01. For 1st particle $t_1 = \frac{2u\sin\theta}{g}$ (5)

$R = u\cos\theta\, t$ (5)

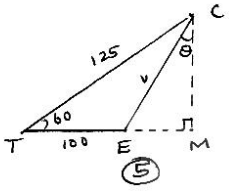
For 2nd particle $t_2 = \frac{2u\sin\alpha}{g}$, $R = u\cos\alpha\, t_2$ (5)

$\frac{g^2t_1^2}{4u^2} + \frac{R^2}{u^2t_1^2} = 1$ & $\frac{g^2t_2^2}{4u^2} + \frac{R^2}{u^2t_2^2} = 1$ (5)

$\Rightarrow R = \frac{1}{2} g\, t_1 t_2$ (5)

25

02. $V_{CE} = V_{CT} + V_{TE} = \overset{125}{\cancel{A}} + \overset{100}{\rightarrow}$ (5)



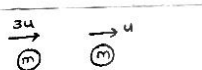
(5)

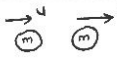
$v^2 = 125^2 + 100^2 - 2\cdot125\cdot100\cos60$ (5)

$v = 25\sqrt{21}$ (5)

$\tan\theta = -\frac{\sqrt{3}}{5}$, $\theta = 59^\circ E$ (5)

25

03. 

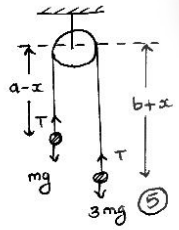


$m\cdot3u + mu = mu + mku$ (10)

$k = 3$ (5)

$3u - u = e(3u - u)$ (10)

25

04. 

(5)

$-3mgb - mga =$

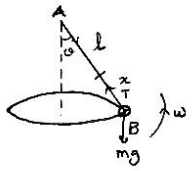
$-mg(a-x) - 3mg(b+x)$

$+\frac{1}{2}m\dot{x}^2 + \frac{1}{2}3m\dot{x}^2$ (10)

$\Rightarrow \ddot{x} = \frac{g}{2}$ (5)

$T = \frac{3mg}{2}$ (5)

25

05. 

$3mg = \frac{2mg}{l}x$ (5)

$x = \frac{3l}{2}$ (5)

$F = mq$

$\leftarrow T\sin\theta = m\frac{5l}{2}\sin\theta\ \omega^2$ (10)

$\Rightarrow \omega = \sqrt{\frac{6g}{5l}}$ (5)

25

06. $\rightarrow S\cos30 - F = 0$

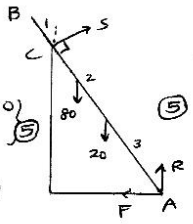
$\uparrow R + S\sin30 - 80 - 20 = 0$ } (5)

A) $S\cdot5 - 20\cdot3\cos60 - 80\cdot4\cos60 = 0$ (5)

$S = 95$

$F = 95\sqrt{3}/2$, $R = \frac{295}{2}$ (5)

$\mu = F/R = \frac{19\sqrt{3}}{59}$ (5)



(5)

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07. $a^2 + \underline{a}\cdot\underline{b} + \underline{a}\cdot\underline{c} = 0$ (5)

$\underline{a}\cdot\underline{b} + b^2 + \underline{b}\cdot\underline{c} = 0$ (5)

$\underline{a}\cdot\underline{c} + \underline{b}\cdot\underline{c} + c^2 = 0$ (5)

$\Rightarrow 2(\underline{a}\cdot\underline{b} + \underline{b}\cdot\underline{c} + \underline{c}\cdot\underline{a}) = -(a^2+b^2+c^2)$ (5)

$= -(1^2 + 2^2 + 3^2)$ (5)

25

08. (i) $P(A|B) = \frac{P(A\cap B)}{P(B)}$ (5)

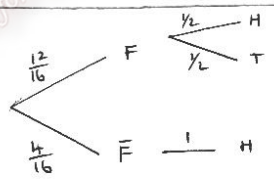
$P(A\cup B) = P(A) + P(B) - P(A|B)\cdot P(B) \le 1$ (5)

(ii) $P(A\cap B) = P(A)\,P(B)$ (5)

$P(A\cup B) = P(A)\,P(\bar{B}) + 1 - P(\bar{B})$ (5)

$= 1 - P(\bar{B})\,P(\bar{A})$ (5)

25

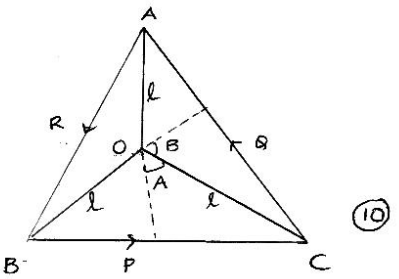
09. 

