1. LHS = RHS = 5 (5)

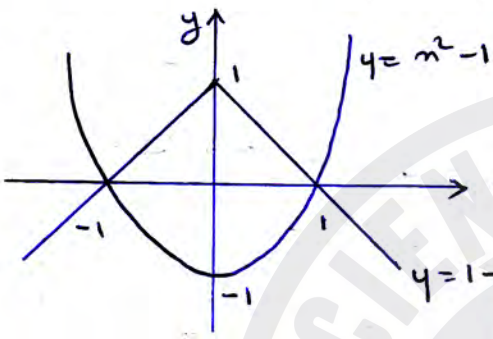
$n=p \Rightarrow \sum_{r=1}^{p}(4r+1) = 2p^2+3p$ (5)

$n=p+1 \Rightarrow \sum_{r=1}^{p+1}(4r+1) = \sum_{r=1}^{p}(4r+1) + (4p+5)$ (5)

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

Statement (5) [25]

2.

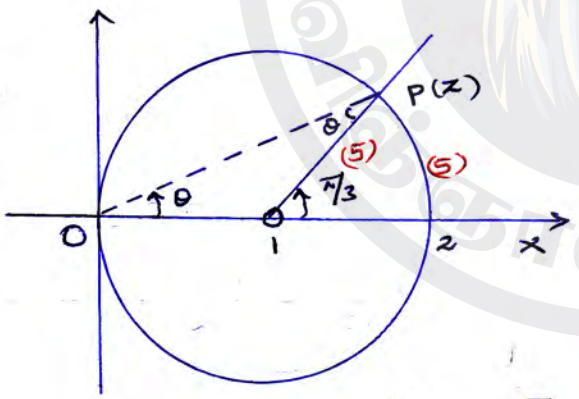


(5) (10)

$1-|x| > x^2-1$ (5)

∴ Solution set $-1 < x < 1$ (5) [25]

3.



(5) (5)

$OP = \sqrt{3}$ (5) $P\hat{O}X = \frac{\pi}{6}$ (5)

$z = \sqrt{3}\left\{\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}\right\}$ (5) [25]

4. (i) ${}^7C_5 = 21$ (5) (5)

(ii) ${}^5C_3 \cdot {}^2C_2 + {}^5C_4 \cdot {}^2C_1 + {}^5C_5$ (10)

$= 21$ (5) [25]

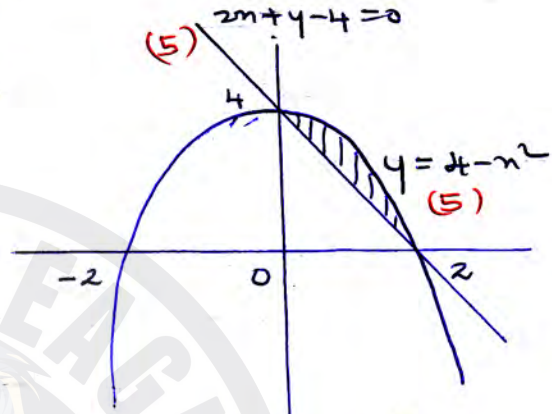
5. $\lim_{x\to 1} \frac{\sin(\pi/2 - \pi/2 x)}{(1-x)(1+x+x^2)}$ (10)

$= \frac{\pi}{2}\lim_{x\to 1} \frac{\sin\frac{\pi}{2}(1-x)}{\frac{\pi}{2}(1-x)} \cdot \lim_{x\to 1} \frac{1}{(1+x+x^2)}$ (5)

$= \frac{\pi}{2} \cdot 1 \cdot \frac{1}{(1+1+1)}$ (5) (5)

$= \pi/6$ [25]

6.



(5) (5)

$A = \int_0^2 (4-x^2)\,dx - \int_0^2 (4-2x)\,dx$ (5)

$= \int_0^2 (2x-x^2)\,dx = \left[x^2 - \frac{x^3}{3}\right]_0^2$ (5)

$= 4 - 8/3 = 4/3$ (5) [25]

7. $\frac{dy}{dx} = \frac{3x^2}{2y}$ (5)

$\left(\frac{dy}{dx}\right)_{P(4t^2,\,8t^3)} = 3t$ (5)

$Q \equiv (4T^2, 8T^3)$, $3t = \frac{8T^3 - 8t^3}{4T^2 - 4t^2}$ (5)

$t^2 + Tt - 2T^2 = 0$ (5)

$Q \equiv (t^2, -t^3)$ (5) [25]

8. $y - 2a = \frac{2a-2b}{a^2-b^2}(x-a^2)$ (5)

$y - 2a = \frac{2}{a+b}(x-a^2)$ (10)

$(1,0) \Rightarrow 0 - 2a = \frac{2}{a+b}(1-a^2)$ (5)

$\Rightarrow ab = -1$ (5) [25]

9. $a=b$ (5)

$a+b-4=0$ (5)

$a=b=2$ (5)

$x^2+y^2-x-y-10=0$ (5)

radius $=\sqrt{21/2}$ (5) [25]

