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General Certificate of Education (A-level)
January 2012

Physics B: Physics in Context PHYB4

(Specification 2455)

Unit 4: Physics inside and out

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 students' 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 students' 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 students' 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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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 and Out

Question 1				
a	i	mention of reaction no reaction	**C1** **A1**	**2**
a	ii	equate mgh and ½ mv^2 39.6 (m s^{-1})	**B1** **B1**	**2**
a	iii	use of s = ½ gt^2 4.1/4.0	**C1** **A1**	**2**
b	i	positive slope from (0,0) negative slope to (6,0) straight lines and meet at (4,40) ecf for time (2:1)	**B1** **B1** **B1**	**3**
b	ii	reaction is greatest/increases/greater	**B1**	**1**
b	iii	$R – mg = ma$ or $R = m (g + a)$ R = 2.2 × 10^3 (N)	**C1** **A1**	**2**
c	i	correct substitution mgh = ½ kx^2 1.9(1) × 10^4 N m^{-1}	**C1** **A1** **B1**	**3**
c	ii	substitution into period equation 2.2 (s) ecf from ci	**C1** **A1**	**2**
c	iii	$a_0 = – \omega^2 x_0 = (2\pi/2.2)^2 \times 15$ = 120 m s^{-2} (~ 12 g) (ecf gives 9.7)/F_0 = 2.8 × 10^5 N (big thrill but) dangerous (or ecf in line with period eg safe for 7.8 s period)	**C1** **A1** **B1**	**3**
			Total	**20**

Question 2				
a	i	reaction and weight labelled sensible positions and directions	**B1** **B1**	**2**
a	ii	mention of reaction contributing ('providing') centripetal force providing rider moves fast enough weight will not exceed the required centripetal force	**B1** **B1**	**2**
b	i	1.6(1) rad s^{-1}	**B1** **B1**	**2**
b	ii	840 – 860 (N)	**B1**	**1**

b	iii	for **A** $R - mg$ – centripetal force **or** for **B** $mg + R$ = centripetal force for **A** 1400 – 1500 (N) for **B** 240 – 270 (N)	**C1** **A1** **A1**	**3**
c		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 candidate's QWC in this answer will be one of the criteria used to assign a level and award the marks for this question. **Descriptor** – an answer will be expected to meet most of the criteria in the level descriptor. **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**

	Examples of the sort of information or ideas that might be used to support an argument • number of people affect the moment of inertia • $I = \sum mr^2$ • larger mass leads to a larger moment of inertia • $T = I\alpha = I\frac{\omega_f - \omega_i}{t}$ • so for constant torque and change of angular momentum the time needs to be longer for a larger moment of inertia • $P = T\omega$ so need to increase power or reduce angular speed for same power • lack of symmetry will lead to stress on ride • uneven torques • damage to bearings etc		
		Total	**16**

Question 3			
a	work done per unit mass in bringing object from infinity to point	**B1**	**3**
	potential at infinity zero by definition	**B1**	
	work has been done by the field so potential at all points closer than infinity negative	**B1**	
b	use of point on graph allow within ± small square	**C1**	**3**
	substitution into $V = -\frac{GM}{r}$	**C1**	
	range from 590 – 6.90 × 10^{24} (kg)	**A1**	
c i	$\Delta E_p = -\frac{GMm}{R_E + h} + \frac{GMm}{R_E}$	**C1**	**3**
	addition of radius of Earth to give 7.25 × 10^6 (m)	**C1**	
	1.54 × 10^{10} (J)	**A1**	
c ii	equates $\frac{mv^2}{r}$ and $G\frac{mM}{r^2}$	**C1**	**4**
	to give $\Delta E_K = G\frac{mM}{2}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$	**C1**	
	1.25 × 10^9 J	**A1**	
	positive or increase	**B1**	
c iii	(lower altitude so) gpe decreases ke increases	**C1**	**2**
	loss of gpe is twice gain in ke	**A1**	
		Total	**15**