(10)

$P(H) = \frac{12}{16}\cdot\frac{1}{2} + \frac{4}{16}\cdot1$ (10)

$= \frac{5}{8}$ (5)

25

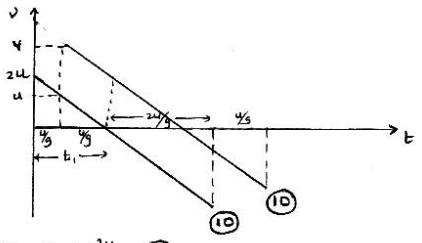
10. 

(10)

$\circlearrowleft P\cdot l\cos A + Q\cdot l\cos B + R\cdot l\cos C = 0$ (15)

25

11. (a)



(10) (10)

(i) $g = \frac{2u}{t_1}$ (5)

(ii) $\frac{1}{2} t_1 \times 2u = \frac{2u^2}{g}$ (10)

(iii) (α) $(v-u)\frac{u}{g} = \frac{2u^2}{g} - \frac{1}{2}\frac{u^2}{g}$ (10)

$v = \frac{5u}{2}$ (5)

(β) Q will hit the ground after time $\left(\frac{5u}{g} - \frac{4u}{g}\right) + \frac{u}{g}$ in which P hits the ground. (10)

(γ) Time Q attains the highest point $= \frac{5u}{2g}$ (5)

Time P moves at this time $= \frac{u}{g} + \frac{5u}{2g}$ (10)

$< \frac{4u}{g}$ (5)

80

(b) (i) $\underline{v}_A = -4\underline{i} + 2\underline{j}$ (10)

$\underline{v}_B = 6\underline{i} - 4\underline{j}$ (10)

(ii) $\underline{r}_A = (-4\underline{i} + 2\underline{j})t + (\underline{i} + 2\underline{j})$ (10)

$\underline{r}_B = (6\underline{i} - 4\underline{j})t + (-\underline{i} + \underline{j})$ (10)

(iii) $\overrightarrow{BA} = \underline{r}_A - \underline{r}_B = (2-10t)\underline{i} + (1+6t)\underline{j}$ (5)

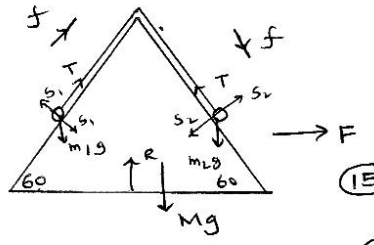
(iv) $AB^2 = (2-10t)^2 + (1+6t)^2$ (10)

$= 136\left[(t - \frac{7}{68})^2 + \frac{5}{136} - (\frac{7}{68})^2\right]$ (10)

$AB_{min} \Rightarrow t = \frac{7}{68}$ (5)

70

12. (a) (i)



(15)

$\underline{F} = m\underline{a}$ (15)

For the system $0 = MF + m_1(F + f\cos 60°) + m_2(F + f\cos 60°)$

For m_1 $T - m_1 g \sin 60° = m_1(f + F\cos 60°)$ (10)

For m_2 $m_2 g \sin 60° - T = m_2(f + F\cos 60°)$ (10)

$\Rightarrow F = \frac{\sqrt{3}(m_1 - m_2)g}{3m_1 + 3m_2 + 4M}$ (10)

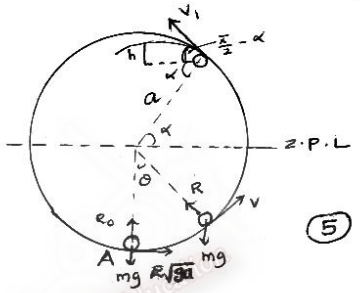
(ii) When $M = 3m$, $m_1 = 2m$ & $m_2 = m$

$F = \frac{\sqrt{3}g}{21}$ (5) $f = -\frac{4\sqrt{3}g}{21}$ (5)

$T = \frac{2\sqrt{3}mg}{3}$ (10)

80

(b)



(5)

(i) Principle of conservation of energy (15)

$\frac{1}{2}mv^2 - mga\cos\theta = \frac{1}{2}m(4ga) - mga$

$v^2 = 2ga(1 + \cos\theta)$ (5)

$\underline{F} = m\underline{a}$

$R - mg\cos\theta = m \cdot v^2/a$ (10)

$R = m(2 + 3\cos\theta)$ (5)

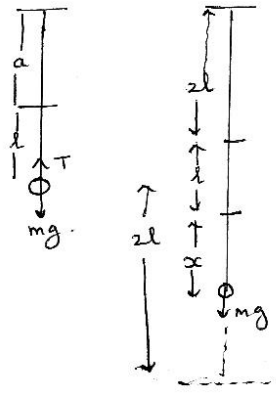
when $\theta = \pi/2 + \alpha$, $R = 0$ (5)

$\Rightarrow \sin\alpha = 2/3$ (5) $a + a\sin\alpha = \frac{5a}{3}$ (5)

$\Rightarrow$ Maximum height $= \frac{50a}{27}$ (15)

70

13.



