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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 1451

Specification A

PHYA2 Mechanics, Materials and Waves

Mark Scheme

2010 examination - January series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Dr Michael Cresswell Director General

Instructions to Examiners

1 Give due credit for alternative treatments which are correct. Give marks for what is correct in accordance with the mark scheme; do not deduct marks because the attempt falls short of some ideal answer. Where marks are to be deducted for particular errors, specific instructions are given in the marking scheme.

2 Do not deduct marks for poor written communication. Refer the scripts to the Awards meeting if poor presentation forbids a proper assessment. In each paper, candidates are assessed on their quality of written communication (QWC) in designated questions (or part-questions) that require explanations or descriptions. The criteria for the award of marks on each such question are set out in the mark scheme in three bands in the following format. The descriptor for each band sets out the expected level of the quality of written communication of physics for each band. Such quality covers the scope (eg relevance, correctness), sequence and presentation of the answer. Amplification of the level of physics expected in a good answer is set out in the last row of the table. To arrive at the mark for a candidate, their work should first be assessed holistically (ie in terms of scope, sequence and presentation) to determine which band is appropriate then in terms of the degree to which the candidate's work meets the expected level for the band.

QWC	descriptor	mark range
Good - Excellent	*see specific mark scheme*	**5-6**
Modest - Adequate	*see specific mark scheme*	**3-4**
Poor - Limited	*see specific mark scheme*	**1-2**
The description and/or explanation expected in a good answer should include a coherent account of the following points: *see specific mark scheme*		

Answers given as bullet points should be considered in the above terms. Such answers without an 'overview' paragraph in the answer would be unlikely to score in the top band.

3 An arithmetical error in an answer will cause the candidate to lose one mark and should be annotated AE if possible. The candidate's incorrect value should be carried through all subsequent calculations for the question and, if there are no subsequent errors, the candidate can score all remaining marks.

4 The use of significant figures is tested **once** on each paper in a designated question or part-question. The numerical answer on the designated question should be given to the same number of significant figures as there are in the data given in the question or to one more than this number. All other numerical answers should not be considered in terms of significant figures.

5 Numerical answers **presented** in non-standard form are undesirable but should not be penalised. Arithmetical errors by candidates resulting from use of non-standard form in a candidate's working should be penalised as in point 3 above. Incorrect numerical prefixes and the use of a given diameter in a geometrical formula as the radius should be treated as arithmetical errors.

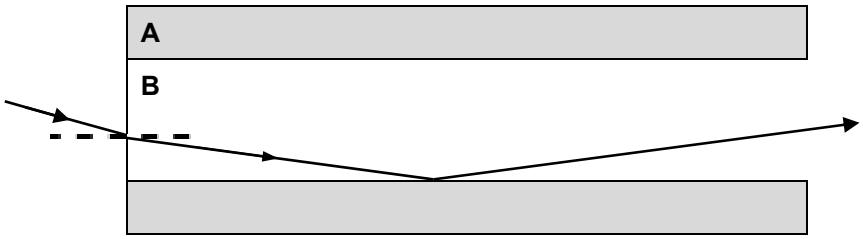
6 Knowledge of units is tested on designated questions or parts of questions in each a paper. On each such question or part-question, unless otherwise stated in the mark scheme, the mark scheme will show a mark to be awarded for the numerical value of the answer and a further mark for the correct unit. No penalties are imposed for incorrect or omitted units at intermediate stages in a calculation or at the final stage of a non-designated 'unit' question.

7 All other procedures including recording of marks and dealing with missing parts of answers will be clarified in the standardising procedures.

GCE Physics, Specification A, PHYA2, Mechanics, Materials and Waves

Question 1		
(a) (i)	$v = \frac{s}{t}$ ✓ t = 0.015 (s) or 15 (ms) ✓ 0.68/0.015 ✓ (= 45)	**3**
(a) (ii)	$\left(a = \frac{\Delta v}{\Delta t} = \frac{45.3}{0.015}\right)$ = 3000 (m s^{-2}) (3022) ✓	**1**
(b) (i)	$s = (ut) = \frac{1}{2} gt^2$ or $t = \sqrt{\frac{2s}{g}}$ ✓ correct substitution seen = $\sqrt{\frac{2 \times 2.3}{9.81}}$ ✓ 0.68 to 0.69 correct answer to more than one dp seen ✓	**3**
(b) (ii)	($s = vt$) = 45(.3) × 0.685 or 0.7 ✓ = 30.6 to 32 ✓ (m)	**2**
(b) (iii)	mention of air resistance or drag ✓ causing **horizontal** deceleration or 'slowing down' ✓	**2**
	Total	**11**

