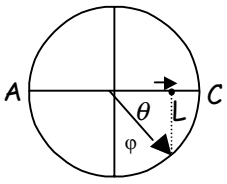
Assessment Schedule – 2006

Physics: Demonstrate understanding of mechanical systems (90521)

Evidence Statement

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
1(a)	$\omega = 2\pi f$ $\Rightarrow f = \frac{2.2}{2\pi} = 0.35014 \quad = 0.35\ s^{-1}$ (Hz)	[2]Correct answer. Has to be a calculation with ω.		
1(b)	$T = T = 2\pi\sqrt{\frac{l}{g}}$ $2.9 = 2 \times \pi \times \sqrt{\left(\frac{l}{9.81}\right)}$ $\Rightarrow l = 2.08980 \quad = 2.1$ m	[2]Correct answer.		
1(c)	As the length is shortened, T will also decrease. If L is halved, T will decrease by square root of 2. T = 2.056 s	[1]Idea that T will decrease if L decreases.	[1] Idea that T will decrease if L decreases, and the appropriate factor is given. Calculation of T can be included with the explanation.	
1(d)	$a_{max} = +/-A\omega^2$ $0.37 \times 2.2^2 = 1.7908$ $a_{max} = 1.8\ m\ s^{-2}$	[2]Correct answer.		
1(e)	Arrow drawn at the tangent to the path in the direction of the equilibrium position.	[1]Arrow drawn in correct direction.	[1]Arrow drawn on tangent in correct direction.	
1(f)	$F = m\omega^2 y = 31 \times 2.2^2 \times 0.25$ $= 37.51 \quad = 38$ N		[2]Correct answer. Accept if method used is to find the component of the gravity force.	
1(g)	 $\theta = \omega t$ $\cos\omega t = \frac{.37 - .12}{.37}$ $\Rightarrow \omega t = 0.828915$ (47.5^0) $\Rightarrow t = 0.377$ s $t_{total} = t + \frac{1}{2}T$ $= 1.826 \quad = 1.8$ s	[1] Ability to relate the angular displacement of a phasor to a linear displacement of a SHM particle.	[2]Calculation of t = 0.377 s	[2]Correct answer.
1(h)	 Approx sin curve.	[1]Graph shows decreasing amplitude.	[1]Graph shows consistently decreasing amplitude and constant period.	
2(a)	The force is the gravitational force and it acts towards the centre of the earth.	[1]Both correct answers		

2(b)	$F_g = mg = \dfrac{GMm}{r^2}$ $\Rightarrow g = \dfrac{6.67\times10^{-11}\times5.98\times10^{24}}{\left(7.00\times10^{6}\right)^2}$ $= 8.14012 = 8.14\ \text{N kg}^{-1}$		[2]Correct answer.	
2b		[1]Answer given to 3 sf plus 5 correct units given. (cannot be 3c unit).		
2(c)	The reaction force of the shuttle on the astronaut gives them the sensation of weight. Because the astronaut and shuttle are falling freely in the gravitational field towards the earth, there is no reaction force of the shuttle on the astronaut and so the astronaut feels no apparent weight.		[1]Idea of astronaut falling freely towards Earth in the gravitational field.	[1]Explanation is clear and accurate and links the fact that the shuttle and astronaut are both accelerating freely towards the earth, and there are no forces between them.
2(d)	$F_c = \dfrac{GMm}{r^2} = \dfrac{mv^2}{r}$ $v = \dfrac{d}{t} = \dfrac{2\pi r}{T}$ $v = 2\times\pi\times9.38\times10^{6} \div 27\ 600 = 2135.37$ $M = \dfrac{v^2 r}{G}$ $= 2135.37^2\times9.38\times10^{6} \div 6.67\times10^{-11}$ $= 6.412439\times10^{23} = 6.41\times10^{23}$ kg	[1]Recognition that the centripetal force is provided by the gravitational force **OR** recognition of how to calculate the tangential speed.	[2]Calculation of speed **AND** Recognition that the centripetal force is provided by the gravitational force.	[2]Correct answer.
3(a)	$I = \dfrac{2}{5}mr^2 \Rightarrow 5\times3.73 = 2\times76\times r^2$ $\Rightarrow r^2 = 0.122698 \Rightarrow r = 0.35$ m	[2]Correct answer.		
3(b)	When Hopi tucks his body, his mass becomes concentrated closer to his axis of rotation, so reducing his rotational inertia. Angular momentum will be conserved and so his angular speed will increase. As the time Hopi has to execute the dive is fixed, rotating at a faster speed enables him to complete all the rotations.	[1]Idea that change in mass distribution is the key factor for decreasing I.	[1] Explanation shows the link between changing mass distribution and reducing I leading to increasing ω.	[1] Explanation shows the link between changing mass distribution and reducing I leading to increasing ω from conservation of L and makes reference to the limited time available for the dive.
3(c)	$L = I\omega = 3.73\times9.82 = 36.6286$	[2]Correct working.		
3(d)	$\omega = \dfrac{\theta}{t}$, $\theta = 2\times2\pi$ radians $t = \dfrac{2\times2\pi}{9.82} =$ $= 1.2797 = 1.28$ s		[2]Correct answer.	
3(e)	Conservation of angular momentum.	[1]Correct answer.		

3(f)	$I\omega$ (initial) = $I\omega$ (final) I (final) = $5 \times I$ (initial) $\frac{I_f}{I_i} = \frac{\omega_i}{\omega_f} = 5$ $\Rightarrow \omega_f = \frac{\omega_i}{5} = \frac{9.82}{5} = 1.964$ $\omega_f = \omega_i + \alpha t$ $\Rightarrow \alpha = \frac{(1.964 - 9.82)}{0.32} = -24.55$ angular deceleration = 25 rad s^{-2} *I_f = 18.65*	[1] Recognition that conservation of angular momentum can be used to find the final angular speed.	[2] Correct final angular speed.	[2] Correct answer.

Judgement Statement

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Criterion One

Achievement	Achievement with Merit	Achievement with Excellence
FOUR opportunities answered at Achievement level or higher. 4 × A1	FIVE opportunities answered with TWO at Merit level or higher. 2 × M1 *plus* 3 × A1	FIVE opportunities answered with ONE at Excellence level and TWO at Merit level or higher. 1 × E1 *plus* 2 × M1 *plus* 2 × A1

Criterion Two

Achievement	Achievement with Merit	Achievement with Excellence
THREE opportunities answered at Achievement level or higher. 3 × A2	FIVE opportunities answered with TWO at Merit level or higher. 2 × M2 *plus* 3 × A2	SIX opportunities answered with TWO at Excellence level and ONE at Merit level or higher. 2 × E2 *plus* 1 × M2 *plus* 3 × A2