(163) $r(t) = \begin{pmatrix} t^2 \\ 5t \\ t^2 - 16t \end{pmatrix}$

when is speed minimum?

$\bar{r}'(t) = \begin{pmatrix} 2t \\ 5 \\ 2t - 16 \end{pmatrix}$

speed^2 $|\bar{r}'(t)|^2 = 4t^2 + 5^2 + (2t-16)^2$

$= 4t^2 + 25 + 4t^2 - 32t + 256$

$= 8t^2 - 32t + 281$

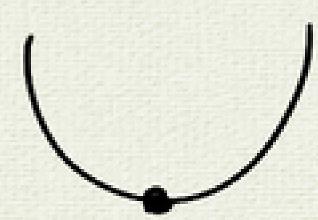
minimize this

$f(t) = 8t^2 - 32t + 281$

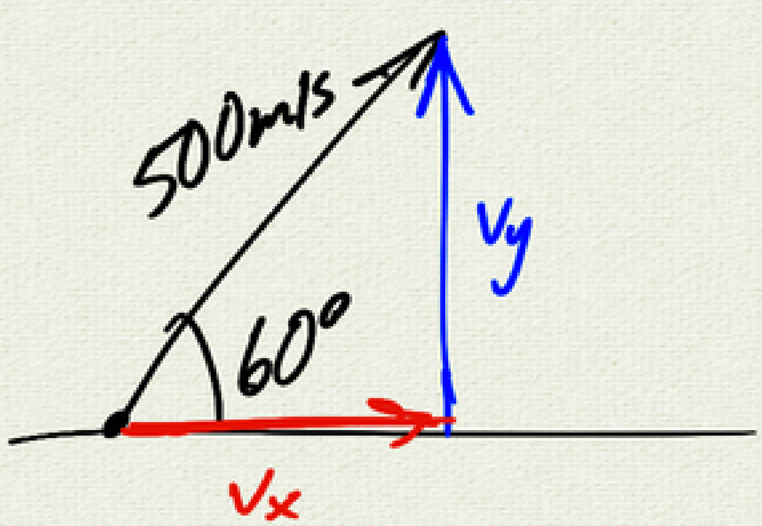
$f'(t) = 16t - 32$

$f'(t) = 0 \Longrightarrow t = 2$

$f''(t) = 16 > 0$ local min



(173 - 177)



