OCR
Oxford Cambridge and RSA

…day June 20X –Morning/Afternoon

A Level Physics A

H556/03 Unified physics

SAMPLE MARK SCHEME

Duration: 1 hour 30 minutes

MAXIMUM MARK 70

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This document consists of 16 pages

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

SCORIS

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *scoris assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to scoris and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the scoris messaging system.

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5. Work crossed out:

   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks

   b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response):

   - if there is nothing written at all in the answer space

   - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')

   - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question.

   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The scoris **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

   If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

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10. For answers marked by levels of response:

- Read through the whole answer from start to finish.
- Decide the level that **best fits** the answer – match the quality of the answer to the closest level descriptor.
- To select a mark within the level, consider the following:

  Higher mark: A good match to main point, including communication statement (in italics), award the higher mark in the level
  Lower mark: Some aspects of level matches but key omissions in main point or communication statement (in italics), award lower mark in the level.

  Level of response questions on this paper are **5(a)** and **7(a)**.

11. **Annotations**

Annotation	Meaning
DO NOT ALLOW	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

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12. **Subject-specific Marking Instructions**

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

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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 Additional Guidance.

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Question			Answer	Marks	Guidance
1	(a)	(i)	$\rho = m/V = m/Av$; so $m = A\rho v$ $7.5 \times 10^{-5} \times 1000 \times v = 0.070$ giving $v = 0.93$ (m s^{-1})	**C1** **A1** **A0**	
		(ii)	3.7 (m s^{-1})	**A1**	Accept 3.72
		(iii)	$F = \Delta(mv)/\Delta t = 0.070 \times (3.72 - 0.93)$ $F = 0.195$ (N)	**C1** **A1**	**ecf(a)(ii)** accept 0.19 or 0.2(0)
		(iv)	arrow into the shower head perpendicular to its face.	**B1**	award mark for a reasonable attempt.
	(b)		$P = (m/t)c\theta = 0.070 \times 4200 \times (30 - 14)$ $= 4700$ unit = W or J s^{-1}	**C1** **A1** **B1**	 or 4.7 **allow** kW if consistent with the value for P.
			Total	**9**	

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Question			Answer	Marks	Guidance
2	(a)		for thinking time t rider moves s = vt for (constant) deceleration from v to 0, $v^2 = 2as$ so total $s = d = v^2/2a + vt$	B1	
	(b)		using y = mx + c d/v =v/2a + t gives an equation resulting in a straight line graph as a and t are constants.	B1 B1	
	(c)	(i)	1.30 ± 0.18 entered in table two points correctly plotted on graph with error bars Line of best fit; If points are plotted correctly then lower end of line should pass between (9.5, 1.3) and (10.5, 1.3) **and** upper end of line should pass between (34.0, 2.9) and (35.5, 2.9). Worst acceptable straight line.	B1 B1	allow ± 0.2 to ± 0.16 **ecf** value and error bar of first point **allow ecf** from points plotted incorrectly. steepest or shallowest possible line that passes through <u>all</u> the error bars; should pass from top of top error bar to bottom of bottom error bar **or** bottom of top error bar to top of bottom error bar.
		(ii)	gradient of best fit line. should be about 0.065 a = 1/(2 x gradient) giving a = 7.7 (m s^{-2}) *y*-intercept of best fit line; should be about 0.65 t = *y*-intercept so should be about 0.65 (s) uncertainty in gradient; should be about 0.010 to 0.012 giving uncertainty in a to be about ± 1.1 to ± 1.2 uncertainty in *y*-intercept and t should be about ± 0.3	B1 B1 B1 B1	**allow ecf** values from graph in all values below allow 7.3 to 7.7 difference in worst gradient and gradient. difference in worst *y*-intercept and *y*-intercept both uncertainties correct for final mark.
	(d)		actual d/v values will be lower. so the y-intercept will be lower. hence the actual t (= y-intercept) will be smaller.	M1 M1 A1	
			Total	**12**	

