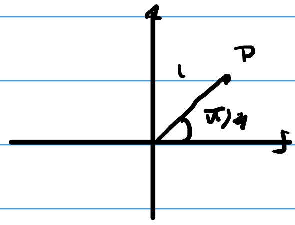
Lista 2

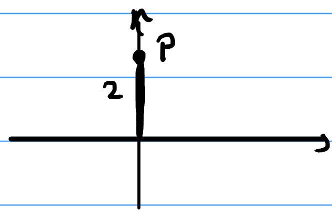
Seção 10.3: 1, 3, 5, 7, 9, 13, 15, 17, 19, 21, 25, 27, 29, 33, 57

① a) $(1, \pi/4) \Rightarrow$



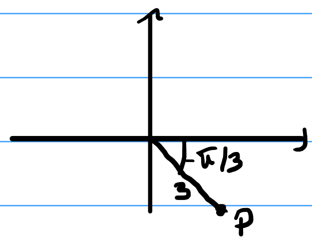
$\Rightarrow (1, \pi/4 + 2\pi)$
$(-1, \pi/4 + \pi)$.

b) $(-2, 3\pi/2) \Rightarrow$



$\Rightarrow (2, \pi/2)$
$(-2, 3\pi/2 + 2\pi)$

c) $(3, -\pi/3) \Rightarrow$



$\Rightarrow (3, 2\pi - \pi/3)$
$(-3, \pi - \pi/3)$.

$r < 0$:
Percorre o ângulo e depois faça uma reflexão

③ $(r, \theta) \Rightarrow \boxed{(r\cos\theta, r\sin\theta) = (x, y)}$

a) $(2, 3\pi/2) \Rightarrow (0, -2)$
b) $(\sqrt{2}, \pi/4) \Rightarrow (1, 1)$
c) $(-1, -\pi/6) \Rightarrow (-\sqrt{3}/2, 1/2)$

(5) a) (i) $r>0$ e $0 \leq \theta < 2\pi$

- $(-4,4) \Rightarrow (4\sqrt{2}, 3\pi/4)$

(ii) $r<0$ e $0 \leq \theta < 2\pi$

- $(-4,4) \Rightarrow (-4\sqrt{2}, 7\pi/4)$

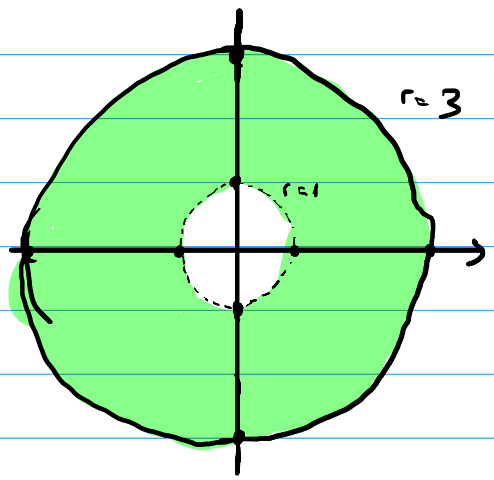
b) (i) $r>0$ e $0 \leq \theta < 2\pi$

- $(3, 3\sqrt{3}) \Rightarrow (6, \pi/3)$

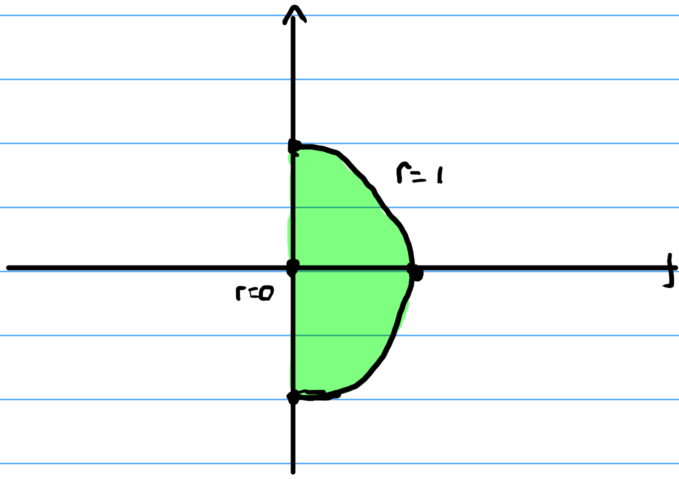
(ii) $r<0$ e $0 \leq \theta < 2\pi$

- $(3, 3\sqrt{3}) \Rightarrow (-6, 4\pi/3)$

(7) $\boxed{1 < r \leq 3}$ "Lembre-se, $r=K$ forma uma circunferência de raio K".