$V_x = 500 \cos 60°$

$V_y = 500 \sin 60°$

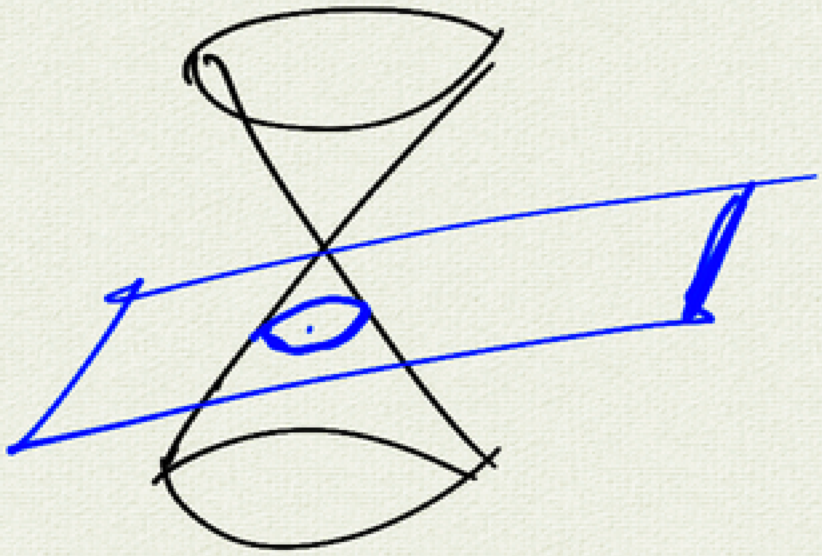
$x(t) = x_0 + v_x t$

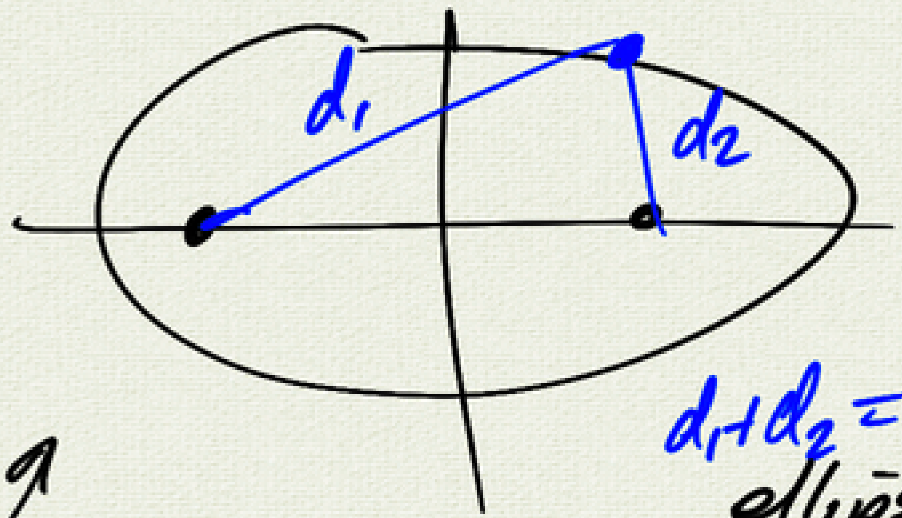
$y(t) = y_0 + v_y t - 4.9t^2$

gravity $-9.8\ m/s^2$

