

GCE

Physics A

Unit **H156/01**: Breadth in physics

Advanced Subsidiary GCE

Mark Scheme for June 2016

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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.

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Annotations available in RM Assessor

Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Level 1
	Level 2
	Level 3
	Transcription error
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Error in number of significant figures
	Correct response
	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
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.

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.

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.

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.

SECTION A

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

SECTION B

Question		Answer	Marks	Guidance
21	(a)	Mass is a scalar (quantity) and velocity is a vector (quantity). (Addition of) velocity depends on direction / sign / vector triangle / resolving (ORA)	B1 B1	Allow 'Velocity can be cancelled out'
	(b)	(i)	B1	Allow arrows in correct directions anywhere on Fig. 21 Not arrow for the tension parallel to the ramp Not arrow perpendicular to the ramp for the weight Not two arrow heads in opposite directions along the string for the tension
		(ii)	C1 A1	Note: Apply SF penalty if 0.7 s is on the answer line or the final answer Allow 1 mark for 0.40 (s); 9.8 m s ⁻² used instead of 3.0 m s ⁻² Allow full credit for alternative methods, e.g: $v^2 = 2 \times 0.80 \times 3.0$; $v = 2.19$ (m s ⁻¹) $t = \frac{2.19}{3.0}$ C1 $t = 0.73$ (s) A1
Total			5	

Question		Answer	Marks	Guidance
22	(a)	The gradient remains the same	B1	Note: This mark is for the idea that the gradient / slope (of the line) remains the same Allow: The line is (just) shifted (to the right) by the same amount (AW)
	(b)	Gradient determined from Fig. 22 <u>and</u> gradient = 16 gradient = $2a$ $(F = ma); F = 920 \times 8.0$ $F = 7.4 \times 10^3$ (N)	C1 C1 A1	Allow ± 0.5 for the value of the gradient Not u^2/x value using the line or a data point because the gradient is not determined Allow this mark even if gradient = a Possible ECF for this A1 mark if the gradient is determined but its value is outside the range 15.5 to 16.5 and the second C1 mark has also been scored Note: The answer to 3 SF is 7360 (N) Note: $F = 920 \times 16 = 14720$ (N) can score the first C1 mark
Total			4	

Question		Answer	Marks	Guidance	
23	(a)	<p>pressure = $\frac{\text{weight (of cylinder)}}{\text{area}}$</p> <p>Weight (of cylinder) determined using a newtonmeter or Measure mass (of cylinder) using balance / scale(s) <u>and</u> multiplying by $g / 9.8(1 \text{ m s}^{-2})$</p> <p>Area determined by measuring the diameter with a ruler / vernier callipers / micrometer <u>and</u> then using (area =) $\pi \times r^2$</p> <p>A sensible suggestion that reduces the % uncertainty: Use micrometer / (vernier) calipers / travelling microscope Use balance / newtonmeter with <u>smaller</u> division (AW)</p>	<p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p>	<p>Note: In this question any symbols used must be defined or previously mentioned Note: Allow full credit for alternative methods, e.g. using the equation pressure = height \times density \times g</p> <p>Allow force/area</p> <p>Not 'gravity' for g</p> <p>Not measure radius Allow other correct methods</p> <p>Not 'repeat readings (of diameter etc.)' because this procedure improves the accuracy and not the precision Allow balance / newtonmeter with 'high resolution'</p>	
	(b)	(i)	The upthrust is equal to the <u>weight</u> of the fluid / liquid / water / air displaced	B1	
		(ii)	<p>(upthrust =) $9.0 - 7.8$ (N) or (mass =) $9.0/9.8(1)$</p> <p>$V = \frac{(1.2/9.81)}{1000}$ or $V = 1.2(23) \times 10^{-4} \text{ (m}^3\text{)}$</p> <p>$\rho = \frac{(9.0/9.81)}{1.223 \times 10^{-4}}$</p> <p>$\rho = 7.5 \times 10^3 \text{ (kg m}^{-3}\text{)}$</p>	<p>C1</p> <p>C1</p> <p>A1</p>	<p>Note: This C1 mark for determining the upthrust (1.2 N) or the mass (0.92 kg) of the cylinder</p> <p>Allow full credit for alternative methods, e.g: $\rho = \left(\frac{9.0}{1.2}\right) \times 1000 = 7.5 \times 10^3 \text{ (kg m}^{-3}\text{)}$</p>
Total			8		

