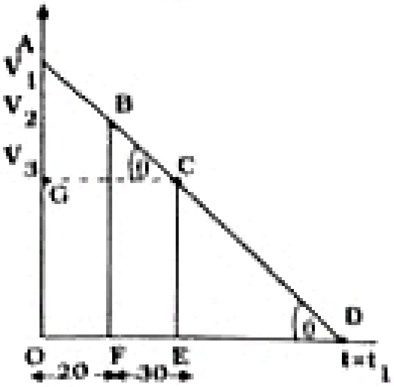
01. (a) (i)



OABF ⏢ $= 750$

$\Rightarrow \frac{(V_1 + V_2)}{2}\ 20 = 750$

$V_1 + V_2 = 75$ — ①

BCEF ⏢ $= 750$

$\Rightarrow \frac{(V_2 + V_3)}{2}\ 30 = 750$

$V_2 + V_3 = 50$ — ②

① - ② $V_1 - V_3 = 25$ — ③

ACG Δ [illegible]

$\tan\theta = a_1 = \frac{AG}{CG}$

[illegible] $a_1 = \frac{(V_1 - V_3)}{50}$

$\Rightarrow$ [illegible] $= \frac{25}{50} = \frac{1}{2}\ ms^{-1}$

(ii) OACE ⏢ $= 1500$

$\Rightarrow \frac{(V_1 + V_3)}{2} \times 50$

$= 1500$

$V_1 + V_3 = 60$ — ④

④ - ③ $2V_3 = 35$

$\Rightarrow V_3 = 17.5\ ms^{-1}$

(iii) ④ [illegible] $V_1 = 42.5\ ms^{-1}$

AOD Δ [illegible] $\tan\theta = \frac{AO}{OD}$

$\Rightarrow \frac{1}{2} = \frac{42.5}{OD}$

$\therefore OD = t_1 = 85$ [illegible]

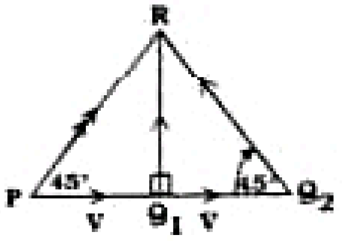
(b) [illegible] E) $= \rightarrow V$ [illegible] $= \uparrow u$

[illegible] E) $= \rightarrow 2V$ [illegible] $=$ ↘ 45°

[illegible]

[illegible] E) $=$ [illegible] $+$ [illegible] E) [illegible] 2 [illegible]

[illegible] E) $= \uparrow + \rightarrow V$ | [illegible] E) $=$ ↘45° $+ \rightarrow 2V$
$= \rightarrow V + \uparrow$ | $= \rightarrow 2V +$ ↘45°
$= \overrightarrow{PQ_1} + \overrightarrow{Q_1R}$ | $= \overrightarrow{PQ_2} + \overrightarrow{Q_2R}$
$= \overrightarrow{PR}$ | $= \overrightarrow{PR}$

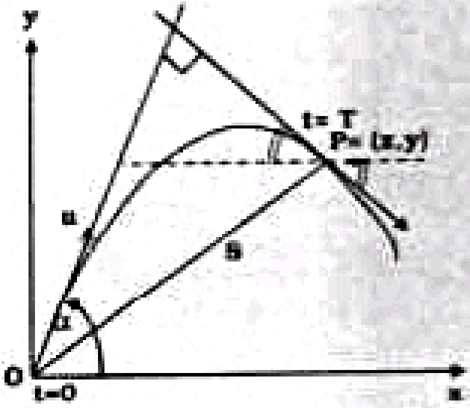


$PR = \sqrt{2}\ V$

$\therefore$ [illegible]

$\sqrt{2}\ V$ [illegible]

02. (a)



(i) $O \rightarrow P$ [illegible]

$s = ut + \frac{1}{2}at^2$ [illegible]

$\rightarrow\ x = u\cos\alpha\ T$ — ①

$\uparrow\ y = u\sin\alpha\ T - \frac{1}{2}gT^2$ — ②

T [illegible]

$\dot{x} = u\cos\alpha$ — ③

$\dot{y} = u\sin\alpha - gT$ — ④

$t = T$ [illegible] (90 - α) [illegible]

$\tan(90 - \alpha) = \frac{-\dot{y}}{\dot{x}}$ [illegible]