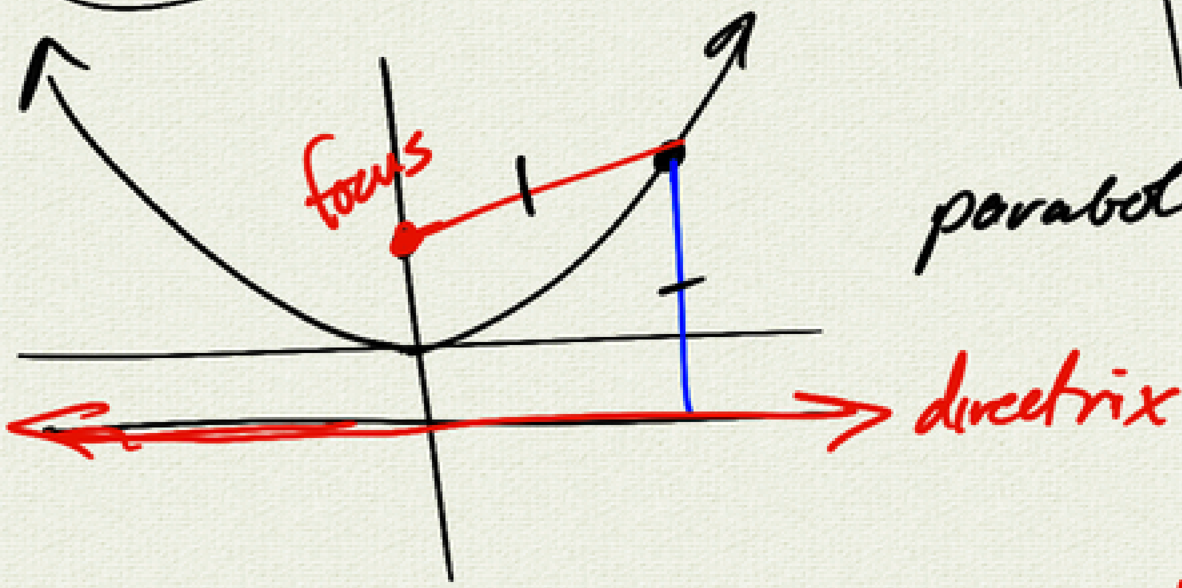
2.6 Polar conics

geometric definitions

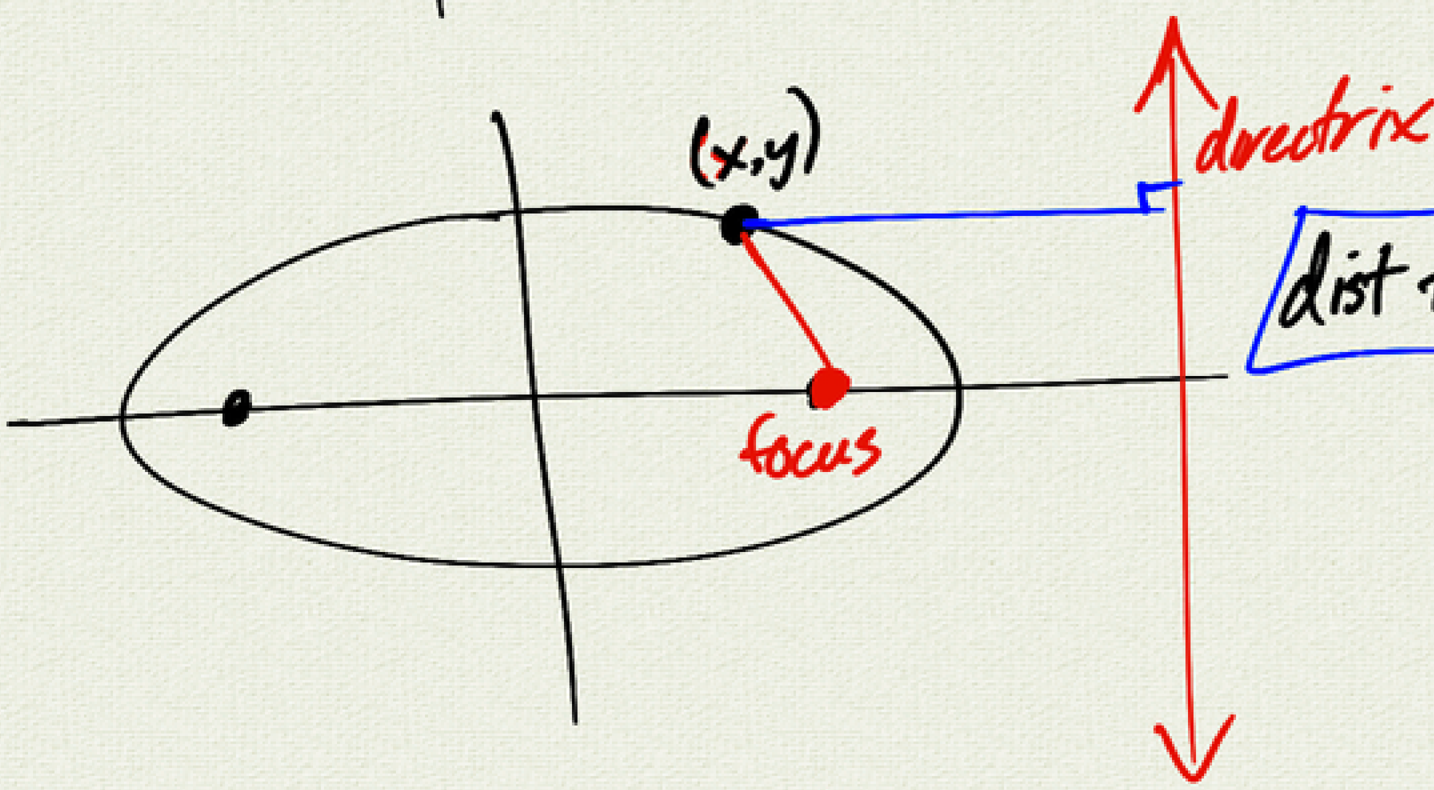




$d_1 + d_2 = \text{const.}$
ellipse



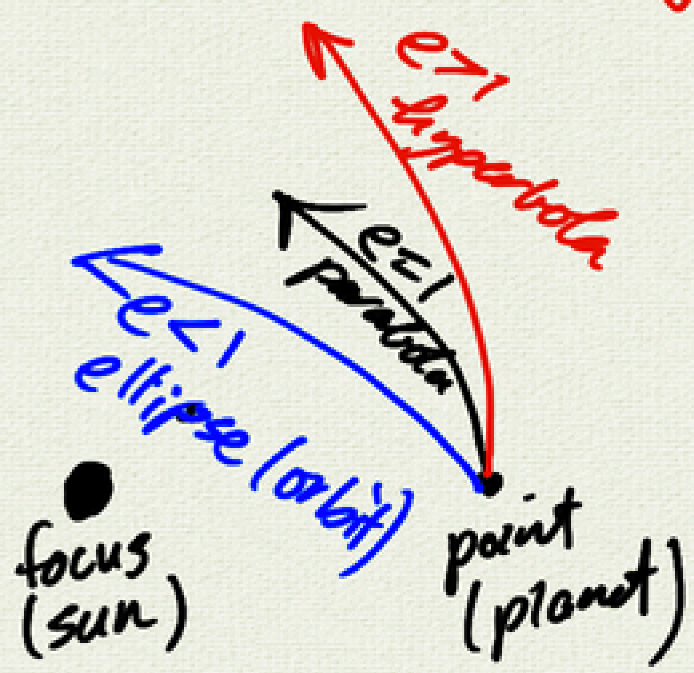
