01] $P(x) = 2x^3 + ax^2 - 11x - 5$

$P(2) = 1$ (5)

$2(2)^3 + a(2)^2 - 11(2) - 5 = 1$

$4a = 12$

$a = 3$ (5)

$\therefore P(x) = 2x^3 + 3x^2 - 11x - 5$

$P(x) - 1 = 2x^3 + 3x^2 - 11x - 6$

$= (x-2)(2x^2 + Ax + 3)$ (5)

$x^2;\ 3 = A - 4$

$A = 7$ (5)

$P(x) - 1 = (x-2)(2x^2 + 7x + 3)$ (5)

$= (x-2)(2x+1)(x+3)$

25

02] $k \in \mathbb{R} \setminus \{0\}$

$\dfrac{1}{x(x-k)^2} = \dfrac{A}{x} + \dfrac{B}{x-k} + \dfrac{C}{(x-k)^2}$ (5)

$1 = A(x-k)^2 + Bx(x-k) + Cx$

$x^2;\ 0 = A + B$

$x;\ 0 = -2Ak - Bk + C$

$x^0;\ 1 = Ak^2$

$A = \dfrac{1}{k^2}$ (5)

$B = -\dfrac{1}{k^2}$ (5)

$C = \dfrac{1}{k}$ (5)

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

25

03] $x + 2 \geq \dfrac{8}{x}$, $x \neq 0$

$x + 2 - \dfrac{8}{x} \geq 0$ (5)

$\dfrac{x^2 + 2x - 8}{x} \geq 0$

$\dfrac{(x+4)(x-2)}{x} \geq 0$ (5)

	$x<-4$	$-4<x<0$	$0<x<2$	$2<x$
$x+4$	(−)	(+)	(+)	(+)
$x-2$	(−)	(−)	(−)	(+)
x	(−)	(−)	(+)	(+) (10)
$\frac{(x+4)(x-2)}{x}$	(−)	(+)	(−)	(+)

$-4 \leq x < 0$ or $x \geq 2$ (5)

25

04] $\log_3 2 = a$, $\log_5 2 = b$

$\log_{2025} 2 = \dfrac{1}{\log_2 2025}$ (5)

$= \dfrac{1}{\log_2 \{5^2 \times 3^4\}}$ (5)

$= \dfrac{1}{2\log_2 5 + 4\log_2 3}$ (5)

$= \dfrac{1}{2\{\frac{1}{b}\} + 4\{\frac{1}{a}\}}$ (5)

$= \dfrac{ab}{2a + 4b}$

$= \dfrac{ab}{2(a+2b)}$ (5)

25

05]

$$\lim_{x\to 0}\frac{1-\cos 2x-\cos 4x+\cos 2x\cos 4x}{x^4}$$

$$=\lim_{x\to 0}\frac{(1-\cos 2x)(1-\cos 4x)}{x^4} \quad 5$$

$$=\lim_{x\to 0}\frac{(2\sin^2 x)(2\sin^2 2x)}{x^4} \quad 5$$

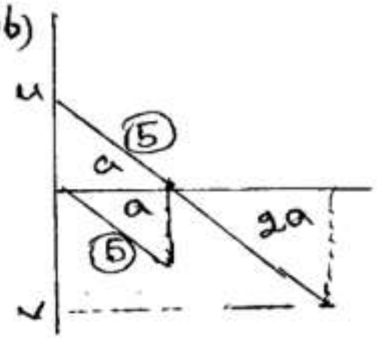
$$=4\times 4\left\{\lim_{x\to 0}\frac{\sin x}{x}\right\}^2\left\{\lim_{2x\to 0}\frac{\sin 2x}{2x}\right\}^2 \quad 5$$

$$=16\times 1^2\times 1^2 \quad 5$$

$$=16 \quad 5$$

$\boxed{25}$

06)



$$\frac{1}{2}\frac{u^2}{g}=a \quad 5$$

$$u^2=2ag$$

$$u=\sqrt{2ag} \quad 5$$

$$\frac{1}{2}\frac{v^2}{g}=2a \quad 5$$

$$v^2=4ag$$

$$v=2\sqrt{ag}$$

$\boxed{25}$

07)

$u=v\tan\theta$
$=3v$ 5

$\uparrow s=ut+\frac{1}{2}at^2$
$0=3vt-\frac{1}{2}gt^2$
$t=\frac{6v}{g}$ 5

$vt=24R$

$\frac{6v^2}{g}=24R$

$v=2\sqrt{gR}$ 5

$\uparrow v^2=u^2+2as$

$0=9v^2-2gh$ 5

$h=\frac{9v^2}{2g}=18R$ 5

$\boxed{25}$

08)