9. $0 \leq r \leq 1 \qquad -\pi/2 \leq \theta \leq \pi/2$



13. Distância entre $(4, 4\pi/3)$ e $(6, 5\pi/3)$

$(4, 4\pi/3) \Rightarrow (4\cos 4\pi/3, 4\,\text{sen}\, 4\pi/3) = (-2, -2\sqrt{3})$

$(6, 5\pi/3) \Rightarrow (6\cos 5\pi/3, 6\,\text{sen}\, 5\pi/3) = (3, -3\sqrt{3})$

Distância: $\sqrt{(3+2)^2 + (+3\sqrt{3} - 2\sqrt{3})^2} = \sqrt{25+3} = \boxed{2\sqrt{7}}$

15. $r^2 = 5 \Rightarrow x^2 + y^2 = 5$

$\boxed{\text{Circunferência do centro na origem e raio } \sqrt{5}}$

17) $r = 5\cos\theta$ $\begin{cases} x = r\cos\theta \\ y = r\,\text{sen}\,\theta \\ x^2 + y^2 = r^2 \end{cases}$

$\Rightarrow r^2 = 5r\cos\theta \Rightarrow r^2 = 5x \Rightarrow x^2 - 5x + y^2 = 0$

$x^2 - 5x + \frac{25}{4} + y^2 = \frac{25}{4}$

$\boxed{(x - 5/2)^2 + y^2 = (5/2)^2}$

19) $r^2\cos 2\theta = 1$

$r^2 \cdot \cos^2\theta - r^2\,\text{sen}^2\theta = 1$

$\boxed{x^2 - y^2 = 1}$ Hipérbole

21) $x^2 + y^2 = 7 \Rightarrow \boxed{r^2 = 7}$

25) $x^2 + y^2 = 4y$

$r^2 = 4r\,\text{sen}\,\theta$

$\boxed{r = 4\,\text{sen}\,\theta}$

27) a) Qualquer uma : Polar : $\theta = \pi/6$

b) $x = 3$.

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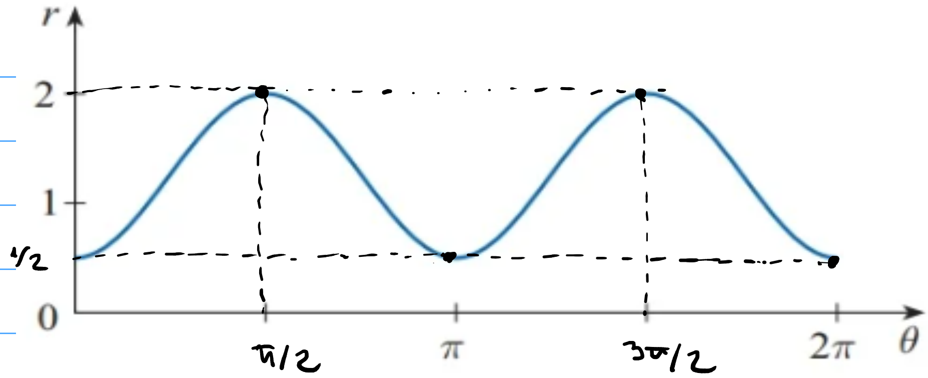
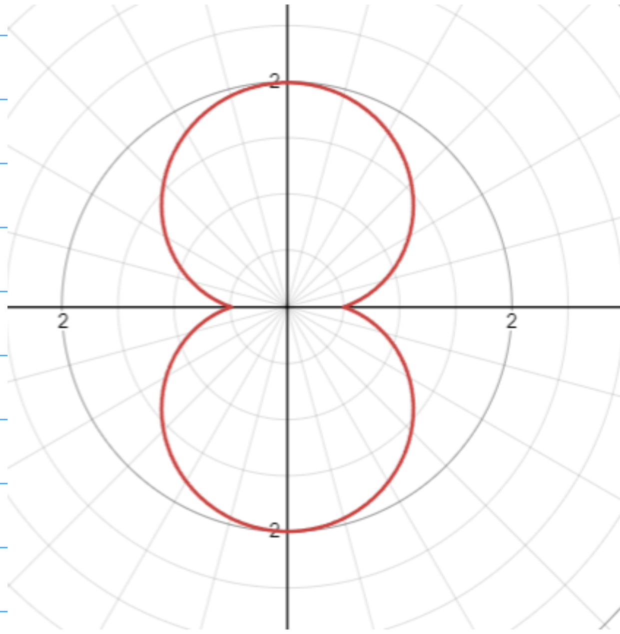


$$\boxed{r = \frac{1}{2} + \frac{3}{2}|\operatorname{sen}\theta|}$$

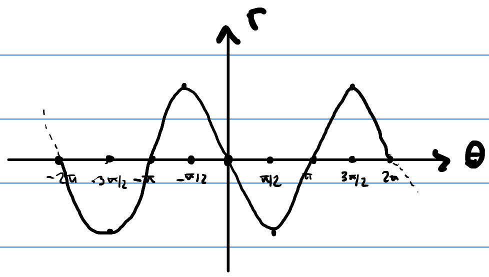


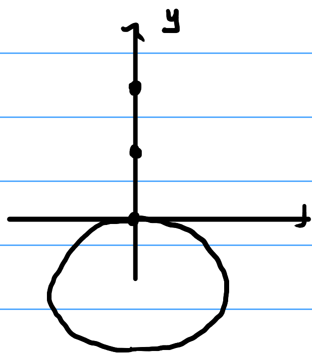
33 $r = -2\operatorname{sen}\theta$

$\downarrow$

$x^2 + y^2 = -4y$

$$\boxed{x^2 + (y+2)^2 = 4}$$





57) $r = a\,\text{sen}\theta + b\cos\theta$ $\qquad \begin{cases} x = r\cos\theta \\ y = r\,\text{sen}\theta \end{cases} \qquad \begin{cases} r^2 = x^2 + y^2 \end{cases}$