10. $f(\theta) = 3(\cos\theta\cos\pi/3 - \sin\theta\sin\pi/3) + 5\cos\theta + 3$ (5)

$= \frac{3}{2}\cos\theta - \frac{3\sqrt{3}}{2}\sin\theta + 5\cos\theta + 3$ (5)

$= 7\left(\frac{13}{14}\cos\theta - \frac{3\sqrt{3}}{14}\sin\theta\right) + 3$ (5)

$= 7\cos(\theta+\alpha) + 3$ (5)

$-4 \le f(\theta) \le 10$ (5) [25]

11. (a)(i) $\Delta = 4(b+c-a)^2 - 4(2bc-c^2)$ (10)

$= 4\{b^2+c^2+a^2+2bc-2ca-2ab-2bc+a^2\}$ (10)

$= 4\{(a-b)^2+(c-a)^2\} \ge 0$ (10) [30]

(ii) $(x-\alpha)(x-\beta) < 0$ (10)

$\Rightarrow f(x) < 0$ (5) [15]

(iii) $(\alpha+\beta)+2a$ (5) $\alpha+\beta = -2$

$= 2(2a-b-c)$ (5) $(b+c-a)$

$\alpha\beta = 2bc-a^2$ (5)

& $\alpha\beta + a(\alpha+\beta) + c^2$ (5)

$= 2(a^2+bc-ab-ac)$ (5)

∴ Equation is

$x^2 - 2(2a-b-c)x + 2(a^2+bc-ab-ac) = 0$ (5) [35]

(b) $f(x) \equiv (ax+b)\phi(x) + R$ (10)

$f(-b/a) = (a(-b/a)+b)\phi(-b/a) + R$ (5)

∴ Reminder is $f(-b/a)$ (5) [20]

$f(1/4) = -25/8 \Rightarrow -\frac{1}{2}\left(A(\frac{1}{4}) + B(\frac{1}{2}) + C\right) = -\frac{25}{8}$ (5)

(5) $A+2B+4C = 25$ (5)

$f(-\frac{1}{2}) = -57/8 \Rightarrow -\frac{1}{2}\left|A(\frac{1}{4}) + B(-\frac{1}{2}) + C\right| = \frac{-57}{8}$ (5) (5)

$A-2B+4C = 17$ (5)

$f(0) = -5 \Rightarrow C = -5$ (5)

$A = 1, B = 2$ (5)

$f(x) = x^3 + x^2 + 3x - 5$ (5) [50]

12. (a) (Expansion [10]

$\frac{{}^nC_r}{{}^nC_{r-1}} = \frac{n-r+1}{r}$ [15]

${}^nC_{r-1} : {}^nC_r : {}^nC_{r+1} = 1:7:42$ (5)

$\frac{n-r+1}{r} = 7 \Rightarrow 8r - n = 1$ (5)

$\frac{n-(r+1)+1}{r+1} = 6 \Rightarrow -7r + n = 6$ (5)

$r = 7$, $n = 57$ (5)

7th, 8th and 9th terms are in the ratio of 1 : 7 : 42. (5) [40]

(b) $U_r = \frac{(2r+1)^2 - 2r}{(2r-1)(2r+1)}\left(\frac{1}{3}\right)^r$ (10)

$\frac{4r^2+2r+1}{(2r-1)(2r+1)} = A + \frac{B}{2r-1} + \frac{C}{2r+1}$ (10)

$A = 1$, $B = 3/2$, $C = -1/2$ (5) (5) (5)

$U_r = \left(\frac{1}{3}\right)^r + \frac{1/2}{2r-1}\left(\frac{1}{3}\right)^{r-1} - \frac{1/2}{2r+1}\left(\frac{1}{3}\right)^r$ (5)

$= \left(\frac{1}{3}\right)^r + f(r) - f(r+1)$; where

$f(r) = \frac{1}{2(2r-1)}\left(\frac{1}{3}\right)^r$ (5) [45]

$U_1 = \left(\frac{1}{3}\right)^1 + f(1) - f(2)$

$U_2 = \left(\frac{1}{3}\right)^2 + f(2) - f(3)$ (5)

$\vdots$

$U_{n-1} = \left(\frac{1}{3}\right)^{n-1} + f(n-1) - f(n)$ (5)

$U_n = \left(\frac{1}{3}\right)^n + f(n) - f(n+1)$

$\sum_{r=1}^{n} U_r = \sum_{r=1}^{n}\left(\frac{1}{3}\right)^r + f(1) - f(n+1)$ (5)

$= \frac{(1/3)(1-(1/3)^n)}{1-1/3}$ (5) $+ 1/2 - \frac{1}{2(2n+1)}\left(\frac{1}{3}\right)^n$ (5)

$= 1 - \left(\frac{n+1}{2n+1}\right)\left(\frac{1}{3}\right)^n$ (5) [30]

$$\lim_{n\to\infty}\left\{1-\left(\frac{1+1/n}{2+1/n}\right)\left(\frac{1}{3}\right)^n\right\}=1$$ (5) (5)

