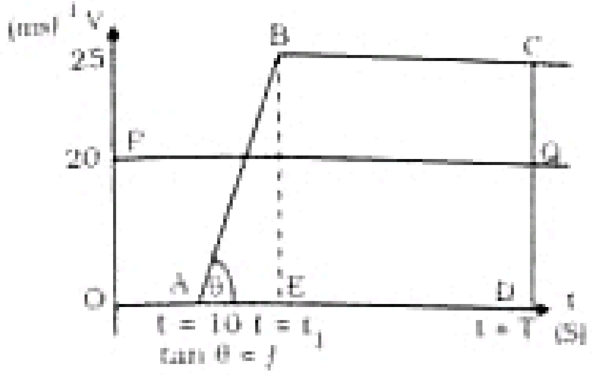
11. (a) [illegible]



72 km h^{-1} = 20 ms^{-1}

90 km h^{-1} = 25 ms^{-1}

[illegible] 200m [illegible]

ABE Δ = 200 [illegible]

$\frac{1}{2}$ AE × BE = ABEΔ

$\frac{1}{2}(t_1 - 10) \times 25 = 200$

$\Rightarrow t_1 = 26$ [illegible]

$\tan\theta = f = \frac{BE}{AE} = \frac{25}{t_1 - 10}$

$= \frac{25}{16}$ ms^{-2}

t = T [illegible]

ABCD ⏢ = OPQD ▭ [illegible]

$\frac{1}{2}$(AD + BC) × BE = OP × OD

[illegible]

$\frac{1}{2}[T - 10 + T - t_1]\, 25 = 20 \times T$;

$t_1 = 26$ [illegible]

T = 90 [illegible]

(b) [illegible]

(v, E) = [illegible] ; (u, E) = u

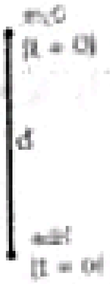
[illegible]

$\uparrow$ = u + v

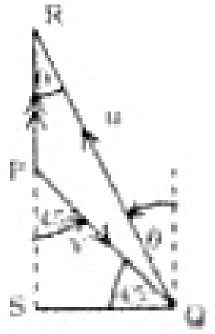
$\uparrow$ = v + u

$= \vec{PQ} + \vec{QR}$

$= \vec{PR}$



[illegible]



$QS = v \sin 45° = \frac{v}{\sqrt{2}} = PS$

$SR = \sqrt{u^2 - \frac{v^2}{2}}$

$PR = \sqrt{\frac{2u^2 - v^2}{2}} - \frac{v}{\sqrt{2}}$

$= \frac{\sqrt{2u^2 - v^2} - v}{\sqrt{2}}$

[illegible] t_1 [illegible]

$t_1 = \frac{d}{|\vec{PR}|}$

$t_1 = \frac{\sqrt{2}\, d}{\sqrt{2u^2 - v^2} - v}$ [illegible]

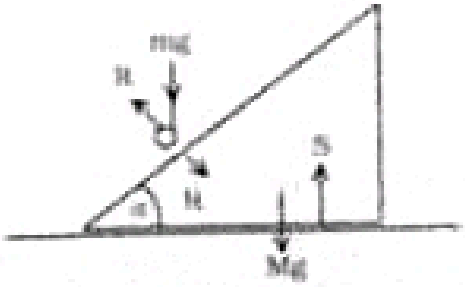
$t_1 = \frac{\sqrt{2}d\,(\sqrt{2u^2 - v^2} + v)}{2(u^2 - v^2)}$ [illegible]

[illegible]

θ [illegible] $\sin\theta = \frac{v \sin 45}{u} = \frac{v}{u\sqrt{2}}$ [illegible]

(c) [illegible]

[illegible]



(m, [illegible]) = a_1

([illegible], E) = a_2

(m, E) = (m, [illegible]) + ([illegible], E)

[illegible]

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$= \frac{a_1}{\alpha} + \overrightarrow{a_2}$

$\underline{F} = m\underline{a}$ [illegible]

$\rightarrow ; 0 = Ma_2 + m(a_2 - a_1 \cos\alpha)$ —— ❶

[illegible] $mg \sin\alpha = m(a_1 - a_2 \cos\alpha)$ —— ❷

❶ + ❷ × $\cos\alpha$ [illegible]

