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i) $\sqrt{288} + 7\sqrt{2} - \sqrt{72} = \sqrt{144\times 2} + 7\sqrt{2} - \sqrt{36\times 2}$

$= 12\sqrt{2} + 7\sqrt{2} - 6\sqrt{2}$

$= 13\sqrt{2}$

(03)

ii) $\frac{2}{3\sqrt{3}+5} = \frac{2}{5+3\sqrt{3}} \frac{(5-3\sqrt{3})}{(5-3\sqrt{3})}$

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

$= \frac{10-6\sqrt{3}}{25-27}$

$= \frac{10-6\sqrt{3}}{-2}$

$= -5+3\sqrt{3}$ (03)

iii) $4^{(1-n/2)} \cdot 2^{n+3} \cdot 16^{-1/2} = 2^{2(1-n/2)} \cdot 2^{n+3} \cdot 2^{4(-1/2)}$

$= 2^{2-n} \cdot 2^{n+3} \cdot 2^{-2}$

$= 2^{2-n+n+3+-2}$

$= 2^3$

$= 8$ (03)

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ii) $\log_{10} 120 + \frac{1}{3}\log_{10} 27 - 2\log_{10} 6$

$= \log_{10} 120 + \log_{10} (3^3)^{1/3} - \log_{10} 6^2$ ✓

$= \log_{10} 120 + \log_{10} 3 - \log_{10} 36$

$= \log_{10}\left(\frac{120 \times 3}{36}\right)$ ✓

$= \log_{10} \frac{360}{36}$

$= \log_{10} 10$

$= 1$ ✓ (03)

iii) $\log_{81} \frac{1}{9} = \frac{\log_9 (1/9)}{\log_9 81}$

$= \frac{\log_9 9^{-1}}{\log_9 9^2}$

$= \frac{-\log_9 9}{2\log_9 9}$

$= -\frac{1}{2}$ (03)

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c) i) $\log_3 a + \log_3 b = 4 \Rightarrow \log_3 ab = 4$

$ab = 3^4$ ----(i) ✓

$3\log_a b = 1$

$\log_a b^3 = 1$

$b^3 = a$ ---(ii) ✓

Solving (i) and (ii) Simultaneously

$b^3 \cdot b = 3^4$ ✓

$b^4 = 3^4$

$b = 3$ ✓

$a = 3^3$

$= 27$ ✓ (05)

d. ii)

$5^{x+2} + 7^{y+1} = 3468$

$5^x \cdot 5^2 + 7^y \cdot 7 = 3468$

let $5^x = p$ $7^y = q$

$25p + 7q = 3468$ ----(i) ✓

$5^x - 7^y = 76$

$p - q = 76$ ---- ii)

$25(76+q) + 7q = 3468$ ✓

$1900 + 25q + 7q = 3468$

$32q = 1568$

$q = 49$ ✓

$p = 76 + 49$

$= 125$ ✓

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$5^x = 5^3$

$x = 3$ ✓

$7^y = 7^2$

$y = 2$ ✓ (06)

ii) $2m - 2n = 1$ $m^2 - mn - 4 = 0$

$2(m-n) = 1$

$m - n = \frac{1}{2}$ ✓

$m(m-n) - 4 = 0$

$m(\frac{1}{2}) = 4$ ✓

$m = 8$ ✓

$8 - n = \frac{1}{2}$

$n = 8 - \frac{1}{2}$

$n = 7.5$ ✓ (04)

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ITEM						TOTAL
SCORE						

TOTAL SCORE	

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Item 2 ~~~~

PART A

a) $x = 3 - 4\sin\theta \quad , \quad y = 4\tan\theta$

$\tan\varphi = y/4$ ✓

$\sin\varphi = \frac{3-x}{4}$ ✓

$\cot\theta = 4/y$ ✓

$\operatorname{cosec}\theta = \frac{4}{3-x}$ ✓

$1 + \cot^2\varphi = \operatorname{cosec}^2\theta$

$1 + \left(4/y\right)^2 = \left(\frac{4}{3-x}\right)^2$ ✓

05

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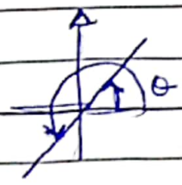
b) $4 = 4\tan Q$

$\tan Q = 1$ ✓

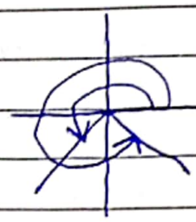
$Q = 45°, 225°$ ✓



$3 + 2\sqrt{2} = 3 - 4\sin Q$

$\sin Q = \frac{-2\sqrt{2}}{4}$ ✓

$= -\frac{1}{2}\sqrt{2}$

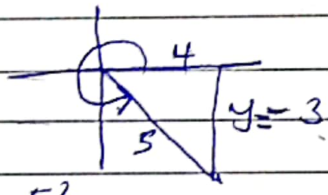


$Q = \sin^{-1}\left(-\frac{1}{2}\sqrt{2}\right)$ (04)

