Version 1.0

General Certificate of Education
June 2010

Physics B: Physics in Context PHYB4

Physics Inside and Out

Unit 4

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 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)	*g* gravitational field strength, *G* gravitational constant	**C1**	**3**
	g force on 1 kg (on or close to) Earth's surface	**A1**	
	G universal constant relating attraction of any two masses to their separation/constant in Newton's law of gravitation	**A1**	
(a) (ii)	equates *w* and cancels *m*	**B1**	**1**
(a) (iii)	substitutes values into equation	**B1**	**3**
	correct calculation 5.99×10^{24}	**C1**	
	answer to two significant figures 6.0×10^{24} (kg)	**A1**	
(b) (i)	1 day/24 hours/86400 (s)	**B1**	**1**
(b) (ii)	4.24×10^{7} (m)	**B1**	**1**
(b) (iii)	$v = 2\pi r/T$ or equivalent	**C1**	**3**
	conversion of period to seconds (allow in (b)(i))	**C1**	
	3.08 (cao)	**A1**	
(b) (iv)	communication/specific example of communication (eg satellite TV/weather)	**B1**	**1**
(b) (v)	avoids dish having to track/stationary **footprint**	**B1**	**1**
		Total	**14**

Question 2			
(a) (i)	*w* down and *F* up	**M1**	**3**
	w and *F* approximately equal lengths	**A1**	
	R perpendicular (by eye) to and directed from wall	**B1**	
(a) (ii)	max **four** from		**max 4**
	mention of centripetal force	**C1**	
	reaction of wall provides centripetal force	**A1**	
	frictional force (plus reaction of floor) equals weight	**B1**	
	as the rotor accelerates the reaction of wall increases	**B1**	
	this increase frictional force	**B1**	
(a) (iii)	friction equated to weight	**C1**	**5**
	use of centripetal force or acceleration equation	**C1**	
	value for ω or *v* found	**C1**	
	$T = 2\pi/\omega$ seen or used	**C1**	
	2.52 (s)	**A1**	

(a) (iv)	glove falls under gravity also moves along tangent to circle until it hits wall which can provide the necessary reaction to give required centripetal force(wall)/friction (floor)	**B1** **B1** **B1**	**3**
(b)	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** answer supported by an appropriate range of evidence good use of information or ideas about physics, going beyond any given in the question answer 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** answer partially supported by evidence good use of information or ideas about any physics given in the question but limited beyond this the answer 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 or ideas 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 • rapid change in direction • rapid change in speed • changes in height above the ground • weightlessness • large accelerations 'big g forces' • acceleration equates to thrill • larger accelerations mean larger forces • forces can harm rider • repetitive vibrations act like driving oscillator • resonance of body can lead to injury • strapped in to reduce effects of inertia when direction changes		
		Total	**21**

Question 3			
(a) (i)	speed with which object escapes gravitational field **minimum or initial** speed/energy	**B1** **B1**	**2**
(a) (ii)	substitution of values $v_{esc} = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 6.4 \times 10^{23}}{3.4 \times 10^{6}}}$ 5011 m s^{-1} (cao) approximates to 5 (km s^{-1})	**B1** **B1** **B1**	**3**
(a) (iii)	max **three** from differentiates from escape speed – unpowered etc fuel/chemical energy transferred into gravitational potential energy this can be done at any speed (given sufficient fuel)	**B1** **B1** **B1** **B1**	**3**
(b)	max **two** from gravitational attraction of Earth varies with relative positions orbital speeds of Earth and Mars different	**B1** **B1** **B1**	**2**

(c)	(i)	equation for gpe	**C1**	
		substituted values irrespective of powers of 10	**C1**	
		1.47×10^{10} (J)	**A1**	**5**
		Mars – negative	**B1**	
		Sun – negative	**B1**	
(c)	(ii)	(–)1.22×10^{15} (ecf from table)	**B1**	**1**
(c)	(iii)	decreases (more negative)	**B1**	**2**
		increases (less negative)	**B1**	
(c)	(iv)	max **two** from		**2**
		gravitational attraction is maximised by proximity of planet	**B1**	
		reduce journey time	**B1**	
		shortest distance to travel	**B1**	
		shortest distance to neutral point	**B1**	
		less work done by rocket	**B1**	
		less fuel needed	**B1**	
		wrongly aligned planets can attract shuttle on wrong course	**B1**	
			Total	