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Question			Answer	Marks	Guidance
3	(a)	(i)	reflected signals from M (amplitude a) and H (amplitude A) are added at the receiver path difference between moving reflected signal and fixed reflected signal varies between 0 and λ sum of the displacements at the receiver varies between A + a and A – a any 3 from • signal from M is attenuated because travels further; • absorbed passing twice through H or some reflected at the back of H • signal from H will increase as H moves towards the detector • if A is much greater than a then variation will be difficult to detect.	**B1** **B1** **B1** **B1x3**	**accept** interfere. **or** phase difference between the two received signals varies between 0 and 2π allow absorbed or similar word for attenuated. allow full credit for discussion in terms of $(A^2 – a^2)/(A^2 + a^2)$.
		(ii)	detected signal varies between max and min for λ/4(= 7.0 mm) as path difference is λ/2 every λ/2 (14 mm) moved, the signal goes through one cycle so for 200 Hz must go through 100 λ in 1 s = 2.8 (m s^{-1}).	**B1** **B1** **B1**	
	(b)		in time t_o car moves vt_o path lengths travelled by the two pulses differ by $c(t_o – t)$ but this is twice the distance the car has moved as it is a reflected signal so $2vt_o = c(t_o – t)$.	**B1** **M1** **A1** **A0**	 justified e.g. best solved by imagining first pulse takes time T_o and second time T and then $T_o – T = t_o – t$ and/or drawing a space diagram.
			Total	**12**	

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Question			Answer	Marks	Guidance
4	(a)		W of tube = upthrust (caused by submerged length) = A(0.30 – l) ρg W = 0.5 x 9.8 = 4.9 = π(2.5 x 10^{-2})^2 x (0.3 – l) x1.0 x 10^3 x 9.8 = 19.2 (0.30 – l) 0.30 – l = 0.255 giving l = 0.045 m =45 (mm).	B1 C1 A1	Archimedes principle expressed in some form.
	(b)	(i)	5 (mm).	A1	
		(ii)	1.0 mark on scale at peak of curve.	B1	minimum requirement for mark: 0 to 3 Hz marked at 1 Hz intervals along axis.
		(iii)	approx. same (or slightly lower) resonance frequency. smaller amplitude/broader peak *but curves must not cross* and passes through (0, 5 mm).	B1 B1	
			Total	**7**	

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Question			Answer	Marks	Guidance
5	(a)*		**Level 3 (5–6 marks)** At least P1 and P2 M1, M2, M4 and M5 At least A2 and A3 At least C1 and C2 *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)** At least P1 M1, M4 and M2 or M5 At least A3 At least C1 *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)** At least P1 At least M1 and M4 At least A3 At least C1 *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** No response or no response worthy of credit.	**B1** **x 6**	**plan P** 1. vary speed of rotation of magnet using motor control 2. expect to see amplitude of signal increase and period of waveform decrease 3. measure (maximum) e.m.f V and period T for each setting from oscilloscope screen. **measurements M** 1. maximum e.m.f. 2. measured from peak to peak distance on graticule 3. and using V/cm scale setting 4. period of rotation 5. measured along t-axis of graticule 6. and using s/cm time base setting. **analysis A** 1. record table of V, T 2. and (calculate and record) f = 1/T. 3. plot graph of V against f **conclusions C** 1. a straight line graph 2. through origin 3. is required to validate Faraday's law.
	(b)	**(i)**	flux = BA = 0.20 x 0.10 x 0.080 = 0.0016 (Wb)	**B1**	

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Question			Answer	Marks	Guidance
			induced emf = NBA/t = 80 x 0.0016/5 = 0.026 (V)	**B1**	
		(ii)	Lenz's law indicates that current must try to maintain the field as it collapses **or** current must produce same field as magnet to try to maintain the field. current is anticlockwise in coil as viewed from S pole.	**M1** **A1**	
			Total	**10**	

