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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 5456

Specification B

PHB1 Foundation Physics

Mark Scheme

2007 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 for Examiners

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.

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

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

c.n.a.o. 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).

Only **one** unit penalty **(u.p.)** in this paper unless there is a mark allocated specifically for giving a correct unit in the marking. Note that the unit is only penalised in the final answer to the question.

Only **one** significant figure penalty **(s.f.)** in this paper.
Allow 2 or 3 s.f. unless otherwise stated. s.f. penalties include recurring figures and fractions for answers.

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

Quality of Written Communication

Before accessing marks for the Quality of Written Communication (QWC) a candidate must first score a minimum of one mark for the physics that is being communicated – this will allow access to 1 mark for QWC. If the candidate scores more marks for physics (a minimum of two or three – depending upon the total mark for that part of the question) then this will allow access to 2 marks for QWC.

Good QWC: the answer is fluent/well argued with few errors in spelling, punctuation and grammar	**2**	
Poor QWC: the answer lacks coherence or spelling, punctuation and grammar are poor	**1**	**Max 2**
Very Poor QWC: the answer is disjointed, with significant errors in spelling, punctuation and grammar	**0**	

PHB1 Foundation Physics

Question 1			
(a)	appreciation of the correct approach (allow only this mark for careless free hand drawings) correct magnitude (14.2 ±0.2 N) correct direction (13 ± 1°)	**C1** **A1** **A1**	**3**
(b)	correct method (allow use of 9.9 N or 10 N) (minimum is $5^2 + 10^2$) 11, 11.1 or 11.2 N	**C1** **A1**	**2**
			Total 5

Question 2			
(a)	attempt to equate moments $4.4d + 5.5 \times 0.2 = 7.5 \times 0.45$ 0.52 (0.517) m	**C1** **C1** **A1**	**3**
(b)	attempt to equate upward and downward forces (not just statement) or reasonable attempt at moments equation that includes the reaction 15.9 (16) N (c.a.o.)	**C1** **A1**	**2**
			Total 5

Question 3			
(a)	$I = nAvQ$ or correct substitution 9.6 to 9.7 × 10^{28} (m^{-3}) (condone minus sign)	**C1** **A1**	**2**
(b)	charge per 1.5 ms = 2.5 × 1.5 x 10^{-3} (not mark for quoting $Q = It$) or electrons per sec = $\frac{2.5}{1.6 \times 10^{-19}}$ or nAv = (9.6 × 10^{28}) × (1.8 × 10^{-6}) × 9 × 10^{-5} 2.34 × 10^{16}	**C1** **A1**	**2**
			Total 4

Question 4				
(a)		quotes parallel resistance formula (or clearly uses 7 Ω) 21 Ω (c.a.o.)		**C1** **A1**	**2**
(b)	(i)	0.175 (0.18) A		**B1**	**3**
	(ii)	emf = current × total R 7.35 (7.4) V or 7.56 (7.6) V	allow e.c.f. (0.35 × their (a))	**C1** **A1**	
					Total 5

Question 5				
(a)		light dependent resistor	**B1**	**1**
(b)		quotes potential divider formula or calculates current (allow $(\frac{1.8}{1.8+2.2})1.5$ as evidence of use of potential divider formula) 0.83 (0.825) V	**C1** **A1**	**2**
(c)	(i)	resistance increases (must answer the question) appreciation that lower light intensity releases fewer electrons/charge carriers **or** the reverse argument fewer charge carriers released	**B1** **B1**	**3**
	(ii)	output voltage falls/decreases/goes down allow only if a correct or no explicit statement about resistance in (i) (if (i) states 'resistance falls' (ii) must state 'output voltage increases')	**B1**	
				Total 6

Question 6				
(a)		A	**B1**	**1**
(b)	(i)	statement that $\Delta E_k = \Delta E_p$ or $\Delta E_p = mgh$	**C1**	**4**
		950 (953) J	**A1**	
	(ii)	$E_k = ½ mv^2$	**C1**	
		$v = 5.9(4)\,m\,s^{-1}$ (use of equation for uniformly accelerated motion = 0)	**A1**	
(c)	(i)	energy lost = mg × difference in heights evidence of mg × 1.6 and subtraction from (i)	**C1**	**4**
		106 (110) J or 100 (from 950 – 850 J)	**A1**	
	(ii)	*work done* = *Fs*	**C1**	
		F = 12.5 or 13.3 N (allow 13 – 14 N) answer = c(i)/8)	**A1**	
(d)		A somewhere between A and B (condone 'just before B')	**B1**	**max 3**
		B appreciation that no acceleration means no **resultant** force or no unbalanced forces or forces cancel out (condone driving force = friction force) or uses $F = ma$ in argument	**B1**	
		C (component of) force down/along the slope must equal frictional force	**B1**	
		D between A and B (component of) weight acts down/along the slope	**B1**	
		E frictional force acts up the slope or opposes motion)	**B1**	
		F accelerating force decreasing so will equal frictional force somewhere between A and B	**B1**	
		G appreciation that on the right hand side the frictional force and component due to weight both act down the slope	**B1**	
		At least 2 marks for physics + **Good QWC** At least 2 marks for physics + **Poor QWC** At least 2 marks for physics + **Very Poor QWC** 1 mark for physics + sufficient attempt + **Good or Poor QWC** 1 mark for physics + insufficient attempt or **Very Poor QWC** No marks for physics or **Very Poor QWC**	**2** **1** **0** **1** **0** **0**	**max 2**
				Total 14