∴ The series is convergent. (5)

Value of convergence is 1. (5)

[15]

13. (a) $2B=\begin{pmatrix}2 & 6\\ 0 & 12\end{pmatrix}$ (5)

$2B-C=\begin{pmatrix}1 & 1\\ 4 & 12-k\end{pmatrix}$ (10)

$A(2B-C)=\begin{pmatrix}6 & 14-k\\ 0 & k-8\end{pmatrix}$ (10)

$k=14$ (5)

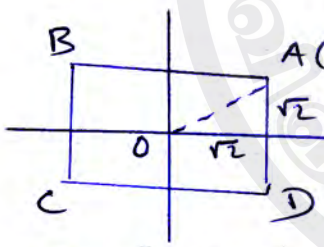
$I=A\left\{\frac{1}{6}(2B-C)\right\}$ (5)

$A^{-1}=\frac{1}{6}(2B-C)$ (5)

$A^{-1}=\frac{1}{6}\left\{\begin{pmatrix}2 & 6\\ 0 & 12\end{pmatrix}-\begin{pmatrix}1 & 5\\ -4 & 14\end{pmatrix}\right\}$ (5)

$=\begin{pmatrix}1/6 & 1/6\\ 4/6 & -2/6\end{pmatrix}$ (5) [50]

(b)



(5)

$Z_B=-\sqrt{2}+\sqrt{2}i$, $Z_C=-\sqrt{2}-\sqrt{2}i$

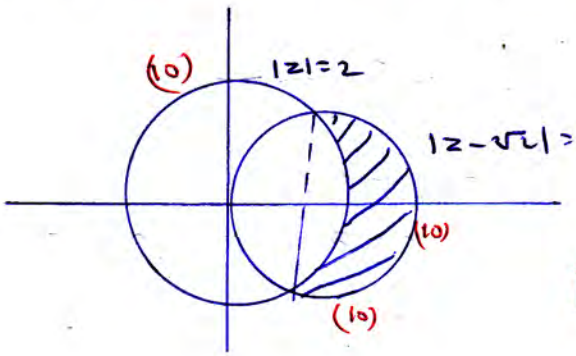
$Z_D=\sqrt{2}-\sqrt{2}i$ (15)

radius $=2$ (5)

centre $=0+i0$ (5)

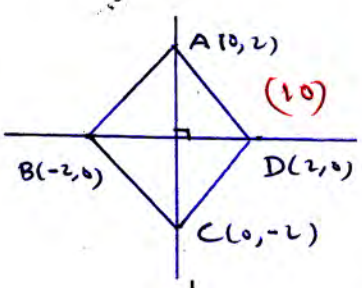
$|z-(0+i0)|=2$ (5) $R=2$ (5)

[40]



[30]

[03]



$Z_A'=0+2i$, $Z_B'=-2$, $Z_C'=-2i$, (20)

14. (a) $f'(x)=\frac{(6x-10)6x-(3x^2-3)6}{(6x-10)^2}$ (10)

$=\frac{6(3x-1)(x-3)}{(6x-10)^2}$ (5)

$f'(x)=0 \Rightarrow x=1/3$ or $x=3$ (5)

$x=5/3$ (5) is a vertical asymptote. (5)

Range of x: $x<1/3$, $1/3<x<5/3$, $5/3<x<3$, $x>3$

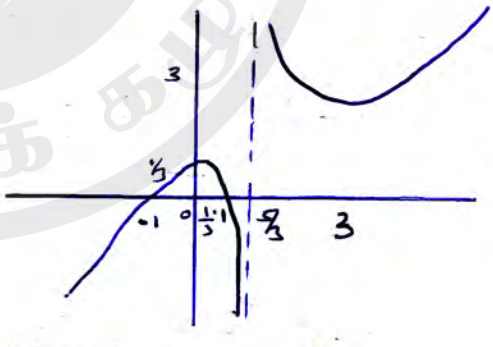
Sign of $f'(x)$: (+) (−) (−) (+) (20)

maximum point $=\left(\frac{1}{3},\frac{1}{3}\right)$ (5)

minimum point $=(3,3)$ (5)

$(0,3/10)$ (5), $(1,0)$ $(-1,0)$ (5)

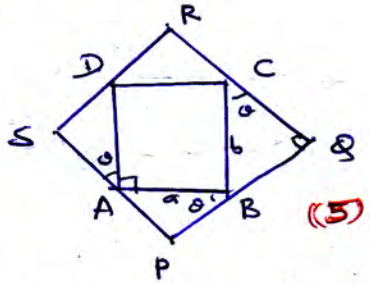
$x\to\pm\infty$, $f(x)\to\pm\infty$ (5)



(15)

[90]

(b)



(5)

$PQ=a\cos\theta+b\sin\theta$ (5) $PS=a\sin\theta+b\cos\theta$ (5)

$S=ab+\left(\frac{a^2+b^2}{2}\right)\sin 2\theta$ (10)

