1}{2}\times 0.16 \times 30^2)$ kinetic energy = 72 (J)	B1	Possible ECF from **(b)(i)** and **(b)(ii)** **Note:** Answer is 63 (J) when 28 (m s^{-1}) is used from **(a)(ii)**
	(c)		The path is always below the original path The maximum height of path is reached before the front of the hockey goal	M1 A1	
			Total	9	

Question			Answer	Marks	Guidance
4	(a)		(1 C =) (1) A s	C1	**Allow** alternative methods
			(1 J =) (1) $\text{kg m s}^{-2} \times \text{m}$ or (1) N = (1) kg m s^{-2}	C1	
			$V = \frac{\text{kg ms}^{-2} \times \text{m}}{\text{As}} = \frac{\text{kgm}^2\text{s}^{-2}}{\text{As}}$	M1	**Note** this mark is for clear substitution and working
			$\text{kg m}^2\text{A}^{-1}\text{s}^{-3}$	A0	
	(b)	(i)	p.d. across 1.2 kΩ = 0.9 V	C1	
			$\frac{R_{LDR}}{1200} = \frac{5.1}{0.9}$ or determines current and R = 5.1 / I	C1	
			R_{LDR} = 6800 (Ω)	A0	**Allow**: 6.8 k(Ω)
			Or $5.1 = \frac{R}{R+1.2} \times 6.0$	C1	
			0.9R = 6.12 or 0.15R = 1020	C1	**Allow** $\frac{6.8}{6.8+1.2} \times 6.0 = 5.1$ for two marks
			R_{LDR} = 6.8 (kΩ)	A0	**Allow**: 6800(Ω)
		(ii)	$(I = \frac{5.1}{6800} = \frac{6}{8000} = \frac{0.9}{1200})$ current = 7.5×10^{-4} (A)	B1	
	(c)		Resistance of LDR decreases / (total) resistance (of circuit) decreases (AW)	M1	
			Current / ammeter reading increases (AW)	A1	
			With increase in current the p.d. across (fixed) resistor / 1.2 kΩ resistor increases (AW)	B1	**Allow** p.d. across resistor increases / p.d. across LDR decreases / resistor has greater share of p.d. / LDR has smaller share of p.d.
			(For fixed e.m.f.) <u>voltmeter</u> reading decreases (AW)	B1	
			Total	10	

Question			Answer	Marks	Guidance
5	(a)		$(V =)\frac{0.1}{5300}$ 1.89×10^{-5} (m^3)	M1 A0	**Note** the mark is for substitution of values
	(b)	(i)	To ensure whole cross-sectional area or end of the conducting putty is in contact with the metal plate (AW)	B1	**Not** good electrical contact / reduces contact resistance / surface area
		(ii)	Use a (Vernier) caliper / micrometer (screw gauge) Repeat measurements along the conducting putty	B1 B1	**Allow** ruler
	(c)	(i)	6.6	B1	**Allow** 6.56 **Ignore** 10^{-3} factor
		(ii)	$\left(\%\text{ uncertainty} = \frac{2\times0.001}{0.049} \times 100 =\right)$ 4.1 %	B1	**Ignore** significant figures **Allow** 4 %
	(d)	(i)	Plots the missing point to less than a half small square Draws straight line of best fit	B1 B1	**Allow** ECF from **(c)(i)** Penalise blob of half a small square or larger **Allow** ECF Expect to be balance of points about line of best-fit. Judge straightness by eye. **Not** a top point to bottom point line / not a top point to (2.0, 10) line
		(ii)	Gradient $= \frac{y_2-y_1}{x_2-x_1} = \frac{\Delta y}{\Delta x}$ gradient = 5700 (5550 – 5850)	M1 A1	**Not** one R/L^2 value using the line or a data point **Ignore** POT for M1 **Allow** ± 150 for the value of gradient **Ignore** units
	(e)		$\rho = 5700 \times 1.9 \times 10^{-5}$ ρ = 0.108 given to 2 or 3 sf Ω m	C1 A1 B1	**Note**: ECF from **(d)(ii)** **Allow** any subject for equation **Not** use of data points from table
			Total	13	