$$r = a \cdot \frac{y}{r} + b \cdot \frac{x}{r}$$

$$r^2 = ay + bx$$

$$x^2 - bx + \frac{b^2}{4} + y^2 - ay + \frac{a^2}{4} = \frac{a^2+b^2}{4}$$

$$\boxed{(x - b/2)^2 + (y - a/2)^2 = \left(\frac{\sqrt{a^2+b^2}}{2}\right)^2}$$

$$\boxed{\text{Raio}: \frac{\sqrt{a^2+b^2}}{2}}$$

Seção 10.4: 1, 3, 5, 7, 9, 11, 17, 19, 21, 23, 27, 29, 35, 37, 45, 48, 63, 67, 69

(1) $r = \sqrt{2\theta}$; $0 \leq \theta \leq \pi/2$

$$A = \frac{1}{2}\int_0^{\pi/2} r^2 \, d\theta$$

⇒ Obtemos esse resultado com a fórmula da área do setor $A = \frac{1}{2} r^2 \theta$ e com a soma de Riemann.

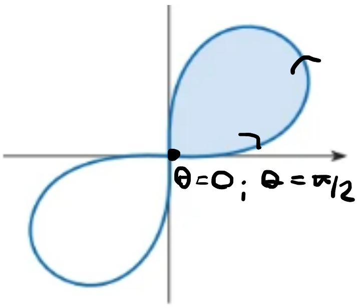
$$A = \frac{1}{2}\int_0^{\pi/2} 2\theta \, d\theta = \int_0^{\pi/2} \theta \, d\theta = \frac{\theta^2}{2}\Big|_0^{\pi/2} = \boxed{\frac{\pi^2}{8}}$$

(3) $r = \operatorname{sen}\theta + \cos\theta$; $0 \leq \theta \leq \pi$

$$A = \frac{1}{2}\int_0^{\pi} (\operatorname{sen}\theta + \cos\theta)^2 \, d\theta = \frac{1}{2}\int_0^{\pi} (1 + \operatorname{sen}2\theta) \, d\theta = \frac{1}{2}\left(\theta - \frac{\cos 2\theta}{2}\right)\Big|_0^{\pi}$$

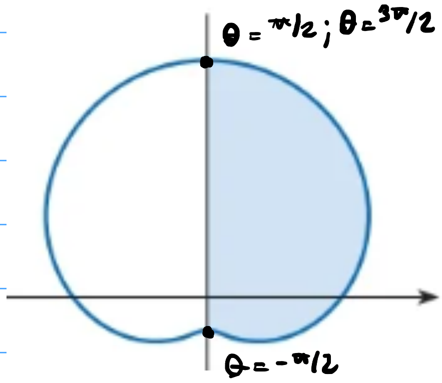
$$= \frac{1}{2}\left(\pi - \frac{1}{2} - \left(0 - \frac{1}{2}\right)\right) = \boxed{\frac{\pi}{2}}$$

⑤ $r^2 = \operatorname{sen} 2\theta$



$$A = \frac{1}{2}\int_0^{\pi/2} \operatorname{sen} 2\theta \, d\theta = \frac{1}{2}\cdot\left(-\frac{\cos 2\theta}{2}\right)\Bigg|_0^{\pi/2} = \frac{1}{2}\cdot\left(\frac{1}{2}+\frac{1}{2}\right) = \boxed{\frac{1}{2}}$$

⑦ $r = 4 + 3\operatorname{sen}\theta$

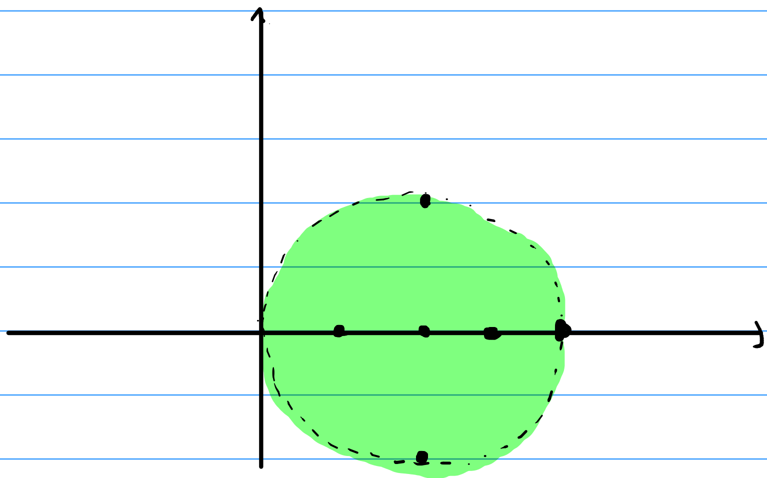


$$A = \frac{1}{2}\int_{-\pi/2}^{\pi/2} (16 + 24\operatorname{sen}\theta + 9\operatorname{sen}^2\theta)\, d\theta = \frac{1}{2}\int_{-\pi/2}^{\pi/2}\left(16 + 24\operatorname{sen}\theta + \frac{9}{2}(1-\cos 2\theta)\right) d\theta$$