$\frac{ds}{d\theta}=\left(\frac{a^2+b^2}{2}\right)\cos 2\theta\cdot 2$ (5)

$\frac{ds}{d\theta}=0 \Rightarrow \cos 2\theta=0$

(5)

Range of θ : $0 < \theta < \frac{\pi}{4}$ $\frac{\pi}{4} < \theta < \frac{\pi}{2}$

Sign of $\frac{ds}{d\theta}$: $+$ $-$ (10)

$PQ = \frac{1}{\sqrt{2}}(a+b)$, $PS = \frac{1}{\sqrt{2}}(a+b)$ (5)

$S_{max} = \frac{(a+b)^2}{2}$ (5)

[60]

15. (a) $\frac{d}{dx}\{\ln(x+\sqrt{x^2+a^2})\} = \frac{1}{\sqrt{a^2+x^2}}$ (10)

$\int \frac{1}{\sqrt{a^2+x^2}}\,dx = \ln\{x+\sqrt{a^2+x^2}\} + k$ (5)

$\frac{d}{dx}(\sqrt{x^2+4x+5}) = \frac{x+2}{\sqrt{x^2+4x+5}}$ (10)

$\int \frac{x+2}{\sqrt{x^2+4x+5}}\,dx = \sqrt{x^2+4x+5} + c$ (10)

$\int \frac{2x+5}{\sqrt{x^2+4x+5}}\,dx = 2\int \frac{x+2}{\sqrt{x^2+4x+5}}\,dx + \int \frac{1}{\sqrt{(x+2)^2+1^2}}\,dx$ (10)

$= 2\sqrt{x^2+4x+5} + \ln\{(x+2)+\sqrt{x^2+4x+5}\} + c_1$ (10)

(b) $\frac{3x-1}{(x^2-1)(x^2+4)} = \frac{A}{x-1} + \frac{B}{x+1} + \frac{Cx+D}{x^2+4}$

$A = 1/5$, $B = 2/5$, $C = -2/5$, $D = 1/5$ (20)

$\int \frac{2x-1}{(x^2-1)(x^2+4)}\,dx = \frac{1}{5}\ln|x-1| + \frac{2}{5}\ln|x+1|$ (5)

$-\frac{2}{10}\ln(x^2+4) + \frac{1}{10}\tan^{-1}(x/2) + k$ (5) (5)

[55]

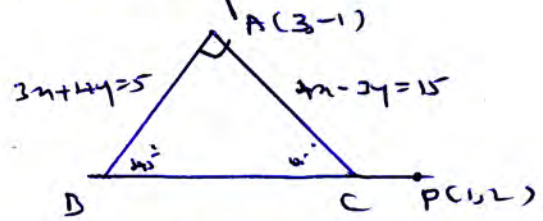
(c) $\int_1^{e^{\pi}} \cos(\ln x)\,dx = -e^{\pi} - 1 + \int_1^{e^{\pi}} \sin(\ln x)\,dx$ (20)

$= -(e^{\pi}+1) - \int_1^{e^{\pi}} \cos(\ln x)\,dx$ (20)

$\Rightarrow \int_1^{e^{\pi}} \cos(\ln x)\,dx = -\frac{1}{2}(e^{\pi}+1)$ (5)

[45]

16. (a) Theory (20)



$m_{AB} \times m_{AC} = -1$ (5) $B\hat{A}C = \pi/2$ (5)

$A \equiv (3,-1)$ (5)

$A\hat{B}C = A\hat{C}B = 45°$ (5)

Let the grad. of BC be m

$\tan 45 = \left|\frac{4+3}{3m-4}\right| \Rightarrow m = -7, 1/7$ (10) (10)

Equations of BC: $7x+y-9=0$ (5)

$x-7y+13=0$ (5)

[70]

(b) Theory (30)

$2g+4f = c+1$, $3g+4f = c-3$ (10) (10)

$-2g+8f = c-3$ (10)

$g = -2$, $f = -7$, $c = -34$ (5) (5) (5)

Equation of the circle: $x^2+y^2-5x-14y-34=0$ (5)

[80]

17. (a) $y^2+2^2 = 10+6\sin(\theta+\alpha)$ (15)

$y^2 = 6+6\sin(\theta+\alpha)$ (15)

$y_{max} = 2\sqrt{3}$ (10)

$\theta = 2\alpha = \pi/3$ (15)

[50]

(b) Sine rule [05]

$\frac{\sin(C-\theta)}{\sin\theta \sin C} = \frac{\sin C}{\sin A \sin B}$ (10)

$\frac{\sin C\cos\theta - \cos C\sin\theta}{\sin\theta\sin C} = \frac{\sin(A+B)}{\sin A \sin B}$ (10)

$\Rightarrow \cot\theta - \cot C = \cot B + \cot A$ (15)

[35]

(c) (i) $\alpha = \tan^{-1}(1/7)$, $\beta = \tan^{-1}(3/17)$

$0 < \alpha < \pi/4$, $0 < \beta < \pi/4$ (5)

$\tan(\alpha+\beta) = 1$ (15)

