Version 1.0



General Certificate of Education (A-level)
June 2012

Physics A PHYA2

(Specification 2450)

Unit 2: Mechanics, materials and waves

Final

Mark Scheme

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 candidates' 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 candidates' 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.

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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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

1	a	i	two from: velocity, acceleration, force etc ✓	1

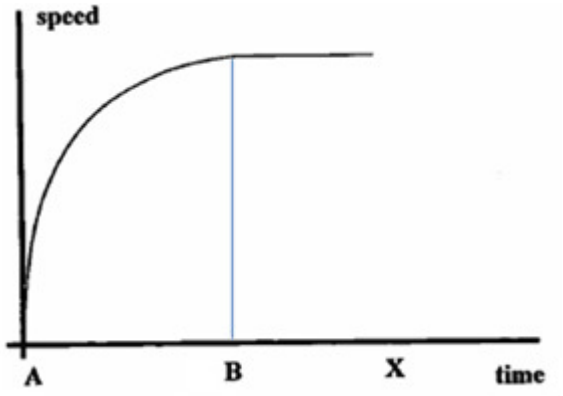
1	a	ii	two from: speed, distance, mass etc ✓	1

1	b	i	B: drag / air resistance ✓ C: weight ✓	2

1	b	ii	closed triangle (of vectors) ✓ so forces are in **equilibrium / resultant force is zero / forces balance** (so moving at constant velocity) ✓	2

1	c		*W* = 9500 sin 74 ✓ = 9100 ✓ (9132) **2 sf** ✓	3

2	a		*GPE* to *KE* to *GPE* ✓ no energy lost (from system) / no <u>work done</u> against resistive forces ✓ initial *GPE* = final (*GPE)* / initial (*GPE)* = final *GPE* **OR** *h* = *GPE* /*mg* and these are all constant so *h* is the same ✓	3

2	b		Initial curve with decreasing gradient and reaching constant maximum speed before X and maintaining constant speed up to X ✓ B labelled in correct place ✓ B labelled in correct place **AND** constant speed maintained for remainder of candidates graph and line is straight ✓  	3

2	c		(first law) ball travels in a straight line at a constant speed / constant velocity / (maintains) uniform / no change in motion / zero acceleration ✓ there is no (external) **unbalanced / resultant** force acting on it ✓	2

3	a	i	(moment = 520 x 0.26) = 140 (135.2) ✓ **Nm** ✓	2

3	a	ii	**180 x 0.41** and **0.63 X** seen ✓ 135.2 = 180 x 0.41 + 0.63 X ✓ ecf from 3(a)(i) (X = (135.2 – 73.8) / 0.63) = 97 ✓ (N) (97.46) allow 105 from use of 140Nm ecf from 3(a)(i)	3

3	a	iii	(520 – (180 + 97.46)) = 240 ✓ (242.5 N) ecf (or from correct moments calculation)	1

3	b	i	($v^2 = u^2 + 2as$) $9.3^2 = 2 \times a \times 35$ OR $9.3^2 = 70a$ OR $a = v^2/2s$ OR $9.3^2/70$ ✓ OR correct alternative approach 1.2 (1.2356) ✓ (m s^{-2})	2

3	b	ii	($m = W/g$) = 520/9.81 (= 53.0) ✓ (kg) $F = ma$ = 53 × 3bi (1.2356) = 65 (N) (65.49) ✓ accept use of 1.2 giving 64(63.6) , allow 53 x 124 = 65.7	2

4	a	i	cladding ✓	1

4	a	ii	sin θ_c = 1.41/1.46 ✓ θ_c = 75.0 (°) (74.96) ✓	2

4	b	i	65 (degrees) ✓	1

4	b	ii	1.46 sin 65 = 1.41 sin r **or** sin r = 0.93845 ✓ ecf bi r = 70 ✓ (degrees) (69.79) ecf bi	2

4	c		Two from: • less light is lost • better quality signal / less distortion • increased probability of TIR • Less change of angle between each reflection • reflects more times (in a given length of fibre) keeping (incident) angle large(r than critical angle) • (angle of incidence is) less likely to fall below the critical angle • less refraction out of the core • improved data transfer / information/ data/ signal carried quicker • less multipath dispersion (smearing / overlap of pulses) ✓✓	2

