



## **General Certificate of Education**

# **Physics 5456**

## *Specification B*

**PHB2      Waves and Nuclear Physics**

# **Mark Scheme**

*2007 examination - January series*

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.

Further copies of this Mark Scheme are available to download from the AQA Website: [www.aqa.org.uk](http://www.aqa.org.uk)

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## Notes for Examiners

Letters are used to distinguish between different types of marks in the scheme.

### **M** indicates OBLIGATORY METHOD MARK

This is usually awarded for the physical principles involved, or for a particular point in the argument or definition. It is followed by one or more accuracy marks which cannot be scored unless the M mark has already been scored.

### **C** indicates COMPENSATION METHOD MARK

This is awarded for the correct method or physical principle. In this case the method can be seen or implied by a correct answer or other correct subsequent steps. In this way an answer might score full marks even if some working has been omitted.

### **A** indicates ACCURACY MARK

These marks are awarded for correct calculation or further detail. They follow an M mark or a C mark.

### **B** indicates INDEPENDENT MARK

This is a mark which is independent of M and C marks.

**e.c.f.** is used to indicate that marks can be awarded if an error has been carried forward (e.c.f. must be written on the script). This is also referred to as a 'transferred error' or 'consequential marking'.

Where a correct answer only (**c.a.o.**) is required, this means that the answer must be as in the Mark Scheme, including significant figures and units.

**c.n.a.o.** is used to indicate that the answer must be numerically correct but the unit is only penalised if it is the first error or omission in the section (see below).

Only **one** unit penalty (**u.p.**) in this paper unless there is a mark allocated specifically for giving a correct unit in the marking. Note that the unit is only penalised in the final answer to the question.

Only **one** significant figure penalty (**s.f.**) in this paper.

Allow 2 or 3 s.f. unless otherwise stated. s.f. penalties include recurring figures and fractions for answers.

Marks should be awarded for **correct** alternative approaches to numerical questions that are not covered by the mark scheme. A correct answer from working that contains a physics error (PE) should not be given credit. Examiners should contact the Team Leader or Principal Examiner for confirmation of the validity of the method, if in doubt.

### Quality of Written Communication

Before accessing marks for the Quality of Written Communication (QWC) a candidate must first score a minimum of one mark for the physics that is being communicated – this will allow access to 1 mark for QWC. If the candidate scores more marks for physics (a minimum of two or three – depending upon the total mark for that part of the question) then this will allow access to 2 marks for QWC.

**Good QWC:** the answer is fluent/well argued with few errors in spelling, punctuation and grammar

**2**

**Poor QWC:** the answer lacks coherence or spelling, punctuation and grammar are poor

**1**

**Max 2**

**Very Poor QWC:** the answer is disjointed, with significant errors in spelling, punctuation and grammar

**0**

## PHB2 Waves and Nuclear Physics

Question 1			
(a)	$v = f\lambda$ correct substitution (condone powers of 10) $5.3 \times 10^{-2} \times 2.9 \times 10^4$ $1540 \text{ m s}^{-1}$	<b>C1</b>  <b>C1</b>  <b>A1</b>	  <b>3</b>
(b)	$s = vt$ in symbols or numbers 177 m	<b>C1</b>  <b>A1</b>	  <b>2</b>
			<b>Total 5</b>

Question 2			
(a)	$\sin\theta = \lambda/b$ 2.7/6.3 condone powers of 10 $25^\circ$	<b>C1</b>  <b>C1</b>  <b>A1</b>	  <b>3</b>
(b)	correct overall shape: central maximum at origin and at least 1 subsequent smaller maximum on each side angle marked for 1 <sup>st</sup> minimum and good overall shape	<b>M1</b>  <b>A1</b>	  <b>2</b>
			<b>Total 5</b>

Question 3			
(a) (i)	$\Delta f/f = v/c$ condone $\Delta f/f = v/c - v$ correct substitution: $\frac{30 \times 330}{420}$ $23.6 \text{ m s}^{-1}$	<b>C1</b>  <b>C1</b>  <b>A1</b>	  <b>4</b>
(ii)	390 Hz <b>e.c.f.</b>	<b>C1</b>	
(b)	measuring speed of blood/other fluids/speed camera/air traffic control	<b>B1</b>	<b>1</b>
			<b>Total 5</b>

<b>Question 4</b>			
(a)	(i)	figure 2: beta/electrons figure 3: alpha/helium nuclei	<b>B1</b> <b>B1</b>
	(ii)	heavy/massive/highly ionizing particles short or thick tracks <b>or</b> all have similar energy all have similar length	<b>M1</b> <b>A1</b>
(b)		2 from $m, v, p, q$ details of deductions e.g. direction of curvature indicates sign of charge	<b>B1</b> <b>B1</b>
			<b>Total 6</b>

<b>Question 5</b>			
(a)		all lines moved to the right clear attempt to maintain the same distribution of lines	<b>B1</b> <b>B1</b>
(b)		red shift (owtte) (size of red shift) indicates velocity of recession (Hubble's law statement that) velocity of recession is related to distance expansion caused by Big Bang	<b>B1</b> <b>B1</b> <b>B1</b> <b>B1</b>
			<b>Total 5</b>

