OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B

Advanced GCE **2865/01**

Advances in Physics

Mark Scheme for June 2010

Oxford Cambridge and RSA Examinations

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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.

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Physics B (ADVANCING PHYSICS) MARK SCHEMES - An introduction

Just as the philosophy of the *Advancing Physics* course develops the student's understanding of Physics, so the philosophy of the examination rewards the candidate for showing that understanding. These mark schemes must be viewed in that light, for in practice the examiners' standardisation meeting is of at least equal importance.

The following points need to be borne in mind when reading the published mark schemes:

- Alternative approaches to a question are rewarded equally with that given in the scheme, provided that the physics is sound. As an example, when a candidate is required to "Show that..." followed by a numerical value, it is always possible to work back from the required value to the data.
- Open questions, such as the questions in section C permit a very wide variety of approaches, and the candidate's own approach must be rewarded according to the degree to which it has been successful. Real examples of differing approaches are discussed in standardisation meetings, and specimen answers produced by candidates are used as 'case law' for examiners when marking scripts.
- Final and intermediate calculated values in the schemes are given to assist the examiners in spotting whether candidates are proceeding correctly. Mark schemes frequently give calculated values to degrees of precision greater than those warranted by the data, to show values that one might expect to see in candidates' working.
- Where a calculation is worth two marks, one mark is generally given for the method, and the other for the evaluation of the quantity to be calculated.
- If part of a question uses a value calculated earlier, any error in the former result is not penalised further, being counted as *error carried forwar*d: the candidate's own previous result is taken as correct for the subsequent calculation.
- Inappropriate numbers of significant figures in a final answer are penalised by the loss of a mark, generally once per examination paper. The maximum number of significant figures deemed to be permissible is one more than that given in the data; two more significant figures would be excessive. This does not apply in questions where candidates are required to show that a given value is correct.
- Where units are not provided in the question or answer line the candidate is expected to give the units used in the answer.
- Quality of written communication will be assessed where there are opportunities to write extended prose.

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

1. Please ensure that you use the **final** version of the Mark Scheme. You are advised to destroy all draft versions.

2. Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (½) should never be used.

3. The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

   x = incorrect response (errors may also be underlined)
   ^ = omission mark
   bod = benefit of the doubt (where professional judgement has been used)
   ecf = error carried forward (in consequential marking)
   con = contradiction (in cases where candidates contradict themselves in the same response)
   sf = error in the number of significant figures

4. The marks awarded for each part question should be indicated in the margin provided on the right hand side of the page. The mark total for each double page should be ringed at the end of the question, on the bottom right hand side. These totals should be added up to give the final total on the front of the paper.

5. In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.

6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

7. Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.

8. An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct and answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

m	= method mark
s	= substitution mark
e	= evaluation mark
/	= alternative and acceptable answers for the same marking point
;	= separates marking points
NOT	= answers which are not worthy of credit
( )	= words which are not essential to gain credit
____	= (underlining) key words which **must** be used to gain credit
ecf	= error carried forward
AW	= alternative wording
ora	= or reverse argument

Qn	Expected Answers	Marks	Additional guidance
1 (a)	(i) Initially stiff(er) ✓; gets easier to pull ✓; gets stiff(er) towards end ✓	2	Any two points
	(ii) B is stiffer than A ✓; stretches (easily) by bond rotation ✓; B identified as bonds rotated as much as possible ✓	2	Any two points
(b)	(i) PE has only H atoms joined to it ✓; F and Cl both bigger than H ✓; bigger atoms hinder rotation ✓	2	Any two points
	(ii) More F atoms than C atoms (or Cl)✓; hinder rotation more ✓	2	
	Total:	**8**	
2 (a)	(i) $pV = \frac{1}{3}Nm\overline{c^2} = nRT$ ✓; if n = 1, $N = N_A$ ✓	2	
	(ii) mean square speed ∝ 1/m ✓	1	Any clear reference to equation, e.g. m is underneath on RHS so m↑ ⇒ c↓
	(iii) $\overline{c^2} = 3\frac{RT}{N_A m} = \frac{3\times 8.3\times 290}{6.0\times 10^{23}\times 58\times 10^{-26}}$ =20 750 ✓; so r.m.s. speed =√ 20 750 = 144 m s^{-1} ✓	2	
(b)	(i) Need ≥ 3 s.f. to distinguish similar masses ✓;	1	Differences in speed are very small OK
	(ii) Displacements are 144 × 120 m and 143.4 × 120 m i.e. 17280 m & 17208 m ✓; mean separation = 72 m ✓	2	
	(iii) UF_6 molecules strike air molecules (frequently) ✓; collisions result in change of direction ✓; tendency to spread out is therefore very slow ✓	2	Any two points
	Total:	**10**	

