



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 acting through body and acting from floor through body/foot/feet	B1 B1	2
(a) (ii)	660/657.27/656.6 (N)	B1	1
(a) (iii)	reaction gives sensation of weight resultant force = ma or 93.8 seen $R = m(g-a)$ $R = 563/566$ (N)	B1 C1 A1 B1	4
(b)	no reaction force acting on skydiver	B1	1
(c) (i)	resistive (force) on object moving in fluid/drag/fluid friction 'stickiness' of fluid owtte/higher viscosity means greater resistive force/determines (rate of) flow	B1 B1	2
(c) (ii)	rearrangement of equation correct units for F , r and v $\text{N s m}^{-2}/\text{Pa s}/\text{kg m}^{-1} \text{s}^{-1}$	C1 C1 A1	3
(c) (iii)	max 2 from not spherical not small air not viscous enough moving too fast non-laminar flow	B1 B1 B1 B1 B1	2
		Total	15

Question 2			
(a)	(i)	substitution into ($E_p = -GMm/r$) -1.25×10^{14} (J)	B1 B1 2
(a)	(ii)	max 3 from GPE is zero at infinity work is done on object in bringing it from infinity to the Earth's surface/to raise object from gravitational potential well loss of energy from zero means negative force is attractive	B1 B1 B1 B1 3
(b)	(i)	additional of radius of Earth and orbital height -1.19×10^{14} (J)	C1 A1 2
(b)	(ii)	work done against Earth's gravitational field increases gravitational potential energy	B1 B1 2
(c)	(i)	any 4 of fuel/fuel tank payload combustion chamber nozzle oxidiser/oxidiser tank fuel pump/injector	B1 B1 B1 B1 B1 B1 4

	examples of the sort of information or ideas that might be used to support an answer: <ul style="list-style-type: none"> • 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 $\tan\theta$ $\theta = 19.3^\circ/70.7^\circ$ 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)	$\omega = 0.98 \text{ (rad s}^{-1}\text{)}$ or $v = 1.24 \text{ (ms}^{-1}\text{)}$ use of $m\omega^2r$ 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 $T = I\alpha$ $\alpha = 0.228 \text{ (rad s}^{-1}\text{)}$ substituted values to give $T = 9.78 \text{ (Nm)}$	B1 B1 B1	3

(d)	(iii)	new $\alpha = 0.088 \text{ (rad s}^{-2}\text{)}$	0.087 to 0.088	C1	3
		$t = 14.7 \text{ (s)}$	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		C1	2
		induced emf proportional to rate of change of flux linkage etc		A1	
(a)	(ii)	direction of induced emf opposes change producing it		B1	1
(a)	(iii)	max 3 from			3
		changing flux produced by transmitter		B1	
		cuts the metal object		B1	
		induces emf and thus eddy currents in object		B1	
		eddy current produce field of direction opposing change		B1	
(a)	(iv)	flux change from transmitter would induce emf across receiver owtte/receiver does not pick up signal from transmitter		B1	2
		producing spurious readings/fail to distinguish metal object from background/confusing the signals		B1	
(b)	(i)	$1.25 \times 10^5 \text{ (Hz)}$		B1	1
(b)	(ii)	$A = 6.2 \times 10^{-2} \text{ (m}^2\text{)}$		C1	4
		use of $\Phi = BA$ or $E = -\frac{N\Delta BA}{\Delta t}$		C1	
		use of 15% and 45 (turns)		C1	
		$9.98 \times 10^{-3} \text{ (V) cao}$		A1	
(c)		any 2 from			2
		landmine detection/earthquake/avalanche sites/ airport security/weapon detection etc		B1 B1	
				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)	$eV = \frac{1}{2}mv^2$ written or used substitution or $v = \sqrt{\frac{2eV}{m}}$ $1.68 \times 10^8 \text{ ms}^{-1}$	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) amplitude = 1.5 (m) maximum speed = $2\pi fA$ $3.14 \text{ (ms}^{-1}\text{) cao}$ alternatively attempt to use gradient tangent at drawn at zero displacement large Δ and correct coordinates read from graph value in region $3.5 - 4.5 \text{ (ms}^{-1}\text{)}$	C1 C1 C1 A1 B1 B1 M1 A1	4
(a)	(ii)	maximum acceleration = $4\pi^2 f^2 A$ ecf for f and A $6.58/6.45 \text{ (ms}^{-2}\text{)}$	C1 A1	2
(b)		series of pulses at $T/4$ and $5T/4$ (neg) or $3T/4$ and $7T/4$ (pos) short pulses (not longer than 1 s)	B1 B1 B1	3
(c)	(i)	oscillations produced by external force external force is periodic	B1 B1	2
(c)	(ii)	amplitude of vibrating system increases to maximum as external periodic force matches natural frequency	B1 B1	2
(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 in phase with oscillation/matching f_0	B1 B1	2
			Total	15