$\alpha+\beta = \pi/4$ (5) $(0 < \alpha+\beta < \pi/2)$ (5)

[30]

(ii) $2\sin 2x\cos x - 2\cos^2 x = 0$ (10)

$2\cos x(2\sin x - 1) = 0$ (10)

$x = 2n\pi \pm \pi/2$ $x = n\pi + (-1)^n \pi/6$,

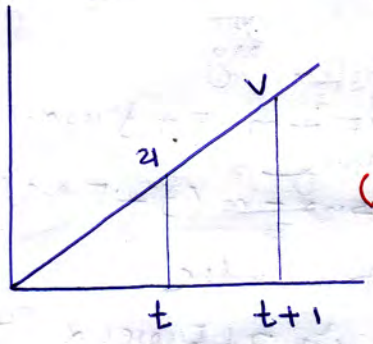
$n \in \mathbb{Z}$ $n \in \mathbb{Z}$

(5) (5)

[30]

[04]

01.



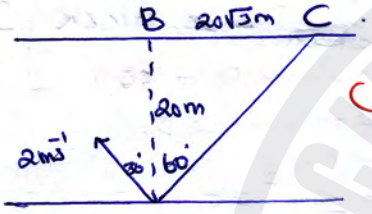
(10)

$v-u=g$ (5) $\quad v+u=h/5$ (5)

$x=\frac{1}{2}\frac{u^2}{g}$ (5)

[25]

02.



(5)

$\rightarrow v = 2\sqrt{3}\cos 60 + w\cos 30 \quad w\cos 60 - 2\sqrt{3}\sin 60$ (10)

$w = 6\ ms^{-1}$ (5) $\quad v = 4\sqrt{3}\ ms^{-1}$ (5)

[25]

03. $kmv = mu + km \times u/n$ (10)

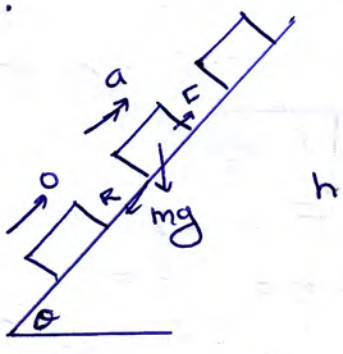
$v = e(u - u/n)$ (5)

$\Rightarrow e = \frac{(n+k)}{k(n-1)}$ (5)

$\frac{n+k}{k(n-1)} < 1 \Rightarrow k > \frac{n}{n-2}$ (5)

[25]

04.



$a = \frac{v^2 \sin\theta}{2h}$ (10)

$F - R - mg\sin\theta = ma$ (10)

$P = (R + mg\sin\theta + \frac{mv^2\sin\theta}{2h})v$ (5)

[25]

07. $P(A \cap B) = P(A) + P(B) - P(A \cup B)$ (5)

$= \frac{1}{2}n + \frac{1}{4}n - \frac{5}{8}n$

$= 1/8\, n$ (5)

$P(A \cap B) = P(A) \cdot P(B)$ (10)

$\Rightarrow n = 1$ (5)

[25]

08. $\frac{{}^6C_4 \cdot {}^8C_4}{{}^{14}C_2} = \frac{48}{91}$

(15) (10)

[25]

09. $\frac{1\cdot 1 + 2n + 3y + 4\cdot 5 + 5\cdot 2}{8+n+y} = 3$ (5)

$n = 7$ (5)

$1\cdot 2 = 1^2\cdot 1 + 2^2\cdot n + 3^2\cdot y + 4^2\cdot 5 + 5^2\cdot 2 - 3^2$

$8+n+y$ (10)

$y = 5$ (5)

[25]

10. $n + y = 24$ (5)

$y > 16$ (5)

$n = 4$ or 8 (5)

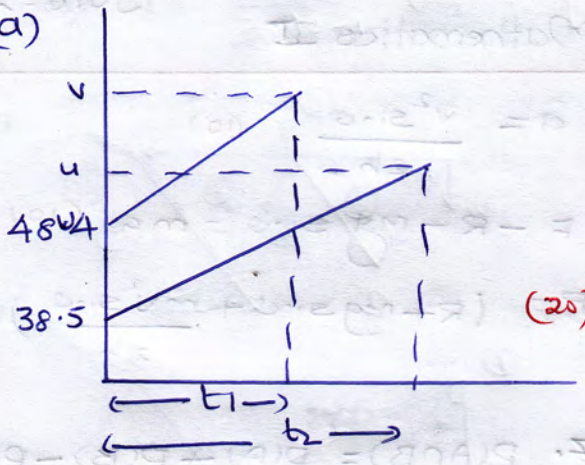
$\Downarrow$

$y = 16$ impossible (5)

$\Rightarrow n = 4,\ y = 20$ (5)

[25]

11. (a)



(20)

$\frac{v-48.4}{t_1} = 0.55$ (5) $\quad \frac{u-38.5}{t_2} = 0.44$ (5)