$$= \frac{1}{2}\cdot\left(16\theta - 24\cos\theta + \frac{9}{2}\theta - \frac{9}{4}\operatorname{sen} 2\theta\right)\Bigg|_{-\pi/2}^{\pi/2}$$

$$= \frac{1}{2}\left(\frac{41\theta}{2} - 24\cos\theta - \frac{9}{4}\operatorname{sen} 2\theta\right)\Bigg|_{-\pi/2}^{\pi/2} = \frac{1}{2}\left(\frac{41\pi}{4} - \left(-\frac{41\pi}{4}\right)\right) = \boxed{\frac{41\pi}{4}}$$

(9) $r = 4\cos\theta \Rightarrow x^2 + y^2 = 4x \Rightarrow \boxed{(x-2)^2 + y^2 = 2^2}$



$$A = \frac{1}{2}\int_0^{\pi} 16\cos^2\theta \, d\theta$$

$$A = 4\int_0^{\pi} (1+\cos 2\theta)\, d\theta$$

$$A = 4\left(\theta + \frac{\sin 2\theta}{2}\right)\Big|_0^{\pi}$$

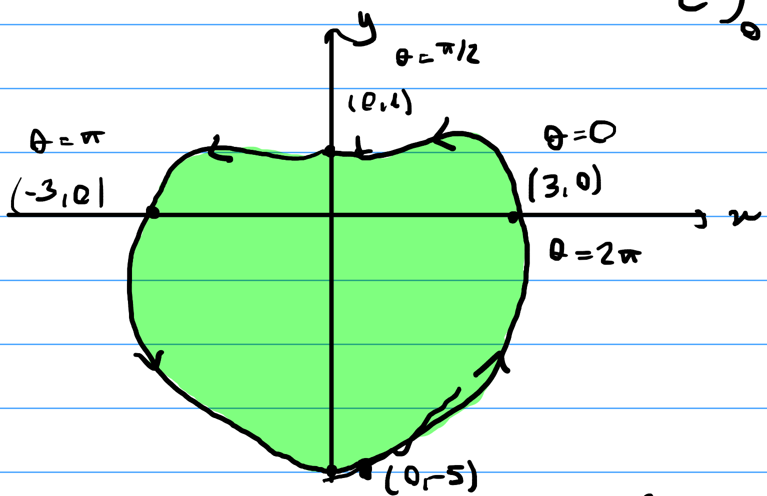
$$\boxed{A = 4\pi}$$

(11) $r = 3 - 2\sin\theta$

$$A = \frac{1}{2}\int_0^{2\pi} (9 - 12\sin\theta + 2(1-\cos 2\theta))\, d\theta$$

$x = (3 - 2\sin\theta)\cos\theta$

$y = (3 - 2\sin\theta)\sin\theta$



$$A = \frac{1}{2}\left(11\theta + 12\cos\theta - \sin 2\theta\right)\Big|_0^{2\pi} = \frac{1}{2}(22\pi) = \boxed{11\pi}$$

Isso seria apenas 1 dos 3 laços da Rosácea

(17) $r = 4\cos 3\theta \Rightarrow A = \frac{1}{2}\int_0^{\pi/3} \frac{16(1+\cos 6\theta)}{2}\, d\theta$

$$A = 4 \cdot \int_0^{\pi/3} (1+\cos 6\theta)\, d\theta = 4 \cdot \left(\theta + \frac{\operatorname{sen} 6\theta}{6}\right)\Bigg|_0^{\pi/3} = \boxed{\frac{4\pi}{3}}$$

(19) $r = \operatorname{sen} 4\theta \Rightarrow A = \frac{1}{2}\int_0^{\pi/4} \frac{1}{2}(1-\cos 8\theta)\, d\theta$

$$A = \frac{1}{4}\left(\theta - \frac{\operatorname{sen} 8\theta}{8}\right)\Bigg|_0^{\pi/4} = \frac{1}{4} \cdot \frac{\pi}{4} = \boxed{\frac{\pi}{16}}$$

(21) $r = 1 + 2\operatorname{sen}\theta$ (laço interno) $\}$ $\operatorname{sen}\theta = -1/2 \Rightarrow \theta = \{\frac{7\pi}{6}, \frac{11\pi}{6}\}$

$$A = \frac{1}{2}\int_{7\pi/6}^{11\pi/6} \left(1 + 4\operatorname{sen}\theta + \frac{4}{2}(1-\cos 2\theta)\right) d\theta = \frac{1}{2}\int_{7\pi/6}^{11\pi/6} (3 + 4\operatorname{sen}\theta - 2\cos 2\theta)\, d\theta$$

$$= \frac{1}{2}\left(3\theta - 4\cos\theta - \operatorname{sen} 2\theta\right)\Bigg|_{7\pi/6}^{\frac{11\pi}{6}} = \frac{1}{2}\left(2\pi - 3\sqrt{3}\right) = \boxed{\pi - \frac{3\sqrt{3}}{2}}$$

