

13.  $\frac{(y-7)^2}{4} - \frac{x^2}{33} = 1$

center: (0, 7)

$a = 2, b = \sqrt{33}$

$c = \sqrt{a^2 + b^2} = \sqrt{33 + 4} = \sqrt{37}$

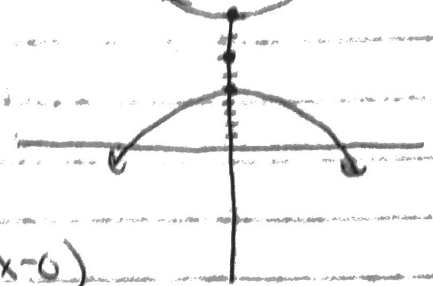
vertices: (0, 5), (0, 9)

foci: (0,  $\sqrt{37}$ ), (0,  $-\sqrt{37}$ )

asymptotes:  $y - 7 = \pm \frac{2}{\sqrt{33}}(x - 0)$

$y - 7 = \pm \frac{2}{\sqrt{33}}(x - 0)$

vertical hyperbola (y first)



15.  $\frac{(x-5)^2}{49} - \frac{(y-1)^2}{17} = 1$

center: (5, 1)

$a = 7, b = \sqrt{17}$

$c = \sqrt{49 + 17} = \sqrt{66}$

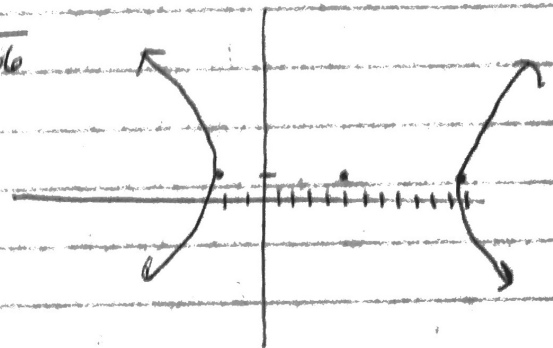
vertices: (12, 1), (-2, 1)

foci: (5 +  $\sqrt{66}$ , 1), (5 -  $\sqrt{66}$ , 1)

asymptotes:  $y - 1 = \pm \frac{\sqrt{17}}{7}(x - 5)$

$y - 1 = \pm \frac{\sqrt{17}}{7}(x - 5)$

horizontal hyperbola (x first)



17.  $\frac{(x+6)^2}{64} - \frac{(y+5)^2}{58} = 1$

center: (-6, -5)

$a = 8, b = \sqrt{58}$

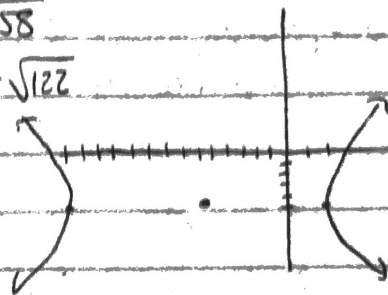
$c = \sqrt{64 + 58} = \sqrt{122}$

vertices: (2, -5), (-14, -5)

foci: (-6 +  $\sqrt{122}$ , -5), (-6 -  $\sqrt{122}$ , -5)

asymptotes:  $y + 5 = \pm \frac{\sqrt{58}}{8}(x + 6)$

horizontal (x first)



19.  $-x^2 + 3y^2 - 4x + 6y = 28$

$-(x^2 + 4x) + 3(y^2 + 2y) = 28$

$-(x+2)^2 + 3(y+1)^2 = 28 + (-1)(4) + 3(1)$

$3(y+1)^2 - (x+2)^2 = 27$

$\frac{(y+1)^2}{9} - \frac{(x+2)^2}{27} = 1$

vertices: (-2, 2), (-2, -4)

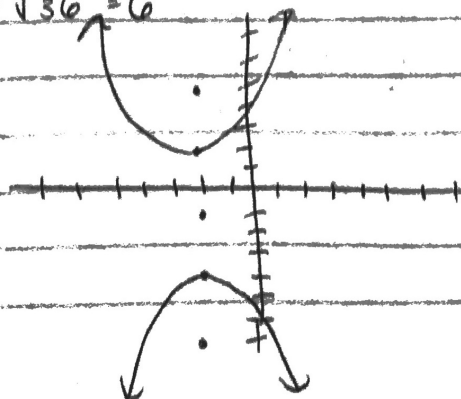
foci: (-2, 5), (-2, -7)

asymptotes:  $y + 1 = \pm \frac{3}{\sqrt{27}}(x + 2)$

center: (-2, -1) vertical (y first)

