SOLUTIONS

Module:	Physics C		
Module Code	BBC4924	Paper	M
Time allowed	1hrs	Filename	**Solutions_2223_BBC4924_M**
Rubric	ANSWER ALL 12 QUESTIONS		
Examiners	Dr. Gang Song		

Part I Multiple Choice (5 marks for each question)

1. C, 2. B, 3. A, 4. A, 5. B,

6. C, 7. B, 8. A, 9. D, 10. A.

Part II Problems (50%)

11. Solution:

(a) $\rho = \dfrac{M}{\pi R^2 - \pi\left(\frac{1}{2}R\right)^2} = \dfrac{4M}{3\pi R^2}$ [2 marks]

$M_b = \frac{4}{3}M, M_s = \frac{1}{3}M$ [2 marks]

$I_{P,b} = \frac{1}{2}\frac{4}{3}MR^2 + \frac{4}{3}MR^2 = 2MR^2$ [3 marks]

$I_{P,s} = \frac{1}{2}\frac{1}{3}M\left(\frac{1}{2}R\right)^2 + \frac{1}{3}M\left(\frac{1}{2}R\right)^2 = \frac{1}{8}MR^2$ [3 marks]

$I_P = I_{P,b} - I_{P,s} = \frac{15}{8}MR^2$ [2 marks]

Angular momentum is conserved. [2 marks]

$I_p\omega - 2Rmv\sin\theta = \left(I_p + 4mR^2\right)\omega'$, $\omega' = \dfrac{I_p\omega - 2Rmv\sin\theta}{\left(I_p + 4mR^2\right)}$ [4 marks]

(b) $E_k = \frac{1}{2}\left(I_P + 4mR^2\right)\omega'^2 = \dfrac{\left(15m\omega R - 16mv\sin\theta\right)^2}{240M + 512m}$ [8 marks]

12. Solution:

$\vec{v} = \dfrac{d\vec{r}}{dt} = 6t\vec{i} + 3t^2\vec{j}$, $\vec{p} = m\vec{v} = 18t\vec{i} + 9t^2\vec{j}$ [2 marks]

(a) $\vec{p}_1 = m\vec{v}_1 = 18\times 3\vec{i} + 9\times 9\vec{j} = 54\vec{i} + 81\vec{j}$

$\vec{p}_2 = m\vec{v}_2 = 18\times 5\vec{i} + 9\times 25\vec{j} = 90\vec{i} + 225\vec{j}$ [2 marks]

$\overline{\vec{F}}\Delta t = \vec{p}_2 - \vec{p}_1 = 36\vec{i} + 144\vec{j}$, $\overline{\vec{F}} = \left(36\vec{i} + 144\vec{j}\right)/\Delta t = \left(36\vec{i} + 144\vec{j}\right)/\left(5-3\right) = 18\vec{i} + 72\vec{j}$ [4 marks]

(b) $\left|v_1\right|^2 = 12^2 + 12^2 = 288, \left|v_2\right|^2 = 36^2 + 108^2 = 12960$ [2 marks]

$W = \Delta E_k = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 = \frac{1}{2}\times 3\times\left(12960 - 288\right) = 19008$ [3 marks]

(c) $\Delta\vec{r} = \vec{r} - \vec{r}_0 = \left(3t^2 - 15\right)\vec{i} + \left(t^3 - 4\right)\vec{j}$, $\vec{a} = \frac{d\vec{v}}{dt} = 6\vec{i} + 6t\vec{j}$ [3 marks]

$\vec{M} = \Delta\vec{r}\times m\vec{a} = \left(36t^3 - 270t + 72\right)\vec{k}$ [3 marks]

(d) $\Delta\vec{r} = \vec{r} - \vec{r}_0 = \left(3t^2 - 3\right)\vec{i} + \left(t^3 - 2\right)\vec{j}$ [3 marks]

$\vec{L} = \Delta\vec{r}\times m\vec{v} = \left(9t^4 - 27t^2 + 36t\right)\vec{k}$ [3 marks]