Question 2		
(a) (i)	force × perpendicular distance ✓ between line of action of force and the point ✓	**2**
(a) (ii)	rear ✓ at rear + idea that centre of mass is closer to the rear wheel (than to the front wheel) ✓	**2**
(a) (iii)	14000 × 1.4 = F × 2.5 ✓ F = 7840 (N) ✓ divides their final answer by 2 ✓ = 3900 (N) ✓ (3922)	**4**
(b)	$(F = k\Delta l)\frac{F}{k}$ or (Δl =) $\frac{\text{a(iii)}}{100000}$ ✓ = 0.039 (m) ✓ ecf	**2**
(c)	F = (100000 × 0.065 =) 6500 (N) ✓ F = (2 × 6500) = 13000 (N) ✓	**2**
	Total	**12**

Question 3		
(a) (i)	A: **cladding** + B: **core** ✓	**1**
(a) (ii)	 refraction towards the normal line ✓ continuous lines + strikes boundary + TIR correct angles by eye + maximum 2 TIRs ✓	**2**
(b)	$\left(sin\theta_c = \frac{n_2}{n_1}\right)$ or = 0.9865 ✓ 80.6 or 80.8 or 81 (°) only ✓	**2**
(c)	to reduce **multipath** or **multimode dispersion** ✓ (which would cause) light travelling at different angles to arrive at different times/pulse broadening/merging of adjacent pulses/'smearing'/ poor resolution/lower transmission rate/lower bandwidth/less distance between regenerators ✓ **or** to prevent light/data/signal loss (from core or fibre) ✓ (which would cause) signal to get weaker/attenuation/crossover/data to be less secure ✓	**2**
(d)	correct application ✓ (endoscope, cytoscope, arthroscope etc, communications etc) linked significant benefit stated eg improve medical diagnosis/improve transmission of data/high speed internet ✓	**2**
	Total	**9**

Question 4		
(a) (i)	one 'loop' (accept single line only, accept single dashed line) + nodes at each bridge (± length of arrowhead) + antinode at centre ✓	**1**
(a) (ii)	$\lambda_0 = 2L$ or $\lambda = 0.64 \times 2$ ✓ = 1.3 (m) ✓ (1.28)	**2**
(a) (iii)	($c = f\lambda$) = 108 × (a)(ii) ✓ = 138 to 140(.4) ($m\,s^{-1}$) ✓ ecf from (a)(ii)	**2**
(b) (i)	four antinodes ✓ (single or double line) first node on 0.16 m (within width of arrowhead) + middle node between the decimal point and the centre of the 'm' in '0.64 m' + middle 3 nodes labelled 'N', 'n' or 'node' ✓	**2**
(b) (ii)	(4 f_0 =) 430 (Hz) ✓ (432) or use of $f = \frac{v}{\lambda}$ gives 430 to 440 Hz correct answer only, no ecf	**1**
(c)	decrease the length/increase tension/tighten string ✓	**1**
	Total	**9**

Question 5		
(a)	showed that light was a **wave** (rather than a particle)/**wave** nature (of light) ✓	**1**
(b) (i)	single wavelength (or frequency) ✓	**1**
(b) (ii)	(waves/source(s) have) constant phase difference ✓	**1**
(b) (iii)	any sensible precaution, eg do not look into laser/do not point the laser at others/do not let (regular) reflections enter the eye/safety signs/suitable safety goggles ✓	**1**
(c)	(0.16/8) = 0.02(0) ✓ = $\frac{0.020 \times 0.30\ (\times 10^{-3})}{10.0}$ ✓ ecf from calculation of fringe spacing = 6.0×10^{-7} m ✓ (= 600 nm) ecf from calculation of fringe spacing	**3**
(d)	maxima closer together ✓ (quotes equation and states that) spacing is proportional to wavelength/ D and s are constant therefore as λ decreases so ω decreases ✓ **or** links smaller wavelength to smaller path difference ✓	**2**
	Total	**9**

