Sri Chaitanya IIT Academy, India

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A right Choice for the Real Aspirant

ICON CENTRAL OFFICE, MADHAPUR-HYD

Sec: Sr. IPLCO	JEE ADVANCED	DATE : 06-09-15
TIME : 3:00	2013_P1 MODEL	MAX MARKS : 180

KEY & SOLUTIONS

PHYSICS

1	**D**	2	**D**	3	**C**	4	**D**	5	**A**	6	**A**
7	**B**	8	**C**	9	**D**	10	**D**	11	**AC**	12	**ABCD**
13	**ABCD**	14	**AD**	15	**BD**	16	**5**	17	**2**	18	**5**
19	**3**	20	**4**								

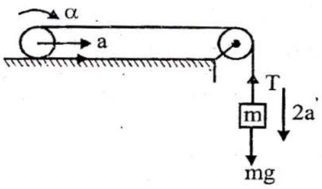
CHEMISTRY

21	**C**	22	**D**	23	**A**	24	**C**	25	**C**	26	**A**
27	**D**	28	**D**	29	**B**	30	**D**	31	**AB**	32	**AB**
33	**ABCD**	34	**AC**	35	**ABCD**	36	**4**	37	**1**	38	**3**
39	**1**	40	**4**								

MATHEMATICS

41	**D**	42	**B**	43	**C**	44	**D**	45	**D**	46	**A**
47	**C**	48	**D**	49	**A**	50	**B**	51	**AC**	52	**ABD**
53	**AB**	54	**CD**	55	**ABCD**	56	**5**	57	**9**	58	**3**
59	**9**	60	**5**								

PHYSICS

1. 

Applying Newton's II law on block; mg – T = 2ma

Considering force and torque on the ring (i)

$T \times r - f \times r = mr\alpha$ (ii)

$a = r\alpha$ (iii)

$T + f = ma$ (iv)

Solving (ii), (iii) and (iv)

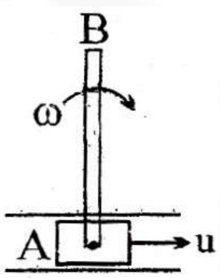
f = 0

T = ma

$\therefore$ from (i)

$a = \dfrac{g}{3}$

2. Since the height of point of application increases and centre of mass moves closer to the vertical line passing through point of contact the torque increases. So α increases. Therefore, horizontal component of acceleration increases. So friction has to decrease

3. 

$$K_{system} = K_{cm} + K_{sys/cm}$$

$$v_{cm} = u + \frac{wL}{2}$$

$$K_{sys} = \frac{1}{2}m\left(u + \frac{wL}{2}\right)^2 + \frac{1}{2}\frac{mL^2}{12} \times w^2$$

$$= \frac{1}{2}mu^2 + \frac{1}{8}mw^2L^2 + \frac{1}{8}muwL + \frac{1}{2}\frac{mL^2}{12}w^2$$

$$= \frac{1}{2}mu^2 + \frac{1}{8}muwL + \frac{1}{6}mw^2L^2$$

4. 

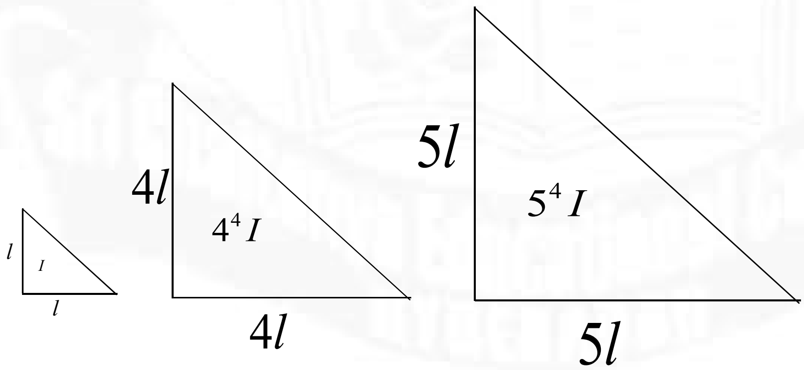
By constraints,

$$u\,cos\,60^o = v\,cos\,60^o$$

$$\therefore u = v$$

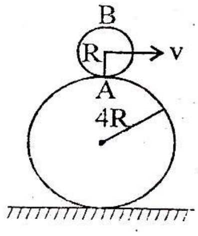
$$w = \frac{(v\perp)_{rel}}{\ell}$$

For a rigid body w is same about any point.

5. 

Required moment of inertia is $\left(5^4 - 4^4\right)I + I$

Where $I = \frac{\sigma l^4}{24}$

6. 

