Version 1.0: 0310

ASSESSMENT and QUALIFICATIONS ALLIANCE

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.

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

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**	
(a) (ii)	660/657.27/656.6 (N)	**B1**	**1**
(a) (iii)	reaction gives sensation of weight	**B1**	**4**
	resultant force = *ma* or 93.8 seen	**C1**	
	$R = m(g-a)$	**A1**	
	R = 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**	**2**
	'stickiness' of fluid owtte/higher viscosity means greater resistive force/determines (rate of) flow	**B1**	
(c) (ii)	rearrangement of equation	**C1**	**3**
	correct units for F, r and v	**C1**	
	$N\,s\,m^{-2}$/Pa s/kg $m^{-1}\,s^{-1}$	**A1**	
(c) (iii)	**max 2 from**		**2**
	not spherical	**B1**	
	not small	**B1**	
	air not viscous enough	**B1**	
	moving too fast	**B1**	
	non-laminar flow	**B1**	
		Total	**15**

Question 2			
(a) (i)	substitution into ($E_p = -GMm/r$)	**B1**	**2**
	-1.25×10^{14} (J)	**B1**	
(a) (ii)	**max 3 from**		**3**
	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**	
	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^{14} (J)	**A1**	
(b) (ii)	work done against Earth's gravitational field	**B1**	**2**
	increases gravitational potential energy	**B1**	
(c) (i)	**any 4 of**		**4**
	fuel/fuel tank	**B1**	
	payload	**B1**	
	combustion chamber	**B1**	
	nozzle	**B1**	
	oxidiser/oxidiser tank	**B1**	
	fuel pump/injector	**B1**	

(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 • 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 **Level 2 – Modest** • claims partly 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 **Level 1 – Limited** • valid points but not clearly linked to an argument structure • limited use of information about physics • unstructured • errors in spelling, punctuation and grammar or lack of fluency **Level 0** • incorrect, inappropriate or no response		**5-6** **3-4** **1-2** **0**

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

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

(d)	(iii)	new α = 0.088 (rad s^{-2})	0.087 to 0.088	**C1**	**3**
		t = 14.7 (s)	15.0 to 14.7	**C1**	
		difference = 9.0 (s)	to 9.3	**A1**	
				Total	**19**

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

Question 5			
(a) (i)	spectrum from 0 – 60 kV below curve shown spikes in the same place	**B1** **B1**	**2**
(a) (ii)	electrons (striking target/anode) eject inner electrons of target material outer electrons fall to fill vacancies change of energy levels results in photon/radiation being emitted	**B1** **B1** **B1**	**3**
(b) (i)	$eV = ½ mv^2$ written or used substitution or $v = \sqrt{\frac{2eV}{m}}$ 1.68×10^8 m s^{-1}	**C1** **C1** **A1**	**3**
(b) (ii)	substitution in $P = IV$ irrespective of powers 11200 (W) seen or 0.994 IV 1.1×10^4 (W) 2 or 3 sf	**C1** **C1** **A1** **B1**	**4**
(c)	**max 3 from** attenuation of X-rays distinguishes tissues/organs clearer image seen/lighter image weaker X-rays may be used	 **B1** **B1** **B1** **B1**	**3**
		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 ($m\,s^{-1}$) cao	**A1**	
	alternatively		**4**
	attempt to use gradient	**B1**	
	tangent at drawn at zero displacement	**B1**	
	large Δ 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 f and A	**C1**	**2**
	6.58/6.45 ($m\,s^{-2}$)	**A1**	
(b)	series of pulses	**B1**	
	at T/4 and 5T/4 (neg) **or** 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**	
(c) (ii)	amplitude of vibrating system increases to maximum	**B1**	**2**
	as external periodic force matches natural frequency	**B1**	
(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**