$a_2 = \frac{mg \sin\alpha \cos\alpha}{M + m \sin^2\alpha}$ [illegible]

$\underline{F} = m\underline{a}$ [illegible] $\rightarrow$ [illegible]

$R \sin\alpha = M \times a_2$

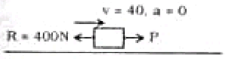
$R = \frac{M mg \cos\alpha}{M + m \sin^2\alpha}$

(ii) $144\ kmh^{-1} = 40\ ms^{-1}$

[illegible] P [illegible]

$Pv = H$ [illegible]

$P = \frac{H}{40}$



[illegible]

$\underline{F} = m\underline{a}$ [illegible]

$P - R = m \times 0$

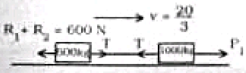
$P = R$

$\frac{H}{40} = 400 \Rightarrow H = 16000\ W$

$H = 16\ kW$

$24\ km\,h^{-1} = \frac{20}{3}\ ms^{-1}$

[illegible] $P_1 = \frac{16 \times 1000}{20/3}$ N



[illegible] a_1 [illegible]

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

$P_1 - R_1 - R_2 = 1600 \times a_1$

$\frac{16 \times 1000}{20} \times 3 - 600 = 1600\, a_1$

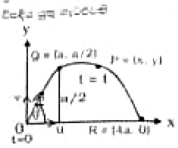
$\Rightarrow a_1 = \frac{18}{16} = \frac{9}{8}\ ms^{-2}$

[illegible] $\underline{F} = m\underline{a}$ [illegible] $\rightarrow$

$T - R_2 = 600 \times a_1$

$\Rightarrow T = \left(600 \times \frac{9}{8}\right) + 200 = 875\ N$

03. (a) [illegible]



$O \rightarrow P$ [illegible]

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

$\rightarrow x = ut$ —— ❶

$\uparrow y = vt - \frac{1}{2}gt^2$ —— ❷

❶ [illegible] ❷ [illegible] t [illegible]

$y = \frac{vx}{u} - \frac{g}{2u^2}x^2$ [illegible]

$Q = \left(a, \frac{a}{2}\right)$ [illegible] $R = (4a, 0)$ [illegible]

[illegible]

$\frac{a}{2} = \frac{va}{u} - \frac{ga^2}{2u^2}$ —— ❶

$\Rightarrow \frac{1}{2} = \frac{v}{u} - \frac{ga}{2u^2}$ —— ❶'

$0 = 4a\frac{v}{u} - \frac{g}{2u^2}16a^2$ —— ❷

$\Rightarrow 0 = \frac{v}{u} - \frac{4ga}{2u^2}$ —— ❷'

❶' - ❷' [illegible] $\frac{1}{2} = \frac{3ga}{2u^2}$

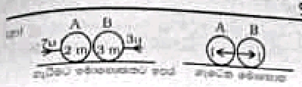
$\Rightarrow u^2 = 3ga \Rightarrow u = \sqrt{3ga}$

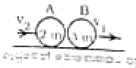
[illegible] ❶' [illegible] $v = 2\sqrt{\frac{ga}{3}}$

[illegible] θ [illegible]

$\tan\theta = \frac{v}{u} \Rightarrow \theta = \tan^{-1}\left(\frac{2}{3}\right)$

(b)





[illegible] $\rightarrow$

$(2m \times 7u) + (3m \times -3u) = 2mv_2 + 3mv_1$

$5u = 2v_2 + 3v_1$ —— ❶

[illegible]

$v_1 - v_2 = e(7u + 3u)$ —— ❷

❶ [illegible] ❷ [illegible] $v_1 = u(1 + 4e)$

B [illegible] $I = \Delta(mv)$ [illegible]

$I = 3mv_1 - 3m(-3u)$

$= 3mu(1 + 4e) + 9mu$

$= 12mu(1 + e)$

❶ [illegible] ❷ [illegible] $v_2 = u - 6eu$ [illegible]

[illegible] A [illegible] $v_2 = 0$ [illegible]

$u - 6eu = 0 \Rightarrow e = \frac{1}{6}$

[illegible]

$= \frac{1}{2} \times 2m \times 49u^2 + \frac{1}{2} \times 3m \times 9u^2$

$= \frac{125}{2}\ mu^2$

[illegible]