Question		Answer	Marks	Guidance
24	(a)	(Resultant) force is (directly) proportional / equal to the rate of change of momentum	B1	Not force = mass × acceleration Not 'force ∝ change in momentum <u>over</u> time'
	(b)	(i)	B1	Not: <u>kinetic</u> energy
		(ii)	B1 B1	Not 'This is because action = reaction' Not Newton's third law Allow 1 mark for a correct graph if there is no description or explanation
	(c)	<p><i>Method 1: Momentum is conserved</i></p> <p>$1.7 \times 10^{-27} \times 500$ or $1.7 \times 10^{-27} \times (-) 420$ or $2.0 \times 10^{-26} \times v$</p> <p>$1.7 \times 10^{-27} \times 500 = 1.7 \times 10^{-27} \times -420 + 2.0 \times 10^{-26} \times v$</p> <p>$v = 78 \text{ (m s}^{-1}\text{)}$</p> <p><i>Method 2: Kinetic energy is conserved</i></p> <p>$\frac{1}{2} \times 1.7 \times 10^{-27} \times 500^2$ or $\frac{1}{2} \times 1.7 \times 10^{-27} \times 420^2$ or $\frac{1}{2} \times 2.0 \times 10^{-26} \times v^2$</p> <p>$\frac{1}{2} \times 1.7 \times 10^{-27} \times 500^2 = \frac{1}{2} \times 1.7 \times 10^{-27} \times 420^2 + \frac{1}{2} \times 2.0 \times 10^{-26} \times v^2$</p> <p>$v = 79 \text{ (m s}^{-1}\text{)}$</p>	C1 C1 A1 C1 C1 A1	Allow 1 mark for $6.8 \text{ (m s}^{-1}\text{)}$; + 420 used instead of - 420 Allow full credit for correct use of 'velocity of approach = - velocity of recession', e.g: 'speed' of approach = (-) 'speed' of recession C1 500 = v + 420 C1 v = 80 (m s ⁻¹) A1
Total			7	

Question			Answer	Marks	Guidance								
25	(a)	(i)	<p>Similarity – same unit (AW)</p> <p>Difference – For e.m.f, energy is transformed from chemical / other forms to electrical and for p.d., energy is transformed to heat / other forms from electrical</p>	<p>B1</p> <p>B1</p>	<p>Allow ‘both defined as energy (transformed) per unit charge’ or ‘both defined as work done per unit charge’</p> <p>Allow any pair from:</p> <table border="1"> <thead> <tr> <th>e.m.f.</th> <th>p.d.</th> </tr> </thead> <tbody> <tr> <td>Energy (transformed) <u>to</u> electrical</td> <td>Energy (transformed) <u>from</u> electrical or Energy (transformed) <u>to</u> heat /other forms</td> </tr> <tr> <td>Charges gain energy</td> <td>Charges lose energy</td> </tr> <tr> <td>Work done <u>on</u> charges</td> <td>Work done <u>by</u> charges</td> </tr> </tbody> </table>	e.m.f.	p.d.	Energy (transformed) <u>to</u> electrical	Energy (transformed) <u>from</u> electrical or Energy (transformed) <u>to</u> heat /other forms	Charges gain energy	Charges lose energy	Work done <u>on</u> charges	Work done <u>by</u> charges
e.m.f.	p.d.												
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Charges gain energy	Charges lose energy												
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		(ii)	$n = \frac{9.6 \times 10^{16}}{1.2 \times 10^{-6} \times 6.0 \times 10^{-3}} \quad \text{or} \quad n = 1.3(3\dots) \times 10^{25} \text{ (m}^{-3}\text{)}$ <p>$(I = Anev)$</p> $0.003 = 1.2 \times 10^{-6} \times 1.33\dots \times 10^{25} \times 1.6 \times 10^{-19} \times v$ $v = 1.2 \times 10^{-3} \text{ (m s}^{-1}\text{)}$	<p>C1</p> <p>C1</p> <p>A1</p>	<p>Note Any subject for this equation</p> <p>Allow 1 mark for $1.6(3) \times 10^5 \text{ (m s}^{-1}\text{)}$; $n = 9.6 \times 10^{16}$ used</p>								

