

1.(1 pt) If $f(x,y) = 2x^2 - 1y^2$, find the value of the directional derivative at the point $(-4, -1)$ in the direction given by the angle $\theta = \frac{2\pi}{3}$.

2.(1 pt) Suppose $f(x,y) = -2x^2 + 3xy - 1y^2$, $P = (-2,0)$, and $\mathbf{u} = (\frac{-3}{5}, \frac{4}{5})$.

A. Compute the gradient of f .

$\nabla f =$ _____ $\mathbf{i} +$ _____ \mathbf{j}

Note: Your answers should be expressions of x and y ; e.g. "3x - 4y"

B. Evaluate the gradient at the point P .

$(\nabla f)(-2,0) =$ _____ $\mathbf{i} +$ _____ \mathbf{j}

Note: Your answers should be numbers

C. Compute the directional derivative of f at P in the direction

\mathbf{u} .
 $(D_{\mathbf{u}}f)(P) =$ _____

Note: Your answer should be a number

3.(1 pt) Suppose $f(x,y) = \frac{x}{y}$, $P = (-3,3)$ and $\mathbf{v} = -2\mathbf{i} + 4\mathbf{j}$.

A. Find the gradient of f .

$\nabla f =$ _____ $\mathbf{i} +$ _____ \mathbf{j}

Note: Your answers should be expressions of x and y ; e.g. "3x - 4y"

B. Find the gradient of f at the point P .

$(\nabla f)(P) =$ _____ $\mathbf{i} +$ _____ \mathbf{j}

Note: Your answers should be numbers

C. Find the directional derivative of f at P in the direction of

\mathbf{v} .
 $D_{\mathbf{u}}f =$ _____

Note: Your answer should be a number

D. Find the maximum rate of change of f at P .

Note: Your answer should be a number

E. Find the (unit) direction vector in which the maximum rate of change occurs at P .

$\mathbf{u} =$ _____ $\mathbf{i} +$ _____ \mathbf{j}

Note: Your answers should be numbers

4.(1 pt) Suppose $f(x,y,z) = \frac{x}{y} + \frac{y}{z}$, $P = (3,3,3)$.

A. Find the gradient of f .

$\nabla f =$ _____ $\mathbf{i} +$ _____ $\mathbf{j} +$ _____ \mathbf{k}

Note: Your answers should be expressions of x , y and z ; e.g. "3x - 4y"

B. What is the maximum rate of change of f at the point P ?

Note: Your answer should be a number

5.(1 pt) Suppose that distances are measured in lightyears and that the temperature T of a gaseous nebula is inversely proportional to the distance from a fixed point, which we take to be the origin. Suppose that the temperature 1 lightyear from the origin is 900 degrees celsius. Find the gradient of T at (x,y,z) .

$\nabla f =$ _____ $\mathbf{i} +$ _____ $\mathbf{j} +$ _____ \mathbf{k}

Note: Your answers should be expressions of x , y and z ; e.g. "3x - 4y"

6.(1 pt) Consider the surface

$$1x^2 + 9y^2 + 4z^2 = 14$$

and the point $P = (1, 1, 1)$ on this surface.

A. Starting with the equation $x = 1 + 2t$, find equations for y and z which combine with this equation to give parametric equations for the normal line through P .

$y =$ _____

$z =$ _____

Note: Your answers should be expressions of t ; e.g. "3x - 4y"

B. Find an equation for the tangent plane through P .

$z =$ _____

Note: Your answers should be expressions of x and y ; e.g. "3xy + 2y"

7.(1 pt) The axis of a light in a lighthouse is tilted. When the light points east, it is inclined upward at 9 degree(s). When it points north, it is inclined upward at 9 degree(s). What is its maximum angle of elevation?

_____ degrees

8.(1 pt) You are hiking the Inca Trail on the way to Machu Picchu. When you arrive at the highest point on the trail, which of the following are possibilities? In alphabetical order without punctuation or spacing, list the letters which indicate possibilities.

(A) The path passes through the center of a set of concentric contour lines.

(B) The path is tangent to a contour line.

(C) The path follows a contour line.

(D) The path crosses a contour line.

possibilities: _____