$\frac{\cos\alpha}{\sin\alpha} = -\frac{(u\sin\alpha - gT)}{u\cos\alpha}$

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$\Rightarrow u\cos^2\alpha$

$= -u\sin^2\alpha + gT\sin\alpha$

$u(\cos^2\alpha + \sin^2\alpha) = gT\sin\alpha \Rightarrow$

$T = \frac{u}{g\sin\alpha}$

(ii) $S^2 = x^2 + y^2$

$S^2 = (u\cos\alpha\, T)^2 + (u\sin\alpha\, T - \frac{1}{2}gT^2)^2$

$S^2 = u^2\cos^2\alpha\, T^2 + u^2\sin^2\alpha\, T^2 - gu\sin\alpha\, T^3 + \frac{1}{4}g^2T^4$

$= u^2T^2 - gu\sin\alpha \cdot \frac{u}{g\sin\alpha}\, T^2 + \frac{1}{4}g^2T^4$

$(\because T = \frac{u}{g\sin\alpha}$ [illegible]$)$

$S^2 = \frac{1}{4}g^2T^4 \Rightarrow S = \frac{1}{2}gT^2$

(b) (i) $54\ k\,mh^{-1} = 15\ ms^{-1}$

[illegible] R $= 300 \times 50$

$= 15000\ N$

[illegible] H [illegible] $V = 15$ [illegible]

[illegible] P $= \frac{H}{15}$ [illegible]

[illegible] $P = R$ [illegible]

$\therefore \frac{H}{15} = 15000 \Rightarrow$

$H = 225000\ W = 225\ kW$

[illegible]

$= 250$ [illegible]

[illegible] a_1 [illegible]

[illegible] $= 250 \times 50$

$= 12500\ N$

[illegible] 15000 N [illegible] $F = ma$ [illegible]

$15000 - 12500 = 250 \times 1000\, a_1$

$\Rightarrow a_1 = \frac{1}{100}\ ms^{-2}$

(ii) [illegible] a_2 [illegible] $50 \times 50 = 2500\ N$ [illegible]

$F = ma$ [illegible]

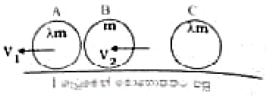
$-2500 = 50 \times 1000 \times a_2 \Rightarrow a_2 = -\frac{1}{20}$ [illegible]

[illegible] $15\ ms^{-1}$ [illegible] $V^2 = u^2 + 2as$ [illegible] x [illegible]

$0 = (15)^2 + 2\left(-\frac{1}{20}\right)x$

$x = 2250\ m$ [illegible]

03. (a)



I [illegible]

[illegible] $\lambda m V_1 + m V_2 = m u$ — ①

[illegible] $V_1 - V_2 = u$ — ②

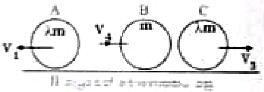
$(\because e = 1$ [illegible]$)$

① $- \lambda \times$ ② $V_2 + \lambda V_2 = u - \lambda u$

$V_2 = \frac{u(1-\lambda)}{1+\lambda} < 0$

$(\because \lambda > 1$ [illegible]$)$

B [illegible] C [illegible]



II [illegible]

[illegible] $\lambda m V_3 + m V_4 = m V_2$ — ③

[illegible] $V_3 - V_4 = V_2$ — ④

③ $- \lambda \times$ ④ $V_4 + \lambda V_4 = V_2 - \lambda V_2$

$V_4 = \frac{V_2(1-\lambda)}{1+\lambda}$

$< 0\ (\because \lambda > 1)$

[illegible] B [illegible] A [illegible]

I [illegible] A [illegible] II [illegible] B [illegible]

① + ② [illegible] $V_1 = \frac{2u}{1+\lambda}$

[illegible]

$\frac{2u}{1+\lambda} \geq V_2 \frac{(\lambda-1)}{1+\lambda}$

$= u\frac{(\lambda-1)}{(1+\lambda)} \cdot \frac{(\lambda-1)}{(1+\lambda)}$

[illegible]

$\frac{2u}{1+\lambda} \geq u\frac{(\lambda-1)^2}{(1+\lambda)^2}$

$\Rightarrow 2(\lambda + 1) \geq (\lambda - 1)^2$

$2\lambda + 2 \geq \lambda^2 - 2\lambda + 1 \Rightarrow \lambda^2 - 4\lambda - 1 \leq 0$

$(\lambda - 2)^2 - 5 \leq 0 \Rightarrow \lambda - 2 \leq \pm\sqrt{5}$

$\lambda \leq 2 \pm \sqrt{5}$ [illegible] $\lambda > 1$ [illegible]