$\overrightarrow{AB}=2\sqrt{3}\,\underline{i}-2\underline{j}$ 5

$\overrightarrow{OC}=x\underline{i}+y\underline{j}$, $x^2+y^2=4$ 5

$\overrightarrow{AB}\cdot\overrightarrow{OC}=0$

$(2\sqrt{3}\,\underline{i}-2\underline{j})\cdot(x\underline{i}+y\underline{j})=0$ 5

$2\sqrt{3}x-2y=0$

$y=\sqrt{3}x$

$4x^2=4$

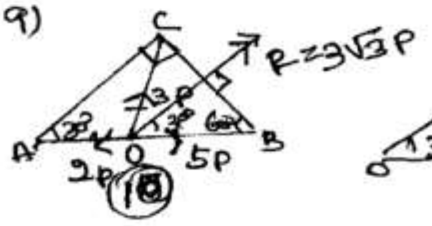
$x=\pm 1$ 5

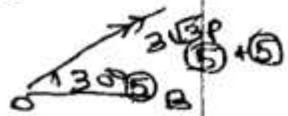
$\overrightarrow{OC}=\underline{i}+\sqrt{3}\,\underline{j}$ or 5

$\overrightarrow{OC}=-\underline{i}-\sqrt{3}\,\underline{j}$

$\boxed{25}$

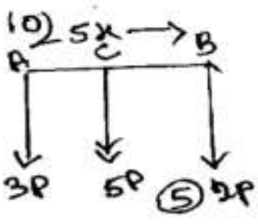
9)

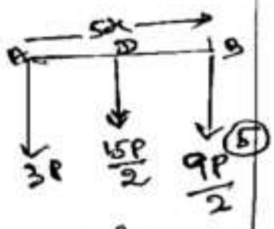




$\boxed{25}$

10)





$AC=\frac{2}{5}\times 5x$
$=2x$ 5

$AD=\frac{3}{5}\times 5x$
$=3x$ 5

[illegible] $=3x-2x$
(moving distance $=x$ // 5

$\boxed{25}$

11)

a) $f(x)=0$

$x^2-(3k+1)x+(k+1)(k-2)=0$

Discriminant Δ

$\Delta=\{-(3k+1)\}^2-4(1)(k+1)(k-2)$ (10)

$=(9k^2+6k+1)-4(k^2-k-2)$ (5)

$=5k^2+10k+9$ (5)

$=5\{k^2+2k+\frac{9}{5}\}$

$=5\{(k+1)^2+\frac{4}{5}\}$ (5)

$=5(k+1)^2+4$

>0 (5)

$\therefore$ the roots of $f(x)=0$ are real and distinct $\boxed{30}$

$\alpha+\beta=3k+1$, $\alpha\beta=(k+1)(k-2)$ (5)

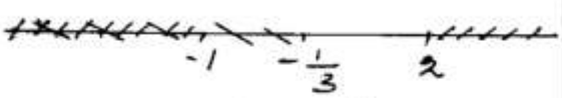
Both α, β are negative

$\alpha<0$, $\beta<0$

$\Leftrightarrow \alpha+\beta<0$ & $\alpha\beta>0$ (5)

$\Leftrightarrow 3k+1<0$ & $(k+1)(k-2)>0$

$\Leftrightarrow k<-\frac{1}{3}$ & $k<-1$ or $k>2$ (5)



sol^n $k<-1$ (5) $\boxed{20}$

$x^2-(3k+1)x+(k+1)(k-2)=0$ —(*)

put $y=x+1$ (5)

$x=\alpha \Rightarrow y=\alpha+1$

$x\to\beta \Rightarrow y=\beta+1$

$x\to y-1$ substitute in (*)

(*) $\to (y-1)^2-(3k+1)(y-1)+(k+1)(k-2)=0$ (5)

$y^2-3(k+1)y+k(k+2)=0$ (5)

The required eq^n is (5)

$x^2-3(k+1)x+k(k+2)=0$ $\boxed{20}$

---

b) $f(x)=(x-a)\phi_1(x)+A$ —(1) (5)

$\phi_1(x)=(x-b)\phi_2(x)+B$ —(2) (5)

(1), (2) $\Rightarrow$

$f(x)=(x-a)\{(x-b)\phi_2(x)+B\}+A$ (5)

$=(x-a)(x-b)\phi_2(x)+B(x-a)+A$ —(3) (5)

(1) $\Rightarrow f(a)=A$ (5)

(2) $\Rightarrow \phi_1(b)=B$ (5)

(1) $\Rightarrow f(b)=(b-a)\phi_1(b)+A$

$f(b)=(b-a)B+f(a)$

$B=\dfrac{f(b)-f(a)}{b-a}$ (5)

