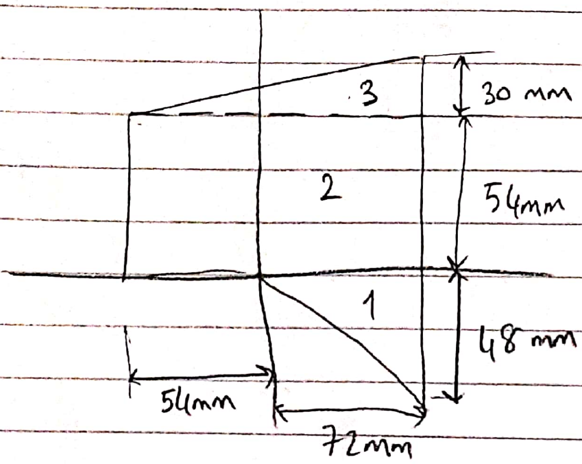
Q1 Free Body Diagram



Using Table form to locate the centroid

	Area	$\bar{x}$	$\bar{y}$	$\bar{x} \times$ Area	$\bar{y} \times$ Area
Part 1	1728	48	-16	82944	-27648
Part 2	6804	9	27	61236	183708
Part 3	1890	30	64	56700	120960
Σ	10422			200880	277020

Law of the centroid

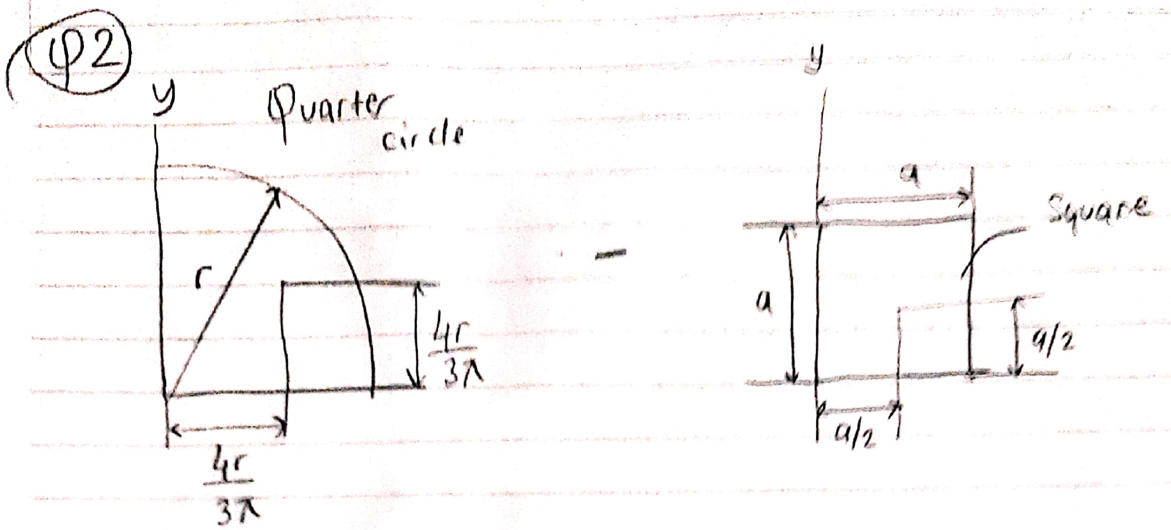
$$\bar{X} \Sigma A = \Sigma \bar{x} A$$

$$\bar{X} \times 10422 = 200880 \rightarrow \boxed{\bar{X} = 19.3 \text{ mm}}$$

$$\bar{Y} \Sigma A = \Sigma \bar{y} A$$

$$\bar{Y} \times 10422 = 277020 \rightarrow \boxed{\bar{Y} = 26.6 \text{ mm}}$$

Q2



Since, the x and y coordinates of each of the area component are equal, So, the x any y coordinates of the centroid are similar.

Component	Area (A)	$\bar{x}$	$\bar{x}A$
Quarter-circle	$\frac{\pi r^2}{4}$	$\frac{4r}{3\pi}$	$\frac{4r}{3\pi} \times \frac{\pi r^2}{4} = \frac{r^3}{3}$
Square	$-a^2$	$-\frac{a}{2}$	$\frac{-a^3}{2}$
	$\Sigma A = \frac{\pi r^2}{4} - a^2$		$\Sigma \bar{x} A = r^3 - \frac{a^3}{2}$

$\bar{x} \rightarrow$ centroid of individual areas.

$r \rightarrow$ radius

$a \rightarrow$ side of square

$\bar{X} = \frac{\Sigma \bar{x} A}{\Sigma A}$ $\quad \frac{r^3}{3} - \frac{a^3}{2}$ for $\Sigma \bar{x} A$ and $\frac{\pi r^2}{4} - a^2$ for ΣA

$$\bar{X} = \frac{\left(\frac{r^3}{3} - \frac{a^3}{2}\right)}{\frac{\pi r^2}{4} - a^2} \quad \text{...... (1)}$$

Substitude a for $\bar{x}$ in equation(1).

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

$$\frac{\pi a r^2}{4} - a^3 = \frac{r^3}{3} - \frac{a^3}{2}$$

$$\frac{\pi a r^2}{4} - \frac{r^3}{3} = a^3 - \frac{a^3}{2}$$

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

$$\frac{a^3}{2} - \frac{r^3}{3}\left(\frac{3\pi a}{4r} - 1\right) = 0$$

$$\frac{3a^3}{2r^3} - \frac{3\pi}{4}\left(\frac{a}{r}\right) + 1 = 0$$

$$1.5\left(\frac{a}{r}\right)^3 - \frac{3\pi}{4}\left(\frac{a}{r}\right) + 1 = 0$$

$$\frac{a}{r} = 0,917 \text{ or } -1,423 \text{ or } 0.508$$

the possible ratio $\boxed{a/r = 0,508}$