

### 3C5 Dynamics: Answers to Tripos Paper 2009

1. (a) AAA body with  $A=28ma^2/5$ .  
(b)  $I_{zz} = 16ma^2/3$ ,  $I_{xy} = 0$ ,  $I_{yz} = -4ma^2$ .
2. (a)  $\dot{\phi} = mga/(C\omega)$ .  
(b) (i)  $\dot{\mathbf{h}} = Q\mathbf{K}$ , (ii)  $\dot{\theta} = -Q/(C\omega)$ .
3. (a)  $Q = (mV^2a/R)\cos\alpha - mga\sin\alpha$ .
4. (c)  $Q_1 = F\sin(\pi x_0/L)$ ,  $Q_2 = F\sin(2\pi x_0/L)$ .  
(d) Additional  $T = 0.5[\dot{q}_1\sin(\pi x_0/L) + \dot{q}_2\sin(2\pi x_0/L)]^2$ ,  
 $\omega_1^2 = \pi^2 EI/(mL^2 + 2ML)$ ,  $\omega_2^2 = 4\pi^2 EI/(mL^2)$ .  
(e)  $M_{jk} = M\sin(j\pi x_0/L)\sin(k\pi x_0/L)$ .
5. (b)  $mr^2\ddot{\theta}_1 - mr^2\ddot{\theta}_2\cos\theta_1 + mgr\sin\theta_1 = 0$ ,  
 $(mr^2 + 2Mr^2)\ddot{\theta}_2 - mr^2\ddot{\theta}_1\cos\theta_1 + mr^2\dot{\theta}_1^2\sin\theta_1 = Fr$ .