23 $r = 4\,\text{sen}\,\theta \; ; \; r = 2$

$$\text{sen}\,\theta = \frac{1}{2} \Rightarrow \theta = \left\{\frac{\pi}{6}, \frac{5\pi}{6}\right\}$$

$$A = \frac{1}{2}\int_{\pi/6}^{5\pi/6} \left(16\,\text{sen}^2\theta - 4\right) d\theta = \frac{1}{2} \cdot \int_{\pi/6}^{5\pi/6} \left(\frac{16}{2}(1 - \cos 2\theta) - 4\right) d\theta$$

$$= \frac{1}{2} \cdot \int_{\pi/6}^{5\pi/6} \left(4 - 8\cos 2\theta\right) d\theta = 2 \cdot \int_{\pi/6}^{5\pi/6} \left(1 - 2\cos 2\theta\right) d\theta = 2\left(\theta - \text{sen}\,2\theta\right)\Big|_{\pi/6}^{5\pi/6}$$

$$= 2 \cdot \left(\frac{5\pi}{6} + \frac{\sqrt{3}}{2} - \left(\frac{\pi}{6} - \frac{\sqrt{3}}{2}\right)\right) = 2 \cdot \left(\frac{4\pi}{6} + \sqrt{3}\right) = \boxed{\frac{4\pi}{3} + 2\sqrt{3}}$$

27 $r = 3\cos\theta \Rightarrow 3\cos\theta = 1 + \cos\theta$

$r = 1 + \cos\theta \Rightarrow \cos\theta = 1/2 \Rightarrow \theta = \{\pi/3, -\pi/3\}$

$$A = \frac{1}{2}\int_{-\pi/3}^{\pi/3} \left(9\cos^2\theta - (1 + 2\cos\theta + \cos^2\theta)\right) d\theta = \frac{1}{2}\int_{-\pi/3}^{\pi/3} \left(8\cos^2\theta - 2\cos\theta - 1\right) d\theta$$

$$= \frac{1}{2}\int_{-\pi/3}^{\pi/3} \left(\frac{8}{2}(1 + \cos 2\theta) - 2\cos\theta - 1\right) d\theta = \frac{1}{2}\int_{-\pi/3}^{\pi/3} \left(3 + 4\cos 2\theta - 2\cos\theta\right) d\theta$$

$$= \frac{1}{2}\left(3\theta + 2\,\mathrm{sen}\,2\theta - 2\,\mathrm{sen}\,\theta\right)\Big|_{-\pi/3}^{\pi/3} = \frac{1}{2}\left(\pi + \pi\right) = \boxed{\pi}$$

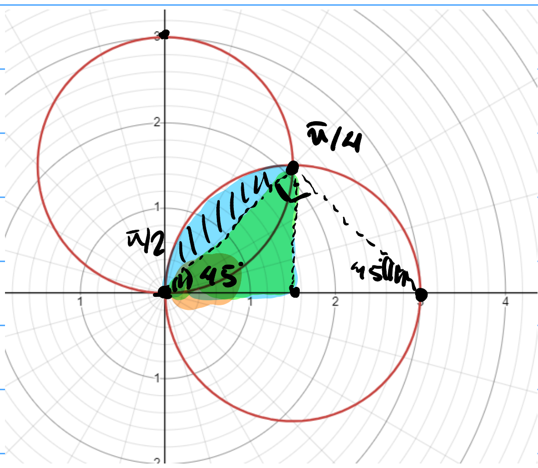
$$\pi - 2\cdot\frac{\sqrt{3}}{2} + \frac{2\sqrt{3}}{2} - \left(-\pi + \frac{2\sqrt{3}}{2} - \frac{2\sqrt{3}}{2}\right)$$

(29) Sem cálculo:

$r = 3\,\mathrm{sen}\,\theta$

$r = 3\cos\theta$

$$\boxed{\theta = \{\pi/4,\ 5\pi/4\}}$$



Circunferência de raio $3/2$. Área pedida:

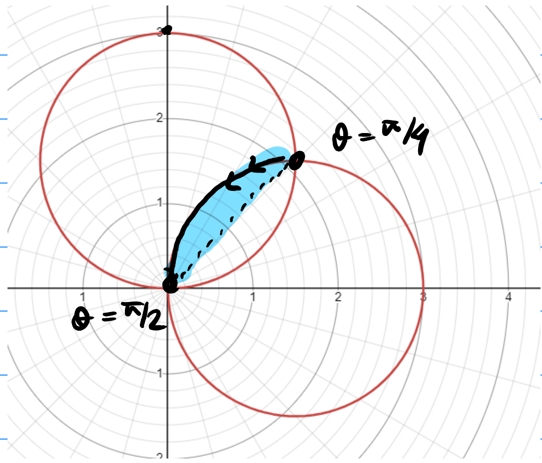
$$2\cdot\left(\frac{1}{4}\cdot\pi\cdot\left(\frac{3}{2}\right)^2 - \left(\frac{3}{2}\right)^2\cdot\frac{1}{2}\right) = \boxed{\frac{9\pi}{8} - \frac{9}{4}}$$