$a = 3, b = \sqrt{27}$

$c = \sqrt{36} = 6$



21.  $-5x^2 + 2y^2 - 70x - 8y = 287$

center:  $(-7, 2)$ ; vertical ↻

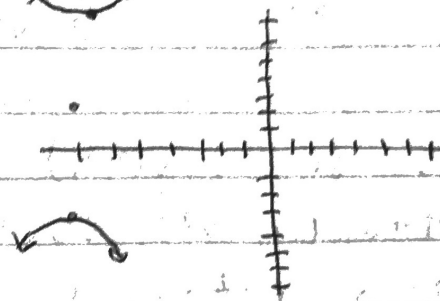
$-5(x^2 + 14x) + 2(y^2 - 4y) = 287$

$a = 5, b = \sqrt{10}$

$-5(x+7)^2 + 2(y-2)^2 = 287 + (-5 \times 49) + 2(4)$   $c = \sqrt{35}$

$2(y-2)^2 - 5(x+7)^2 = 50$

$\frac{(y-2)^2}{25} - \frac{(x+7)^2}{10} = 1$



vertices:  $(-7, 7), (-7, -3)$

foci:  $(-7, 2 + \sqrt{10}), (-7, 2 - \sqrt{10})$

asymptotes:  $y - 2 = \pm \frac{5}{\sqrt{10}}(x + 7)$

23. foci  $(-1, 9), (-1, -7)$  ← center:  $(-1, 1)$ ,  $c = 8$ , ↻

conjugate axis length of 14 units ←  $b = 7$

$c = \sqrt{a^2 + b^2}$

$8 = \sqrt{a^2 + 49}$

$64 = a^2 + 49$

$15 = a^2$

$\frac{(y-1)^2}{15} - \frac{(x+1)^2}{49} = 1$

$15(2-49)$

25. foci  $(9, -1), (-3, -1)$  ← center:  $(3, -1)$ ,  $c = 6$ , ↻ ↻

conjugate axis length of 6 units ←  $b = 3$

$6 = \sqrt{a^2 + 9}$

$36 = a^2 + 9$

$27 = a^2$

$\frac{(x-3)^2}{27} - \frac{(y+1)^2}{9} = 1$

$27 \quad 9$

27. vertices:  $(-3, -12), (-3, -4)$  ← center:  $(-3, -8)$ , ↻ ↻,  $a = 4$

foci:  $(-3, -15), (-3, -1)$  ←  $c = 7$

$7 = \sqrt{16 + b^2}$

$49 = 16 + b^2$

$33 = b^2$

$\frac{(y+8)^2}{16} - \frac{(x+3)^2}{33} = 1$

$16 \quad 33$

29. center:  $(-7, 2)$

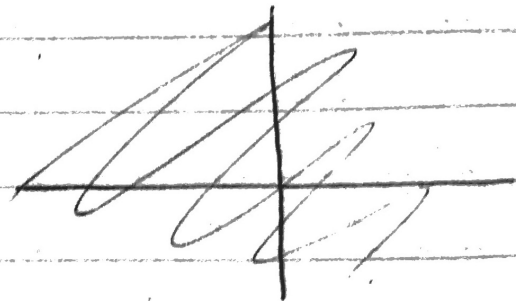
asymptotes:  $y = \pm \frac{7}{5}x + \frac{59}{5}$

transverse axis length of 10 units  $\leftarrow a=5$

$$y = \pm \frac{7}{5}x + \frac{59}{5}$$

$$\text{slope} = \pm \frac{b}{a} = \pm \frac{7}{5} \quad b=7$$

$$\frac{(x+7)^2}{25} - \frac{(y-2)^2}{49} = 1$$



31. vertices  $(0, -3), (-4, -3)$   $\leftarrow$  center =  $(-2, -3)$ ,  $a=2$ ,  $\int \int$

conjugate axis length of 12 units  $\leftarrow b=6$

$$c = \sqrt{4+36}$$

$$c = \sqrt{40}$$

$$\frac{(x+2)^2}{4} - \frac{(y+3)^2}{36} = 1$$

33. center =  $(5, 4)$

$$a=3, b=5$$

$$\frac{(y-4)^2}{9} - \frac{(x-5)^2}{25} = 1$$