(3) $\Rightarrow$
$f(x)=(x-a)(x-b)\phi_2(x)+(x-a)\left\{\dfrac{f(b)-f(a)}{b-a}\right\}+f(a)$ (5)

$\therefore$ Reminder

$\left\{\dfrac{f(b)-f(a)}{b-a}\right\}(x-a)+f(a)$ (5) $\boxed{45}$

$f(x)=x^3+px^2+qx+1$

put $a=1$, $b=2$

then

$-10x+5=\left\{\dfrac{f(2)-f(1)}{2-1}\right\}(x-1)+f(1)$ (5)

x; $-10=f(2)-f(1)$ (5)

$-10=(8+4p+2q+1)-(1+p+q+1)$

$3p+q=-17$ (5) —(*)

x^0; $5=-\{f(2)-f(1)\}+f(1)$

$5=2f(1)-f(2)$ (5)

$5=2\{1+p+q+1\}-\{8+4p+2q+1\}$ (5)

$2p=-10$

$p=-5$ (5)

(*) $\to q=-2$ (5) $\boxed{35}$

12]

a) Let $f(x)=\sqrt{\sin x}$

$$f'(x)=\lim_{h\to 0}\frac{f(x+h)-f(x)}{h} \quad (5)$$

$$=\lim_{h\to 0}\frac{\sqrt{\sin(x+h)}-\sqrt{\sin x}}{h} \quad (5)$$

$$=\lim_{h\to 0}\frac{\sin(x+h)-\sin x}{h\{\sqrt{\sin(x+h)}+\sqrt{\sin x}\}} \quad (5)$$

$$=\lim_{h\to 0}\frac{2\cos(x+\frac{h}{2})\sin\frac{h}{2}}{h\{\sqrt{\sin(x+h)}+\sqrt{\sin x}\}} \quad (5)$$

$$=\lim_{\frac{h}{2}\to 0}\frac{\sin\frac{h}{2}}{\frac{h}{2}} \quad (5) \cdot \lim_{h\to 0}\frac{\cos(x+\frac{h}{2})}{\{\sqrt{\sin(x+h)}+\sqrt{\sin x}\}}$$

$$=1\cdot\frac{\cos x}{\sqrt{\sin x}+\sqrt{\sin x}} \quad (5)$$

$$=\frac{\cos x}{2\sqrt{\sin x}} \quad (5)$$

$\boxed{35}$

b) $y=\frac{x^2-1}{x^2+1}$

$$\frac{dy}{dx}=\frac{(x^2+1)2x-(x^2-1)2x}{(x^2+1)^2} \quad (5)$$

$$=\frac{4x}{(x^2+1)^2} \quad (5)$$

$$y=\frac{1+e^x}{1-e^x}$$

$$\frac{dy}{dx}=\frac{(1-e^x)e^x-(1+e^x)(-e^x)}{(1-e^x)^2} \quad (5)$$

$$=\frac{2e^x}{(1-e^x)^2} \quad (5)$$

$$y=x^{x^2+1}$$

$$\ln y=\ln x^{x^2+1}$$

$$\ln y=(x^2+1)\ln x \quad (5)$$

$$\frac{1}{y}\frac{dy}{dx}=(x^2+1)\cdot\frac{1}{x}+(\ln x)\{2x\} \quad (10)$$

$$\frac{dy}{dx}=x^{x^2+1}\left\{\frac{x^2+1}{x}+2x\ln x\right\} \quad (5)$$

$\boxed{40}$

c) $y=e^x\cos e^x$ —— (1)

$$\frac{dy}{dx}=e^x(-)\sin e^x\cdot e^x+\cos e^x\cdot e^x \quad (10)$$

$$\frac{dy}{dx}=-e^{2x}\sin e^x+y \quad (\text{by }(1))$$

$$\frac{dy}{dx}-y=-e^{2x}\sin e^x \quad \text{—— (2)} \quad (5)$$

$$\frac{d^2y}{dx^2}-\frac{dy}{dx}=-\left\{e^{2x}\cos e^x e^x + \sin e^x e^{2x}\cdot 2\right\} \quad (10)$$

$$\frac{d^2y}{dx^2}-\frac{dy}{dx}=-e^{2x}y+2\left\{\frac{dy}{dx}-y\right\} \quad (5)$$