$= \frac{1}{2} \times 3m \times v_1^2 \left(e = \frac{1}{6}\right)$

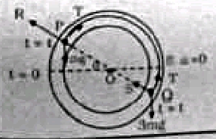
$= \frac{1}{2} \times 3m \times \frac{25u^2}{9}$

[illegible]

$= \frac{\frac{1}{2} \times 3m \times \frac{25u^2}{9}}{\frac{1}{2}125\ mu^2}$

$= \frac{1}{15}$ [illegible]

04. (a)



[illegible]

P [illegible] θ [illegible] P [illegible] $a\dot{\theta}$ [illegible]

Q [illegible]

[illegible]

$\frac{1}{2}m(a\dot{\theta})^2 + \frac{1}{2}3m(a\dot{\theta})^2 + mg\,a\sin\theta - 3mg\,a\sin\theta = 0$

$2a\dot{\theta}^2 = 2\, g \sin\theta$

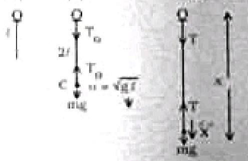
$a\dot{\theta}^2 = g \sin\theta$

P [illegible] $\underline{F} = m\underline{a}$ [illegible]

$R - mg \sin\theta = m(-a\dot{\theta}^2) \Rightarrow$

$R = mg \sin\theta - mg \sin\theta = 0$

(b) (I) (II) (III)



(II) [illegible]

[illegible]

$T_0 = mg$ —— ❶

[illegible] λ [illegible]

$T_0 = \frac{\lambda l}{l}$ —— ❷

❶ = ❷ [illegible] $\lambda = mg$ [illegible]

(III) [illegible]

[illegible] $\underline{F} = m\underline{a}$

[illegible]

$mg - T = m\ddot{x}$ —— ❶

$T = \frac{mg \times (x - l)}{l}$ —— ❷

$\therefore mg - \frac{mg\,(x - l)}{l} = m\ddot{x} \Rightarrow$

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

$\ddot{x} = -\frac{g}{l}(x - 2l) \Rightarrow \ddot{x} + \frac{g}{l}(x - 2l) = 0$

$\therefore$ [illegible]

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[illegible] $\vec{R} = 0$ [illegible] $x = 2l$ [illegible].

[illegible] C [illegible].

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

$\omega = \sqrt{\frac{g}{l}}$

[illegible] $T = 2\pi\sqrt{\frac{l}{g}}$ [illegible]

$\dot{x}^2 = \omega^2(a^2 - x^2)$ [illegible] A [illegible]

[illegible] $g\,l = \frac{g}{l}(a^2 - 0)$

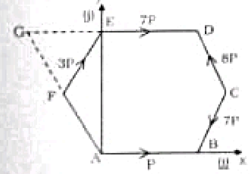
[illegible] C [illegible] $= \sqrt{gl}$ [illegible]

$\therefore a = l$ [illegible]

[illegible] $x = 2l + l = 3l$ [illegible]

[illegible] $x = 2l - l = l$ [illegible]

05.



BC [illegible]

$= \text{Cos}60\, i + \text{Sin}\, 60\, j$

$= \frac{1}{2}i + \frac{\sqrt{3}}{2}j$

$\therefore \vec{CB}$ [illegible] $= -\frac{1}{2}i - \frac{\sqrt{3}}{2}j$

$\vec{CD}$ [illegible] $= -\frac{1}{2}i + \frac{\sqrt{3}}{2}j$

$\vec{FE}$ [illegible] $= \frac{1}{2}i + \frac{\sqrt{3}}{2}j$

[illegible]	[illegible]	[illegible]
$\vec{AB}$	P	Pi
$\vec{CB}$	7P	$-7P\left(\frac{1}{2}i + \frac{\sqrt{3}}{2}j\right)$
$\vec{CD}$	8P	$8P\left(-\frac{1}{2}i + \frac{\sqrt{3}}{2}j\right)$
$\vec{ED}$	7P	$\frac{1}{2}7Pi$
$\vec{FE}$	3P	$3P\left(\frac{1}{2}i + \frac{\sqrt{3}}{2}j\right)$

