Oxford Cambridge and RSA

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.

Annotations available in RM Assessor

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

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).	B1	
			(Addition of) velocity depends on direction / sign / vector triangle / resolving (ORA)	B1	**Allow** 'Velocity can be cancelled out'
	(b)	(i)	An arrow from trolley to ramp along the string (for the tension) and a downwards arrow from the trolley (for the weight).	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)	($s = ½at^2$); $0.80 = ½ \times 3.0 \times t^2$ (Any subject)	C1	
			$t =$ 0.73 (s)	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	C1	**Allow** $\pm$ 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
			gradient = 2a ($F = ma$); $F = 920 \times 8.0$	C1	
			$F = 7.4 \times 10^3$ (N)	A1	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)		pressure = $\frac{\text{weight (of cylinder)}}{\text{area}}$ 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 m s^{-2}) Area determined by measuring the diameter with a ruler / vernier callipers / micrometer <u>and</u> then using (area =) $\pi \times r^2$ A sensible suggestion that reduces the % uncertainty: Use micrometer / (vernier) calipers / travelling microscope Use balance / newtonmeter with <u>smaller</u> division (AW)	B1 B1 B1 B1	**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 × density × g **Allow** force/area **Not** 'gravity' for g **Not** measure radius **Allow** other correct methods **Not** 'repeat readings (of diameter etc.)' because this procedure improves the accuracy and not the precision **Allow** balance / newtonmeter with 'high resolution'
	(b)	(i)	The upthrust is equal to the <u>weight</u> of the fluid / liquid / water / air displaced	B1	
		(ii)	(upthrust =) 9.0 – 7.8 (N) or (mass =) 9.0/9.8(1) $V = \frac{(1.2/9.81)}{1000}$ or $V = 1.2(23) \times 10^{-4}$ (m^3) $\rho = \frac{(9.0/9.81)}{1.223 \times 10^{-4}}$ $\rho = 7.5 \times 10^3$ (kg m^{-3})	C1 C1 A1	**Note**: This C1 mark for determining the upthrust (1.2 N) or the mass (0.92 kg) of the cylinder **Allow** full credit for alternative methods, e.g: $\rho = \left(\frac{9.0}{1.2}\right) \times 1000 = 7.5 \times 10^3$ (kg m^{-3})
			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 $\times$ acceleration **Not** 'force $\propto$ change in momentum <u>over</u> time'
	(b)	(i)	Any <u>two</u> from: momentum, (total) energy and mass	**B1**	**Not**: <u>kinetic</u> energy
		(ii)	The force will have the same magnitude (at any time t) The force is in the opposite direction / has negative value	**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)		*Method 1: Momentum is conserved* $1.7 \times 10^{-27} \times 500$ or $1.7 \times 10^{-27} \times (-)\ 420$ or $2.0 \times 10^{-26} \times v$ $1.7 \times 10^{-27} \times 500 = 1.7 \times 10^{-27} \times -420 + 2.0 \times 10^{-26} \times v$ $v = 78$ (m s^{-1}) *Method 2: Kinetic energy is conserved* $\frac{1}{2} \times 1.7 \times 10^{-27} \times 500^2$ or $\frac{1}{2} \times 1.7 \times 10^{-27} \times 420^2$ or $\frac{1}{2} \times 2.0 \times 10^{-26} \times v^2$ $\frac{1}{2} \times 1.7 \times 10^{-27} \times 500^2 = \frac{1}{2} \times 1.7 \times 10^{-27} \times 420^2 + \frac{1}{2} \times 2.0 \times 10^{-26} \times v^2$ $v = 79$ (m s^{-1})	 **C1** **C1** **A1** **C1** **C1** **A1**	 **Allow** 1 mark for 6.8 (m s^{-1}); + 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)	Similarity – same unit (AW)	B1	**Allow** 'both defined as energy (transformed) per unit charge' or 'both defined as work done per unit charge'
			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	B1	**Allow** any pair from: <table><tr><td>e.m.f.</td><td>p.d.</td></tr><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></table>
		(ii)	$n = \dfrac{9.6\times10^{16}}{1.2\times10^{-6}\times6.0\times10^{-3}}$ or $n = 1.3(3...) \times 10^{25}$ (m^{-3})	C1	
			($I = Anev$) $0.003 = 1.2 \times 10^{-6} \times 1.33... \times 10^{25} \times 1.6 \times 10^{-19} \times v$	C1	**Note** Any subject for this equation
			$v = 1.2 \times 10^{-3}$ (m s^{-1})	A1	**Allow** 1 mark for $1.6(3) \times 10^{5}$ (m s^{-1}); $n = 9.6 \times 10^{16}$ used

Question			Answer	Marks	Guidance
	(b)		Circuit with cell in series with an ammeter and variable resistor. A voltmeter is connected across the variable resistor / (terminals of the) cell	**B1**	**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
			Measure current and p.d. / voltage across variable resistor / cell	**B1**	**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
			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.	**B1**	
			($E = V + Ir$) Plot a graph of V against I <u>and</u> the gradient (of the graph / line) is equal to (-) r (AW)	**B1**	
			Total	**9**	

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

Question			Answer	Marks	Guidance
27	(a)		-1.0 V to 2.6 V: I = 0 / negligible <u>and</u> $R = \infty$ / (very) large (AW)	B1	
			2.6 V to 3.0 V: R decreases	B1	**Allow** 'rapid decrease in R'
			3.0 V to 3.4 V: R decreases	B1	**Allow** 'slow decrease in R' **Not** R is constant (because it is a straight line)
			Justification of a B1 point in terms of $R = V/I$. For example to show: • R is infinite: $R = 2.0/0 = \infty$ • R decreases: R calculated once and has $R = \infty$, or R calculated twice	B1	**Not** R = gradient^{-1} **Ignore** powers of 10 and units **Note**: V and I values within $\pm$ 1 small square
	(b)		(The circuit does not work because) the LED is reverse biased / incorrect polarity of the cell (AW)	B1	**Allow**: (For the circuit to work) the LED must be forward-biased / 'reverse the LED' / 'reverse the cell'
			V must be <u>greater</u> than 2.6 (V for the LED to be lit)	B1	**Allow** $\pm$ 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
			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>	B1	**Note**: This B1 mark can be scored on Fig. 27.2 **Allow** this mark even if the LED is reverse biased
	(c)		$E = \dfrac{6.63\times10^{-34}\times3.0\times10^{8}}{480\times10^{-9}}$ or $E = 4.1(4)\times10^{-19}$ (J)	C1	
			$N = \dfrac{1.2\times10^{-3}}{4.1(4)\times10^{-19}}$	C1	
			$N = 2.9\times10^{15}$ (s^{-1})	A1	
			Total	**10**	

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