(by (1), (2))

$$\frac{d^2y}{dx^2}-3\frac{dy}{dx}+(e^{2x}+2)y=0 \quad (5)$$

$\boxed{35}$

d) $x=\sin n\theta \qquad y=\cos m\theta$

$$\frac{dx}{d\theta}=n\cos n\theta \quad (5) \qquad \frac{dy}{d\theta}=-m\sin m\theta \quad (5)$$

$$\frac{dy}{dx}=\frac{dy}{d\theta}\cdot\frac{d\theta}{dx}=\frac{-m\sin m\theta}{n\cos n\theta} \quad (5)$$

$$n^2\cos^2 n\theta\left(\frac{dy}{dx}\right)^2=m^2\sin^2 m\theta \quad (5)$$

$$n^2(1-x^2)\left(\frac{dy}{dx}\right)^2=m^2(1-y^2) \quad (5)$$

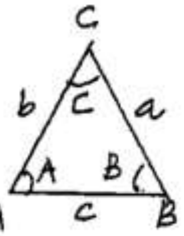
$$n^2\left\{(1-x^2)2\left(\frac{dy}{dx}\right)\frac{d^2y}{dx^2}+\left(\frac{dy}{dx}\right)^2(-2x)\right\}=m^2\left\{-2y\frac{dy}{dx}\right\} \quad (10)$$

$$n^2\left\{(1-x^2)\frac{d^2y}{dx^2}-x\frac{dy}{dx}\right\}=-m^2y$$

$$n^2(1-x^2)\frac{d^2y}{dx^2}-n^2x\frac{dy}{dx}+m^2y=0 \quad (5)$$

$\boxed{40}$

13] a) Sin rule



$$\frac{\sin A}{a}=\frac{\sin B}{b}=\frac{\sin C}{c} \quad (5)$$

proof - (15)

[20]

$$\frac{\sin A}{a}=\frac{\sin B}{b}=\frac{\sin C}{c}=\frac{1}{k} \quad -(1) \text{ (say)} \quad (5)$$

$$\frac{a+b-c}{a+b+c}$$

$$=\frac{k\sin A+k\sin B-k\sin C}{k\sin A+k\sin B+k\sin C} \quad (\text{by } (1)) \quad (5)$$

$$=\frac{2\sin\left(\frac{A+B}{2}\right)\cos\left(\frac{A-B}{2}\right)-2\sin\frac{C}{2}\cos\frac{C}{2}}{2\sin\left(\frac{A+B}{2}\right)\cos\left(\frac{A-B}{2}\right)+2\sin\frac{C}{2}\cos\frac{C}{2}} \quad (10)$$

$$=\frac{\cos\frac{C}{2}\cos\left(\frac{A-B}{2}\right)-\sin\frac{C}{2}\cos\frac{C}{2}}{\cos\frac{C}{2}\cos\left(\frac{A-B}{2}\right)+\sin\frac{C}{2}\cos\frac{C}{2}}$$

(5) $\left(\frac{C}{2}=\frac{\pi}{2}-\left(\frac{A+B}{2}\right)\right)$ $\cos\frac{C}{2}=\sin\left(\frac{A+B}{2}\right)$

$$=\frac{\cos\left(\frac{A-B}{2}\right)-\sin\frac{C}{2}}{\cos\left(\frac{A-B}{2}\right)+\sin\frac{C}{2}} \quad (5)$$

$$=\frac{\cos\left(\frac{A-B}{2}\right)-\cos\left(\frac{A+B}{2}\right)}{\cos\left(\frac{A-B}{2}\right)+\cos\left(\frac{A+B}{2}\right)} \quad (5)$$

$$=\frac{2\sin\frac{A}{2}\sin\frac{B}{2}}{2\cos\frac{A}{2}\cos\frac{B}{2}} \quad (10)$$

$$=\tan\frac{A}{2}\tan\frac{B}{2} \quad (5)$$

[50]

b) $\tan^{-1}\left(\frac{x}{2}\right)+\tan^{-1}\left(\frac{x}{3}\right)=\frac{\pi}{4}$ — (1)

put $\alpha=\tan^{-1}\left(\frac{x}{2}\right) \Rightarrow \tan\alpha=\frac{x}{2}$

$\beta=\tan^{-1}\left(\frac{x}{3}\right) \Rightarrow \tan\beta=\frac{x}{3}$ (5)

$(1) \Rightarrow \alpha+\beta=\frac{\pi}{4}$

$\tan(\alpha+\beta)=1$ (5)

$$\frac{\tan\alpha+\tan\beta}{1-\tan\alpha\tan\beta}=1 \quad (5)$$

$$\frac{\frac{x}{2}+\frac{x}{3}}{1-\left(\frac{x}{2}\right)\left(\frac{x}{3}\right)}=1 \quad (5)$$

$$\frac{5x}{6-x^2}=1$$

$x^2+5x-6=0$ (5)

$(x+6)(x-1)=0$ (5)

$x-1=0 \quad (\because x>0)$

$x=1$ (5)

$(1) \Rightarrow \tan^{-1}\left(\frac{1}{2}\right)+\tan^{-1}\left(\frac{1}{3}\right)=\frac{\pi}{4}$ (5)

