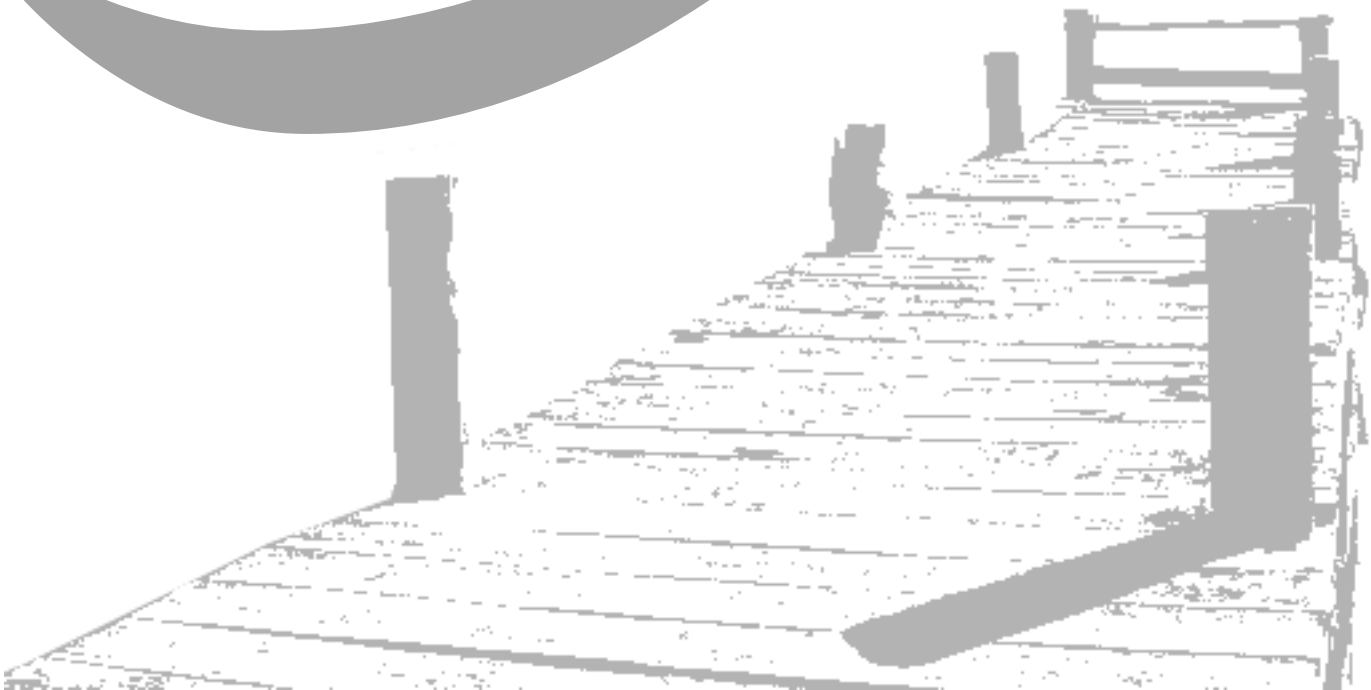
GCE
AS and A Level

Physics B: Physics In Context

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 5:
Approved specimen mark scheme

Version 1.1



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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 2456

Specification B Physics In Context

PHYB5 Energy Under the Microscope

Mark Scheme

Specimen Draft

The specimen assessment materials are provided to give centres a reasonable idea of the general shape and character of theplanned question papers and mark schemes in advance of the first operational exams.

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

PHYB5: Energy Under the Microscope

Question 1				
(a)	(i)	$PV = NkT$ ✓	AO1	6
		223×10^5 Pa ✓	AO2	
	(ii)	pV = const or repeat calculation from (i) ✓	AO1	
		3.5×10^{-3} m^3 ✓	AO2	
	(iii)	kinetic energy = 3/2 kT ✓	AO1	
		$5.9(0) \times 10^{-21}$ J ✓	AO2	
(b)	(i)	volume increase ✓ } max 3	AO1	6
		time between collisions increases ✓ } max 3	AO1	
		speed constant as temp constant ✓ } max 3	AO2	
		rate of change of momentum decreases ✓ } max 3	AO2	
	(ii)	volume smaller in cylinder ✓	AO1	
		molecules occupy significantly greater proportion of the volume ✓	AO2	
		molecules closer so intermolecular forces greater ✓	AO2	
(c)		internal energy stays the same ✓	AO2	4
		gas does work in expanding so W is negative ✓	AO2	
		gas must be heated to make U positive ✓	AO2	
		U and W equal and opposite ✓	AO2	
			Total	**16**

Question 2				
(a)		number correct for alpha ✓	AO1	6
		number correct for beta ✓	AO1	
		alpha decay first goes via Tl ✓	AO2	
		numbers correct for Tl (208, 81) ✓	AO2	
		beta decay first goes via Po ✓	AO2	
		numbers correct for Po (212, 84) ✓	AO2	
(b)	(i)	use of GM tube + counter/rate-meter ✓	AO3	9
		measurement of count rate ✓	AO3	
		at range of distances + suitable ruler or tape measure ✓	AO3	
		specifies suitable range ✓ **max 6**	AO3	
		determines background & corrects ✓	AO3	
		safety precaution given ✓	AO3	
		graph of count rate or corrected count rate against $1/d^2$ ✓	AO3	
	(ii)	gamma not absorbed ✓	AO1	
		spreads uniformly from a point source/spherically symmetrically ✓ **max 2**	AO1	
		area over which it spreads is proportional to radius squared ✓	AO1	
		alpha and beta are absorbed in addition to spreading out ✓	AO2	
			Total	**15**