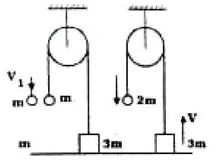
$\lambda \leq 2 + \sqrt{5}$ [illegible]

(b) h [illegible] $V^2 = u^2 + 2aS\downarrow$

$V_1^2 = 2gh$

[illegible] J [illegible]

$J = \Delta(mV)$ [illegible]



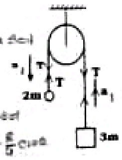
(3m) $\therefore J = 3mV - 3m(0)$; (m) [illegible] (m)

$\uparrow J = 2m(-V) - m(-V_1)$

$3mV = -2mV + mV_1 =$

$V = \frac{1}{5}V_1 = \frac{1}{5}u\ (\because u^2 = 2gh$ [illegible]$)$

[illegible] a_1 [illegible]



$\downarrow 2mg - T = 2ma_1$

$\uparrow T - 3mg = 3ma_1$

[illegible] $a_1 = -\frac{g}{5}$ [illegible]

(3m) $\uparrow V^2 = u^2 + 2aS$ [illegible] x [illegible]

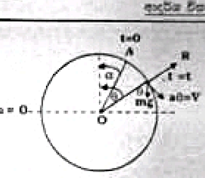
$0 = V^2 - \frac{2g}{5}x \Rightarrow \frac{2gx}{5} = \frac{u^2}{25} = \frac{2gh}{25}$

$\therefore x = \frac{2gh}{25} \times \frac{5}{2g} = \frac{h}{5}$; [illegible] t_1 [illegible]

$\uparrow V = u + at$ [illegible]

$0 = \frac{u}{5} - \frac{g}{5}t_1 \Rightarrow t_1 = \frac{u}{g}$

04. (a)



$t = 0$ [illegible] $t = t$ [illegible]

$0 + mga\cos\alpha = \frac{1}{2}m(a\dot{\theta})^2 + mga\cos\theta$

[illegible]

$g\cos\alpha - g\cos\theta = \frac{1}{2}a\dot{\theta}^2$ [illegible]

[illegible]

$\dot{\theta}^2 = \frac{2g}{a}(\cos\alpha - \cos\theta)$

$F = ma$, O [illegible]

$mg\cos\theta - R = ma\dot{\theta}^2$

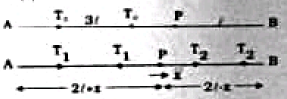
$R = mg\cos\theta - m2g(\cos\alpha - \cos\theta)$

$= mg(3\cos\theta - 2\cos\alpha)$

[illegible] $R = 0$ [illegible]

[illegible] $\cos\theta = \frac{2}{3}\cos\alpha$ [illegible]

(b)



$T_1 = \frac{mg(2l + x - l)}{l} = \frac{mg(l + x)}{l}$

$T_2 = \frac{mg(2l - x - l)}{l} = \frac{mg(l - x)}{l}$

$F = ma$ [illegible] $\rightarrow$

$T_2 - T_1 = m\ddot{x}$

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

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

$-\frac{2g}{l}x = \ddot{x}$

$\frac{2g}{l} = \omega^2$ [illegible] $\ddot{x} + \omega^2 x = 0$ [illegible]

[illegible] $\ddot{x} = 0$ [illegible] $x = 0$ [illegible] AB [illegible]

[illegible]

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$x = \ell$ විට $\dot{x} = 0$ බැවින්

($\because AP = 3\ell$ විට [illegible])

$\dot{x}^2 = \omega^2(a^2 - x^2)$ යෙදීමෙන්

([illegible] a නම්)

$0 = \frac{2g}{\ell}(a^2 - \ell^2)$ බැවින් $a = \ell$ වේ

[illegible] $T = \frac{2\pi}{\omega}$ බැවින්

$$T = \frac{2\pi}{\sqrt{\frac{2g}{\ell}}} = \pi\sqrt{\frac{2\ell}{g}}$$

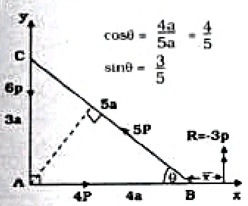
[illegible] $x = 0$, [illegible]

$\therefore$ [illegible] $\dot{x} = a\omega = \ell\sqrt{\frac{2\ell}{g}} = \sqrt{2g\ell}$

[illegible]

$$\frac{T}{4} = \frac{\pi}{4}\sqrt{\frac{2\ell}{g}} = \frac{\pi}{2}\sqrt{\frac{\ell}{2g}}$$