Question			Answer	Marks	Guidance
6	(a)		**Level 3 (5–6 marks)** Clear procedure, measurements **and** analysis *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Some procedure, some measurements and some analysis. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Limited procedure and limited measurements **or** limited analysis *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.	**B1 x6**	**Indicative scientific points may include:** **Procedure** • labelled diagram • incremental increase in load / mass until wire breaks • method of attaching wire at fixed end • method of attaching load at other end • use of safety screen / goggles to protect eyes • method of securing retort stand **Measurements** • measurement of load / mass • measurement of diameter • use micrometer to measure diameter • averages diameter • repeats experiment **Analysis** • equation to determine force, e.g. *mg* • equation to determine cross-sectional area or $A = \pi r^2$ • (breaking) stress = (max) force / cross-sectional area or $\sigma = \frac{F}{A}$
	(b)		Glass: A straight line from the origin. Rubber: A correct sketch for loading and unloading sections, with the graph starting and finishing at the origin.  	**B1** **B1**	**Ignore** arrows **Allow** either arrows or labelled curves
			Total	**8**	

Question			Answer	Marks	Guidance
7	(a)		**Level 3 (5–6 marks)** Clear explanation of observations **and** clear evidence of particulate nature of electromagnetic waves *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Clear explanation of observations **or** clear evidence of particulate nature of electromagnetic waves **or** has limited explanation of observations and limited evidence of particulate nature of EM radiation *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Has limited explanation of observations **or** limited evidence of particulate nature of EM radiation *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.	**B1**	**Indicative scientific points may include:** **Explanation of Observations** • Discharge due to the emission of electrons / negative charge • Intensity depends on distance • Rate of incident photons is more at smaller distances • Greater intensity / rate of uv photons linked to quicker fall • uv causes instantaneous discharge • No effect with light • Intensity of light has no effect on the discharge • Natural discharge over a long period of time **Evidence of particulate nature of em** • Wave theory suggests leaf would fall with light • Photon as packet of energy • One to one interaction • uv photon greater energy than work function/greater frequency than threshold frequency • Light photons have less energy than the work function • $E = hf$ / photon energy depends on frequency • Energy of photon independent of intensity • Energy conserved in interaction • Einstein's equation (words or symbol)

Question			Answer	Marks	Guidance
	(b)		$3.2 \times 1.6 \times 10^{-19}$ or $6.63 \times 10^{-34} \times 960 \times 10^{12}$	C1	
			$E_{k\,max} = 6.63 \times 10^{-34} \times 960 \times 10^{12} - 5.12 \times 10^{-19}$	C1	
			$E_{k\,max} = 1.2 \times 10^{-19}$(J)	A1	**Note** answer to 3 SF is 1.24×10^{-19} (J)
			Total	**9**	

Question			Answer	Marks	Guidance
8	(a)		(kinetic energy =) $1.6 \times 10^{-19} \times 300$ $eV = \frac{1}{2}mv^2$ $v = \sqrt{\frac{2\times1.6\times10^{-19}\times300}{9.11\times10^{-31}}}$ speed = 1.03×10^7 (m s^{-1})	C1 C1 C1 A0	**Note** 1.05×10^{14} scores 2 marks; omitted square rooting
	(b)		$\lambda = \frac{6.63\times10^{-34}}{9.11\times10^{-31}\times1.0\times10^{7}}$ $\lambda = 7.3 \times 10^{-11}$ (m)	C1 A1	**Allow** ECF from **(a)** **Allow** 2 marks for 7.1×10^{-11}, $v = 1.03 \times 10^7$ used
	(c)		Momentum / (kinetic) energy / speed (of electrons) increases / (de Broglie) wavelength decreases Radius / diameter of rings decreases / pattern becomes 'smaller' (AW) or the rings are now brighter	B1 B1	
			Total	**7**	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553