5	a		**The candidate's writing should be legible and the spelling, punctuation and grammar should be sufficiently accurate for the meaning to be clear.** The candidate's answer will be assessed holistically. The answer will be assigned to one of three levels according to the following criteria. **High Level (Good to excellent): 5 or 6 marks** The information conveyed by the answer is clearly organised, logical and coherent, using appropriate specialist vocabulary correctly. The form and style of writing is appropriate to answer the question. Candidate must suggest: • drawing a graph of F vs ΔL (or *vice versa*) • AND that k is in some way linked to the gradient • AND use of a suitable named instrument to measure or determine extension • AND 1 further means of reducing uncertainty: repeats / minimum 8 different readings / use of vernier scale / check values of mass with balance / parallax elimination with set square, pointer in contact with scale, mirror. For 6 marks: must also give suitable range at least up to 10N but not beyond 20N (accept 'up to 20N' / 'not beyond 20N') AND minimum **8 different readings** OR **parallax** elimination must be included AND **repeats** must be included AND correctly explains how k is obtained from their graph. **Intermediate Level (Modest to adequate): 3 or 4 marks** The information conveyed by the answer may be less well organised and not fully coherent. There is less use of specialist vocabulary, or specialist vocabulary may be used incorrectly. The form and style of writing is less appropriate. Candidate must suggest: • to measure / determine extension OR initial and final length • AND to use $F = k\,\Delta L$ or $k = F / \Delta L$ OR drawing a graph of F vs ΔL (or *vice versa*) • AND use of suitable **instrument** to measure extension OR 1 means of reducing **uncertainty**: repeats / use of vernier scale / check values of mass with balance / parallax elimination with set square, pointer in contact with scale,	max 6

			mirror / minimum 8 different readings / graphical approach For 4 marks, **uncertainty** comment AND **instrument** required **Low Level (Poor to limited): 1 or 2 marks** The information conveyed by the answer is poorly organised and may not be relevant or coherent. There is little correct use of specialist vocabulary. The form and style of writing may be only partly appropriate. Any relevant statement from the marking points above For 2 marks: must mention minimum two points including: • to measure / determine extension OR initial and final length	

5	b	i	(k = 2 × 85 = 170 (N m^{-1})) (ΔL = F / k =) 15 / 170 (or 7.5 / 85) ✓ = 0.088 ✓ (m) (0.0882)	2

5	b	ii	(k = ½ × 85 = 42.5) (ΔL = F / k =) 15/42.5 (or 2 x 15/85) ✓ = 0.35 ✓ (m) (0.3529)	2

5	b	iii	(W = ½ $F\Delta L$ or ½ $k\Delta L^2$) = ½ × 15 × 0.0882 (or 2 x ½ × 7.5 × 0.0882) ✓ ecf 5bi = 0.66 ✓ (J) (0.6615) ecf 5bi	2

5	b	iv	(series) **greater** ✓ ecf for answer 'less' or 'same' where candidates incorrect answers to 5bi and 5bii support this. extension is more (in series) and the **force is the same** (in both situations) ✓ **AND** quotes Energy stored = (½)Fs or ½ $F\Delta L$ OR energy proportional to extension ✓	3

6	a	i	oscillates / vibrates ✓ (allow goes up and down / side to side / etc, repeatedly, continuously,etc) about equilibrium position / perpendicularly to central line ✓	2

6	a	ii	X and Y: antiphase / 180 (degrees out of phase) / π (radians out of phase) ✓ X and Z: in phase / zero (degrees) / 2π (radians) ✓	2

6	b	i	$v = f\lambda$ = **780 x 0.32 / 2** or **780 x 0.16 OR 780 x 320 / 2** or **780 x 16**0 ✓ THIS IS AN INDEPENDENT MARK = 124.8 ✓ (m s^{-1}) correct 4 sig fig answer must be seen	2

6	b	ii	¼ cycle ✓ T = 1 / 780 OR = 1.28×10^{-3} ✓ $0.25 \times 1.28 \times 10^{-3}$ = 3.2×10^{-4} (s) ✓ Allow correct alternative approach using distance of 0.04m ✓ travelled by progressive wave in ¼ cycle divided by speed. 0.04 /125 ✓ = 3.2×10^{-4} (s) ✓	3

6	c	i	antinode ✓	1

6	c	ii	2 x 0.240 ✓ = 0.48 m ✓ '480m' gets 1 mark out of 2	2

6	c	iii	($f = v/\lambda$ = 124.8 or 125 / 0.48) = **260** (Hz) ecf from cii ✓	1

7	a		(wave) **B** ✓ (the parts of the) spring oscillate / move back and forth **in direction of** / **parallel to** wave travel OR mention of compressions and rarefactions ✓ Second mark can only be scored if first mark is scored	2

7	b	i	(double ended arrow / line / brackets) from between two points in phase ✓	1

7	b	ii	wave A: arrow vertically upwards ✓ wave B: arrow horizontally to the left ✓	2

7	c		(transmitted radio waves are often) polarised ✓ aerial (rods) must be aligned in the same plane (of polarisation / electric field) of the wave ✓	2

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