Question		Answer	Marks	Guidance
	(b)	<p>Circuit with cell in series with an ammeter and variable resistor. A voltmeter is connected across the variable resistor / (terminals of the) cell</p> <p>Measure current and p.d. / voltage across variable resistor / cell</p> <p>Correct description of how to get multiple readings (of current or p.d) E.g. change the resistance of the variable resistor / use different value resistors, etc.</p> <p>$(E = V + Ir)$ Plot a graph of V against I <u>and</u> the gradient (of the graph / line) is equal to (-) r (AW)</p>	<p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p>	<p>Allow this B1 mark for a clearly drawn circuit with correct symbols for the cell, variable resistor, voltmeter and ammeter. Allow a battery symbol instead of symbol for a cell</p> <p>Allow 'terminal p.d.' for p.d. across the cell Allow 'measure I and V if the circuit is correct Allow 'measure voltmeter and ammeter readings' if the circuit is correct Possible ECF for incorrect symbol for variable resistor</p>
Total			9	

Question			Answer	Marks	Guidance
26	(a)	(i)	A and B move in opposite directions	B1	<p>Allow A is moving up and B is moving down (or vice versa)</p> <p>Allow they have a phase difference of 180° or π (rad)</p> <p>Allow they are in antiphase</p>
		(ii)	$\lambda = 0.80$ (m) $v = f\lambda$; $v = 75 \times 0.80$ $v = 60$ (m s ⁻¹) absolute uncertainty = $\frac{2.0}{40} \times 60$ absolute uncertainty = 3.0 (m s ⁻¹)	<p>C1</p> <p>A1</p> <p>A1</p>	<p>Allow 80 (cm) for this C1 mark</p> <p>Allow 1 mark for 30 (m s⁻¹) from the C1A1 marks; $\lambda = 0.40$ m used</p> <p>Note 60 ± 3 (m s⁻¹) scores full marks Allow 2 marks for 6000 ± 300 (m s⁻¹); λ in cm (POT error) Allow 2 marks for 30 ± 1.5 (m s⁻¹); $\lambda = 0.40$ m used</p>
	(b)	(i)	<p><u>Reflection</u> (of progressive waves) at (fixed) end(s) / X / Y</p> <p>Superposition (of these waves gives rise to the stationary wave)</p>	<p>B1</p> <p>B1</p>	<p>Allow: 'interference' instead of 'superposition'</p>
		(ii)	The wavelength is <u>twice</u> the length of cord / distance between X and Y	B1	Allow $\lambda = 2XY$ or equivalent
Total				7	

Question		Answer	Marks	Guidance
27	(a)	<p>-1.0 V to 2.6 V: $I = 0$ / negligible <u>and</u> $R = \infty$ / (very) large (AW)</p> <p>2.6 V to 3.0 V: R decreases</p> <p>3.0 V to 3.4 V: R decreases</p> <p>Justification of a B1 point in terms of $R = V/I$. For example to show:</p> <ul style="list-style-type: none"> R is infinite: $R = 2.0/0 = \infty$ R decreases: R calculated once and has $R = \infty$, or R calculated twice 	<p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p>	<p>Allow 'rapid decrease in R'</p> <p>Allow 'slow decrease in R' Not R is constant (because it is a straight line)</p> <p>Not $R = \text{gradient}^{-1}$ Ignore powers of 10 and units Note: V and I values within ± 1 small square</p>
	(b)	<p>(The circuit does not work because) the LED is reverse biased / incorrect polarity of the cell (AW)</p> <p>V must be <u>greater</u> than 2.6 (V for the LED to be lit)</p> <p>Use two (or more 1.5 V) <u>cells</u> (in series) / use a <u>supply</u> greater than 2.6 (V) / use a 3.0 (V) <u>supply</u></p>	<p>B1</p> <p>B1</p> <p>B1</p>	<p>Allow: (For the circuit to work) the LED must be forward-biased / 'reverse the LED' / 'reverse the cell'</p> <p>Allow ± 0.1 V Not V must be <u>equal</u> to / 'at least' 2.6 V Allow this mark even if the LED is reverse biased</p> <p>Note: This B1 mark can be scored on Fig. 27.2 Allow this mark even if the LED is reverse biased</p>
	(c)	$E = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{480 \times 10^{-9}} \quad \text{or} \quad E = 4.1(4) \times 10^{-19} \text{ (J)}$ $N = \frac{1.2 \times 10^{-3}}{4.1(4) \times 10^{-19}}$ $N = 2.9 \times 10^{15} \text{ (s}^{-1}\text{)}$	<p>C1</p> <p>C1</p> <p>A1</p>	
Total			10	

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

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Head office
Telephone: 01223 552552
Facsimile: 01223 552553

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