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General Certificate of Education (A-level)
June 2012

Physics A PHYA1

(Specification 2450)

Unit 1: Particles, quantum phenomena and electricity

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.

Further copies of this Mark Scheme are available from: aqa.org.uk

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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.

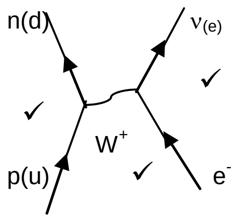
6 Knowledge of units is tested on designated questions or parts of questions in each a paper. On each such question or part-question, unless otherwise stated in the mark scheme, the mark scheme will show a mark to be awarded for the numerical value of the answer and a further mark for the correct unit. 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, PHYA1, Particles, Quantum Phenomena and Electricity

1	a	i	quark antiquark pair OR $q\overline{q}$ OR named quark antiquark pair ✓	1
1	a	ii	0 ✓	1
1	a	iii	$u\overline{s}$ ✓	1
1	b	i	Weak ✓ any of the following also score 1 mark: weak interaction weak interaction force weak nuclear weak nuclear interaction weak decay weak force weak nuclear force	1
1	b	ii	conserved: baryon number, charge, lepton number, spin ✓✓ not conserved: strangeness ✓	3
1	b	iii	$K^- \rightarrow \pi^0 + e^- + \overline{\nu_{(e)}}$ ✓✓ OR $K^- \rightarrow \pi^0 + \mu^- + \overline{\nu_{(\mu)}}$	2
2	a	i	nucleon number is the number of protons and neutrons OR mass number proton number is the number of protons OR atomic number✓	1
2	a	ii	14 – 6 =8 ✓	1
2	a	iii	specific charge =6 × 1.6 × 10^{-19}✓/(14×1.66×10^{-27} ✓) specific charge = 4.1 × 10^{7} (C kg^{-1}) ✓	3
2	b	i	isotopes are variations of an element that have same proton/atomic number ✓ but different nucleon number OR different number of neutrons ✓	2
2	b	ii	4.8 × 10^{7} = 6 × 1.6 × 10^{-19} ✓/(A × 1.66 × 10^{-27}) A = 6 × 1.6 × 10^{-19}/(4.8 × 10^{7} × 1.66 × 10^{-27}) A = 12 ✓ Number of neutrons = 12-6 ✓	3
3	a		see table below	2

interaction	exchange particle
weak	W^+ OR W^- OR Z° ✓
electromagnetic	photon OR γ ✓

3	b		*uud* ✓	1
3	c	i	an **atomic/orbital/shell** electron ✓ interacts with a proton in the **nucleus (**via the weak interaction) ✓ neutron formed **or** u quark changes to d quark(and neutrino released) ✓	3
3	c	ii		3
4	a	i	<u>minimum energy</u> required ✓ to remove electron from metal (surface) OR cadmium OR the material ✓	2
4	a	ii	photons have energy dependent on frequency OR energy of photons constant ✓ one to one interaction between photon and electron✓ Max KE = photon energy – work function in words or symbols✓ more energy required to remove deeper electrons✓	4
4	a	iii	(*use of* $hf=\phi+E_{k(max)}$) $6.63 \times 10^{-34} \times f = 4.07 \times 1.60 \times 10^{-19}$ ✓ $+ 3.51 \times 10^{-20}$ ✓ $f = 1.04 \times 10^{15}$ (Hz) OR 1.03×10^{15} (Hz) ✓✓ (3 sig figs)	4
4	b		theory makes predictions tested✓ by repeatable/checked by other scientists/peer reviewed (experiments) OR new evidence that is repeatable/checked by other scientists/peer reviewed✓	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. *The candidate states that the power supply is connected*	max 6

			to the input of the oscilloscope. The time base is switched off and the y gain adjusted until a complete vertical line is seen on the screen. The length of the line is measured and this is converted to peak to peak voltage using the calibration. The peak voltage is divided by root two to get the rms voltage and this is compared with the stated value. The time base is now switched on and adjusted until a minimum of one cycle is seen on the screen. The length of one cycle is measured and this is converted to time using the time base setting. Frequency is the reciprocal of this time.	
			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. *The candidate states that the power supply is connected to the input of the oscilloscope. The y gain adjusted. The length of the line/height of peak is measured. The peak voltage is divided by root two to get the rms voltage. The time base is now switched on and adjusted until a minimum of one cycle is seen on the screen. The length of one cycle is measured and this is converted to time using the time base setting.*	
			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**.** *The candidate states that the power supply is connected to the input of the oscilloscope. The length of the line/height of peak is measured. The time base is now switched on and adjusted until a minimum of one cycle is seen on the screen. The length of one cycle is measured and this is converted to time.* **The explanation expected in a competent answer should include a coherent selection of the following points concerning the physical principles involved and their consequences in this case.** • power supply connected to oscilloscope input • time base initially switched off • y gain adjusted to get as long a line as possible • length of line used to find peak to peak voltage • rms voltage found • time base switched on and adjusted to get several cycles on the screen • use the time base setting to find period • use period to find frequency • compare vales with stated values	

5	b	i	*(use of P = IV)* I = 24/12 = 2.0 (A) ✓	1

5	b	ii	peak current = √2 × 2.0 = 2.8 (A) ✓	1
5	b	iii	peak power = √2 × 12 × √2 × 2.0 ✓ = 48 (W) ✓	2
6	a	i	*(use of P=VI)* I = 36/12 + 6/12 ✓ = 3.5 (A) ✓	2
6	a	ii	*(use of V=IR)* R = 12/3 =4 (Ω) ✓	1
6	a	iii	*R* = 12/0.50 = 24 ✓ (Ω)	1
6	b		terminal pd/voltage across lamp is now less OR current is less ✓ due to lost volts across internal resistance OR due to higher resistance✓ lamps less bright ✓	3
6	c	i	current through lamps is reduced as resistance is increased **or** pd across lamps is reduced as voltage is shared ✓ hence power is less OR lamps dimmer ✓	2
6	c	ii	lamp Q is brighter ✓ lamp Q has the <u>higher resistance</u> hence <u>pd/voltage</u> across is greater ✓ current is the same for both ✓ hence power of Q greater ✓	max 3
7	a	i	*(use of V = IR)* *I* = (12-8) /60✓ = 0.067 Or 0.066(A) ✓	2
7	a	ii	*(use of V = IR)* R = 8/0.067 = 120 (Ω) ✓	1
7	a	iii	*(use of Q = It)* *Q = 0.067* × *120* = 8.0 ✓ C ✓	2
7	b		reading will increase ✓ resistance (of thermistor) decreases (as temperature increases) ✓ current in circuit increase (so pd across R_1 increases) OR correct potential divider argument ✓	3

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