

### **General Certificate of Education**

## Physics 2456

Specification B: Physics in Context

## PHYB4 Physics Inside & Out

# **Mark Scheme**

2010 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.

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#### NOTES

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.

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

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

**cnao** 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).

Marks should be awarded for **correct** alternative approaches to numerical question that are not covered by the marking 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.

Question 1				
(a)	(i)	downward arrow labelled weight and upward arrow labelled reaction	B1	2
		acting through body and acting from floor through body/foot/ feet	B1	2
(a)	(ii)	660/657.27/656.6 (N)	B1	1
(a)	(iii)	reaction gives sensation of weight	B1	
		resultant force = <i>ma</i> or 93.8 seen	C1	
		R = m(g-a)	A1	4
		<i>R</i> = 563/566 (N)	B1	
(b)		no reaction force acting on skydiver	B1	1
(c)	(i)	resistive (force) on object moving in fluid/drag/fluid friction	B1	
		'stickiness' of fluid owtte/higher viscosity means greater resistive force/determines (rate of) flow	B1	2
(c)	(ii)	rearrangement of equation	C1	
		correct units for <i>F</i> , <i>r</i> and <i>v</i>	C1	3
		N s m <sup>-2</sup> /Pa s/kg m <sup>-1</sup> s <sup>-1</sup>	A1	
(c)	(iii)	max 2 from		
		not spherical	B1	
		not small	B1	2
		air not viscous enough	B1	2
		moving too fast	B1	
		non-laminar flow	B1	
			Total	15

### GCE Physics, Specification B: Physics in Context, PHYB4, Physics Inside & Out

Que	stion 2			
(a)	(i)	substitution into $(E_p = -GMm/r)$	B1	0
		-1.25 × 10 <sup>14</sup> (J)	B1	2
(a)	(ii)	max 3 from		
		GPE is zero at infinity	B1	
		work is done on object in bringing it from infinity to the Earth's surface/to raise object from gravitational potential well	B1	3
		loss of energy from zero means negative	B1	
		force is attractive	B1	
(b)	(i)	additional of radius of Earth and orbital height	C1	2
		-1.19 × 10 <sup>14</sup> (J)	A1	2
(b)	(ii)	work done against Earth's gravitational field	B1	2
		increases gravitational potential energy	B1	2
(c)	(i)	any 4 of		
		fuel/fuel tank	B1	
		payload	B1	
		combustion chamber	B1	4
		nozzle	B1	
		oxidiser/oxidiser tank	B1	
		fuel pump/injector	B1	

1			
	(c) (ii)	The marking scheme for this 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 question.	
		Level 3 – Good	
		claims supported by an appropriate range of evidence	
		<ul> <li>good use of information or ideas about physics, going beyond those given in the question</li> </ul>	5-6
		<ul> <li>argument well structured with minimal repetition or irrelevant points</li> </ul>	
		accurate and clear expression of ideas with only minor errors of grammar, punctuation and spelling	
		Level 2 – Modest	
		claims partly supported by evidence	
		<ul> <li>good use of information or ideas about physics given in the question but limited beyond this, the argument shows some attempt at structure</li> </ul>	3-4
		• the ideas are expressed with reasonable clarity but with a few errors of grammar, punctuation and spelling	
		Level 1 – Limited	
		<ul> <li>valid points but not clearly linked to an argument structure</li> </ul>	
		limited use of information about physics	1-2
		unstructured	
		<ul> <li>errors in spelling, punctuation and grammar or lack of fluency</li> </ul>	
		Level 0	0
		incorrect, inappropriate or no response	U

		Total	21
	increases mass over and above payload/adds extra	B1	2
(c) (iii)	large mass of rocket means that it needs a lot of fuel	B1	2
	Newton's third law		
	total momentum still zero		
	in opposite direction		
	momentum of waste gases must equal that of rocket		
	initial total momentum zero		
	<ul> <li>wasted gases ejected through nozzle</li> </ul>		
	<ul> <li>fuel additional mass to payload</li> </ul>		
	fuel oxidised and combusted in combustion chamber		
	fuel combined with oxidiser		
	examples of the sort of information or ideas that might be used to support an answer:		