Qn	Expected Answers	Marks	Additional guidance
3 (a)	(i) Arrow radially inwards ✓ (ii) Ticks in 2nd and 4th boxes ✓	1 1	
(b)	antiprotons negative/opposite charge to protons ✓; inward *qvB* force requires motion in opposite direction ✓	2	
(c)	(i) $E_{rest} = mc^2 = 1.7 \times 10^{-27}$ kg × $(3.0 \times 10^8$ m s$^{-1})^2$ $= 1.5 \times 10^{-10}$ J ✓ $= 1.5 \times 10^{-10}/1.6 \times 10^{-19}$ J = 9.4 x10^8 eV ✓ = 0.94 GeV✓ (ii) For very high *v*/*c*, E_{total} is 10s / 100s of GeV ✓ rest energy 1 GeV so can be ignored in equation, leading to $E \approx pc$ ✓	3 2	E_{rest}= 1.53 x 10^{-10} J =0.96 GeV
	Total:	**9**	
4 (a)	Large current required for large magnetic field strength ✓ ; Increasing current increases heat dissipated ✓ ; heat produced will damage coils ✓; presence of resistance reduces current✓	2	Any two or similar plausible points.
(b)	Copper has resistance ✓; all strands in parallel so have same p.d. = 0 ✓; I = 0 when V = 0 (as $V = R\,I$) ✓	2	Any two points
(c)	(i) Flux change induces emf✓; rapid change (collapse) produces large emf ✓;large emf produces large current✓ (ii) Copper lower resistance than Ni-Ti so current flows in copper✓ (iii) Large current produces (I^2R) heating in resistance ✓.	2 1 1	Any two points (iii)Resistance should be stated or implied /description in terms of electron collisions in the lattice is OK.
(d)	Large force (or torque) produced by large field which may damage the body / large emf could be induced. ✓	1	Or other valid point e.g. iron distorts field and affects image.
	Total:	**9**	
5 (a)	(i) $E = hf = 6.6 \times 10^{-34} \times 50 \times 10^6 = 3.3 \times 10^{-26}$ J ✓; $= 3.3 \times 10^{-26}/1.6 \times 10^{-19} = 2.1 \times 10^{-7}$eV ✓≈ 2×10^{-7}eV (ii) X-ray photons carry much more energy/cause ionisation ✓; a single high energy photon can damage DNA/cells/cause cancer while many low-energy photons cannot ✓	2 2	Evidence of evaluation
(b)	MRI maps protons/hydrogen in all tissues ✓; X-rays only detect (gross) density differences ✓;	2	Any reasonable comparison with one mark for X-ray, one for MRI
(c)	can be processed ✓; easy to store ✓; easy to share with other medical staff ✓; can be produced faster ✓; no consumables (valuable silver, polluting chemicals) involved ✓.	2	Any two points
	Total:	**8**	