$\tan^{-1}\left(\frac{1}{2}\right)=\frac{\pi}{4}-\tan^{-1}\left(\frac{1}{3}\right)$

$\sin^{-1}\left(\frac{1}{\sqrt{5}}\right)=\frac{\pi}{4}-\tan^{-1}\left(\frac{1}{3}\right)$ (5)

$\frac{1}{\sqrt{5}}=\sin\left\{\frac{\pi}{4}-\tan^{-1}\left(\frac{1}{3}\right)\right\}$ (5)

[50]

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c) $0<x<1$, $x=\tan\alpha$

$$\sin^{-1}\left\{\frac{2x}{1+x^2}\right\}+\cos^{-1}\left\{\frac{1-x^2}{1+x^2}\right\}+\tan^{-1}\left\{\frac{2x}{1-x^2}\right\}=\pi$$

$$\sin^{-1}\left\{\frac{2\tan\alpha}{1+\tan^2\alpha}\right\}+\cos^{-1}\left\{\frac{1-\tan^2\alpha}{1+\tan^2\alpha}\right\}+\tan^{-1}\left\{\frac{2\tan\alpha}{1-\tan^2\alpha}\right\}=\pi \quad (5)$$

$$\sin^{-1}\{\sin 2\alpha\}+\cos^{-1}\{\cos 2\alpha\}+\tan^{-1}\{\tan 2\alpha\}=\pi \quad (5)$$

$\left(0<2\alpha<\frac{\pi}{2}\right)$ (5)

$2\alpha+2\alpha+2\alpha=\pi$ (5)

$6\alpha=\pi$

$\alpha=\frac{\pi}{6}$ (5)

$x=\tan\frac{\pi}{6}=\frac{1}{\sqrt{3}}$ (5)

[30]

14]

a)

$\sin(A+B) = \sin A\cos B + \cos A\sin B$ (5) —(1)

$\sin(A-B) = \sin A\cos B - \cos A\sin B$ (5) —(2)

(1) + (2) $\Rightarrow$

$\sin(A+B) + \sin(A-B) = 2\sin A\cos B$ (5) —(3)

$\left.\begin{array}{l} A+B=C \\ A-B=D \end{array}\right\} \Rightarrow A = \frac{C+D}{2}$, $B = \frac{C-D}{2}$ (5)

(3) $\Rightarrow \sin C + \sin D = 2\sin\left(\frac{C+D}{2}\right)\cos\left(\frac{C-D}{2}\right)$ (5)

$\sin C - \sin D$

$= \sin C + \sin(-D)$ (5)

$= 2\sin\left\{\frac{C+(-D)}{2}\right\}\cos\left\{\frac{C-(-D)}{2}\right\}$ (5)

$= 2\cos\left(\frac{C+D}{2}\right)\sin\left(\frac{C-D}{2}\right)$ (5)

$\boxed{40}$

$\sin 7x + \sin 5x - \cot x(\sin 7x - \sin 5x) = 0$ (10)

$2\sin 6x\cos x - \frac{\cos x}{\sin x}(2\cos 6x\sin x) = 0$ (5)

$\sin 6x\cos x - \cos 6x\cos x = 0$

$\cos x(\sin 6x - \cos 6x) = 0$ (5)

$\cos x = 0$ or $\sin 6x - \cos 6x = 0$

$\cos x = \cos\frac{\pi}{2}$ (5) $\quad \tan 6x = 1 \ (\because \cos 6x \neq 0)$

$x = 2n_1\pi \pm \frac{\pi}{2}$ (5) $\quad \tan 6x = \tan\frac{\pi}{4}$ (5)

$n_1 \in \mathbb{Z}$

$6x = n_2\pi + \frac{\pi}{4}$

$x = \frac{n_2\pi}{6} + \frac{\pi}{24}$ (5)

$n_2 \in \mathbb{Z}$

$\boxed{40}$

b) $\sin 7\theta + \sin\theta$

$= 2\sin 4\theta\cos 3\theta$ (5)

$= 2\{2\sin 2\theta\cos 2\theta\}\cos 3\theta$ (5)

$= 4\{2\sin\theta\cos\theta\}\cos 2\theta\cos 3\theta$ (5)

$= 8\sin\theta\cos\theta\cos 2\theta\cos 3\theta$ (5)

$\sin 7\theta + \sin\theta = 8\sin\theta\cos\theta\cos 2\theta\cos 3\theta$

$\sin 7\theta = \sin\theta\{8\cos\theta\cos 2\theta\cos 3\theta - 1\}$ (5)

$4\cos\theta\cos 2\theta\cos 3\theta = 1$

$8\cos\theta\cos 2\theta\cos 3\theta = 2$

$\frac{\sin 7\theta}{\sin\theta} + 1 = 2$ (5)