Question 6		
(a)	the mark scheme for this part of the question includes an overall assessment for the Quality of Written Communication	
QWC	**descriptor**	**mark range**
good - excellent	(i) Uses accurately appropriate grammar, spelling, punctuation and legibility. (ii) Uses the most appropriate form and style of writing to give an explanation or to present an argument in a well structured piece of extended writing. [may include bullet points and/or formulae or equations] **Physics**: describes a workable account of making most measurements accurately. **For 6 marks**: complete description of the measurements required + **how to find the extension** + instruments needed + at least 2 accuracy points **For 5 marks**: all 4 quantities measured including **varying** load + 2 instruments, 2 accuracy points.	**5 - 6**
modest - adequate	(i) Only a few errors. (ii) Some structure to answer, style acceptable, arguments or explanations partially supported by evidence or examples. **Physics**: describes a workable account of making all or most of the measurements and has some correct awareness of at least one accurate measurement. **For 4 marks**: all 4 quantities measured including **varying** load + 2 instruments mentioned + 1 accuracy point. **For 3 marks**: 3 quantities (**load**, **extension**, **diameter** or **cross-sectional area**) may only omit original length + 1 instrument + 1 accuracy point.	**3 - 4**
poor - limited	(i) Several significant errors. (ii) Answer lacking structure, arguments not supported by evidence and contains limited information. **Physics**: unable to give a workable account but can describe some of the measurements. **For 2 marks**: load or mass + measure extension + one instrument mentioned. **For 1 mark**: applying a single load/mass + one other quantity or one instrument named or shown.	**1 – 2**
incorrect, inappropriate or no response		**0**

	Quantities to be measured • describe/show means of applying a **load/force** to a wire • measure **original length** • measure **extension** • measure **diameter** • extension = extension length – original length (needed for six marks) Measuring instruments • use of **rule**/ruler/tape measure • measure diameter with **micrometer** • use of **travelling microscope** to measure extension, or extension of wire measured with **vernier** scale for Searle's apparatus Accuracy • varying load/mass • repeat readings (of length or extension) • diameter measured in several places • Searle's 'control' wire negating effect of temperature change • change in diameter monitored (with micrometer) • original length of wire ≥ 1.0 m Additional creditworthy point • explain how cross-sectional area is found using $A = \pi (D/2)^2$ • showing how Young modulus is found is regarded as neutral	
(b) (i)	good straight line through origin (within one square) up to stress = 5.1×10^7 and line that lies close to data points thereafter ✓	**1**
(b) (ii)	evidence of use of gradient or stress/strain ✓ Δ strain used ≥ 3.2 ($\times 10^{-3}$) for correct gradient calculation ✓ $1.0 \pm 0.05 \times 10^{10}$ ✓ (0.95 to 1.05) allow 1 sf ecf form their line – may gain full marks Pa or $N\,m^{-2}$ or N/m^2 only ✓	**4**
(c)	originates at last point + parallel to their first line + straight + touches *x* axis ✓	**1**
	Total	**12**

Question 7		
(a) (i)	($m = \rho V$) = 1.2 × 3.5 × 10^5 must be seen ✓ 4.2 × 10^5 (kg) seen ✓	**2**
(a) (ii)	($E_k = \frac{1}{2} mv^2$) = $\frac{1}{2}$ × 4.2 × 10^5 × 11^2 ✓ 2.5 or 2.4 × 10^7 (J) ✓ (25.4 or 24.2 MJ)	**2**
(a) (iii)	$\frac{10 \times 10^6}{2.54 \times 10^7}$ ✓ allow ecf from (a)(ii) 39 to 41.6 (%) ✓ allow ecf from (a)(ii) unless percentage is greater than 100	**2**
(b)	**advantages**, any one: wind has: no fuel cost/causes no air pollution/no CO_2/is renewable ✓ **disadvantages**, any one from: wind: varies/is intermittent/unreliable/causes visual pollution/noise/danger to birds/has a high capital cost/high 'start up' cost/requires changes to National Grid need ✓ allow 'unpredictable'	**2**
	Total	**8**