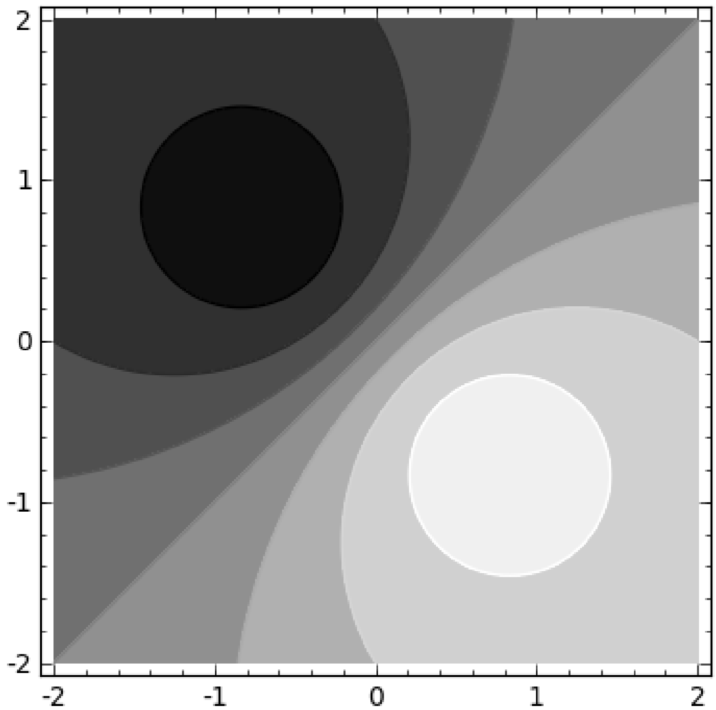
1. Find the velocity, acceleration, and speed of a particle with position function $\mathbf{r}(t) = \langle 2\cos t, 3t, 2\sin t\rangle$.

2. What force is required so that a particle of mass 2 kg has position $\mathbf{r}(t) = t^3\mathbf{i} + t^2\mathbf{j} + t\mathbf{k}$ at time t?

3. Find the position function of a particle with acceleration $\mathbf{a}(t) = \langle 2, 6t, 12t^2\rangle$, initial velocity $\mathbf{v}(0) = \langle 1, 0, 0\rangle$, and initial position $\mathbf{r}(0) = \langle 0, 1, -1\rangle$.

4. In the contour plot of $z = f(x, y)$ shown below lighter shades are higher, the x-axis is horizontal, the y-axis is vertical, and the point $(0, 0, 0)$ is at the center. Estimate the value of $D_{\mathbf{u}}f(0, 0)$ when $\mathbf{u} = \left\langle \frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}} \right\rangle$.



5. Find the limit $\displaystyle\lim_{(x,y)\to(0,0)} \frac{x^4 - y^4}{x^2 + y^2}$.

6. On which points is the function $f(x, y) = \sqrt{1 + x - y}$ continuous?

7. Find the first partial derivatives of the function $f(x, y) = \frac{x}{(x+y)^2}$.

8. Find $\frac{\partial z}{\partial x}$ and $\frac{\partial z}{\partial y}$ when $yz + x\ln y = z^2$.

9. Find $f_{xyx}(x, y)$ for $f(x, y) = \sin(2x + 3y)$.

10. Find an equation for the tangent plane to the surface $z = \ln(x - 2y)$ at the point $(3, 1, 0)$.

11. Calculate $\frac{\partial z}{\partial t}$ if $z = x^2e^{xy}$, $x = 5st - rt$, and $y = rs\ln t$.

12. Calculate $\frac{\partial z}{\partial x}$ when $xyz = \cos(x + y + z)$.

13. In what direction is $f(x, y) = \frac{y^2}{x}$ changing the fastest at the point $(1, 2, 4)$?

14. Calculate $D_{\mathbf{u}}f(0, 1, -1)$ for $f(x, y, z) = y^2e^{xyz}$ and $\mathbf{u} = \langle \frac{3}{13}, \frac{4}{13}, \frac{12}{13}\rangle$.

15. Find and equation for the tangent plane to the surface $y = x^2 - z^2$ a the point $(4, 7, 3)$.

16. Find the local maximum and minimum values of the function $f(x, y) = xy + \frac{1}{x} + \frac{1}{y}$.

17. Find the absolute maximum and minimum values of the function $f(x, y) = 4x + 6y - x^2 - y^2$ over the region $\{(x, y) \mid 0 \le x \le 4,\ 0 \le y \le 5\}$.

18. Find the point(s) on the surface $y^2 = 9 + xz$ that are closest to the origin.