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General Certificate of Education (A-level)
January 2011

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 candidates' 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 candidates' 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 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 and out

Question 1				
(a)	(i)	$mg = 6\pi\eta av$	**C1**	**4**
		v = 0.125/22 or 0.00568 (m s^{-1})	**C1**	
		1.38 × 10^{-5} × 9.81 = 6 × 3.14 × η 0.77 × 10^{-3} × their v	**C1**	
		1.6 (1.64)	**A1**	
(a)	(ii)	Pa s or N m^{-2} s or kg m^{-1} s^{-1}	**B1**	**1**
(b)		force due to viscosity is lower than mg **or** assumed resistance due to viscosity is too high **or** upthrust makes velocity lower than it would be if viscosity alone were acting	**B1**	**2**
		the value in (i) is too high **or** actual value of viscosity is lower	**B1**	
(c)		**any two from**		**2**
		not small	**B1**	
		not a sphere	**B1**	
		sky diver moving too fast	**B1**	
		turbulent air flow **or** non-lamina air flow	**B1**	
			Total	**9**

Question 2				
(a)	(i)	use of $F = ma$	**C1**	**4**
		total thrust = 30.5 MN or arrives at 9 (m s^{-2})	**C1**	
		resultant force = 30.5 – 19.62 = 10.88 (10.9) MN or arrives at 15.3 (m s^{-2}) or evidence of subtracting weight from thrust	**C1**	
		acceleration = 5.44 (5.4) (m s^{-2})	**A1**	
(a)	(ii)	**any two from**		**2**
		gravitation force (per kg) falls; gravitational field strength decreases	**B1**	
		shuttle mass falls	**B1**	
		variation in air resistance	**B1**	
(b)	(i)	$GMm/r^2 = mv^2/r$ or $v = \sqrt{(GM/r)}$	**B1**	**3**
		$r = \frac{6.67 \times 10^{-11} \times 5.97 \times 10^{24}}{(7.7 \times 10^3)^2}$	**B1**	
		answer calculated to at least 3 sf (6716 km)	**B1**	

(b)	(ii)	attempt using change in PE = $GMm\ (1/r_1 - 1/r_2)$	**C1**	
		total change in PE to reach orbit = 64.1 GJ	**C1**	
		total KE in orbit = 682 GJ	**C1**	**5**
		total energy used 750 GJ (adds their KE and their PE)	**A1**	
		answer to 2 sf only	**B1**	
			Total	**14**

Question 3				
(a)	(i)	force shown horizontal	**B1**	**1**
(a)	(ii)	arrow labelled 'weight', '*W*' or '*mg*' (not gravity)	**B1**	**2**
		arrow on rod labelled 'tension' (allow T)	**B1**	
(a)	(iii)	F = mrω^2 (attempt using) **or** $mg = T\cos 40$ or T = 83.2 N **or** $F = mg \tan 40$	**C1**	**3**
		r = 4.0 + 2.5 sin 40 or 5.61 m seen **or** F = their T sin 40 (allow 8.0 + 2.5 sin 40)	**C1**	
		53.4 N (allow 2 for 38 N) or 53.5 N	**A1**	
(b)		angular speed ω = 2πf	**B1**	**3**
		revs per second = 0.193	**B1**	
		angular speed = 11.6	**B1**	
(c)	(i)	θ = ½ ωt (average angular speed × time) **or** use of $\omega_2^2 - \omega_1^2 = 2\alpha\theta$	**C1**	**3**
		½ × 1.21 × 25 **or** acceleration α = 1.21/25	**C1**	
		15.1 (radian)	**A1**	
(c)	(ii)	extra KE provided = ½/ω^2 or ½ 16000 × 1.21^2	**C1**	**4**
		extra KE = 11713 J	**C1**	
		extra power = 470 (469)	**A1**	
		W, J s^{-1}, N m s^{-1}	**B1**	
(c)	(iii)	moment of inertia increases	**B1**	**2**
		moment of inertia depends on distribution of mass **or** mass moves further from the axis of rotation	**B1**	
			Total	**18**

Question 4			
(a)	$B = F/IL$ field is 1 T when force is 1 N or 1 m of wire carrying 1 A	**C1** **A1**	**2**
(b) (i)	**any three from** the current required the number of turns on the coil uniformity of the field produced diameter of coil in which field is to be produced (allow area)	 **B1** **B1** **B1** **B1**	**3**
(b) (ii)	superconductors have no resistance/resistivity no (condone low) thermal energy produced/no need to have the extraction system **or** semiconductors allow high currents and so high fields	**B1** **B1**	**2**
(c) (i)	in a uniform field the flux density/B or force produced (on a moving charge) is the same everywhere in a gradient field B (or the force on a moving charge) is different at different points	**B1** **B1**	**2**
(c) (ii)	$B = f/4.258 \times 10^7$ or correct substitution of data B = 1.5120 T correct position read for their B (if in range of graph) 15 cm from A if correct	**C1** **A1** **B1**	**3**
(d) (i)	the amplitude of the signal received mentioned	**C1**	**1**
(d) (ii)	amplitude is greater where density of protons is greater	**A1**	**1**
(e)	**any two from** noise aspects effect of high fields on patients size of the patient claustrophobic/psychological aspects ability to shut down quickly in emergency siting of machine so that magnetic fields do not interfere with other hospital technology ensure they are not wearing/have insertions in the body that are metallic/ensure no free metallic objects in the room	 **B1** **B1** **B1** **B1** **B1** **B1** **B1**	**2**
		Total	