05. (a)



$\cos\theta = \frac{4a}{5a} = \frac{4}{5}$

$\sin\theta = \frac{3}{5}$

$\rightarrow X = 4P - 5P\cos\theta$

$= 4P - 5P \cdot \frac{4}{5} = 0$

$\uparrow Y = -6P + 5P\sin\theta$

$= -6P + 5P \cdot \frac{3}{5} = -3P$

[illegible] 3P [illegible] CA [illegible]

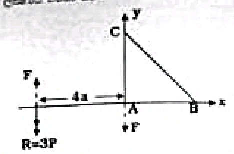
[illegible] AB [illegible] B [illegible] $\bar{x}$ [illegible] A [illegible]

$5P \times 4a \sin\theta = -3P \times (\bar{x} + 4a)$

$5P \times 4a \times \frac{3}{5} = -3P(\bar{x} + 4a) \Rightarrow$

$\bar{x} = -8a$

[illegible] BA [illegible] A [illegible] 4a [illegible]

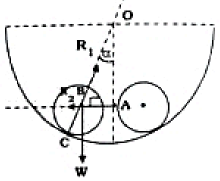


[illegible] M [illegible] ACB [illegible] $F \times 4a$ [illegible]

$F = 3P$ [illegible]

$\therefore M = 3P \times 4a = 12Pa$ [illegible] ACB [illegible]

(b)



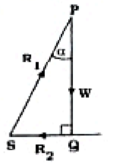
[illegible] O [illegible]

$OC = b$ හා $BC = a$ නිසා

$OB = b - a$

$AB = a$

[illegible] QSP [illegible]



$$\frac{R_2}{\sin\alpha} = \frac{W}{\sin(90-\alpha)} \Rightarrow$$

$$R_2 = W\frac{\sin\alpha}{\cos\alpha} = W\tan\alpha$$

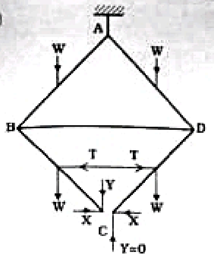
$$\sin\alpha = \frac{AB}{OB} = \frac{a}{b-a}$$

$$\therefore \tan\alpha = \frac{a}{\sqrt{(b-a)^2 - a^2}}$$

$$= \frac{a}{\sqrt{b^2 - 2ab}}$$

$$\therefore R_2 = \frac{Wa}{\sqrt{b(b-2a)}}$$

06. (a)



[illegible] AC [illegible] $Y = 0$

AB, BC [illegible] A [illegible]

$\circlearrowleft$; $W \times a\cos45 + W \cdot a\cos45 + X \cdot 4a\cos45 = T \times 3a\cos45$

$2W + 4X = 3T$ —①

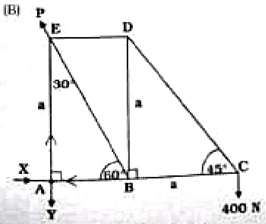
BC [illegible] B [illegible]

$\circlearrowleft$; $W \cdot a\cos45 + T \cdot a\cos45 = X \cdot 2a\cos45$

$W + T = 2X$ —②

① හා ② [illegible] $T = 4W$ හා $X = \frac{5W}{2}$ [illegible]

(B)



[illegible]

A [illegible]

$P \times a\sin30 = 400(a\tan30 + a)$

$P \times \frac{a}{2} = 400a\left(\frac{1}{\sqrt{3}} + 1\right)$

[illegible]

$X = P\cos60 = \frac{P}{2} = 400\left(\frac{1}{\sqrt{3}} + 1\right)$

$P = 800\left(\frac{1}{\sqrt{3}} + 1\right)$ N

[illegible]

$P\cos30 = Y + 400 \Rightarrow$

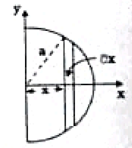
$Y = 800\left(\frac{1}{\sqrt{3}} + 1\right) \cdot \frac{\sqrt{3}}{2} - 400$

$= 400\sqrt{3}$ N

A [illegible] AB [illegible] $400\left(\frac{1}{\sqrt{3}} + 1\right)$ N [illegible] AE [illegible] $400\sqrt{3}$ N [illegible]

C [illegible] BC [illegible] 400 N; CD [illegible] $400\sqrt{2}$ N [illegible]

07.