$\sin 7\theta = \sin\theta$ (5)

$7\theta = n\pi + (-1)^n\theta$ (5), $n = 0, \pm 1, \pm 2$

$n = 0 \Rightarrow \theta = 0$

$n = 1 \Rightarrow \theta = \frac{\pi}{8}$

$n = 2 \Rightarrow \theta = \frac{\pi}{3}$

$\therefore \theta = \frac{\pi}{8}$ (5) $\left(\because 0 < \theta < \frac{\pi}{2}\right)$ $\boxed{45}$

c) $\frac{\tan 5\theta + \tan 3\theta}{\tan 5\theta - \tan 3\theta}$

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

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

$= \frac{\sin 8\theta}{\sin 2\theta}$ (5)

$= \frac{2\sin 4\theta\cos 4\theta}{\sin 2\theta}$ (5)

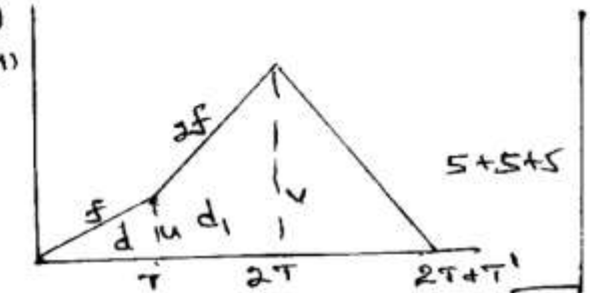
$= \frac{4\sin 2\theta\cos 2\theta\cos 4\theta}{\sin 2\theta}$

$= 4\cos 2\theta\cos 4\theta$ (5)

$\boxed{25}$

(15)

(i)



5+5+5

15

(ii) $u = fT$ (5)

$\frac{1}{2} fT^2 = d$ (5)

$T = \sqrt{\frac{2d}{f}}$ (5)

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

$v = 3fT$ (5)

$d_1 = \frac{(u+v)}{2} \times T = 2fT^2$ (5) (5)

$= 4d$ (5)

40

(iii) $\frac{1}{2} vT' = 2d$ (5)

$T' = \frac{4d}{v} = \frac{4d}{3fT} = \frac{2}{3}T$ (5)

Total time $= T + T + \frac{2}{3}T$

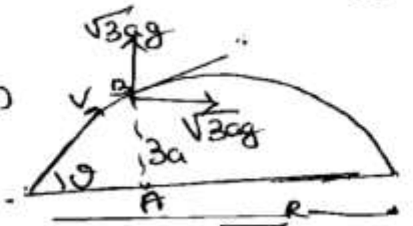
$= \frac{8T}{3}$ (5)

$f' = \frac{v}{T'} = \frac{3v}{T} = \frac{9f}{2}$ (5)

20

75

(b)



(i) $v\cos\theta = \sqrt{3ag} \rightarrow (1)$ (5)

↑ $v^2 = u^2 + 2as$

$3ag = v^2\sin^2\theta - 2g \times 3a$ (5)

$v\sin\theta = 3\sqrt{ag} \rightarrow (2)$ (5)

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

$\theta = \frac{\pi}{3}$ (5)

$v = 2\sqrt{3ag}$ (5)

25

(ii) ↑ $S = ut + \frac{1}{2}at^2$

$0 = v\sin\theta\, T - \frac{1}{2}gT^2$ (5)

$T = \frac{2v\sin\theta}{g}$ (5)

$R = v\cos\theta \times T$ (5)

$= \frac{v\cos\theta \times 2v\sin\theta}{g}$

$= \frac{\sqrt{3ag} \times 2 \times 3\sqrt{ag}}{g}$

$= 6\sqrt{3}a$ (5)

20

(iii) T_1 is the time P reach B

↑ $v = u + at$

$\sqrt{3ag} = v\sin\theta - gT_1$ (5)

$T_1 = \frac{v\sin\theta - \sqrt{3ag}}{g}$ (5)

Time taken to reach C to Q

$T_2 = T - T_1$

$= \frac{v\sin\theta + \sqrt{3ag}}{g}$ (5)

$= \frac{3\sqrt{ag} + \sqrt{3ag}}{g}$

$= (3+\sqrt{3})\sqrt{\frac{a}{g}}$ (5)

$u\cos\alpha\, T_2 = R$

$\frac{u\sin\alpha}{T_2} = \frac{g}{2}$ (5)

$\tan\alpha = \frac{gT_2^2}{2}$

$\alpha = \tan^{-1}\left(\frac{gT_2^2}{2}\right)$ (5)

$u = \sqrt{\frac{T_2^2 g^2}{4} + \frac{R^2}{T_2^2}}$ (5)