Question 3				
(a)		clear attempt to find mass defect ✓	AO2	
		0.1860 u (condone 3 s.f.) ✓	AO2	
		converts their answer to kg (3.09 × 10-28) ✓	AO2	**5**
		uses $\Delta E = \Delta m\, c^2$ ✓	AO1	
		2.78×10^{-11} J ✓	AO2	
(b)	(i)	slow neutrons down ✓	AO1	
		slow neutrons more likely to produce fission ✓	AO2	
	(ii)	water ✓	AO1	**5**
	(iii)	small atomic mass ✓	AO2	
		not a strong neutron absorber ✓	AO2	
(c)	(i)	start up and close down – control rods ✓	AO1	
		power control in operation – material injected into coolant ✓	AO2	**4**
	(ii)	boron rods or boric acid ✓	AO1	
	(iii)	strong neutron absorber ✓	AO2	

(d)	The marking scheme for this part of the question includes an overall assessment for the Quality of Written Communication (QWC). There are no discrete marks for the assessment of QWC but the candidates' QWC in this answer will be one of the criteria used to assign a level and award the marks for this part of the question.		
Level	**Descriptor** an answer will be expected to meet most of the criteria in the level descriptor		**Mark range**
Good **3**	- claims supported by an appropriate range of evidence - good use of information or ideas about physics, going beyond those given in the question - argument well structured with minimal repetition or irrelevant points - accurate and clear expression of ideas with only minor errors of grammar, punctuation and spelling		**5-6**
Modest **2**	- claims partially supported by evidence - good use of information or ideas about physics given in the question but limited beyond this - the argument shows some attempt at structure - the ideas are expressed with reasonable clarity but with a few errors of grammar, punctuation and spelling		**3-4**
Limited **1**	- valid points but not clearly linked to an argument structure - limited use of information or ideas about physics - unstructured - errors in spelling, punctuation and grammar or lack of fluency		**1-2**
0	- incorrect, inappropriate or no response		**0**
	examples of the sort of information or ideas that might be used to support an argument: does not contribute to greenhouse gases doesn't use up oil reserves danger of nuclear accident legacy of radioactive waste risk of spread of nuclear technology or materials	 AO3 AO3 AO3 AO3 AO3	
(e)	fission has long lasting very harmful fission products ✓ fusion fuel safely and readily available without dangerous reprocessing ✓	AO1 AO2	**2**
		Total	**22**

Question 4				
(a)	(i)	charge stored per unit volt or equation with terms defined ✓	AO1	**2**
	(ii)	0.108 C or 0.11 C c.a.o. ✓	AO2	
(b)	(i)	1.7 s ✓	AO2	**4**
	(ii)	correct curvature ✓	AO1	
		intercept on V axis, asymptotic to t axis ✓	AO2	
		initial voltage, time constant and V after RC seconds shown ✓	AO2	
(c)		initially no pd across C so rate of charging is high ✓	AO1	**3**
		Pd across C increases as the capacitor charges ✓	AO1	
		rate of charging reduces ✓	AO1	
			Total	**9**

Question 5				
(a)	(i)	ions experience a force due to both the magnetic and electric fields ✓	AO1	**8**
		fields are in opposite directions ✓	AO1	
		equal and opposite for ions of only 1 speed ✓	AO2	
	(ii)	$v = E/B$ and $E = V/d$ ✓	AO1	
		data substituted and evaluated correctly ✓	AO2	
	(iii)	$Bqv = mv^2/r$ ✓	AO1	
		correct substitution with or without the doubling to find d ✓	AO2	
		0.29 m ✓	AO2	
(b)	(i)	a.c. supply connected to electrodes ✓	AO1	**7**
		electrons accelerated in the electric fields between consecutive electrodes ✓	AO1	
		electrons are going faster each time so need more distance between ✓	AO2	
		electrodes to be phase with the alternating supply ✓	AO2	
	(ii)	$m = \frac{m_o}{\sqrt{1-\frac{v^2}{c^2}}}$ ✓	AO1	
		correct substitution of data ✓	AO2	
		$2.5(4) \times 10^{30}$ kg ✓	AO2	
			Total	**15**

Question 6				
(a)	(i)	use of $\lambda = (\ln 2)/t_{½}$ ✓	AO1	**6**
		shows that years have been converted to seconds ✓	AO2	
	(ii)	use of 1 mole 238 g ✓	AO2	
		$4.0(4) \times 10^{20}$ ✓	AO2	
	(iii)	states $A = \lambda N$ ✓	AO1	
		multiples (i) by (ii) ✓	AO2	
(b)	(i)	multiples 1.0×10^{11} by 5600×10^{3} ✓	AO2	**4**
		0.090 J ✓	AO2	
	(ii)	$7.5 \times 10^{-4}/0.090$ ✓	AO2	
		0.83% ✓	AO2	
(c)		use of any $e^{-\lambda t}$ relationship ✓	AO1	**3**
		uses 6/7.5 ✓	AO2	
		5.0×10^{9} s ✓	AO2	
(d)		uses $E = mc\Delta\theta$ ✓	AO1	**3**
		9.1 ✓	AO2	
		K or ºC ✓	AO1	
(e)	(i)	chooses beta emitter so there is no risk of neutron production ✓	AO3	**4**
		rejects strontium as to energetic ✓	AO3	
		selects Nickel which has an appropriate half life ✓	AO3	
	(ii)	may be alpha or gamma emitters in the decay chain ✓	AO3	
(f)		compares risk of death with and without pacemaker ✓	AO3	**3**
		mentions quality of life ✓	AO3	
		clinical trials/prior testing to establish reliability ✓	AO3	
			Total	**23**