parabola

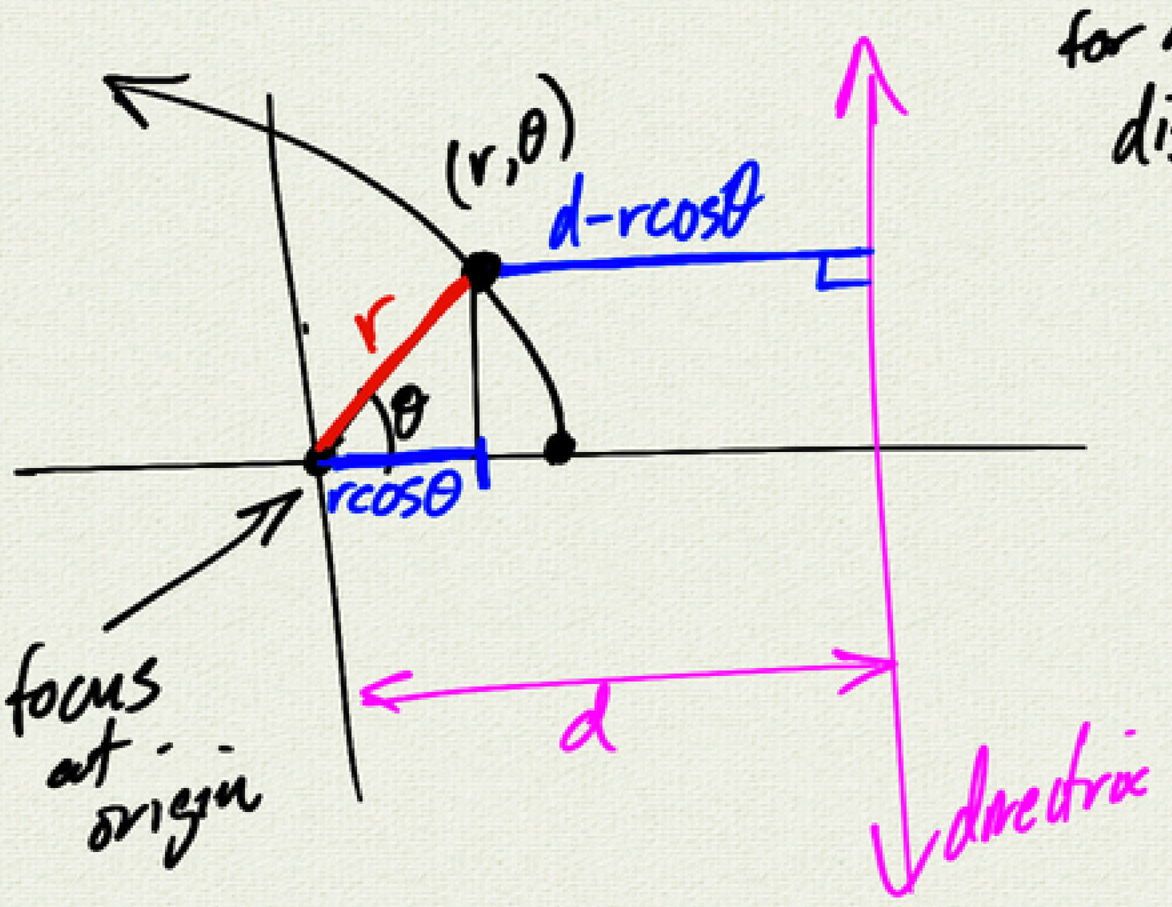


eccentricity

$\boxed{\text{dist to focus} = e(\text{dist to directrix})}$

ellipse	$0 < e < 1$
parabola	$e = 1$
hyperbola	$e > 1$





for any (x,y):