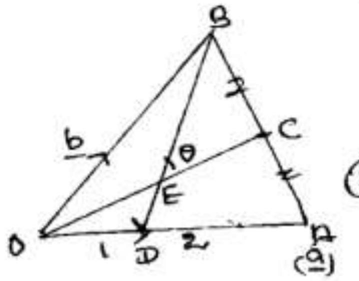
35

max hight of P $= \frac{v^2\sin^2\theta}{2g}$

max hight of Q $= \frac{u^2\sin^2\alpha}{2g}$ (5)

150

16)
(a)



(5)

(b) (i) $\vec{OC} = \vec{OA} + \vec{AC}$ (5)

$= \vec{OA} + \frac{1}{2}\vec{AB}$

$= \underline{a} + \frac{1}{2}(\underline{b} - \underline{a})$

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

$\vec{OD} = \frac{1}{3}\vec{OA} = \frac{1}{3}\underline{a}$ (5) (5) $\boxed{25}$

(ii) $\vec{OE} = \vec{OB} + \vec{BE}$ (5)

$= \vec{OB} + \lambda\vec{BD}$

$= \vec{OB} + \lambda(\vec{BO} + \vec{OD})$

$= \underline{b} + \lambda(-\underline{b} + \frac{1}{3}\underline{a})$ (5)

$= (1-\lambda)\underline{b} + \frac{\lambda}{3}\underline{a}$ (5) $\boxed{15}$

(iii) $\vec{OE} = \mu\vec{OC}$

$(1-\lambda)\underline{b} + \frac{\lambda}{3}\underline{a} = \frac{\mu}{2}(\underline{a} + \underline{b})$ (5)

(5) $\frac{\lambda}{3} = \frac{\mu}{2}$, $1 - \lambda = \frac{\mu}{2}$

$\frac{\lambda}{3} = 1 - \lambda$

$4\lambda = 3$

$\lambda = \frac{3}{4}$ (5), $\mu = \frac{1}{2}$ (5) $\boxed{20}$

(c) $\underline{a} = 12\underline{i}$, $\underline{b} = 2\underline{i} + 8\underline{j}$

(i) $\vec{OC} = 7\underline{i} + 4\underline{j}$ (5)

$\vec{OD} = 4\underline{i}$ (5) $\boxed{10}$

(ii) $\vec{OC} = 7\underline{i} + 4\underline{j}$

$\vec{DB} = \vec{DO} + \vec{OB}$

$= -4\underline{i} + 2\underline{i} + 8\underline{j}$

$= -2\underline{i} + 8\underline{j}$ (5)

$\vec{OC} \cdot \vec{DB} = (7\underline{i} + 4\underline{j}) \cdot (-2\underline{i} + 8\underline{j})$ (5)

$= -14 + 32$

$= 18$ (5)

$18 = |\vec{OC}|\,|\vec{DB}|\cos\theta$ (5)

$= \sqrt{49+16}\,\sqrt{64+4}\cos\theta$ (5) + (5)

$= \sqrt{65} \times \sqrt{68}\cos\theta$

$\cos\theta = \frac{18}{\sqrt{65}\sqrt{68}}$ (5)

$\theta = \cos^{-1}\left(\frac{18}{\sqrt{65}\sqrt{68}}\right)$ $\boxed{35}$

(iii) $\vec{OP} = \beta\underline{b}$ என்க (5)

$\vec{AP} = \gamma\vec{AE}$ (5)

$\vec{AO} + \vec{OP} = \gamma(\vec{AO} + \vec{OE})$ (5)

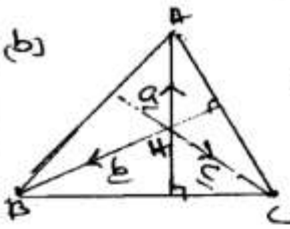
$-\underline{a} + \beta\underline{b} = \gamma(-\underline{a} + \frac{1}{4}\underline{b} + \frac{1}{4}\underline{a})$

$-1 = -\frac{3}{4}\gamma$, $\beta = \frac{\gamma}{4}$

$\gamma = \frac{4}{3}$, $= \frac{1}{3}$ (5)

$\therefore \vec{OP} = \frac{1}{3}\underline{b}$ (5) $\boxed{25}$

(b)



$\vec{AH} \perp \vec{CB}$ -

$\therefore \vec{AH} \cdot \vec{CB} = 0$ (5)

$\underline{a} \cdot (\underline{b} - \underline{c}) = 0 \to (1)$

$\vec{BH} \perp \vec{AC}$

$\vec{BH} \cdot \vec{AC} = 0$ (5)

$\underline{b} \cdot (\underline{c} - \underline{a}) = 0 \to (2)$

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

$(\underline{b} - \underline{a}) \cdot \underline{c} = 0$ (5)