$= -45°, 225°, 315°$

The smallest rotation angle in the interval $180° \leq Q \leq 360°$ is $225°$ ✓

c) $\cos Q = 4/5$



$4^2 + y^2 = 5^2$

$y^2 = 5^2 - 4^2$

$y^2 = 9$

$y = 3$

$\sec Q = 5/4$ ✓

$\tan Q = -3/4$ ✓

$\cot Q = -4/3$ ✓ $\sin Q = -3/5$ ✓

$\frac{\cot Q - \sin Q}{\sec Q + \tan Q} = \frac{-4/3 - -3/5}{5/4 + -3/4}$ ✓

$= -11/15 \,/\, 1/2$

$= -22/15$ ✓ (06)

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part B

a) $P(3,-1)$

Path $y = \frac{15}{8} - \frac{3}{4}x \Rightarrow 8y = 15 - 6x$

$6x + 8y - 15 = 0$ ---- (i) ✓

perpendicular distance from the monument

$= \left| \frac{6\times3 + 8(-1) - 15}{\sqrt{6^2+8^2}} \right|$ ✓

$= \left| \frac{-5}{\sqrt{100}} \right|$

$= \frac{1}{2}$ ✓ 03

b) Slope of the path $= -\frac{3}{4}$

Slope of the perpendicular from the monument to the proposed path $= \frac{4}{3}$ ✓

Equation of the perpendicular from the monument to the proposed path

$\frac{y - -1}{x-3} = \frac{4}{3}$ ✓

$3(y+1) = 4(x-3)$

$3y + 3 = 4x - 12$

$4x - 3y - 15 = 0$ ✓ ---(ii) B1

$4x - 3\left(\frac{15}{8} - \frac{3}{4}x\right) - 15 = 0$ ✓ Solving and manipulation

$4x - \frac{45}{8} + \frac{9x}{4} - 15 = 0$

$\frac{25}{4}x = \frac{165}{8}$

Answer Sheet

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ITEM						TOTAL
SCORE						

TOTAL SCORE	

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$$x = \frac{165}{8} \times \frac{4}{25}$$

$$= \frac{33}{10}$$

$$y = \frac{15}{8} - \frac{3}{4}\left(\frac{33}{10}\right)$$

$$= -3/5$$

Coordinates of the foot of the perpendicular

$$\left(\frac{33}{10}, -\frac{3}{5}\right)$$

(05)

c) A (2,1) B (5,1) C(2,4)

$$\overline{AB} = \sqrt{(5-2)^2+(1-1)^2}$$

$$= \sqrt{3^2} = 3$$

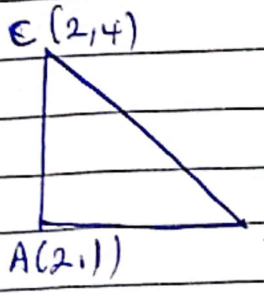
$$\overline{AC} = \sqrt{(2-2)^2+(4-1)^2}$$

$$= 3$$

$$\overline{BC} = \sqrt{(2-5)^2+(4-1)^2}$$

$$= \sqrt{3^2+3^2}$$

$$= 3\sqrt{2}$$



Since $\overline{AB} = \overline{AC} \neq BC$

and that A,B lies on a horizontal line where $y=1$

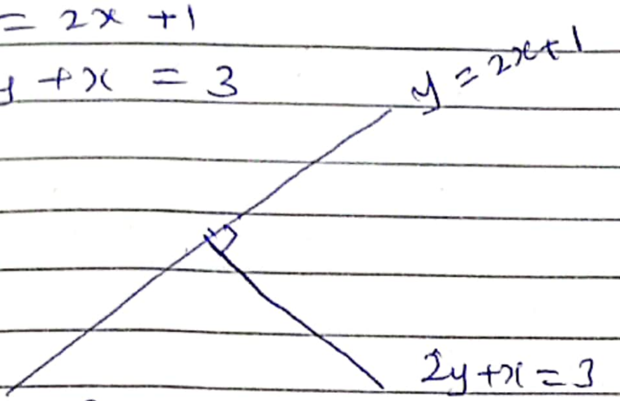
AC lies on a vertical line $x=2$

then the class forms a right angled isosceles triangle.