Question 4				
a		**max 3 from**		
		gravity survey	**B1**	
		magnetic survey	**B1**	
		seismic survey	**B1**	**max 3**
		ground penetrating radar (not just 'radar')	**B1**	
		aerial survey	**B1**	
		not metal detection		
b	i	curves joining $\mathbf{P_1}$ and $\mathbf{P_4}$ with four lines, fairly evenly spaced in the middle – not crossing	**B1**	**1**
b	ii	current shown from $\mathbf{P_4}$ to $\mathbf{P_1}$	**B1**	**1**
b	iii	**max 2 from**		
		(conventional) current goes from positive to negative	**B1**	
		shows direction of electric field	**B1**	**max 2**
		current flows between $\mathbf{P_4}$ and $\mathbf{P_1}$	**B1**	
		argues that paths not changed at interface/no shape change	**B1**	
c	i	different soil type/anomaly roughly 10 m from origin/anomaly 5-8 m wide	**B1**	
		either side of anomaly **could be clay or limestone** (300-400 Ωm) – allow one of these soil types	**B1**	**3**
		anomaly **could be sandy, limestone or sandstone** (580-670 Ωm) – two of three soil types needed	**B1**	
c	ii	**max 2 from**		
		depends on moisture content	**B1**	
		limited depth measureable	**B1**	
		equipment bulky/cumbersome/time-consuming (to use)/difficult in insert probes in hard soil	**B1**	**max 2**
		water can give spurious results	**B1**	
		cannot identify soil types precisely	**B1**	
		unreliable because of electrode contact resistances	**B1**	
		spurious emfs generated when electrodes on contact with salts	**B1**	
			Total	**12**

Question 5			
a i	resistance zero at or below transition/critical temperature	**B1** **B1**	**2**
a ii	**max 2 from** very strong magnetic fields required no cooling needed/no heat dissipated (in coils) high currents needed to produce these	 **B1** **B1** **B1**	**max 2**
b i	rearrangement seen: $k = (-)\frac{\omega}{B_0}$ rad s^{-1} T^{-1}	**C1** **A1**	**2**
b ii	(ω =) 6.5×10^8 recognition that $\omega = 2\pi f$ $1.0(3) \times 10^8$ (Hz)	**C1** **C1** **A1**	**3**
c	when frequency matched resonance occurs maximum energy transferred (to protons)/stronger signal/larger induced emf/larger amplitude of precession	**B1** **B1**	**2**
d	$\frac{\Delta\Phi}{\Delta t} = 1.7 \times 10^{-8}$ Wb s^{-1} $E = N\frac{\Delta(BA)}{\Delta t}$ or substituted values irrespective of powers 3.51×10^{-5} (V)	**C1** **C1** **A1**	**3**
e	**max 2 from** **advantages** safe and no **ionising** radiation any plane or orientation slice can be used/3D images excellent soft tissue contrast/more detail possible **and max 2 from** **disadvantages** high costs (all types) complex use – training and cost of professional operator (claustrophobia) takes long time (for patient to be in scanner) hazard to implants limit to body size of patient	 **B1** **B1** **B1** **B1** **B1** **B1** **B1** **B1**	**max 4**
		Total	**18**

Question 6			
a i	T = 293	**C1**	
	rearrangement of or substitution into $pV = nRT$	**C1**	**3**
	0.037 mol	**A1**	
a ii	**max 2 from**		
	pressure very high	**B1**	
	molecules too close	**B1**	**max 2**
	intermolecular forces present	**B1**	
	liquid in bulb	**B1**	
b	reference to first law equation		
	gas emitted rapidly so adiabatic/no time for heat exchange	**B1**	
	Q=0	**B1**	**4**
	work done by gas on surroundings (W –ve)	**B1**	
	internal energy reduced and temperature falls (ΔU –ve)	**B1**	
c	**max 3 from**		
	no external force acting/closed system	**B1**	
	gas expelled in one direction so rocket moves in opposite direction	**B1**	
	total momentum at start is zero	**B1**	**max 3**
	at any instant total momentum of whole system is still zero	**B1**	
	so change in momentum of gas = change in momentum of rocket	**B1**	
	appropriate equation	**B1**	
d i	use of $Ft = mv - mu$	**C1**	
	$85 \times 10^{-3} \times 18 = F \times 5.0 \times 10^{-2}$	**C1**	**3**
	31 (N)	**A1**	
d ii	gas speed much higher	**B1**	**2**
	total mass of gas less than bulb	**B1**	
e	**max 2 from**		
	limited amount of gas/limited thrust	**B1**	
	difficult to control release	**B1**	**max 2**
	thrust falls as pressure reduces/short-lived thrust	**B1**	
	efficiency falls as pressure reduces	**B1**	
	more gas means more massive container	**B1**	
		Total	**19**

	UMS conversion calculator www.aqa.org.uk/umsconversion		