

Find the equilibria and determine their type for the systems below. Plot the zero isoclines and make a guess for the phase portrait. Make a nice phase portrait by computer.

- 1) $x' = x^2 + y^2 - 10, y' = xy - 4$
- 2) $x' = x^2 + y^2 - 4, y' = xy - 1$
- 3) $x' = x^2 - y^2 - 1, y' = x^2 + y^2 - 2$
- 4) $x' = x^2 - y^2 - 2, y' = x^2 + y^2 - 5$
- 5) $x' = x^2 + y^2 - 2, y' = x^2 - y^2 - 1$
- 6) $x' = x^2 + y^2 - 6, y' = x^2 - y^2 - 2$
- 7) $x' = x^2 + 2y^2 - 3, y' = xy - 1$
- 8) $x' = x^2 + 2y^2 - 6, y' = xy - 2$
- 9) $x' = x^2 + y^2 - 3, y' = 2x^2 + y^2 - 4$
- 10) $x' = x^2 + y^2 - 4, y' = 2x^2 + y^2 - 6$
- 11) $x' = 3x^2 + y^2 - 2, y' = x^2 + y^2 - 1$
- 12) $x' = 4x^2 + y^2 - 3, y' = x^2 + y^2 - 2$
- 13) $x' = x^2 - y^2 - 6, y' = y^2 - 4$
- 14) $x' = x^2 - y^2 - 3, y' = y^2 - 1$
- 15) $x' = x^2 - y^2 - 7, y' = y^2 - 9$
- 16) $x' = x^2 + y^2 - 10, y' = x^2 - 9$
- 17) $x' = x^2 + y^2 - 5, y' = x^2 - 4$
- 18) $x' = x^2 + y^2 - 2, y' = x^2 - 1$
- 19) $x' = 10x^2 + y^2 - 8, y' = x^2 + y^2 - 2$
- 20) $x' = 9x^2 + y^2 - 5, y' = x^2 + y^2 - 2$

What kind of phase portraits are possible for the following systems depending on the parameters

- a) $x' = x^2 + y^2 - a, y' = x^2 - b, a > b > 0$
- b) $x' = x^2 - y^2 - a, y' = y^2 - b, b > 0$
- c) $x' = ax^2 + y^2 - b, y' = x^2 + y^2 - c, a > 1, b > c > 0, c > b/a$
- d) $x' = x^2 - y^2 - a, y' = x^2 - b, b > a > 0$
- e) $x' = x^2 + y^2 - a, y' = xy - b, 0 < b < a/2$
- f) $x' = x^2 - y^2 - a, y' = x^2 + y^2 - b, 0 < a < b$