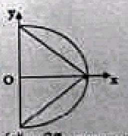


[illegible] x [illegible] O [illegible] x [illegible] δx [illegible] ρ [illegible] $= \pi(a^2 - x^2)\,\delta x\,\rho$

[illegible]

$$\bar{x} = \frac{\int_0^a \pi(a^2 - x^2)\,dx\,\rho \cdot x}{\int_0^a \pi(a^2 - x^2)\,dx\,\rho}$$ [illegible]

$\bar{x} = \frac{3}{8}a$ [illegible]



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[illegible]	[illegible]	[illegible] Y [illegible]
	$\frac{2}{3}\pi a^3\rho$	$\frac{3}{8}a$
	$\frac{1}{3}\pi a^2 . a\rho$	$\frac{1}{4}a$
	$\frac{1}{3}\pi a^3\rho$	$\overline{x}$

Y [illegible]

$\frac{2}{3}\pi a^3\rho . \frac{3a}{8} - \frac{1}{3}\pi a^3\rho . \frac{a}{4} = \frac{1}{3}\pi a^3\rho\overline{x}$

$\overline{x} = \frac{a}{2}$

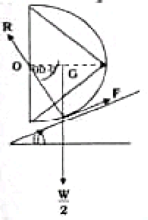
[illegible]

$\cos(90-\theta) = \frac{\frac{a}{2}}{a} \Rightarrow \sin\theta = \frac{1}{2} \Rightarrow$

$\theta = 30°$

$W = \frac{2}{3}\pi a^3\rho$ [illegible]

[illegible] $\frac{W}{2}$ [illegible]



[illegible]

$F = \frac{W}{2}\sin\theta ; R = \frac{W}{2}\cos\theta$

[illegible] $\frac{F}{R} \le \mu$ [illegible]

$\tan\theta \le \mu \Rightarrow \mu \ge \frac{1}{\sqrt{3}}$

08. (a) A [illegible] B [illegible]

$P(A \cap B) = P(A).P(B)$ —①

$P(B) = P(B)$ —②

② - ①

$P(B) - P(A \cap B) = P(B) - P(A).P(B)$

$P(A' \cap B) = P(B)[1 - P(A)]$

$P(A' \cap B) = P(B) . P(A')$—③

∴ A' [illegible] B [illegible]

[illegible]

$P(A' \cap B) = P(A').P(B)$ —③

$P(A') = P(A')$ —④

④ - ③

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

$P(A \cup B)' = P(A')[1 - P(B)]$

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

A' [illegible] B' [illegible]

[illegible] = p [illegible]

$= 1 - p \times p = 1 - p^2$

$1 - p^2 > 0.999999 \Rightarrow 1 - 0.999999 > p^2$

$0.000001 > P^2 \Rightarrow 0.001 > p$

[illegible]

(b)

[illegible] \ [illegible]	A	B	C
A	0	0	0
B	0	½	½
C	0	½	1

$P(A) = \frac{1}{4}, P(B) = \frac{1}{2}$

$P(C) = \frac{1}{4}$ [illegible]

X [illegible] A, B, C [illegible]

(A,A), (A,B), (A,C), (B,A), (B,B), (B,C), (C,A), (C,B), (C,C) [illegible]

[illegible]

$P(X) = P[X|(A,A)]P(A,A) + P[X|(A,B)]P(A,B) + \ldots\ldots + P[X|(C,C)]P(C,C)$

[illegible] $P(A,A) = P(A).P(A) ; P(A,B) = P(A).P(B)$ [illegible]

∴ P(X)

$= \left(0 \times \frac{1}{4} \times \frac{1}{4}\right) + \left(0 \times \frac{1}{4} \times \frac{1}{2}\right) + \left(0 \times \frac{1}{4} \times \frac{1}{4}\right) + \left(0 \times \frac{1}{2} \times \frac{1}{4}\right) + \left(\frac{1}{4} \times \frac{1}{2} \times \frac{1}{2}\right) + \left(\frac{1}{2} \times \frac{1}{2} \times \frac{1}{4}\right) + \left(0 \times \frac{1}{4} \times \frac{1}{4}\right) + \left(\frac{1}{2} \times \frac{1}{4} \times \frac{1}{2}\right) + \left(1 \times \frac{1}{4} \times \frac{1}{4}\right)$

$= \frac{1}{4}$

Y : [illegible]

$P(Y) = P[Y|(A,A)]P(A,A) + P[Y|(A,B)]P(A,B) + P[Y|(A,C)]P(A,C) + \ldots\ldots + P[Y|(C,C)]P(C,C)$

$P[Y|A,A] = 1$ [illegible]