$\left(\frac{v+48.4}{2}\right)t_1 = 1320$ (5) $\quad \left(\frac{u+38.5}{2}\right)t_2 = 1100$ (5)

$t_1 = 24$ (5) $\quad t_2 = 25$ (5)

∴ Y will reach the finishing before 1 s. X will reach the finishing. (5)

$\left(\frac{2\times 48.4 + 0.55t}{2}\right)t - \left(\frac{38.5\times 1 + 0.44t}{2}\right) = 220$ (10)

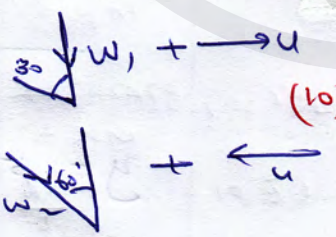
$t = 20$ (10)

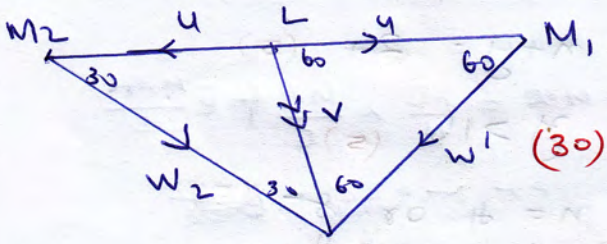
$S_x = 858$ (5)

∴ Before the finishing $= 1110 - 858$
$= 252$ m. (5)

[85]

(b) $V_{AE} =$





(30)

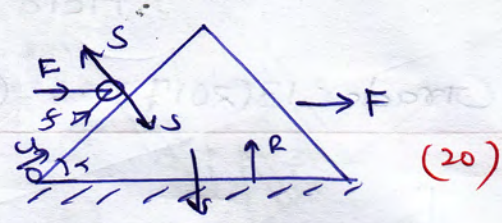
$V = u$ (10)

Speed of wind equals speed of motorcar. (5)

Direction from west 30° of North (10)

[65]

12. (a)



(20)

For the system

→ $0 = MF + m(F + f\cos\alpha)$ (15)

For the particle

↗ $-mg\sin\alpha = m(f + F\cos\alpha)$ (15)

Relative to wedge

↗ $0 = v^2 + 2fh\sec\alpha$ (5)

$\Rightarrow v = \sqrt{\frac{2gh(M+m)}{M + m\sin^2\alpha}}$ (10)

↗ $0 = v + ft$ (5)

Time taken $= t = \sec\alpha \sqrt{\frac{h(M+m\sin^2\alpha)}{2g(M+m)}}$ (10)

[80]

(b) $\theta = \sin^2 2t$

$\dot{\theta} = 2\sin 4t$ (5)

$a\dot{\theta}^2 = 4a\sin^2 4t$ (10)

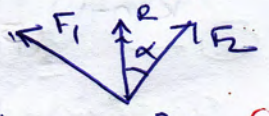
$\ddot{\theta} = 8\cos 4t$ (5)

$a\ddot{\theta} = 0 \Rightarrow t = \pi/8$ (5)

$F_1 = 3am$ (10)

$F_2 = 4am$ (10)

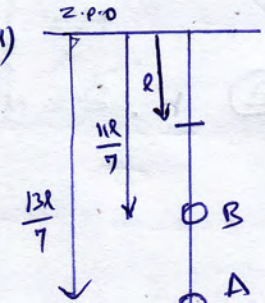
$R = 5am$ (10)



$\tan\alpha = 3/4$ (10)

[70]

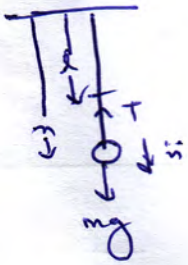
13. (a)



Conservation of energy

$$-\frac{13mgl}{7}+\frac{1}{2}\lambda\frac{\left(\frac{6l}{7}\right)^2}{l}=-\frac{11mgl}{7}+\frac{1}{2}\lambda\frac{\left(\frac{4l}{7}\right)^2}{l}$$ (20)

$$\Rightarrow \lambda=\frac{7mg}{5}$$ (10)



$mg-T=m\ddot{x}$ (10)

$mg-\frac{7mg(x-l)}{5l}=m\ddot{x}$

$g-\frac{7g}{5l}(x-l)=\ddot{x}$ (10)

$\ddot{x}=-\frac{7g}{5l}\left(x-\frac{12l}{7}\right)$ (10)

$x-\frac{12l}{7}=A\cos\omega t+B\sin\omega t$ (10)

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

$\ddot{x}=-\omega^2\left(x-\frac{12l}{7}\right)$ (10)

$\omega=\sqrt{\frac{7g}{5l}}$ (10)

$A=\frac{l}{7}$ (10), $B=0$ (10)