Question 3				
(a)	(i)	calculation of angle from $tan \theta$	C1	
		$\theta = 19.3^{\circ}/70.7^{\circ}$	C1	
		recognition that $T\cos\theta = mg/8 = 265/8$ or sine equivalent	C1	4
		35.1 (N)	A1	
(a)	(ii)	centripetal force needed	B1	2
		(horizontal component and therefore) tension increases	B1	2
(b)		$\omega = 0.98 (\text{rad s}^{-1}) \text{or } v = 1.24 (\text{m s}^{-1})$	C1	
		use of $m\omega^2 r$ or $v^2/r$ – ie candidates values substituted	C1	3
		26.7 (N) <b>not</b> 27.2 ( <i>ω</i> not squared)	A1	
(C)		need for centripetal force	B1	2
		friction insufficient/nothing to provide centripetal force	B1	2
(d)	(i)	opposition to change in rotational motion	B1	2
		related to distribution of mass of body	B1	2
(d)	(ii)	use of $T = I \alpha$	B1	
		$\alpha = 0.228 (\text{rad s}^{-1})$	B1	3
		substituted values to give $T = 9.78$ (Nm)	B1	

(d)	(iii)	new $\alpha$ = 0.088 (rad s <sup>-2</sup> )	0.087 to 0.088	C1	
		<i>t</i> = 14.7 (s)	15.0 to 14.7	C1	3
		difference = 9.0(s)	to 9.3	A1	
				Total	19

Question 4				
(a)	(i)	emf induced if conductor cuts flux etc	C1	0
		induced emf proportional to rate of change of flux linkage etc	A1	2
(a)	(ii)	direction of induced emf opposes change producing it	B1	1
(a)	(iii)	max 3 from		
		changing flux produced by transmitter	B1	
		cuts the metal object	B1	3
		induces emf and thus eddy currents in object	B1	
		eddy current produce field of direction opposing change	B1	
(a)	(iv)	flux change from transmitter would induce emf across receiver owtte/receiver does not pick up signal from transmitter	B1	2
		producing spurious readings/fail to distinguish metal object from background/confusing the signals	B1	
(b)	(i)	1.25 × 10 <sup>5</sup> (Hz)	B1	1
(b)	(ii)	$A = 6.2 \times 10^{-2} (m^2)$	C1	
		use of $\Phi = BA$ or $E = -\frac{N\Delta BA}{\Delta t}$	C1	4
		use of 15% and 45 (turns)	C1	
		9.98 × 10 <sup>-3</sup> (V) cao	A1	
(c)	(c) any 2 from			
		landmine detection/earthquake/avalanche sites/	B1	2
airport security/weapon detection etc		airport security/weapon detection etc	B1	
			Total	15

Question 5				
(a)	(i)	spectrum from 0 – 60 kV below curve shown	B1	2
		spikes in the same place	B1	2
(a)	(ii)	electrons (striking target/anode) eject inner electrons of target material	B1	
		outer electrons fall to fill vacancies	B1	3
		change of energy levels results in photon/radiation being emitted	B1	
(b)	(i)	$eV = \frac{1}{2}mv^2$ written or used	C1	
		substitution or $v = \sqrt{\frac{2eV}{m}}$	C1	3
		1.68 × 10 <sup>8</sup> ms <sup>-1</sup>	A1	
(b)	(ii)	substitution in $P = IV$ irrespective of powers	C1	
		11200 (W) seen or 0.994 <i>IV</i>	C1	
		$1.1 \times 10^4$ (W)	A1	4
		2 or 3 sf	B1	
(c)		max 3 from		
		attenuation of X-rays	B1	
		distinguishes tissues/organs	B1	3
		clearer image seen/lighter image	B1	
		weaker X-rays may be used	B1	
			Total	15

Question 6				
(a)	(i)	period taken from graph = 3.0 (s) or frequency = 0.33 (Hz)	C1	
		amplitude = 1.5 (m)	C1	
		maximum speed = $2\pi fA$	C1	
		3.14 (m s <sup>-1</sup> ) cao	A1	
		alternatively		4
		attempt to use gradient	B1	
		tangent at drawn at zero displacement	B1	
		large $\Delta$ and correct coordinates read from graph	M1	
		value in region $3.5 - 4.5 (m s^{-1})$	A1	
(a)	(ii)	maximum acceleration = $4\pi^2 f^2 A$ ecf for <i>f</i> and <i>A</i>	C1	2
		6.58/6.45 (m s <sup>-2</sup> )	A1	2
(b)		series of pulses	B1	
		at T/4 and 5T/4 (neg) <b>or</b> 3T/4 and 7T/4 (pos)	B1	3
		short pulses (not longer than 1 s)	B1	
(c)	(i)	oscillations produced by external force	B1	2
		external force is periodic	B1	۷
(c)	(ii)	amplitude of vibrating system increases to maximum	B1	2
		as external periodic force matches natural frequency	B1	2
(c)	(iii)	raising and lowering child's centre of mass/changing moment of inertia/moving centre of mass forwards and backwards/swinging legs/shifting body	B1	2
		in phase with oscillation/matching $f_0$	B1	
			Total	15