

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 events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

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Set and published by the Assessment and Qualifications Alliance.



**General Certificate of Education (A-level)
January 2012**

Physics A

PHYA2

(Specification 2450)

Unit 2: Mechanics, materials and waves

Final

Mark Scheme

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	<i>see specific mark scheme</i>	5-6
Modest - Adequate	<i>see specific mark scheme</i>	3-4
Poor - Limited	<i>see specific mark scheme</i>	1-2
The description and/or explanation expected in a good answer should include a coherent account of the following points: <i>see specific mark scheme</i>		

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.

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

Question 1		
a	$170 \times 10^3 \times \cos 40$ (or 1.3×10^5) ✓ $\times 1000$ ✓ (= 1.302×10^8 J)	2
b	i $(P = Fv) = 1.3 \times 10^5 \times 7.0$ ✓ $= 9.1 \times 10^5$ ✓ (911.6 kW) ecf wrong force from part a or correct alternative approach using $t=s/v$ and $P= E/t$	2
b	ii (total power =) $9.1 (\times 10^5) + 21 (\times 10^5)$ ✓ ecf from bi powers of 10 must be consistent for this mark (eg not $9.1 + 2.1$) (percentage = $(9.1/9.1 + 21) \times 100$) $= 30$ (%) ✓ ecf for power of 10 error in first mark ecf from bi, but must have attempted to calculate total power eg 9.1/21 gains zero	2
c	any two from (surface) area (of the sail) ✓ wind speed/strength/power/KE/force (not air resistance;) ✓ acceleration or speed of the ship ✓	max 2
Total		8

Question 2		
a	i $(s = \frac{1}{2}(u+v) t) t = 2s/v$ ✓ (correct rearrangement, either symbols or values) $(= 100/6.7) = 15$ ✓ (s) (14.925) or alternative correct approach	2
a	ii $(KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 83 \times 6.7^2) = 1900$ ✓ (1862.9 J) 2 sf ✓	2
a	iii GPE = $83 \times 9.81 \times 3.0$ ✓ penalise use of 10, allow 9.8 $= 2400$ (2443 J) ✓ do not allow 2500 (2490) for use of $g = 10$	2
b	i $5300 + 3700$ (or 9000 seen) or – 2443 – 1863 (or (–) 4306 seen) ✓ $= 4700$ (J) ✓ (4694) ecf from parts aii & aiii	2

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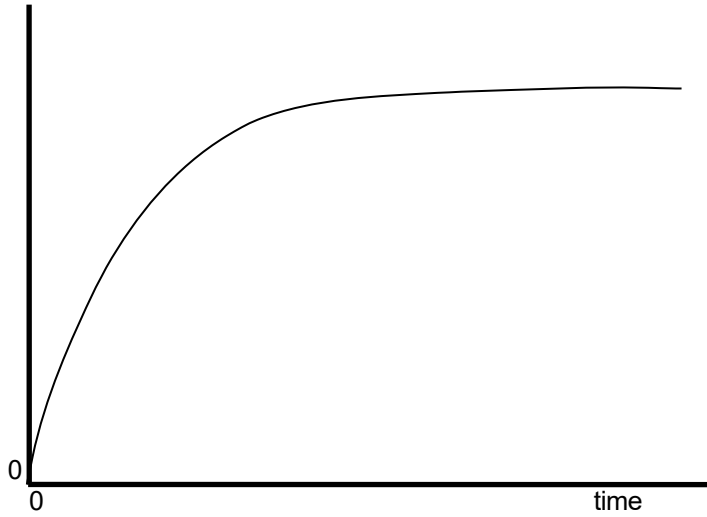
b	ii	mention of friction and appropriate location given ✓ mention of air resistance (or drag) ✓ do not allow energy losses or friction within the motor do not allow energy losses from the cyclist must give a cause not just eg 'heat loss in tyres'	2
Total			10

Question 3			
a	i	180000×2.8 ✓ $= 500000$ ✓ (504000 Nm) ecf from first line for incorrect power of 10	2
a	ii	$7.4 \times$ lift fan thrust ✓ $= 180000 \times 2.8$ (504000 Nm) ✓ ecf from part ai $F = 68000$ or 68 k (N) ✓ (68108 N) ecf	3
a	iii	$180\text{k} - 68.1\text{k} = (111.9 =) 112\text{k (N)}$ ✓ ecf from part aii or by taking moments	1
b	i	$(m = W/g) = 180\,000/9.81$ ✓ (= 18349 kg) $a = F/m = 155\,000/18349 = 8.4$ ✓ (8.4475 ms ⁻²) ecf for use of 180 in 1 st mark use of weight rather than mass gets zero	2
b	ii	cross-sectional or surface area/shape/streamlining/aerodynamics/nature of surface/drag coefficient ✓ correctly linked to its effect on air resistance/drag ✓ or maximum thrust/force power of engine ✓ counterforce increases with speed or when drag equals thrust (forces are balanced) ✓	2

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b	ii	velocity 	2
		line starting at zero and curving with decreasing gradient ✓ reaching a constant velocity ✓	
c		steepest/maximum gradient ✓	1
		Total	13

Question 4			
a		extension divided by its original length ✓ do not allow symbols unless defined ✓	1
b		1.9×10^8 (Pa) ✓	1
c		point on line marked 'A' between a strain of 1.0×10^{-3} and 3.5×10^{-3} ✓	1
d		clear evidence of gradient calculation for straight section eg $1.18 (1.2) \times 10^8 / 1.0 \times 10^{-3}$ ✓ = 120 GPa and stress used $\geq 0.6 \times 10^8$ Pa ✓ allow range 116 – 120 GPa Pa or Nm^{-2} or N/m^2 ✓	3
e	i	clear attempt to calculate correct area (evidence on graph is sufficient) ✓ (32 whole squares + 12 part/2 = 38 squares) (38 × 10000 =) 380000 (J m^{-3}) ✓ allow range 375000 to 400000	2
e	ii	$V = m/\rho$ or $0.015/8960$ or 1.674×10^{-6} (m^3) ✓ $380\,000 \times 1.674 \times 10^{-6} = 0.64$ (0.6362 J) ✓ ecf from ei	2
f		straight line passing through origin (small curvature to the right only above 160 MPa is acceptable) end at 176 MPa ✓ (allow 174 to 178) straight section to the left of the line for copper (steeper gradient) ✓	2
		Total	12

b	ii	mention of friction and appropriate location given ✓ mention of air resistance (or drag) ✓ do not allow energy losses or friction within the motor do not allow energy losses from the cyclist must give a cause not just eg 'heat loss in tyres'	2
Total			10

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