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Question			Answer	Marks	Guidance
6	(a)		$\lambda_1 = d \sin 12.5 = 4.33 \times 10^{-7}$ m giving $1/d = 5 \times 10^5$ or $d = 2 \times 10^{-6}$ $\lambda_3 = \sin 19.0/5 \times 10^5 = 6.51 \times 10^{-7}$ (m) **or** $\lambda_1 = d \sin 12.5 = 4.33 \times 10^{-7}$ and $\lambda_3 = d \sin 19.0$ so $\lambda_3 = 4.33 \times 10^{-7} \sin 19.0/\sin 12.5 = 6.51 \times 10^{-7}$ (m)	**C1** **A1**	or $\lambda_2 = d \sin 14.0 = 4.84 \times 10^{-7}$ (m) or use $\lambda_2 = d \sin 14.0 = 4.84 \times 10^{-7}$ m $\sin 19.0/\sin 12.5 = 0.326/0.216 = 1.50$
	(b)	(i)	the uncertainty in the measurement of angle is the same for all angles and the bigger the angle measured the smaller the % error	**B1**	
		(ii)	$n_{max} = d \sin 90$ $= 1/(5 \times 10^5 \times 4.33 \times 10^{-7}) = 4.6$ but n is an integer so n = 4	**C1** **A1**	
	(c)	(i)	3 downward arrows correctly labelled.	**B1**	longest being 4.33×10^{-7} (m)
		(ii)	$\Delta E = hc/\lambda$ $\lambda = 6.63 \times 10^{-34} \times 3 \times 10^8 / 4.8 \times 10^{-20} = 4.1(4) \times 10^{-6}$ (m) region: infra red	**C1** **A1** **B1**	 **allow** ecf if wavelength calculation incorrect.
			Total	**9**	

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Question			Answer	Marks	Guidance
7	(a)*		**Level 3 (5–6 marks)** All of B correct. One of S and one of D stated. C fully described. *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)** B partially given. S and D given but one not clear. C lacks detail. *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)** B poor and incomplete. Only S or D given. C not mentioned or very inadequate. *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** **x 6**	**basic description (B)** 1. *fission:* neutron is absorbed by the nucleus causing it to split into two (major) fragments and several/two/three neutrons 2. *fusion:* two light nuclei (moving rapidly enough) overcome the Coulomb repulsion between them fuse. **similarity (S)** 1. release of energy 2. total (rest) mass decrease 3. 'increase' in binding energy 4. conservation of charge/mass-energy. **difference (D)** 1. cold, hot 2. heavy, light nuclei 3. large (200 MeV), small (30 MeV) energy release per reaction. **conditions (C)** 1. fission rate can be varied/controlled by absorbing and or slowing released neutrons in reactor where chain reaction is occurring 2. fusion needs a very hot and sufficiently dense and plentiful plasma for random fusion collisions to occur, e.g. inside Sun/star.

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Question			Answer	Marks	Guidance
	(b)	(i)	Fission reactors produce radioactive by-products which affect future generations and the environment in terms of possible contamination/exposure to humans and animals.	B1	
		(ii)	No of particles in 1000g U =1000/235 x 6.02 x 10^{23} =2.56 x 10^{24}	B1	Appreciate that the key to the answer is the difference in numbers of atoms/nuclei **or** equal number of nucleons involved scores one mark if nothing else achieved.
			No of reactions for U = 2.56 x 10^{24}		
			Energy from U =2.56 x 10^{24} x 200 = 5.12 x 10^{26} MeV	B1	
			No of particles in 1000g H = 6.02 x 10^{26}		
			No of reactions = 6.02 x 10^{26}/4	B1	
			Energy from H = 6.02 x 10^{26}/4 x 28 = 42.14 x 10^{26} MeV		
			Hence energy 42/5 = 8.2 times higher	B1	
			second method	**or**	
			235 g of U and 4 g of H/He contain 1 mole of atoms	B1	
			there are 4.26 moles of U and 250 moles of He	B1	
			so at least 58 times as many energy releases in fusion	B1	
			ratio of energies is only 7 fold in favour of U		
			therefore 58/7 times as much energy released by 1 kg of H	B1	
			similar alternative argument, e.g.	**or**	
			For U each nucleon 'provides' 0.85 MeV	B1	
			For H each nucleon 'provides' 7 MeV	B1	
			(Approx) same number of nucleons per kg of U or H	B1	
			so 8.2 times as much energy from H	B1	
			Total	**11**	

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Summary of updates

Date	Version	Change
January 2019	2.0	Minor accessibility changes to the paper: i) Additional answer lines linked to Level of Response questions ii) One addition to the rubric clarifying the general rule that working should be shown for any calculation questions

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