6 (a)	(i) (The Earths') gravity ✓ (ii) 'freefall' = moving just under the effect of gravity ✓; accelerating towards the centre of the Earth✓ (iii) $F = GMm/r^2 = mv^2/r$ ✓ ; rearrange to $v = \sqrt{\frac{GM}{r}}$ ✓ (iv) $v = \sqrt{\frac{4.0\times10^{14}}{6.8\times10^{6}}} = 7700\ \text{m s}^{-1}$ ✓; $½mv^2 = ½ \times 1.9 \times 10^5 \times 7700^2 = 5.6 \times 10^{12}$ J ✓	1 2 2 2	
(b)	$\Delta V_{\text{grav}} = GM(\frac{1}{r_E} - \frac{1}{r}) = 4.0\times10^{14}\left(\frac{1}{6.4\times10^{6}} - \frac{1}{6.8\times10^{6}}\right)$ $= 3.68 \times 10^6 \approx 4 \times 10^6$ J kg^{-1}✓m ✓e; $\Delta PE = m\Delta V_{\text{grav}} = 1.9 \times 10^5 \times 3.68 \times 10^6 = 7.0 \times 10^{11}$ J ✓	3	Can use -GMm/r, with (1) for each calculation Initial PE= -1.19 x10^{13} J Final PE= -1.12 x10^{13} J and (1) for difference. Calculation of potential difference (2) V_1= -6.25 x10^7 J kg^{-1} V_2 = -5.88 x 10^7 J kg^{-1} ΔV = 3.68 x10^6 J kg^{-1} penalise negative final answer
(c)	Need to lift fuel ✓; need to lift rockets carrying ISS ✓; dissipative losses in atmosphere ✓	2	Any two points
	Total:	**12**	
7 (a)	(i) Each spring carries half the load /springs in parallel✓ Therefore half extension obtained, so *k* doubles ✓ (ii) Weight = 1000 kg x 9.8 N kg^{-1} = 9800 N ✓ $x = F/k$ =9800 N/(5.2 x 10^4 N m^{-1}) = 0.19 m ≈ 20 cm ✓	2 2	Or needs double the force for the same extension as two springs share the load
(b)	$T = 2\pi\sqrt{(m/k)}$ = $2\pi\sqrt{}$(500 kg/5.2 x 10^4 N m^{-1}) = 0.62 s ≈ 0.6 s m✓ e✓	2	
(c)	$T \propto \sqrt{m}$ so doubling T doubles $\sqrt{m}$ ✓ m is quadrupled i.e. 2000 kg ✓ (Load is 2000 kg – 500 kg = 1500 kg) so overloaded ✓	3	Can work through arithmetically leads to 1900 kg total mass
(d)	Wheel moves vertically suddenly compressing spring exerting a force on the body ✓ massive body accelerates upwards beyond its equilibrium position, as wheel drops down the bump body falls causing oscillation owtte✓	2	Inertial idea needed to explain initial spring compression and then extension
(e)	Resonance occurs ✓ Period matches the time between bumps owtte ✓	2	
(f)	Period unchanged ✓ Concave envelope (allow linear) ✓ Ratios of amplitudes at times 0:T, T:2T and 2T:3T approximately equal ✓	3	Allow slight increase Should be x_o,0.63x_o,0.4x_o,0.25x_o (0.5x_o at 1.5T)
		16	

8(a)	(i) **A** violet **B** green **C** red ✓ (ii) Set of spectral lines nearest to straight-on direction / lines given by n = 1 in $n\lambda = d \sin\theta$ ✓ (iii) All wavelengths superpose constructively at this point/ $\theta = 0$ is a solution for all values of λ when n =0 ✓ (iv) $d = 1 \times 10^{-3}/600 = 1.67 \times 10^{-6}$ m ✓ $\lambda = 1.67 \times 10^{-6} \sin(19.1°) = 545$ nm ✓ m ✓ e	1 1 1 3	All colours are present here acceptable
(b)	(i) **A** and **B** ✓ because narrow line/single energy of each photon ✓ (ii) **C** ✓ because range of energies ✓	2 2	
(c)	No distinct lines/continuous range of wavelengths separately encompassing RGV on each side ✓	1	Ignore absence of 0 order.
(d)	(i) Circuit with power supply & lamp + correct ammeter + voltmeter✓ (ii) Quote $P=IV$ ✓ Explain calculation & comparison ✓	1 2	Allow correct alternatives. Mark (i) and (ii) together.
		14	
QWC	Use all script	**4**	

QWC Marking quality of written communication

The appropriate mark (0-4) should be awarded based on the candidate's quality of written communication in the whole paper.

4 max The candidate will express complex ideas extremely clearly and fluently. Answers are structured logically and concisely, so that the candidate communicates effectively. Information is presented in the most appropriate form (which may include graphs, diagrams or charts where their use would enhance communication). The candidate spells, punctuates and uses the rules of grammar with almost faultless accuracy, deploying a wide range of grammatical constructions and specialist terms.

3 The candidate will express moderately complex ideas clearly and reasonably fluently. Answers are structured logically and concisely, so that the candidate generally communicates effectively. Information is not always presented in the most appropriate form. The candidate spells, punctuates and uses the rules of grammar with reasonable accuracy; a range of specialist terms are used appropriately.

2 The candidate will express moderately complex ideas fairly clearly but not always fluently. Answers may not be structured clearly. The candidate spells, punctuates and uses the rules of grammar with some errors; a limited range of specialist terms are used appropriately.

1 The candidate will express simple ideas clearly, but may be imprecise and awkward in dealing with complex or subtle concepts. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling may be noticeable and intrusive, suggesting weakness in these areas.

0 The candidate is unable to express simple ideas clearly; there are severe shortcomings in the organisation and presentation of the answer, leading to a failure to communicate knowledge and ideas. There are significant errors in the use of language which makes the candidate's meaning uncertain.

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