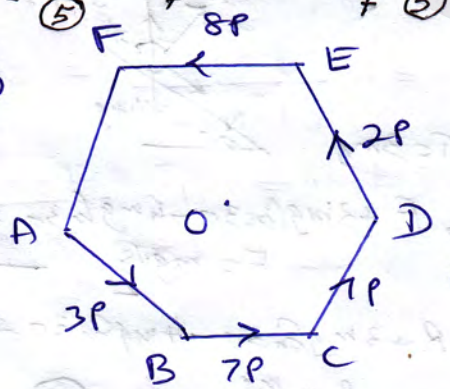
$-\frac{l\omega}{14}=-\frac{l\omega}{7}\sin\omega t$ (15)

$\Rightarrow t=\frac{\pi}{6}\sqrt{\frac{5l}{7g}}$ (05)

[150]

$v.\frac{3m}{2}=m\frac{l\omega}{7}\Rightarrow v=\frac{2l\omega}{7}$ (5)

14. (a)



$AB=2l$

$\rightarrow X=7P+P\cos60-2P\cos60-8P+3P\cos60$ (10)

$=0$ (5)

$\uparrow Y=P\sin60+2P\sin60-7P\sin60$ (10)

$=0$ (5)

$\circlearrowleft G_0=\sqrt{3}lP(7+1+2+8+3)$ (10)

$=21\sqrt{3}lP$ (5)

$x=0, y=0, G_0\neq0$. (5)

Reduces to a couple. (5)

If it reduces to a single force along AD,

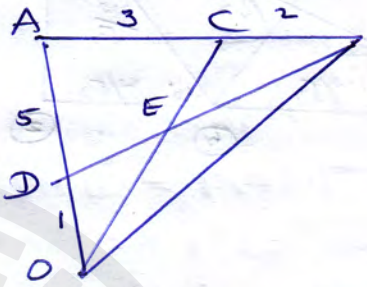
$G_0=0, X\neq0$ (5)

$G_0=0$ (5)

$(7+1+2-\lambda+8+3)P2a$ (10)

$\lambda=21$ (5) [80]

(a)



$\overrightarrow{OC}=\overrightarrow{OA}+\overrightarrow{AC}=\underline{a}+\frac{3}{5}\overrightarrow{AB}$ (5)

$=\frac{2}{5}\underline{a}+\frac{3}{5}\underline{b}$ (5) (10)

$\overrightarrow{OE}=\lambda\overrightarrow{OC}$, $\overrightarrow{DB}=\overrightarrow{DO}+\overrightarrow{OB}$ (5)

$=-\frac{1}{6}\underline{a}+\underline{b}$ (5)

$\overrightarrow{DE}=\overrightarrow{DO}+\overrightarrow{OE}=\left(\frac{2\lambda}{5}-\frac{1}{6}\right)\underline{a}+$ (5)

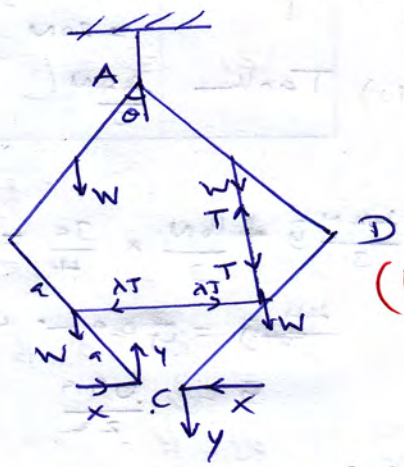
D, E, B straight line. $\frac{3\lambda}{5}\underline{b}$ (10)

$\frac{\frac{2\lambda}{5}-\frac{1}{6}}{-\frac{1}{6}}=\frac{3\lambda/5}{1}\Rightarrow\lambda=\frac{1}{3}$ (10) (5)

$OE:EC=1:2$ (5)

[70]

15. (a)



(10)

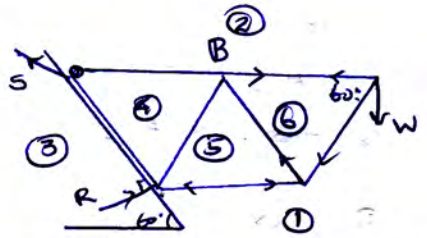
BC: $B\uparrow\ X2a\cos\theta+Y2a\sin\theta=2Ta\cos\theta+Wa\sin\theta$ (15)

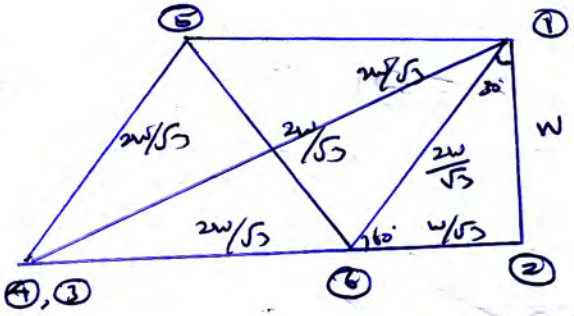
DC: $D\uparrow\ Y.2a\sin\theta+(W+T)a\cos\theta+2Ta\cos\theta=X2a\sin\theta$ (15)

AB+BC: $A\uparrow\ X4a\cos\theta+2Wa\cos\theta=2T.3a\cos\theta$ (15)