$P[Y|(A,C)] = P[Y|(B,C)]$
$= P[Y|(C,B)]$
$= P[Y|(C,A)]$
$= P[Y|(C,C)] = 0$ [illegible]

$P[Y|(B,C)] = P[Y|(C,B)] = P[Y|(B,B)]$

$= \frac{3}{4}$ [illegible]

∴ $P(Y) = \left(1 \times \frac{1}{4} \times \frac{1}{4}\right) + \left(\frac{3}{4} \times \frac{1}{4} \times \frac{1}{2}\right) + 0 + \left(\frac{3}{4} \times \frac{1}{2} \times \frac{1}{4}\right) + \left[\frac{3}{4} \times \frac{3}{4} \times \frac{1}{2} \times \frac{1}{2}\right] + 0 + 0 + 0 + 0$

$= \frac{1}{16} + \frac{3}{32} + \frac{3}{32} + \frac{9}{64}$

$= \frac{4 + 6 + 6 + 9}{64} = \frac{25}{64}$

[illegible] Y [illegible] X [illegible]

$P(X|Y) = \frac{P(X \cap Y)}{P(Y)} = \frac{\frac{3}{4} \times \frac{3}{4} \times \frac{1}{2} \times \frac{1}{2}}{\frac{25}{64}}$

$= \frac{9}{25}$

09.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	fd	fd^2
1	28 – 32	30	7	-2	-14	28
2	33 – 37	35	6	-1	-6	6
3	38 – 42	40	4	0	0	0
4	43 – 47	45	2	1	2	2
5	48 – 52	50	1	2	2	4
			20		-16	40

[illegible] $d = \frac{x - 40}{5}$, 40 [illegible] (A) [illegible]

[illegible] 5 [illegible]

[illegible] $= A + \frac{\Sigma fd}{\Sigma f} \times C$

$= 40 + \frac{(-16) \times 5}{20} = 36$ [illegible]

[illegible] $= L + C\,(N/2 - F_{m-1})/f_{(m)}$

[illegible] L [illegible]

F_{m-1} - [illegible]

$f_{(m)}$ - [illegible]

[illegible] $= 32.5 + 5\left(\frac{20}{2} - 7\right) \div 6$

$= 35$ [illegible]

[illegible]

[illegible] = [illegible] $+ \frac{C}{2}\left\{\frac{(f_2 - f_1) - (f_2 - f_3)}{(f_2 - f_1) + (f_2 - f_3)}\right\}$

$= 30 + \frac{5}{2}\left\{\frac{(7-0) - (7-6)}{(7-0) + (7-6)}\right\}$

$= 30 + \frac{5}{2}\left\{\frac{6}{8}\right\}$

$= 31.9 \triangleq 32$ [illegible]

[illegible] (36) > [illegible] (35) > [illegible] (32) [illegible]

[illegible] = [illegible]^2

$= C^2\left[\frac{\Sigma f_i d_i^2}{N} - \left(\frac{\Sigma f_i d_i}{N}\right)^2\right]$

$= 25\left[\frac{40}{20} - \left(\frac{-16}{20}\right)^2\right]$

$= 25\left[2 - \left(\frac{4}{5}\right)^2\right]$

$= 25\left[2 - \frac{16}{25}\right]$

$= 34$

[illegible] $= 3\frac{([illegible] - [illegible])}{[illegible]}$

$= \frac{3(36 - 35)}{\sqrt{34}} \triangleq 0.5$

[illegible]	1	2	3	4	5
[illegible]	1	2	4	6	7

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[illegible]

(i) [illegible] : [illegible]

(ii) [illegible] : [illegible] ft [illegible] ft^2 [illegible] 1ft [illegible]

(iii) [illegible] : [illegible] 4 [illegible] 1 [illegible] 45 − 1 = 44 [illegible]

[illegible] : [illegible] 45 [illegible]

[illegible] : [illegible] 1.9 [illegible] 50 [illegible] 1.9 [illegible] ∴ [illegible] = 50 − 1.9 ≅ 48 [illegible]

[illegible]	[illegible]	[illegible]	[illegible]
1	36 [illegible]	35 [illegible]	32 [illegible]
[illegible]	7.2 kg	7.0 kg	6.4 kg
2	44 [illegible]	45 [illegible]	48 [illegible]
[illegible]	8.8 kg	9.0 kg	9.6 kg

[illegible] 1 [illegible]

[illegible] 2 [illegible] 1 [illegible]

[illegible]

*** ***

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