dist to focus $= e$(dist to directrix)

$$r = e(d - r\cos\theta)$$
$$= ed - er\cos\theta$$
$$r(1 + e\cos\theta) = ed$$
$$\boxed{r = \frac{ed}{1 + e\cos\theta}}$$

$e = 0$ circle

$0 < e < 1$ ellipse

$e = 1$ parabola

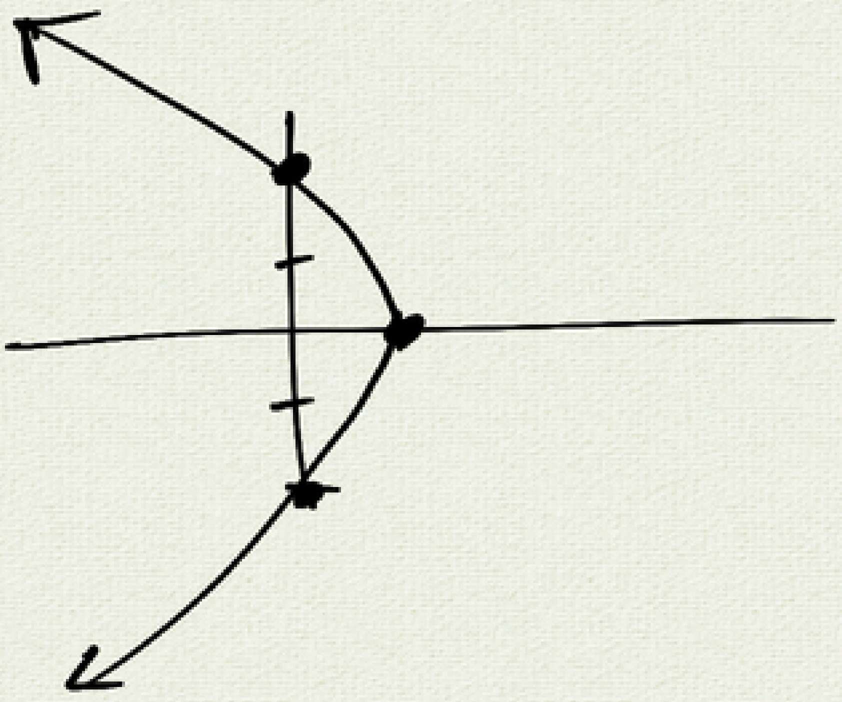
$e > 1$ hyperbola

example:

$e = 1, d = 2$

$$r = \frac{2}{1 + \cos\theta}$$

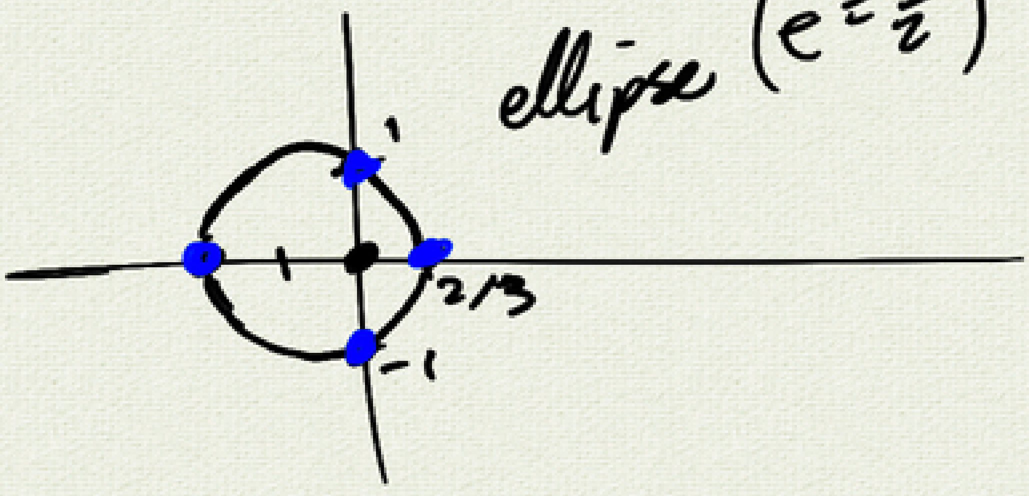
θ	r
0	1
$\pi/2$	2
π	undef ←
$3\pi/2$	2
2π	1