<b>Question 6</b>			
(a)		N $\beta + N + \nu$ correct data on $\beta$ & N and antineutrino (condone lack of antineutrino)	<b>C1</b> <b>C1</b> <b>A1</b>
(b)	(i)	at least one vertical line and one horizontal line seen as construction lines on graph or other clear evidence of graph use at least one answer correct correct averaging <b>no unit penalty</b>	<b>B1</b> <b>C1</b> <b>A1</b>
	(ii)	$A = \lambda N$ $8.6 \times 10^{10}$	<b>C1</b> <b>A1</b>
			<b>5</b>

(c)	activity of 1 g is 0.24 (Bq) 2600y	<b>C1</b> <b>A1</b>	<b>2</b>
			<b>Total 10</b>

<b>Question 7</b>			
(a)	one loop correct identification of nodes and antinodes	<b>B1</b> <b>B1</b>	<b>2</b>
(b) (i)	tension or mass per unit length (in either order)	<b>B1</b>	<b>2</b>
(b) (ii)	<i>f</i> increases as <i>T</i> increases <b>or</b> <i>f</i> increases as $\mu$ decreases	<b>B1</b>	
(c)	means of causing a vibration that can be observed in a steady situation means of varying and measuring frequency means of applying tension in a controllable way means of measuring and varying length states that <i>l</i> is varied and frequency measured or vice versa display of results	<b>B1</b> <b>B1</b> <b>B1</b> <b>B1</b> <b>B1</b> <b>B1</b>	<b>max 5</b>
	At least 2 marks for physics + <b>Good QWC</b> At least 2 marks for physics + <b>Poor QWC</b> At least 2 marks for physics + <b>Very Poor QWC</b> 1 or 2 marks for physics + sufficient attempt + <b>Good or Poor QWC</b> 1 or 2 marks for physics + insufficient attempt or <b>Very Poor QWC</b> No marks for physics or <b>Very Poor QWC</b>	<b>2</b> <b>1</b> <b>0</b> <b>1</b> <b>0</b> <b>0</b>	<b>max 2</b>
			<b>Total 11</b>

<b>Question 8</b>			
(a) (i)	$y = \lambda D/d$ correct substitution (condone powers of 10) $5.9(2) \times 10^{-4} \text{ m}$ condone powers of 10	<b>C1</b> <b>C1</b> <b>A1</b>	<b>5</b>
(ii)	fringe separation smaller smaller wavelength and reference to equation	<b>M1</b> <b>A1</b>	
(b)	light reflected from the water path difference between the 2 (reflected) rays two rays behave as rays from coherent sources/have the same frequency superpose (at <b>O</b> ) bright where in phase/dark where out of phase - allow similar argument for path difference	<b>B1</b> <b>B1</b> <b>B1</b> <b>B1</b>	<b>max 4</b>
	At least 2 marks for physics + <b>Good QWC</b> At least 2 marks for physics + <b>Poor QWC</b> At least 2 marks for physics + <b>Very Poor QWC</b> 1 or 2 marks for physics + sufficient attempt + <b>Good or Poor QWC</b> 1 or 2 marks for physics + insufficient attempt or <b>Very Poor QWC</b> No marks for physics or <b>Very Poor QWC</b>	<b>2</b> <b>1</b> <b>0</b> <b>1</b> <b>0</b> <b>0</b>	<b>max 2</b>
			<b>Total 11</b>

<b>Question 9</b>			
(a)	<p>electrons are negative</p> <p>muons may have either charge</p> <p>neutrinos have no charge</p> <p>electrons have mass</p> <p>muons also have mass</p> <p>muons are heavier (than electrons)</p> <p>neutrinos have no mass/extremely small mass</p> <p><b>must make correct reference to all three particles for maximum marks</b></p>	<p><b>B1</b></p> <p><b>B1</b></p> <p><b>B1</b></p> <p><b>B1</b></p> <p><b>B1</b></p> <p><b>B1</b></p> <p><b>B1</b></p>	<p><b>max 4</b></p>
(b)	<p>Q:      +1    +1</p> <p>        or    or    +    0</p> <p>        +e-&gt; +e</p> <p>B:    0-&gt;    0    +    0</p> <p>L:    -1 -&gt; -1    +    +1</p> <p>won't work because of lack of conservation of lepton number</p>	<p><b>M1</b></p> <p><b>M1</b></p> <p><b>M1</b></p> <p><b>A1</b></p>	<p><b>max 2</b></p> <p><b>-1 for each wrong line</b></p> <p><b>3</b></p>
			<b>Total 7</b>



<b>Question 10</b>			
(a)	divides 1100 or 1100 000 by 4500 or 9000 1100/9 or 1100 000/9000 122 not 122.2	<b>C1</b> <b>A1</b> <b>A1</b>	<b>3</b>
(b)	relates quality to range of frequencies or number of overtones relates bandwidth to frequencies used	<b>B1</b> <b>B1</b>	<b>2</b>
(c) (i)	sampled amplitudes or voltages assigned digital values converted to binary code sampled at 2 × max frequency (to include necessary detail) transmitted in sync with analogue signal	<b>B1</b> <b>B1</b> <b>B1</b> <b>B1</b> <b>B1</b>	<b>max 3</b>
(ii)	more faithful reproduction of sound ...because less information lost <b>or</b> reference to noise noise eliminated providing that (binary 1) voltage > noise	<b>B1</b> <b>B1</b>	<b>2</b>
			<b>Total 10</b>