$T = mg$

$\frac{2mgl}{a} = mg \Rightarrow a = 2l$ (20)

$x = 2l\cos\omega t$

when $x = -l$ (10) $\Rightarrow \cos\omega t = -\frac{1}{2}$ (5)

$\omega t = 2\pi/3$ (5)

$t = 2\pi/3\omega$ (10)

$F = mg$

$mg - T = m\ddot{x}$ (15) $\Rightarrow \ddot{x} = -\frac{g}{l}x$ (15) $\longrightarrow *$

$x = A\cos\omega t + B\sin\omega t \longrightarrow (1)$

$\dot{x} = -A\omega\sin\omega t + B\omega\cos\omega t \longrightarrow (2)$ (10)

$\ddot{x} = -A\omega^2\cos\omega t - B\omega^2\sin\omega t \longrightarrow (3)$ (10)

$= -\omega^2 x \longrightarrow (3)$ (10)

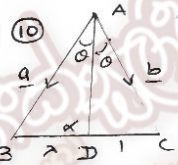
$t = 0,\ x = 2l,\ \dot{x} = 0$ (10)

$(1) \Rightarrow A = 2l,\ (2) \Rightarrow B = 0$ (20)

$(3) \Rightarrow \omega = \sqrt{g/l}$ (10)

150

14. (a) (i) $\overrightarrow{BD} = \frac{\lambda}{\lambda+1}(\underline{b} - \underline{a})$ (10)



$\overrightarrow{DC} = \frac{1}{\lambda+1}(\underline{b} - \underline{a})$ (10)

(ii) $\overrightarrow{AD} = \overrightarrow{AB} + \overrightarrow{BD} = \frac{\lambda\underline{b} + \underline{a}}{\lambda+1}$ (10)

(iii) $\underline{a}\cdot\overrightarrow{AD} = \frac{\lambda\underline{a}\cdot\underline{b} + a^2}{\lambda+1} = a\cdot AD\cos\theta$ (10)

$\underline{b}\cdot\overrightarrow{AB} = \frac{\lambda b^2 + \underline{a}\cdot\underline{b}}{\lambda+1} = b\cdot AD\cos\theta$ (10)

$\Rightarrow (\lambda b - a)(\underline{a}\cdot\underline{b} - ab) = 0$ (10)

$\Rightarrow \frac{a}{b} = \lambda$ (10)

70

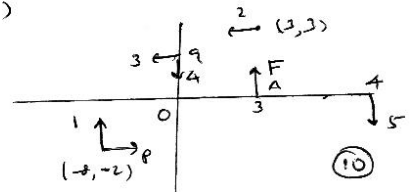
(b) (i) $\underline{R} = (-2\underline{i}) + (-5\underline{j}) + (P\underline{i} + \underline{j}) + (-3\underline{i} - 4\underline{j}) = (P-5)\underline{i} - 8\underline{j}$ (10)

(ii) $R = F$ & $F \parallel y$-axis (10)

$\Rightarrow P - 5 = 0$

$P = 5$ (5)

(iii)



(10)

$A\uparrow = 0$ (5)

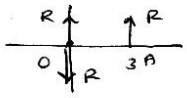
$3\cdot 4 + 9\cdot 3 + 3\cdot 2 - 1\cdot 5 - 11\cdot 1 + 2P = 0$ (15)

$\Rightarrow P = -4$ (5)

(iv) $G\uparrow = R\cdot 3$

$= (-8)\cdot 3$ (10)

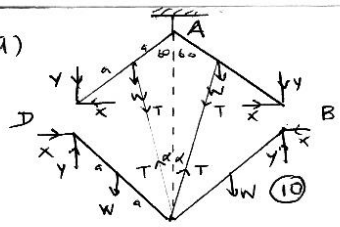
$= -24$



$\therefore G\downarrow = 24$ (10)

80

15. (a)



(10) $\alpha = 30°$ (5)

BCD: $\uparrow\ 2Y + 2T\cdot\frac{\sqrt{3}}{2} = 2W$ (5)

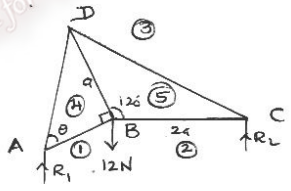
CB: $C\circlearrowleft\ Y\cdot 2a\cdot\frac{\sqrt{3}}{2} + X\cdot 2a\cdot\frac{1}{2} = W\cdot\frac{a\sqrt{3}}{2}$ (10)