(05)

d) $y = 2x + 1$

$2y + x = 3$



Gradient of $y = 2x+1$

$M_1 = 2$

Gradient of $2x + x = 3$

$M_2 = -\frac{1}{2}$ ✓

Since the walk ways are perpendicular the largest negative angle is $-90°$ ✓ (02)

$$\tan\theta = \frac{M_2 - M_1}{1 + M_1M_2}$$ Alt

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

$$= \frac{-5/2}{0}$$

$$= -5/0$$

$$\theta = \tan^{-1}(-5/0)$$

$$= -90°$$

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TOTAL SCORE	X/20

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class '000'	f	c.f	I (10^3)	f.d (10^{-3})	x '000'	fx '000'	fx^2 (10^6)
0–100	10	10	100	0.1	50	2500	25000
100–180	32	42	80	0.4	140	19600	627200
180–270	18	60	90	0.2	225	50625	911250
270–350	12	72	80	0.15	310	96100	1153200
350–550	72	144	200	0.36	450	202500	14580000
550–560	16	160	10	1.6	555	308025	4928400
560–700	28	188	140	0.2	630	396900	11113200
700–800	12	200	100	0.12	750	562500	6750000
	$\Sigma f = 200$					$\Sigma fx = 80670$	$\Sigma fx^2 = 40088250$

(Don't allow if the thousands in the column heads are missing)

~~Def~~ Mean $= \frac{\Sigma fx}{\Sigma f}$

$= \frac{80670}{200} \times 1000$

$= (403.35) \times 1000$

$= 403,350$

Income per capita (annual) $= 403,350 \times 12$

$=$ sh. 4,839,000

Variability

variance $= \frac{\Sigma fx^2}{\Sigma f} - \left(\frac{\Sigma fx}{\Sigma f}\right)^2$

$= \frac{40088250}{200} - (403.35)^2 \times 10^6$

$= 37750.03 \times 10^6$

S.D $= 194.29 \times 10^3$

Accept any measure of dispersion | standard deviation, variance, mean absolute deviation, interquartile range

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$$Mode = L_0 + \left(\frac{d_1}{d_1+d_2}\right)i$$

$d_1 = 1.6 - 0.36 = 1.24 \times 10^{-6}$

$d_2 = 1.6 - 0.2 = 1.4 \times 10^{-6}$

$$Mode = \left[550 + \left(\frac{1.24}{1.24+1.4}\right)10\right] \times 1000$$

$= [550 + 4.70] \times 1000$

$= 554.70 \times 1000$

Mode $= 554.70 \times 1000$

$= 554{,}700$

(Accept the solution from the histogram)

