Assessment Schedule – 2007

Physics: Demonstrate understanding of mechanical systems (90521)

Evidence Statements

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
1(a)	$p = (1.50 + 0.25) \times 5.4 = 9.45$	[2] Correct working		
1(b)	Before the collision the jack is stationary, so the momentum of the bowl is the momentum of the system.	[1] Idea that the stationary jack is a key issue.	[1] Idea that the momentum of the system is the sum of the individual momentums, and that the momentum of the jack is zero.	
1(c)	$d_j = d \times \frac{m_b}{m_b + m_j}$ $= 10.0 \times \frac{1.50}{1.50 + 0.25} = 8.57143$		[2] Correct working.	
1(d)	$t = \frac{d}{v} = \frac{8.57143}{5.4} = 1.58730 =$ **1.6 s**		[2] Correct answer.	
1(e)	$\cos\theta = 8.7 \div 9.45$ $\Rightarrow \theta = 22.981$ **= 23°**		[2] Correct answer.	
1(f)	$\Delta p(\text{bowl}) = Ft$ $\Delta p(\text{bowl}) = \sqrt{9.45^2 - 8.7^2} = 3.689512$ $\Rightarrow F = \frac{3.689512}{0.025}$ $= 147.5805$ N **= 150 N**	[1] *Correct answer shows recognition that the Δp of the bowl is the final p minus the initial p.*	[2] *Correct Δp(bowl).*	[2] Correct answer
2(a)	There is more mass on one side of the centre of curvature than the other.	[1] Idea of uneven spread of mass.		
2(b)	The bowl is in contact with the surface at point P. The gravity force does not act through point P and so will create a clockwise torque on the bowl that will make it roll over to the right.	[1] Recognition that a torque is needed / that the forces are not in a line.	[1] Correct explanation of how a torque on the bowl is created.	
2(c)	$E_K(\text{rot}) = \frac{1}{2}I\omega^2$ $= \frac{1}{2} \times 2.16 \times 10^{-3} \times 2.8^2$ $= 0.0084672$	[2] Correct working.		
2(d)	$E_K(\text{lin}) = \frac{1}{2}mv^2$ $v = r\omega = 0.060 \times 2.8 = 0.168$ m s^{-1} $E_K(\text{lin}) = \frac{1}{2} \times 1.50 \times 0.168^2 = 0.021168$		[2] Correct working.	
2(e)	From the gravitational potential energy lost by the bowl as its centre of mass falls.	[1] Correct idea of gravitational potential energy.		
2(f)	$mgh = E_K(\text{rot}) + E_K(\text{lin})$ $\Rightarrow h = \frac{0.0084672 + 0.0211}{1.50 \times 9.81}$ $= 2.0139 \times 10^{-3} =$ **2.0×10^{-3} m**		[2] Correct answer.	

2(g)	The unbalanced torque on the bowl will try to make it rotate. This will cause the bottom bit that is in contact with the flat surface to try to slip backwards to the left. Friction acting against this motion must therefore act to the right.	[1] *Some idea of friction opposing the turning of the bowl.*	[1] Correct idea of friction opposing the turning motion of the bowl.	[1] Correct idea of friction acting against the backwards push of the turning bowl on the surface.
2(h)	Because the frictional force acts on the moving bowl at right angles to its motion, it will act as a centripetal force and will cause the bowl to move in a circular path.	[1] *Idea that a force that acts at an angle is needed.*	[1] *Idea of friction providing the centripetal force.*	[1] Correct idea of friction being at an angle to the direction of motion and therefore providing the centripetal force.
3(a)	$T = \dfrac{9.32}{13} = 0.716923$ **= 0.717 s**	[2] Correct answer [1] Answer given to 3 sf and FOUR answers given with correct units.		
3(b)	$T = 2\pi\sqrt{\dfrac{R}{g}} \Rightarrow R = \dfrac{0.716923^2 \times 9.81}{(2\pi)^2}$ $= 0.127171$ **= 0.13 m**	[2] Correct answer consequential to answer given in 3(a).		
3(c)	The restoring force is proportional to the displacement / in the opposite direction to the displacement / acts towards the equilibrium position.	[1] One statement is given.		
3(d)	$F_R = \dfrac{F_g y}{R}$, and $F_R = ma$ but $a = \omega^2 y = \left(\dfrac{2\pi}{T}\right)^2$ and $F_g = mg$ $\Rightarrow \dfrac{mgy}{R} = my\left(\dfrac{2\pi}{T}\right)^2$ $\Rightarrow \quad T = 2\pi\sqrt{\dfrac{R}{g}}$	[1] *Correct answer shows recognition that F_R also equals ma.*		[2] Correct working
3(e)	Friction with the air and against the surface.	[1] Must state friction		
3(f)	Because of the changed shape of the surface the forces opposing the bowl's motion will be greater. This means that the rate at which the SHM energy is dissipated will be greater.	[1] *Idea of increased forces acting against the bowl / idea of greater rate of change of energy.*	[1] Idea of increased forces creating more energy change / of how a soft surface causes a greater rate of change of energy.	[1] Increased opposing forces clearly linked to greater rate of change of energy.

Judgement Statement

	Achievement	Achievement with Merit	Achievement with Excellence
Criterion 1	4 × A1	4 × A1 + 2 × M1	3 × A1 + 2 × M1 + 1 × E1
Criterion 2	3 × A2	3 × A2 + 3 × M2	3 × A2 + 2 × M2 + 1 × E2