Com cálculo:

$$A = 2 \cdot \frac{1}{2} \int_{\pi/4}^{\pi/2} 9 \cos^2\theta \, d\theta = \frac{9}{2} \int_{\pi/4}^{\pi/2} (1+\cos 2\theta) \, d\theta = \frac{9}{2}\left(\theta + \frac{\operatorname{sen} 2\theta}{2}\right)\Bigg|_{\pi/4}^{\pi/2}$$

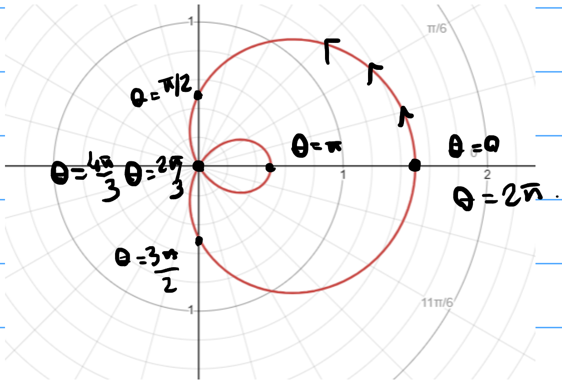
$$= \frac{9}{2}\left(\frac{\pi}{2} + 0 - \left(\frac{\pi}{4} + \frac{1}{2}\right)\right) = \frac{9}{2}\left(\frac{\pi}{4} - \frac{1}{2}\right) = \boxed{\frac{9}{8}\pi - \frac{9}{4}}$$

A paramétrica $r = 3\cos\theta$ vai percorrer a área em azul de $\theta = \pi/4$ a $\theta = \pi/2$



(35) Curva: $r = \frac{1}{2} + \cos\theta$

$$\begin{cases} x = (1/2 + \cos\theta)\cos\theta \\ y = (1/2 + \cos\theta)\,\text{sen}\,\theta \end{cases}$$



$$A_{TOTAL} = 2 \cdot \frac{1}{2} \int_0^{2\pi/3} \left(\frac{1}{4} + \cos\theta + \frac{1}{2}(1 + \cos 2\theta)\right) d\theta$$

$$= \int_0^{2\pi/3} \left(\frac{3}{4} + \cos\theta + \frac{1}{2}\cos 2\theta\right) d\theta$$

$$= \left(\frac{3}{4}\theta + \text{sen}\,\theta + \frac{\text{sen}\,2\theta}{4}\right)\Bigg|_0^{2\pi/3}$$

$$A_{TOTAL} = \left(\frac{\pi}{2}\right)$$

$$A_{interior} = 2 \cdot \frac{1}{2}\left(\frac{3}{4}\theta + \text{sen}\,\theta + \frac{\text{sen}\,2\theta}{4}\right)\Bigg|_{\pi}^{4\pi/3} = \left(\frac{\pi}{4} - \frac{3\sqrt{3}}{4}\right)$$

$$\boxed{A = \frac{1}{4}(\pi + 3\sqrt{3})}$$

37) todos os pontos de interseção entre

$r = \operatorname{sen}\theta$

$r = 1 - \operatorname{sen}\theta$

$\Rightarrow r_1 : \begin{cases} x = \operatorname{sen}\theta\cos\theta \\ y = \operatorname{sen}^2\theta \end{cases} ; \quad r_2 : \begin{cases} x = \cos\theta(1-\operatorname{sen}\theta) \\ y = (1-\operatorname{sen}\theta)\operatorname{sen}\theta \end{cases}$

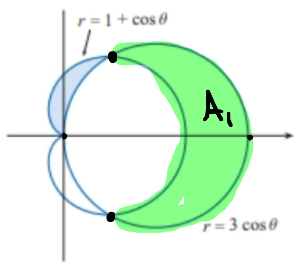
$\Rightarrow \begin{cases} \operatorname{sen}\theta\cos\theta = \cos\theta(1-\operatorname{sen}\theta) \\ \operatorname{sen}^2\theta = (1-\operatorname{sen}\theta)\operatorname{sen}\theta \end{cases}$

I) $\cos\theta(1-2\operatorname{sen}\theta) = 0 \Rightarrow \cos\theta = 0$, $\operatorname{sen}\theta = 1/2$ $\quad \boxed{\theta = \{\pi/2, 3\pi/2, \pi/6, 5\pi/6\}}$

II) $\operatorname{sen}\theta(1-2\operatorname{sen}\theta) = 0 \Rightarrow \operatorname{sen}\theta = 0$, $\operatorname{sen}\theta = 1/2$ $\quad \boxed{\theta = \{0, \pi, 2\pi, \pi/6, 5\pi/6\}}$

$\boxed{\text{Interseções: } (1/2, \pi/6), (1/2, 5\pi/6) \text{ e polo}}$

45) 45.