Question 7				
(a)	(i)	clear attempt to determine gradient (use of data from graph)	C1	4
		4.17 (4.2) ($m\,s^{-2}$) (c.a.o.) (ignore minus sign)	A1	
	(ii)	$F = ma$	C1	
		3960 (4000) N (e.c.f. 950 × their (a) (i)) (ignore minus sign)	A1	
(b)	(i)	16 m	B1	4
	(ii)	attempt to find area under graph during deceleration or uses $1/2at^2$ with deceleration from (a) and time from graph	C1	
		braking distance = 48 m (allow ±2 for counting squares in both 48 m and 64 m) or total distance to stop = 64 m [allow e.c.f. from (b) (i)}	C1	
		compares correct (*allowing ecf from (b) (i)*) stopping distance with distance to lorry and states conclusion explicitly e.g. total distance to stop = 64 m so doesn't stop in time (owtte) braking distance needed = 44 m actual braking distance = 48 m so collides with lorry	A1	
(c)	(i)	time to react the same ±1/2 square	B1	3
		same slope afterwards (v = 0 at 3.2 s ± 0.1 s if time to react same otherwise judge by eye)	B1	
	(ii)	36 ($km\,h^{-1}$)	B1	
				Total 11

Question 8			
(a)	B C A (one correct B1, all three correct B1)	**B1** **B1**	**2**
(b) (i)	circuit for potential divider correct (allow potential divider consisting of two variable resistors)	**B1**	**3**
	circuit showing voltmeter across wire-wound resistor (or wire-wound resistor and ammeter) and ammeter in series with resistor	**B1**	
(ii)	resistance = 18 (17.6) Ω	**B1**	
(iii)	(graph shows) resistance increases as *V* or *I* increases	**B1**	**max 3**
	plus any 2 from resistance is the instantaneous value of *V*/*I*	**B1**	
	as *I* (or *V*) increases temperature rises/resistor heats up	**B1**	
	as temperature (or *I* or *V*) rises lattice ions vibrate with greater amplitude	**B1**	
	increased rate of collision of electrons with atoms or lattice ions or clear reference to electron collisions with atoms/lattice ions as cause of resistance	**B1**	
(c)	$R = \frac{\rho L}{A}$ or $\rho = \frac{RA}{L}$	**C1**	**4**
	$A = \pi r^2$ or area = 0.0415×10^{-6} (m^2) (or correct substitution in equation)	**C1**	
	(1.08 to 1.1) × 10^{-6}	**A1**	
	Ω m (condone ambiguous m Ω)	**B1**	
			Total 12

Question 9			
(a)	power = *VI* power per generator = 8000 MW/200 = 40 MW or arrives at 727 000 A *I* = 3640 A	**C1** **C1** **A1**	**3**
(b)	energy = power × time or a recognisable power × time seen in calculation correct energy per day = $8000 \times 10^6 \times 12 \times 60 \times 60$ or 3.45×10^{14} J or total power used for 12 hours a day = 133 000 MW or other correct use of 0.06 seen in attempt to determine total energy $(5.7 – 5.8) \times 10^{15}$ (J) (condone incorrect power of 10 for MΩ if e.c.f. from (a))	**C1** **C1** **A1**	**3**

(c)	**decommissioning and/or waste for reactors**		
	d1 disposing of waste a problem/reference to activity of products/no chemical pollutants for barrage	**B1**	
	d2 cost of decommissioning	**B1**	
	renewable or non-renewable energy source		
	r1 fuel requirement for reactors	**B1**	
	r2 or nuclear energy is non- renewable	**B1**	
	r3 or tidal energy is renewable	**B1**	
	environment		
	e1 effect on wildlife habitats for barrage and/or reactors	**B1**	
	e2 possible local climate changes mentioned for either option	**B1**	
	e3 visual impact on environment (could argue either way)	**B1**	**max 5**
	practical issues		
	p1 suitable sites for reactors	**B1**	
	p2 transportation and mining costs for nuclear fuel	**B1**	
	p3 continuity of supply (control of supply)	**B1**	
	p4 health/risk hazards to workers/general public or security of reactor materials –terrorist threat	**B1**	
	p5 problems for shipping for tidal system not transmission problems (not significantly reduced)	**B1**	
	spin offs		
	s1 isotope production from reactors	**B1**	
	s2 a road-rail bridge for the dam	**B1**	
	not planning problems due to local opposition/employment creation (same for both)/political opportunism/level of expertise required/space taken up		
	At least 2 marks for physics + **Good QWC** At least 2 marks for physics + **Poor QWC** At least 2 marks for physics + **Very Poor QWC** 1 mark for physics + sufficient attempt + **Good or Poor QWC** 1 mark for physics + insufficient attempt or **Very Poor QWC** No marks for physics or **Very Poor QWC**	**2** **1** **0** **1** **0** **0**	**max 2**
			Total 13