AB: $A\circlearrowleft\ X\cdot 2a\cdot\frac{1}{2} = Y\cdot 2a\cdot\frac{\sqrt{3}}{2} + W\cdot\frac{a\sqrt{3}}{2} + T\cdot a$ (10)

$\Rightarrow T = \sqrt{3}W$ (20)

60

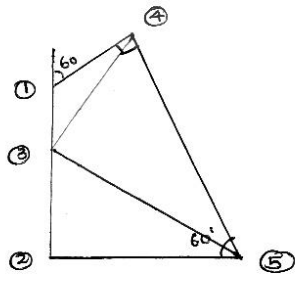
(b)



$R_1 = 6$ N (5)

$R_2 = 6$ N (5)

$\tan\theta = \sqrt{3}/4$

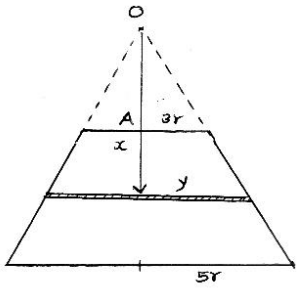


30

Rod	Tension	Thrust	
AB	9	—	(10)
BC	$10\sqrt{3}$	—	(10)
CD	—	$4\sqrt{21}$	(10)
AD	—	$3\sqrt{19}$	(10)
BD	$11\sqrt{3}$	—	(10)

90

16. (i)



$x = y$ (10)

or $\bar{x}\int \pi y^2 dx \rho = \int \pi y^2 x\, dx \rho$ (10)

$\bar{x}\int \pi x^2 dx = \int \pi x^3 dx$ (10)

$\bar{x}\,\pi\left[\frac{x^3}{3}\right]_{3r}^{5r} = \pi\left[\frac{x^4}{4}\right]_{3r}^{5r}$ (10)

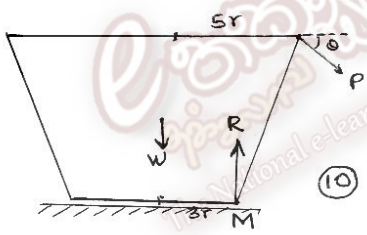
$\bar{x}\,\frac{\pi}{3}\left(125r^3 - 27r^3\right) = \frac{\pi}{4}\left(625r^4 - 81r^4\right)$ (10)

$\Rightarrow \bar{x} = \frac{204}{49}r$ (10)

The distance of the centre of gravity from A $= \frac{57}{49}r$ (10)

70

(ii)



(10)

At the position of toppling

$M) = 0$ (5)

$P\cos\theta \cdot 2r + P\sin\theta \cdot 2r - W \cdot 3r = 0$ (15)

$P = \frac{3W}{2(\cos\theta + \sin\theta)}$ (10)

40

(iii) $P = \frac{3W}{2\sqrt{2}\left(\frac{1}{\sqrt{2}}\cos\theta + \frac{1}{\sqrt{2}}\sin\theta\right)}$ (10)

$= \frac{3W}{2\sqrt{2}\cos(\theta - \pi/4)}$ (10)

$P_{min} = \frac{3W}{2\sqrt{2}}$ (10) when $\theta = \frac{\pi}{4}$ (10)

40

17. (a) To show that

$P(A' \cap B) = P(A') \cdot P(B)$

40

(b) (i) $\frac{{}^2C_1}{{}^9C_1} \cdot \frac{1}{{}^{10}C_1} = \frac{2}{90}$ (10)

$\frac{{}^3C_1}{{}^9C_1} \cdot \frac{{}^3C_1}{{}^{10}C_1} = \frac{9}{90}$ (10)

$\frac{{}^2C_1}{{}^9C_1} \cdot \frac{{}^3C_1}{{}^{10}C_1} = \frac{6}{90}$ (10)

$\frac{1}{{}^9C_1} \cdot \frac{{}^2C_1}{{}^{10}C_1} = \frac{2}{90}$ (10)

Adding $\frac{19}{90}$ (10)

50

(ii) $\frac{2}{9} \cdot \frac{2}{10}$ (15)

$\frac{1}{9} \cdot \frac{1}{10}$

Adding $\frac{1}{18}$ (5)

20

(iii) $\frac{1}{18}$ (5)

$\frac{2}{9} \cdot \frac{1}{10}$ (5)

$\frac{1}{9} \cdot \frac{2}{10}$ (5)

Adding $\frac{1}{10}$ (5)

20

(iv) $\frac{3}{9} \cdot \frac{3}{10}$ (15)

$\frac{2}{9} \cdot \frac{3}{10}$

Adding $\frac{1}{6}$ (5)

20