$\vec{AB} \perp \vec{CH}$ $\boxed{20}$

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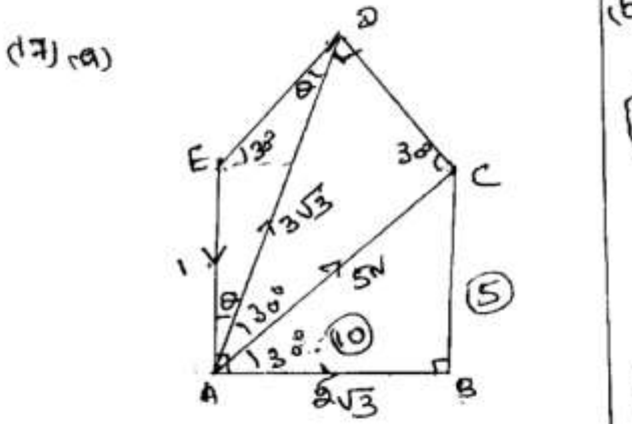
(17) (a)



(5) (10)

(i) $2AE\cos\theta = \sqrt{3}AE$ (5)

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

$\theta = 30^\circ$ (5)

(ii) $\rightarrow$

$x = 2\sqrt{3} + 5\cos 30 + 3\sqrt{3}\cos 60$ (10)

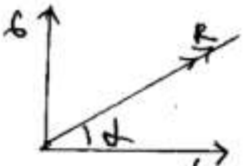
$= 2\sqrt{3} + \frac{5\sqrt{3}}{2} + \frac{3\sqrt{3}}{2}$

$= 6\sqrt{3}$ (5)

$\uparrow y = 5\sin 30 + 3\sqrt{3}\cos 30 - 1$ (10)

$= \frac{5}{2} + \frac{9}{2} - 1$

$= 6$ (5)



$R = \sqrt{6^2 + (6\sqrt{3})^2}$

$= 12N$ (5)

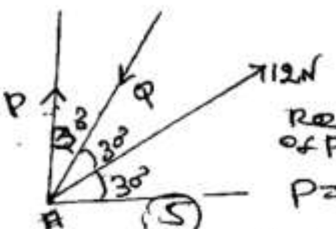
$\tan\alpha = \frac{6}{6\sqrt{3}}$

$= \frac{1}{\sqrt{3}}$

$\alpha = 30^\circ$ (5)

Resultant 12N along $\overrightarrow{AC}$.

(iii)



(5)

Resultant of P, 12 equal

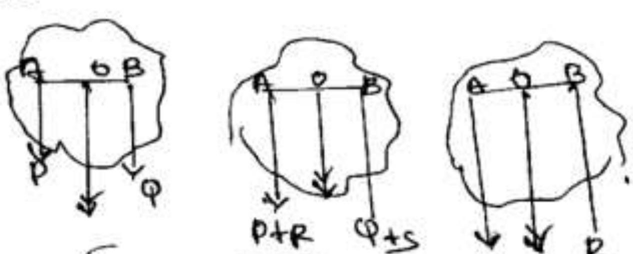
$P = 12N$ (10)

$Q = 12\cos 30 + P\cos 30$

$= 24 \times \frac{\sqrt{3}}{2}$ (5)

$= 12\sqrt{3}N$ (5) $\boxed{95}$

(b)



(5)

$\frac{AO}{OB} = \frac{Q}{P}$ $\quad \frac{AO}{OB} = \frac{Q+S}{P+R}$ $\quad \frac{AO}{OB} = \frac{R}{Q}$

(5)+(5)

$\therefore \frac{Q}{P} = \frac{Q+S}{P+R} = \frac{R}{Q}$

(i) $\frac{Q}{P} = \frac{R}{Q}$

$\therefore Q^2 = RP$ (5)

(ii) $\frac{Q}{P} = \frac{Q+S}{P+R} = \frac{R}{Q} = \frac{Q+S-Q}{P+R-P} = \frac{S}{R}$ (5)

$\therefore \frac{P}{Q} = \frac{Q}{R} = \frac{R}{S}$ (5)

(iii) $Q^2 = RP$, $R = \frac{PS}{Q}$ (5)

$\therefore Q^2 = \frac{PS}{Q} \times P$ (5)

$Q^3 = SP^2$ //

(iv) $\frac{P}{Q} = \frac{Q}{R} = \frac{R}{S} = \frac{Q-R}{R-S} = \frac{P-Q}{Q-R}$ (5) (5)

$\therefore (R-S)(P-Q) = (Q-R)^2$

$R-S = \frac{(Q-R)^2}{P-Q}$ (5)

$\boxed{55}$

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