$\vec{R} = Pi - 7P\left(\frac{1}{2}i + \frac{\sqrt{3}}{2}j\right) + 8P\left(-\frac{1}{2}i + \frac{\sqrt{3}}{2}j\right) + 7Pi + 3P\left(\frac{1}{2}i + \frac{\sqrt{3}}{2}j\right)$

$= 2P(i + \sqrt{3}j) \neq 0$ [illegible]

$\vec{R} = 4P\left(\frac{1}{2}i + \frac{\sqrt{3}}{2}j\right)$ [illegible]

$\frac{1}{2}i + \frac{\sqrt{3}}{2}j$ [illegible] $\vec{BC}$ [illegible]

$\therefore$ [illegible] BC [illegible]

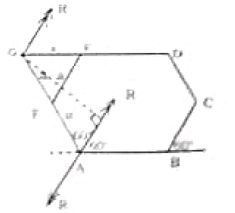
$|\vec{R}| = \left\{4P^2\left[\left(\frac{1}{2}\right)^2 + \left(\frac{\sqrt{3}}{2}\right)^2\right]\right\}^{1/2} = 4P$ [illegible]

DE [illegible] AF [illegible] G [illegible]. G [illegible]

$\circlearrowleft G : P(2a)\frac{\sqrt{3}}{2} - 7P(3a)\frac{\sqrt{3}}{2} + 8P(2a)\frac{\sqrt{3}}{2} + 3P(a)\frac{\sqrt{3}}{2}$

$= 0$ [illegible]

$\therefore$ [illegible] BC [illegible]. G [illegible]

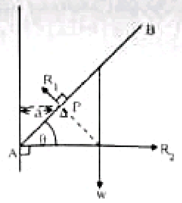


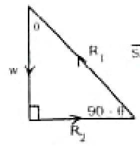
[illegible] A [illegible] R [illegible] G [illegible] R [illegible] A [illegible] -R [illegible] AFEDCB [illegible]

$R = 2a\ \text{Sin}60$ [illegible]

[illegible] $4P \times 2a \times \frac{\sqrt{3}}{2} = 4\sqrt{3}Pa$ Nm

06. (a) [illegible]





$\frac{R_1}{\text{Sin}\,\pi/2} = \frac{w}{\text{Sin}\,(90 - \theta)}$

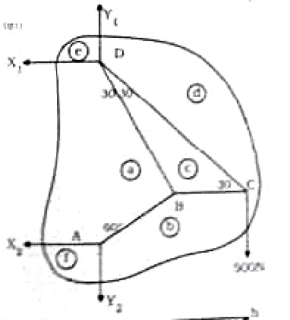
$R_1 = w\text{Sec}\,\theta$

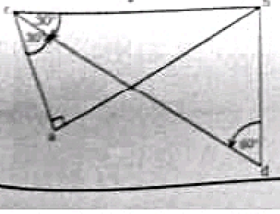
[illegible] A [illegible]

$w \times 3a\ \text{Cos}\theta = w\ \text{Sec}\theta \times a\ \text{Sec}\theta$

$\Rightarrow 3\ \text{Cos}^3\theta = 1$ [illegible]

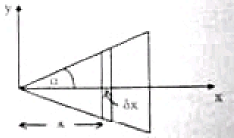
(b)





[illegible]	[illegible]	[illegible]
CD	[illegible]	1000N
BC	[illegible]	$500\sqrt{3}$ N
BD	[illegible]	$250\sqrt{3}$ N
AB	[illegible]	750N

07.



[illegible] α [illegible] x [illegible] y [illegible] x [illegible] δx [illegible]

[illegible] $x \tan\alpha$ [illegible]

[illegible] $= \pi(x\tan\alpha)^2\,\delta x$ [illegible]

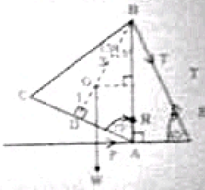
[illegible] ρ [illegible] $\pi(x\tan\alpha)^2\,\delta x\,\rho$ [illegible]

[illegible] y [illegible] x [illegible]

$$\bar{x} = \frac{\int_0^h \pi x^2\tan^2\alpha\,dx\,\rho x}{\int_0^h \pi x^2\tan^2\alpha\,dx\,\rho} = \frac{\int_0^h x^3\,dx}{\int_0^h x^2\,dx}$$

$= \frac{3h}{4}$

$\therefore$ [illegible] $= \left(\frac{3h}{4}, 0\right)$



[illegible]