Question 4				
(a)	(i)	flux cutting induces emf across coil	**B1**	**2**
		higher velocity => larger rate of change of flux	**B1**	
(a)	(ii)	max **three** from		**3**
		strong magnetic field	**B1**	
		large mass (allow 'inertia') magnet	**B1**	
		many turns on coil	**B1**	
		low resistance coil	**B1**	
		low spring constant (allow 'soft') springs	**B1**	
(a)	(iii)	vertical vibrations (allow up and down)	**B1**	**1**
(a)	(iv)	$\frac{\Delta\Phi}{\Delta t} = \frac{\varepsilon}{N}$ or substitution irrespective of powers of 10	**C1**	**3**
		1.7×10^{-3}	**C1**	
		Wb s^{-1} ($Tm^2 s^{-1}$ or V)	**A1**	
(b)	(i)	**wave** speed within a layer is greater in deeper layers	**B1**	**1**
(b)	(ii)	any ratio of velocities seen	**C1**	**3**
		$\sin\theta_c$ = 2400/3400	**C1**	
		44.9°	**A1**	

(b)	(iii)	critical angle marked at B or C	**B1**	**1**
(b)	(iv)	refraction away from normal at E second refraction at clay/sandstone interface so that emergent ray parallel to AE ray by eye	**B1** **B1**	**2**
(b)	(v)	attempt to measure AB - cosine/Pythagoras (= 21.2 m) attempt to measure BC = 15.0 m attempt to measure $t_{AB} + t_{CD}$ (= 2 × AB/2400 = 0.0177 s) attempt to measure t_{BC} (= BC/3200 = 0.0044 s) 0.0221 (s)	**C1** **C1** **C1** **C1** **A1**	**5**
			Total	**21**

Question 5				
(a)	(i)	weight acts **downwards** on far side of frame magnetic force must act **downwards** on near side of frame two torques balance	**B1** **B1** **B1**	**3**
(a)	(ii)	*F=BIL* substitution irrespective of powers of 10 0.116 (T)	**C1** **C1** **A1**	**3**
(a)	(iii)	less than 0.02% of magnet's field – insignificant	**B1**	**1**
(a)	(iv)	max **three** from replace wire with coil ⇨ longer wire inside field use asymmetrical balance ⇨ longer left arm would give larger torque for same force larger current ⇨ larger magnetic force generated	 **B1** **B1** **B1** **B1** **B1** **B1**	**3**
(b)	(i)	triangle minimum of 10 squares vertically coordinates correct only accept (3.67 – 3.70 or 3.7) × 10^7	**C1** **C1** **A1**	**3**
(b)	(ii)	$s^{-1} T^{-1}$ or Hz T^{-1}	**B1**	**1**
(b)	(iii)	$f_L = k \times 10^{-10}$ 3.6×10^{-3} (Hz) ecf from (b) (i)	**M1** **A1**	**2**

(b) (iv)	sensible diagram showing axis of rotation of top or clear circular motion about it axis of precession of top or clear circular motion about it description relating to which motion is rotation and which is precession	 **B1** **B1** **B1**	**3**
(c) (i)	max **two** from metal detection resistance surveying ground penetrating radar gravitational field variation methods	 **B1** **B1** **B1** **B1**	**2**
(c) (ii)	**metal detection** disadvantage limited depth advantage simple well known technique/portable apparatus/works with all types of metal **resistance survey** disadvantage contact resistance/variation of material /cumbersome apparatus/rocky terrain difficult to insert probes/limited range/slow to operate advantage simple technique **ground penetrating radar** disadvantage interference from spurious reflections/frequency dependent/object size dependent/can diffract round objects advantage covers large area quickly/immediate imaging/computer image **gravitational field variation methods** disadvantage significant density variation/large mass anomalies needed advantage simple technique	 **B1** **B1** **B1** **B1** **B1** **B1** **B1** **B1**	**max 2**
(d)	allow either outcome providing there is a coherent reason eg not use because not all mines metallic/could cause detonation use because most mines have significant metallic components	 **B1**	**1**
		Total	**24**