$e = 1/2 \quad d = 2$

$$r = \boxed{\frac{ed}{1 + e\cos\theta}} = \frac{1}{1 + \frac{1}{2}\cos\theta}$$
$$= \frac{2}{2 + \cos\theta}$$

θ	r
0	$2/3$
$\pi/2$	1
π	2
$3\pi/2$	1
2π	$2/3$

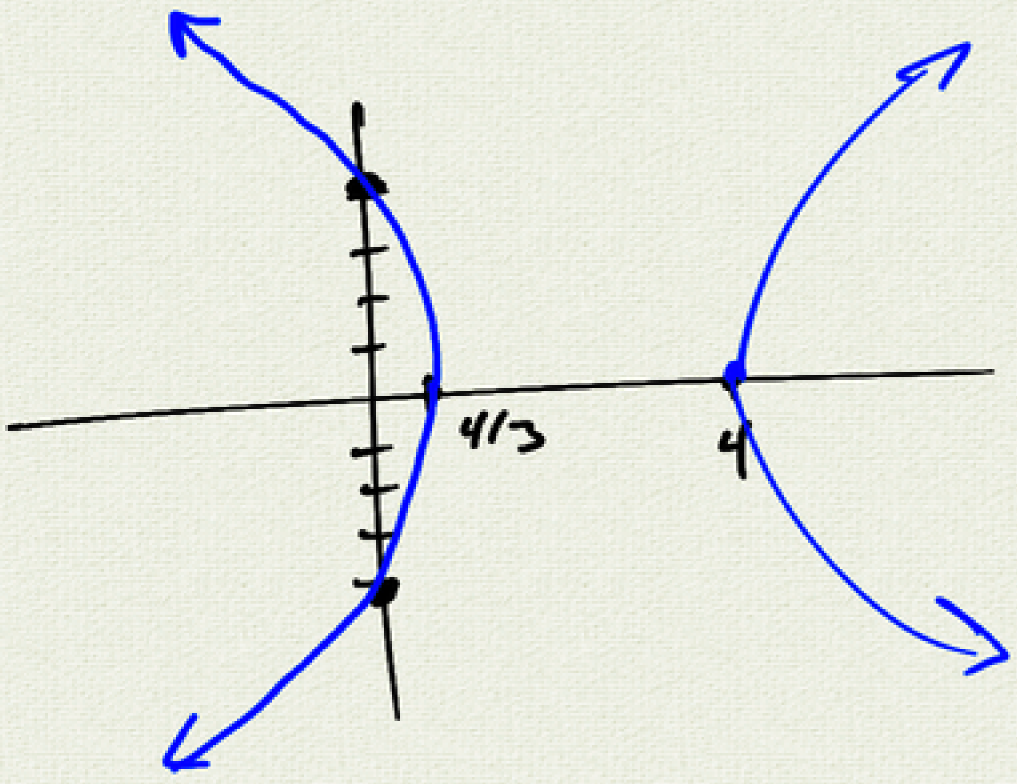


ellipse $(e = \frac{1}{2})$

$e = 2, d = 2$ hyperbola

$$r = \frac{4}{1 + 2\cos\theta}$$

θ	r
0	$4/3$
$\pi/2$	4
π	-4
$3\pi/2$	4
2π	$4/3$



$$r = \frac{ed}{1 + e\boxed{\cos\theta}}$$

← sin/cos (rotation $\pi/2$)

$\pm$ flip