$\rightarrow T\ \text{Cos}\ 45 = F$ —— ①

$\uparrow T\ \text{Sin}\ 45 + R = W$ —— ②

[illegible]

$F = \mu R$ —— ③

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BD = h [illegible]

$BG = \frac{3}{4}h$ [illegible] $AB = h \sec 15$

$AE = AB = h \sin 15$

E [illegible]

$W\left(h \sec 15 + \frac{3h}{4} \sin 15\right)$

$= R \times h \sec 15$ —— ❶

$W\left(\frac{h}{\cos 15} + \frac{3h}{4} \sin 15\right) = \frac{Rh}{\cos 15}$

$Wh + \frac{3}{4} Wh \sin 15 \cos 15 = Rh$

$W + \frac{3}{8} W \sin 30 = R$

$W + \frac{3}{8} W \times \frac{1}{2} = R$

$R = \frac{19w}{16}$, $F = \frac{19w}{16}\mu$

❷ [illegible] $-T \times \frac{1}{\sqrt{2}} + \frac{19w}{16} = w \Rightarrow$

$\frac{-T}{\sqrt{2}} = \frac{-3w}{16} \Rightarrow T = \frac{3\sqrt{2}w}{16}$

❸ [illegible] $F = \frac{3\sqrt{2}w}{16} \times \frac{1}{\sqrt{2}} = \frac{3w}{16}$

❹ [illegible] $\frac{3w}{16} = \frac{19w\mu}{16} \Rightarrow \mu = \frac{3}{19}$

08. (a) $P(A \cup B)$ [illegible] A [illegible] B [illegible]
$P(A \cap B)$ [illegible] A [illegible] B [illegible]

$P(A|B)$ [illegible] B [illegible]
A [illegible]

(i) $P(A) = 0.6$; $P(B) = 0.2$
$= P(A|B) = 0.1$
[illegible]

$P(A|B) = \frac{P(A \cap B)}{P(B)} \Rightarrow$

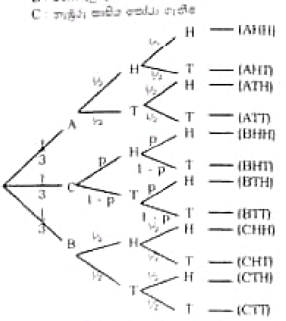
$0.1 = \frac{P(A \cap B)}{0.2} \Rightarrow$

$P(A \cap B) = 0.02$

(ii) $P(A' \cap B) + P(A \cap B')$ [illegible]
$P(A' \cap B) = P(B) - P(A \cap B)$ [illegible]
$P(A \cap B') = P(A) - P(A \cap B)$
$P(A' \cap B) = 0.2 - 0.02 = 0.18$
$P(A \cap B') = 0.6 - 0.02 = 0.58$
$\therefore P(A' \cap B) + P(A \cap B')$
$= 0.18 + 0.58 = 0.76$

(iii) $P(A' \cap B')$ [illegible]
$P(A' \cap B') = P(A \cup B)' = 1 - P(A \cup B)$
$P(A \cup B) = P(A) + P(B) - P(A \cap B)$ [illegible]
$= 0.6 + 0.2 - 0.02$
$= 0.78$
$\therefore P(A' \cap B)' = 1 - 0.78 = 0.22$

(b) A : [illegible]
B : [illegible]
C : [illegible]



[illegible]
AHH, BHH, CHH
[illegible]

$= P(AHH \cup BHH \cup CHH)$
$= P(AHH) + P(BHH) + P(CHH)$
[illegible]
$= P(A)P(H)P(H) + P(B)P(H)P(H) + P(C)P(H)P(H)$
A, B, C, H [illegible]

$= \left(\frac{1}{3} \times \frac{1}{2} \times \frac{1}{2}\right) + \left(\frac{1}{3} \times \frac{1}{2} \times \frac{1}{2}\right) + \left(\frac{1}{3} \times p \times p\right)$

$= \frac{1}{12} + \frac{1}{12} + \frac{p^2}{3}$

[illegible] $\frac{17}{54}$ [illegible]

$\frac{1}{12} + \frac{1}{12} + \frac{p^2}{3} = \frac{17}{54} \Rightarrow p = \frac{2}{3}$ [illegible]