$\vec{a}_A = \vec{a}_{A/cm} + \vec{a}_{cm}$

$\vec{a}_{cm} = \frac{v^2}{5R} \downarrow$

$\vec{a}_{A/cm} = R\omega^2 = \frac{v^2}{5R} \uparrow$

$\vec{a}_A = \left(\frac{v^2}{R} - \frac{v^2}{5R}\right) \uparrow = \frac{4v^2}{5R} \uparrow$

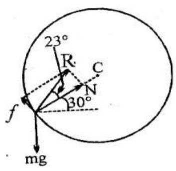
7. If R is resultant of friction and normal reaction

$R\,sin 53^o = mg$

$R\,cos 53^o = ma$

$\Rightarrow g\left(\frac{cos 53^o}{sin 53^o}\right)$

$a = g \times cot 53^o$



8. If v is the velocity of centre of mass of the sphere A at the bottom, then centripetal force is

$F = \frac{mv^2}{R-r}$

Loss in PE = $mg(R-r)$;

Gain in KE = $\frac{1}{2}mv^2 + \frac{1}{2}Iw^2$

$$=\frac{1}{2}mv^2+\frac{1}{2}\times\frac{2}{5}m\gamma^2\times\frac{v^2}{r^2};$$

$$=\frac{1}{2}mv^2\left[1+\frac{2}{5}\right]=\frac{7}{10}mv^2$$

$$\therefore\frac{7}{10}mv^2=mg(R-r);$$

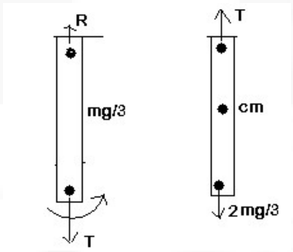
$$\therefore\frac{mv^2}{R-r}=\frac{10}{7}mg$$

Now $N-mg=\dfrac{mv^2}{R-r};$

$$N=\frac{mv^2}{R-r}+mg=\frac{17}{7}mg$$

9. Momentum of each segment in CM frame is equal in magnitude but directions are different.

10. When the rod becomes vertical , apply conservation of energy



$$\frac{MgL}{2}=\frac{1}{2}\frac{ML^2}{3}w^2$$

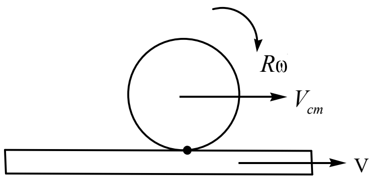
$$w=\sqrt{3g/L}$$

Centre of mass of the lower two-third part moves in a circle of radius 2L/3. We apply Newton's second law on this part

$$T-\frac{2Mg}{3}=\left(\frac{2M}{3}\right)\left(\frac{2L}{3}\right)w^2\ (or)\ T=2Mg$$

11. Friction the sphere is towards east. Thus its torque is anti-clockwise.

12. $\frac{1}{2}\cancel{m}v_0^2=\cancel{m}gh$



$$V_{cm} - R\omega = V$$

$$velocity\,of\ COM = \frac{\cancel{M}V_o}{2\cancel{M}} = \frac{V_o}{2}$$

$$v_o = \sqrt{2gh}$$

$$COM$$

$$\cancel{M}V_o = \cancel{M}V_{cm} + \cancel{M}V$$

$$V_o = 2V + R\omega$$

$$COAM$$

$$MV_oR = MV_{cm}R + \frac{MR^2}{2}\omega$$

$$V_o = V_{cm} + \frac{R\omega}{2} = V + \frac{3R\omega}{2}$$

$$V_o = 2V + R\omega$$

$$2V_o = 2V + 3R\omega$$

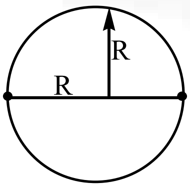
$$V_o = 2R\omega$$

$$R\omega = \frac{V_o}{2} \qquad V = \frac{V_o}{4}, V_{cm} = \frac{V_o}{2} + \frac{V_o}{4} = \frac{3V_o}{4}$$

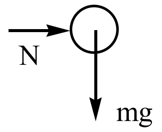
$$l_{cylinder} = \frac{V_o^2 - \left(\frac{3V_o}{4}\right)^2}{2\mu g}$$

$$l_{plank} = \frac{V_o^2}{(16)(2\mu g)}$$

$$l_{min} = \frac{7V_o^2}{32\mu g} = \frac{V_o^2}{32\mu g} = \frac{3V_o^2}{16\mu g}$$

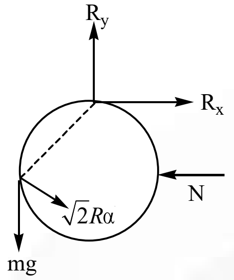
13. 