$\Rightarrow T = \frac{4W}{2\sqrt{6}-1}$ (10) [65]

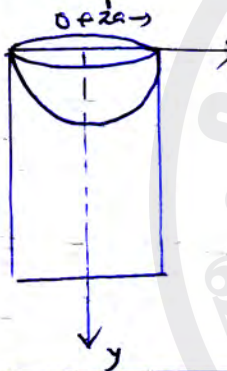
(b)





[85]

16. Theory (40)



Body	weight	cent. Gr.
(10) hemisphere	$\frac{2}{3}\pi(2a)^3\sigma = \frac{16}{3}M$	$(0, \frac{3a}{4})$
(10) cylinder	$4\pi a^2 \times 5a\sigma = 20M$	$(0, \frac{5a}{2})$
(10) Tank	$\frac{44M}{3}$	$(0, \bar{y})$

$\frac{44M}{3}\bar{y} + \frac{16M}{3} \times \frac{3a}{4} = 20M \times \frac{5a}{2}$

$\frac{44}{3}\bar{y} = 50a - 4a$

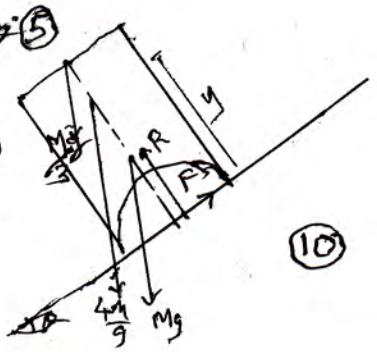
$\bar{y} = \frac{69a}{22}$ (20)

(5) $F = \frac{4mg}{3}\sin\theta$

$R = \frac{4mg}{3}\cos\theta$ (5)

$\frac{F}{R} \le \mu$

$\tan\theta \le \mu$. (5)



(10)

$\frac{4mg}{3}y = Mg\bar{x} + \frac{Mg}{3}2a$ (10)

$y = \frac{317}{88}a$ (5)

$y\tan\theta \le 2a$ (10)

$\tan\theta \le \frac{2a}{y}$ (5)

$\tan\theta \le \frac{176}{317}$. (5)

(5) $A \equiv (4,5)$ $B \equiv (x,y)$

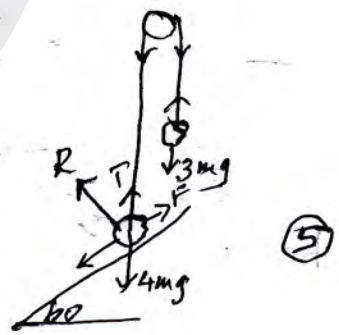
$\overrightarrow{AB} = (x-4)\underline{i} + (y-5)\underline{j} = 2\underline{i} + 6\underline{j}$ (10)

$x - 4 = 2$ $\quad y - 5 = 6$ (5)

$x = 6$ $\quad y = 11$ (5)

$\overrightarrow{OB} = 6\underline{i} + 11\underline{j}$. (5)

(6)



(5)

(5) $T = 3mg$

$\rightarrow F + 3mg\cos 30 = 4mg\sin 30$ (5)

$F = \frac{mg\sqrt{3}}{2}$

$\nwarrow R + 3mg\sin 30 = 4mg\cos 30$ (5)

$R = \frac{mg}{2}$

$\frac{F}{R} = \mu$

$\mu = \sqrt{3}$. (5)

OK

(17) (a)

x	1	2	3
$P(x)$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{4}$

(5)

$x_1 + x_2 = 4$

$P(x_1 + x_2 = 4) = P(1,3) + P(3,1) + P(2,2)$

$= \frac{1}{4} \cdot \frac{1}{4} + \frac{1}{4} \cdot \frac{1}{4} + \frac{1}{2} \cdot \frac{1}{2}$ (15)

$= \frac{3}{8}$ (5)

y	1	2	3
$P(y)$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$

(5)

$y_1 + y_2 = 4$

$P(y_1 + y_2 = 4) = P(1,3) + P(3,1) + P(2,2)$

$= \frac{1}{4} \cdot \frac{1}{2} + \frac{1}{2} \cdot \frac{1}{4} + \frac{1}{4} \cdot \frac{1}{4}$ (15)

$= \frac{5}{16}$ (5)

$P(B/4) = \frac{P(4/B) \cdot P(B)}{P(4/B) \cdot P(B) + P(4/A) \cdot P(A)}$ (10)

$= \frac{\frac{5}{16} \cdot \frac{1}{2}}{\frac{5}{16} \cdot \frac{1}{2} + \frac{3}{8} \cdot \frac{1}{2}}$ (5) (10)

$= \frac{5}{11}$ (5)

(b) Theory (30)

$y = ax + b$

$\bar{y} = a\bar{x} + b$

$50 = 40a + b$ (10)

$64 = a^2 \cdot 25$

$a = \frac{8}{5}$ (10)

$50 = 40 \cdot \frac{8}{5} + b$

$b = -14$ (10)

$x = 40 \Rightarrow y = 50$ (10)