Number of people earning at most sh.400 per day

Monthly Amount $= 400 \times 30$

$= 12000$ in thousands $= \frac{12000}{1000}$

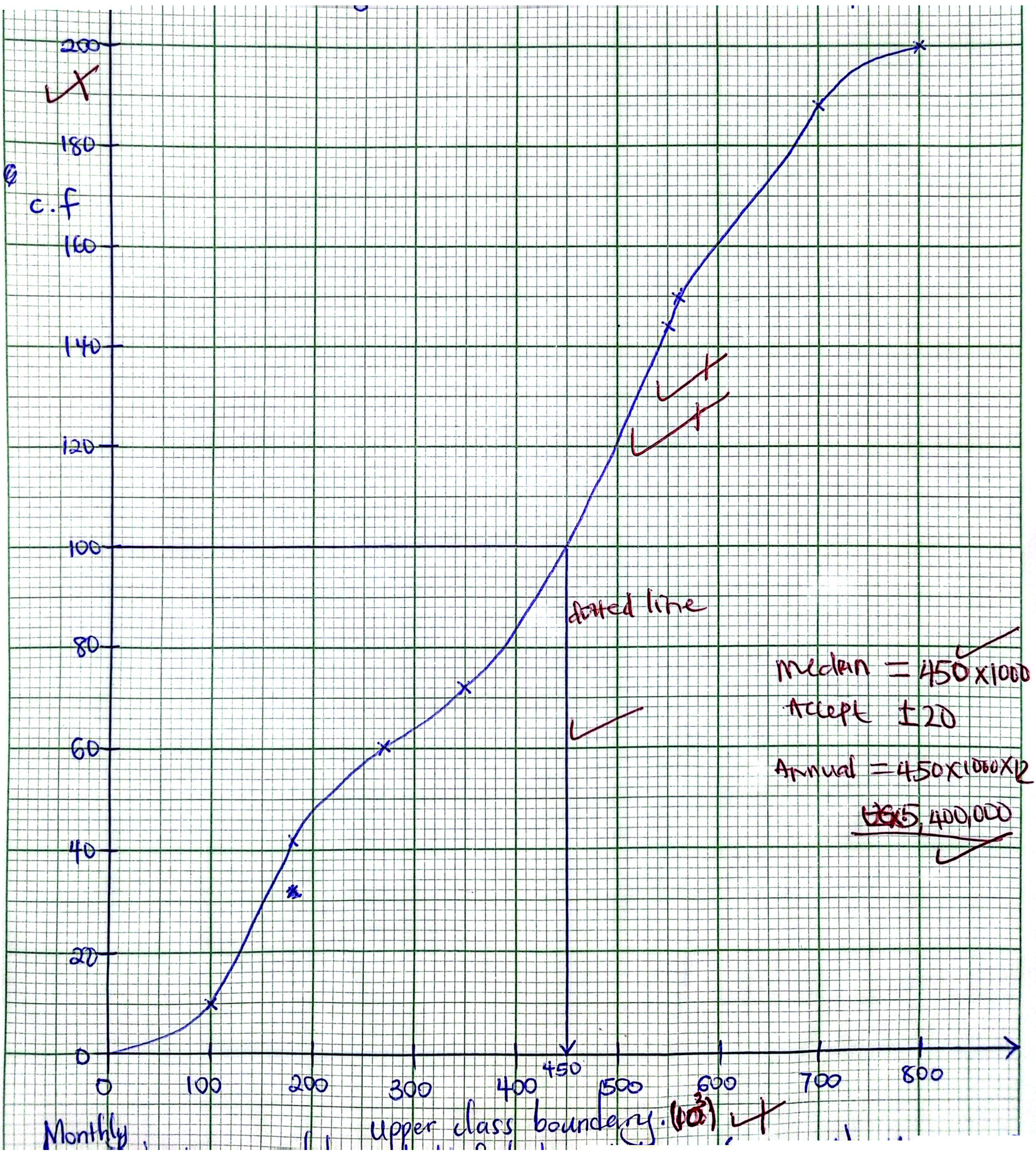
$= 12$

$$\Rightarrow 12 = 0 + \left(\frac{N-0}{10}\right)100$$

$N = 1.2$

$\simeq 2$ households

(Accept the solution from the ogive)



c.f
200
180
160
140
120
100
80
60
40
20
0
100
200
300
400
450
500
600
700
800
dotted line
Median = 450 x 1000
Accept ±20
Annual = 450 x 1000 x 12
5,400,000
Monthly
upper class boundary

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(b) Mark any genuine reason (✓)

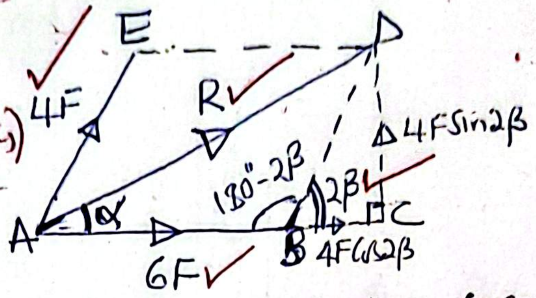
(01)

Total = 20 scores

(a). - Correct parallelogram drawn with ruler

- Correct labelling of 4F, 6F & 2β (2 mks)

- Correct labeling of R (1mk)



(05)

The two breakdowns are treated as two forces inclined at 2β.
Resultant of the two is the least force needed (R)

$$R = \sqrt{(6F + 4F\cos 2\beta)^2 + (4F\sin 2\beta)^2} \quad (\text{Considering } \Delta ACD)$$

$$R = \sqrt{36F^2 + 48F^2\cos 2\beta + 16F^2\cos^2 2\beta + 16F^2\sin^2 2\beta}$$

$$R = \sqrt{36F^2 + 48F^2\cos 2\beta + 16F^2(\cos^2 2\beta + \sin^2 2\beta)}$$

$$R = \sqrt{(52F^2 + 48F^2\cos 2\beta)}$$

$$R = \sqrt{4F^2(13 + 12\cos 2\beta)}$$

$$R = 2F(13 + 12\cos 2\beta)^{\frac{1}{2}} \ \#$$

(06)

Accept resolution of vectors and award accordingly

Accept use of cosine rule

(b) From ΔACD,

$$\tan\alpha = \frac{4F\sin 2\beta}{6F + 4F\cos 2\beta}$$

$$\tan\alpha = \frac{2F(2\sin 2\beta)}{2F(3 + 2\cos 2\beta)}$$

$$\alpha = \arctan\left(\frac{2\sin 2\beta}{3 + 2\cos 2\beta}\right) \ \#$$

(03)

(C) When $F = 50$, $\beta = 60°$

$$R = 2 \times 50\sqrt{13 + 12\cos(2\times 60°)}$$

$$R = 264.5751\text{N}$$

(02)

No, the problem would not have been solved. The required pulling force size (264.5751N) exceeds the maximum breaking tension of available chain (223N). The chain would snap under the load.

Immediate viable solution

(04)

- Doubling the chain or using a snatch block pulley system.

By doubling chain for a single tow car, the load is distributed doubling the breaking strength to 446N which safely accomodates the load (264.5751N)