FBD of bead. (B)



$$N = mR\alpha$$

$$\cancel{m}g = \cancel{m}a_{By}$$



$$R_x - N = mR\alpha$$

$$mg - R_y = mR\alpha$$

$$mg\cancel{R} - N\cancel{R} = 2mR^{\cancel{2}}\alpha$$

$$mg - N = 2mR\alpha$$

$$\cancel{m}g = 3\cancel{m}R\alpha$$

$$\alpha = \frac{g}{3R}$$

Acceleration of Bead 'A' = $\frac{g}{3}$

Acceleration of bead 'B'

$$= \sqrt{(g)^2 + (R\alpha)^2}$$

$$= \sqrt{g^2 + \frac{g^2}{9}}$$

$$= \left(\sqrt{10}\right)\left(\frac{g}{3}\right)$$

$$R_x = \frac{mg}{3} + \frac{mg}{3} = \frac{2mg}{3}$$

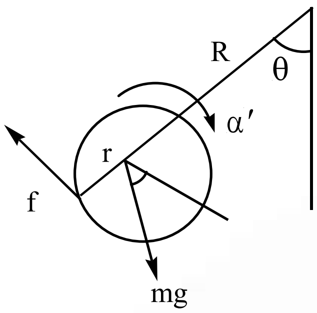
$$R_y = \frac{2mg}{3}$$

$$\frac{R_y}{R_x} = 1$$

$$R_{net} = \left(\sqrt{2}\right)\left(\frac{20}{3}\right)N$$

14. Conceptual

15. $T_2 > T_1$



16.

$mg\,sin\theta = f \quad [\because a_{cm} = 0]$

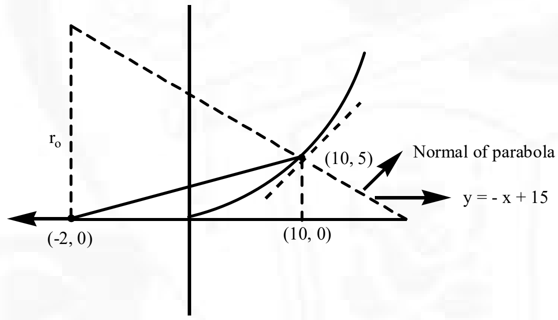
$R\alpha = r\alpha'$

$f(\cancel{r}) = \dfrac{mr^{\cancel{2}}\alpha'}{2}$

$f = \dfrac{\cancel{m}R\alpha'}{2}$

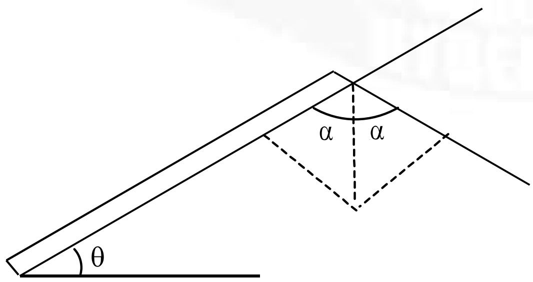
$\alpha = \dfrac{2g\,sin\theta}{R}$

17.



$r_o = 17$

$\omega = \dfrac{V_o}{r_o} = \dfrac{34}{17} = 2\,rad/s$



18.

$$\tan\alpha = \frac{1}{k} \Rightarrow T = mg \Rightarrow T\sin(2\alpha - 90) = Mg\sin\theta$$

$$T = \frac{Mg\sin\theta}{-\cos 2\alpha} \Rightarrow m\cancel{g} = \frac{M\cancel{g}\sin\theta}{2\sin^2\alpha - 1}$$

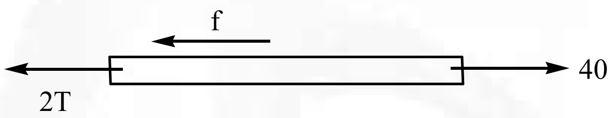
$$m = (10)\times\frac{1}{2}\left[\frac{1}{2\left[\frac{1}{k^2+1}\right]-1}\right]$$

$$= \frac{(5)(k^2+1)}{-k^2+1}$$

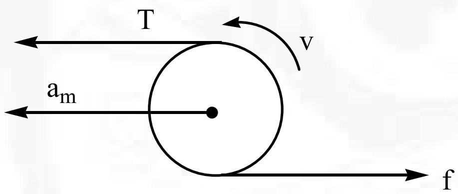
$$= 15$$

19. Statements (a), (e), (g) are correct

20.



$$40 - 2T - f = 8a_1$$



$$T + f = \left(\frac{mR}{2}\right)\alpha$$

$$T + f = \frac{mR\alpha}{2} = (\cancel{m})\frac{3a_1}{\cancel{4}}$$

$$T - f = (m)\left(\frac{a_1}{2}\right) = 2a_1$$