Question 5			
(a)	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 or 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 of 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 argument: ● Eddy currents circular currents (that oscillate) within the ring ● currents oscillate ● mention of Faraday's law ● changing current in coil produces changing magnetic field ● changing field links the ring ● emf/current **induced** in the ring ● mentions Lenz's law ● direction of current in the ring sets up a filed to oppose the change in field produced by the coil ● if coil current is increasing ring current is in opposite direction (to oppose increase in field) ● if coil current is decreasing ring sets up field in same direction (to oppose the decrease in field)		
(b)	area of ring (condone loose reference to which area) greater rate of change of flux linkage so higher induced emf/higher current circumference of ring longer path for current so resistance higher and current lower resistance of ring/resistivity of the material of the ring lower resistance higher current since $I = V/R$ **or** thickness of the ring thicker ring – lower resistance so current is higher **or** depth of ring magnetic field weaker so induced emf/current smaller **or** orientation of the ring flux linkage lower if at angle so induced emf/current smaller	**M1** **A1** **M1** **A1** **M1** **A1** **M1** **A1** **M1** **A1** **M1** **A1**	**6**
		Total	**12**

Question 6				
(a)	(i)	toward B	**B1**	**1**
(a)	(ii)	15 × 0.20 = 3 mm	**B1**	**1**
(b)	(i)	period = 0.8 s use of T = $2\pi\sqrt{L/g}$ 0.16 (0.159) m	**C1** **C1** **A1**	**3**
(b)	(ii)	lower initial displacement lower inertia/more likely to begin moving as the Earth moves no effect period of a simple pendulum is independent of the mass of the bob/mass of bob is not in the formula for the period of a simple pendulum/period only depends on length (and *g*)	**B1** **B1** **B1** **B1**	**4**
(c)	(i)	clearly states consistency of ratios of successive amplitudes as the test one ratio of successive amplitudes correctly determined two ratios correctly determined and conclusion	**B1** **B1** **B1**	**3**
(c)	(ii)	the oscillations are damped/air resistance mentioned/friction of pen against paper energy is lost because of air resistance/work is done against air resistance/energy lost moving air out of the way/giving air kinetic energy	**B1** **B1**	**2**
(c)	(iii)	it will come to rest quicker the bob loses a greater proportion of its energy during each oscillation or pendulum has lower inertia so damping force has greater effect or oscillating pendulum (initially) has less energy or air resistance (initially) is unchanged	**M1** **A1**	**2**
			Total	**16**

Question 7			
(a)	electrons	B1	2
	ions	B1	
(b) (i)	use of $\rho = RA/L$	C1	4
	correct conversion of 0.13 mm^2 to m^2 = 0.13 × 10^{-6} seen **or** attempt to convert and answer 1.1, 1.12, 1.113 with incorrect powers of ten	C1	
	1.1 or 1.12 or 1.116 × 10^{-6}	A1	
	Ω m	B1	
(b) (ii)	straight line through origin	B1	2
	1.5 V at 1.2 m	B1	
(c) (i)	**any three from**		3
	valid use of the term 'anomaly'	B1	
	initially (and finally) resistance is that of liquid only so constant graph linear	B1	
	non-uniform body (because of presence of block)	B1	
	resistance is not proportional to/does not vary linearly, with length	B1	
	central region (current has a) lower resistance path through the metal block/lower resistance per cm	B1	
	charge flows more easily through metal	B1	
	(current constant) the pd drop per cm falls above the metal/central region	B1	
(c) (ii)	**any two from**		2
	resistivity of the metal in the block/how good a conductor the block is (allow resistance)	B1	
	relative conductivities/resistances/resistivities of copper sulphate and metal block (however expressed)	B1	
	emf/pd/current produced by the battery	B1	
	quantity of metal in the block; allow size/length/thickness/width/ cross sectional area	B1	
	depth of block below the surface	B1	
(c) (iii)	identifies change in gradient at either 18/19 cm or 40 to 42 cm	M1	2
	deduces block between 18/19 – 40/42 cm so 21 to 24 cm long	A1	
		Total	**15**