Área Cardioide: $2 \cdot \frac{1}{2} \int_0^{\pi} (1+\cos\theta)^2 \, d\theta$

$= \int_0^{\pi} \left(\frac{3}{2} + 2\cos\theta + \frac{1}{2}\cos 2\theta\right) d\theta$

$= \left(\frac{3}{2}\theta + 2\operatorname{sen}\theta + \frac{\operatorname{sen}2\theta}{4}\right)\Big|_0^{\pi} = \boxed{\frac{3\pi}{2}}$

$1 + \cos\theta = 3\cos\theta$

$\cos\theta = 1/2$

$\theta = \{\pi/3, -\pi/3\}$

Área círculo: $\frac{9\pi}{4}$, $\left(2\cdot\frac{1}{2}\int_0^{\pi/2} 9\cos^2\theta\, d\theta\right)$.

Área A_1: $\frac{1}{2}\int_{-\pi/3}^{\pi/3}\left(9\cos^2\theta - 1 - 2\cos\theta - \cos^2\theta\right) d\theta$

$$= \frac{1}{2}\int_{-\pi/3}^{\pi/3}\left(\frac{8}{2}(1+\cos 2\theta) - 2\cos\theta - 1\right) d\theta$$

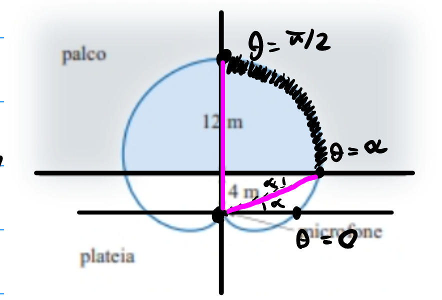
$$= \frac{1}{2}\int_{-\pi/3}^{\pi/3}\left(3 + 4\cos 2\theta - 2\cos\theta\right) d\theta = \frac{1}{2}\left(3\theta + 2\,\text{sen}\,2\theta - 2\,\text{sen}\,\theta\right)\Big|_{-\pi/3}^{\pi/3}$$

$$= \frac{1}{2}\left(\pi + 2\cdot\frac{\sqrt{3}}{2} - 2\cdot\frac{\sqrt{3}}{2} - \left(-\pi - 2\cdot\frac{\sqrt{3}}{2} + 2\frac{\sqrt{3}}{2}\right)\right) = \boxed{\pi}$$

$$A = \frac{\frac{3\pi}{2} - \left(\frac{9\pi}{4} - \pi\right)}{2} = \frac{\frac{3\pi}{2} - \frac{5\pi}{4}}{2} = \boxed{\frac{\pi}{8}}$$

(48)

$y=4$



Queremos a área em azul, sabendo que a cardioide é $8+8\,\text{sen}\,\theta$.

$$\cancel{8}^{2}(1+\text{sen}\,\theta)\,\text{sen}\,\theta = \cancel{4} \Rightarrow 2\,\text{sen}\,\theta + 2\,\text{sen}^2\theta - 1 = 0$$

$$\operatorname{sen}\theta = \frac{-2 \pm \sqrt{4+8}}{4} = \frac{-2 \pm 2\sqrt{3}}{4} = \frac{-1 \pm \sqrt{3}}{2} \Rightarrow \boxed{\frac{\sqrt{3}-1}{2}}$$

$$\boxed{\therefore\ \theta = \operatorname{Arcsin}\left(\frac{\sqrt{3}-1}{2}\right) = \alpha}$$

$$A = 2.\left(\frac{1}{2}\int_{\operatorname{Arcsin}\left(\frac{\sqrt{3}-1}{2}\right)}^{\pi/2} 64\left(1 + 2\operatorname{sen}\theta + \operatorname{sen}^2\theta\right) d\theta - \frac{1}{2}.4.4.\operatorname{cotg}\left(\operatorname{Arcsin}\left(\frac{\sqrt{3}-1}{2}\right)\right)\right)$$

$$A = 64.\int_{\alpha}^{\pi/2}\left(\frac{3}{2} + 2\operatorname{sen}\theta - \frac{1}{2}\cos 2\theta\right)d\theta - 16\operatorname{cotg}\alpha$$

$$\boxed{A = 64\left(\frac{3}{2}\theta - 2\cos\theta - \frac{1}{4}\operatorname{sen}2\theta\right)\Bigg|_{\alpha}^{\pi/2} - 16\operatorname{cotg}\alpha}$$

63) $r = 2\cos\theta \qquad \theta = \pi/3$

$$\begin{cases} x = 2\cos^2\theta \\ y = \text{sen}\,2\theta \end{cases} \qquad \frac{dy}{dx} = \frac{dy/d\theta}{dx/d\theta} = \frac{\cancel{2}\cos 2\theta}{{}_2\cancel{4}\cos\theta\cdot(-\text{sen}\,\theta)} = \boxed{-\cot g\, 2\theta}$$

Em $\theta = \pi/3 \Rightarrow \dfrac{dy}{dx} = -\left(-\dfrac{\sqrt{3}}{3}\right) = \boxed{\dfrac{\sqrt{3}}{3}}$