[illegible]

$P(C|HH) = \frac{P(C \cap HH)}{P(HH)} = \frac{\frac{1}{3} \times p \times p}{\frac{17}{54}}$

$= \frac{1}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{54}{17} = \frac{8}{17}$

(c) [illegible] $\bar{x} = \frac{\sum_{i=1}^{n} f_i x_i}{\sum_{i=1}^{n} f_i}$; f_i [illegible]

[illegible] x_i [illegible]

$y = \frac{x - a}{c}$ [illegible] $yc = x - a$ [illegible]
$x = a + cy$ [illegible]

[illegible] $\bar{x} = \frac{\sum_{i=1}^{n} f_i (a + cy_i)}{\sum f_i}$

$= \frac{a \sum_{i=1}^{n} f_i}{\sum_{i=1}^{n} f_i} + \frac{c \sum_{i=1}^{n} f_i y_i}{\sum_{i=1}^{n} f_i}$

$= a + c\bar{y}$ [illegible]

$\sigma^2 = \frac{\sum f(x - \bar{x})^2}{\sum f}$

$= \frac{\sum f(x^2 - 2x\bar{x} + \bar{x}^2)}{\sum f}$

$= \frac{\sum fx^2}{\sum f} - 2\bar{x}\frac{\sum fx}{\sum f} + \bar{x}^2 \frac{\sum f}{\sum f}$

$= \frac{\sum fx^2}{\sum f} - 2\bar{x}\bar{x} + \bar{x}^2$ [illegible]

$= \frac{\sum fx^2}{\sum f} - \bar{x}^2$

$x = a + cy$ [illegible] $\bar{x} = a + c\bar{y}$ [illegible]

$\sigma^2 = \frac{\sum f(a + cy)^2}{\sum f} - (a + c\bar{y})^2$

$= a^2 \frac{\sum f}{\sum f} + 2ac\frac{\sum fy}{\sum f} + c^2\frac{\sum fy^2}{\sum f} - a^2 - 2ac\bar{y} - c^2\bar{y}^2$

$= a^2 + 2ac\bar{y} + c^2\frac{\sum fy^2}{\sum f} - a^2 - 2ac\bar{y} - c^2\bar{y}^2$

$\sigma^2 = c^2\left[\frac{\sum fy^2}{\sum f} - \bar{y}^2\right]$

$\therefore$ [illegible] $\sigma = c\sqrt{\frac{\sum fy^2}{\sum f} - \bar{y}^2}$

$\sum fy = -23.5$ [illegible] $\sum fy^2 = 155.9$
[illegible] $x = 10y + 45$ [illegible]
$\bar{x} = 10\bar{y} + 45$ [illegible]

$\therefore a = 45$ [illegible] $c = 10$ [illegible]
[illegible] $= a + c\bar{y}$

$= 45 + 10\left(\frac{-23.5}{25}\right)$

$= 45 - 9.4 = 35.6$ [illegible]

[illegible] $\sigma^2 = c^2\left[\frac{\sum fy^2}{\sum f} - \bar{y}^2\right]$

$\because \bar{y} = \frac{\sum fy}{\sum f} = \frac{-23.5}{25} = -0.94$

$\sigma^2 = 100\left[\frac{155.9}{25} - (0.94)^2\right]$

$= 535.24$ [illegible]

[illegible] $\sigma = \sqrt{535.24} = 23.1$ [illegible]

[illegible] (l)	[illegible] (x)	[illegible] (f)	[illegible] $\lvert d \rvert = x - 5\rvert$	$y = \frac{x - 45}{10}$	fy	fy^2
$0 \le x < 10$	5	4.2	40	-4	-16.8	67.2
$10 \le x < 20$	15	3.9	30	-3	-11.7	35.1
$20 \le x < 30$	25	3.4	-20	-2	-6.8	13.6
$30 \le x < 40$	35	3.2	-10	-1	-3.2	3.2
$40 \le x < 50$	45	2.8	0	0	0	0
$50 \le x < 60$	55	2.8	10	1	2.8	2.8
$60 \le x < 70$	65	2.5	20	2	5.0	10.0
$70 \le x < 80$	75	1.6	30	3	4.8	14.4
$80 \le x < 90$	85	0.6	40	4	2.4	9.6
	Total	25.0			-23.5	155.9

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