67) $r = \cos 2\theta \quad , \quad \theta = \pi/4$

$$\begin{cases} x = \cos 2\theta \cos\theta \\ y = \cos 2\theta\, \text{sen}\,\theta \end{cases} \qquad \begin{aligned} dx/d\theta &= -2\,\text{sen}\,2\theta.\cos\theta - \cos 2\theta\,\text{sen}\,\theta \\ dy/d\theta &= -2\,\text{sen}\,2\theta\cdot\text{sen}\,\theta + \cos 2\theta\cos\theta \end{aligned}$$

$$\boxed{\frac{dy}{dx} = -\frac{\cos 2\theta\cos\theta - 2\,\text{sen}\,2\theta\,\text{sen}\,\theta}{\cos 2\theta\,\text{sen}\,\theta + 2\,\text{sen}\,2\theta\cos\theta}}$$

Em $\pi/4$: $dy/dx = -\left(\dfrac{-2\cdot\sqrt{2}/\cancel{2}}{2\cdot\sqrt{2}/\cancel{2}}\right) = \boxed{+1}$

69) $r = \text{sen}\,\theta$

$$\begin{cases} x = \text{sen}\,2\theta/2 \\ y = \text{sen}^2\theta \end{cases} \qquad \begin{aligned} dx/d\theta &= \cos 2\theta \\ dy/d\theta &= \text{sen}\,2\theta \end{aligned}$$

$$\boxed{dy/dx = \frac{\text{sen}\,2\theta}{\cos 2\theta}}$$

Tangentes horizontais: $dy/d\theta = 0 \wedge dx/d\theta \neq 0$

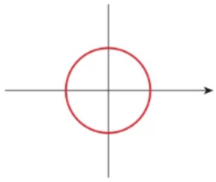
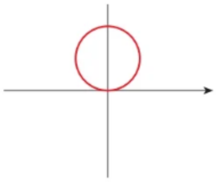
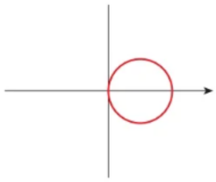
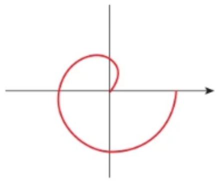
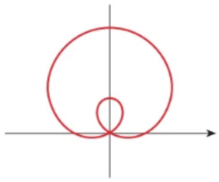
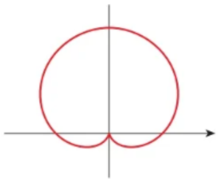
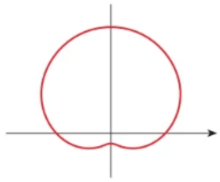
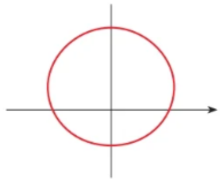
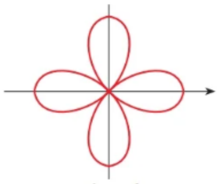
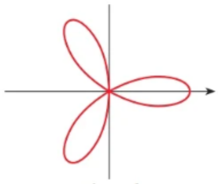
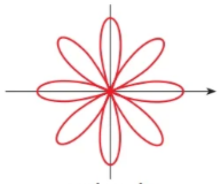
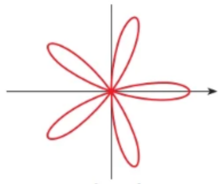
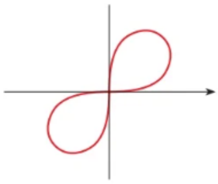
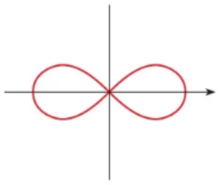
- $\text{sen} 2\theta = 0 \Rightarrow \theta = \{0, \pi/2, \pi\}$
- $\cos 2\theta \neq 0$

$\boxed{\text{Pontos: polo}, (1, \pi/2)}$

Tangentes verticais: $dy/d\theta \neq 0 \wedge dx/d\theta = 0$

- $\text{sen} 2\theta \neq 0 \Rightarrow \theta = \{\pi/4, 3\pi/4\}$
- $\cos 2\theta = 0$

$\boxed{\text{Pontos: } (\sqrt{2}/2, \pi/4), (\sqrt{2}/2, 3\pi/4)}$

Circunferências e Espirais	 circunferência $r = a$	 circunferência $r = a \operatorname{sen} \theta$	 circunferência $r = a \cos \theta$	 espiral $r = a\theta$
Limaçons $r = a \pm b \operatorname{sen} \theta$ $r = a \pm b \cos \theta$ $(a > 0, b > 0)$ A orientação depende da função trigonométrica (seno ou cosseno) e do sinal de b	 limaçon com laço interno $a < b$	 cardioide $a = b$	 limaçon com "covinha" $a > b$	 limaçon convexo $a \geq 2b$
Rosáceas $r = a \operatorname{sen} n\theta$ $r = a \cos n\theta$ Com n pétalas se n é ímpar Com $2n$ pétalas se n é par	 rosácea de quatro pétalas $r = a \cos 2\theta$	 rosácea de três pétalas $r = a \cos 3\theta$	 rosácea de oito pétalas $r = a \cos 4\theta$	 rosácea de cinco pétalas $r = a \cos 5\theta$
Lemniscatas Curvas em forma de oito	 lemniscata $r^2 = a^2 \operatorname{sen} 2\theta$	 lemniscata $r^2 = a^2 \cos 2\theta$		