

Answers: Introduction to partial differentiation

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Summary

Answers to questions relating to the guide on the introduction to partial differentiation.

These are the answers to [Questions: Introduction to partial differentiation](#).

Please attempt the questions before reading these answers!

Q1

1.1. $\frac{\partial f}{\partial x} = 2xy$ and $\frac{\partial f}{\partial y} = x^2 + 3y^2$.

1.2. $\frac{\partial f}{\partial x} = 9x^2 + y$ and $\frac{\partial f}{\partial y} = x - 8y^3$.

1.3. $\frac{\partial f}{\partial x} = 2y \cos(2x)$ and $\frac{\partial f}{\partial y} = \sin(2x)$.

1.4. $\frac{\partial f}{\partial x} = ye^{xy} + 4xy^3$ and $\frac{\partial f}{\partial y} = xe^{xy} + 6x^2y^2$.

1.5. $\frac{\partial f}{\partial x} = \frac{1}{x} + \ln(y) + 3$ and $\frac{\partial f}{\partial y} = \frac{x}{y}$.

1.6. $\frac{\partial f}{\partial x} = -\frac{y}{x^2} - \frac{1}{y}$ and $\frac{\partial f}{\partial y} = \frac{1}{x} + \frac{x}{y^2}$.

1.7. $\frac{\partial f}{\partial x} = \exp(y^2)$ and $\frac{\partial f}{\partial y} = 2xy \exp(y^2)$.

1.8. $\frac{\partial f}{\partial x} = \frac{x}{\sqrt{x^2 + y^2}}$ and $\frac{\partial f}{\partial y} = \frac{y}{\sqrt{x^2 + y^2}}$.

1.9. $\frac{\partial f}{\partial x} = 12(3x + 2y)^3$ and $\frac{\partial f}{\partial y} = 8(3x + 2y)^3$.

1.10. $\frac{\partial f}{\partial x} = y^2 \cos(xy)$ and $\frac{\partial f}{\partial y} = x \cos(xy) - x^2 y \sin(xy)$.

1.11. $\frac{\partial f}{\partial x} = 2x \cos(x^2 + y^2)$ and $\frac{\partial f}{\partial y} = 2y \cos(x^2 + y^2)$.

1.12. $\frac{\partial f}{\partial x} = \frac{2xy^2}{1 + x^2y^2}$ and $\frac{\partial f}{\partial y} = \frac{2x^2y}{1 + x^2y^2}$.

- 1.13. $\frac{\partial f}{\partial x} = 2xy \sin(z)$ and $\frac{\partial f}{\partial y} = x^2 \sin(z)$ and $\frac{\partial f}{\partial z} = x^2 y \cos(z)$.
- 1.14. $\frac{\partial f}{\partial x} = (y+z)(2x+y+z)$ and $\frac{\partial f}{\partial y} = (x+z)(x+2y+z)$ and $\frac{\partial f}{\partial z} = (x+y)(x+y+2z)$.
- 1.15. $\frac{\partial f}{\partial x} = \frac{yz(y+z)}{(x+y+z)^2}$ and $\frac{\partial f}{\partial y} = \frac{xz(x+z)}{(x+y+z)^2}$ and $\frac{\partial f}{\partial z} = \frac{xy(x+y)}{(x+y+z)^2}$.

Q2

- 2.1. $\frac{\partial^2 f}{\partial x^2} = 2$ and $\frac{\partial^2 f}{\partial y^2} = -2$ so $\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = 0$.
- 2.2. $\frac{\partial^2 f}{\partial x^2} = 0$ and $\frac{\partial^2 f}{\partial y^2} = 0$ so $\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = 0$.
- 2.3. $\frac{\partial^2 f}{\partial x^2} = 6x$ and $\frac{\partial^2 f}{\partial y^2} = -6x$ so $\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = 0$.
- 2.4. $\frac{\partial^2 f}{\partial x^2} = -\cos(x) \sinh(y)$ and $\frac{\partial^2 f}{\partial y^2} = \cos(x) \sinh(y)$ so $\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = 0$.
- 2.5. $\frac{\partial^2 f}{\partial x^2} = e^x \sin(y)$ and $\frac{\partial^2 f}{\partial y^2} = -e^x \sin(y)$ so $\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = 0$.
- 2.6. $\frac{\partial^2 f}{\partial x^2} = \frac{2xy}{(x^2+y^2)^2}$ and $\frac{\partial^2 f}{\partial y^2} = -\frac{2xy}{(x^2+y^2)^2}$ so $\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = 0$.
- 2.7. $\frac{\partial^2 f}{\partial x^2} = \frac{2(y^2-x^2)}{(x^2+y^2)^2}$ and $\frac{\partial^2 f}{\partial y^2} = \frac{2(x^2-y^2)}{(x^2+y^2)^2}$ so $\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = 0$.

Q3

- 3.1. $\frac{\partial^2 f}{\partial x \partial y} = 2x + 2y$ and $\frac{\partial^2 f}{\partial y \partial x} = 2x + 2y$ so $\frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2 f}{\partial y \partial x}$.
- 3.2. $\frac{\partial^2 f}{\partial x \partial y} = -4x \sin(y)$ and $\frac{\partial^2 f}{\partial y \partial x} = -4x \sin(y)$ so $\frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2 f}{\partial y \partial x}$.
- 3.3. $\frac{\partial^2 f}{\partial x \partial y} = 20(x+y)^3$ and $\frac{\partial^2 f}{\partial y \partial x} = 20(x+y)^3$ so $\frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2 f}{\partial y \partial x}$.
- 3.4. $\frac{\partial^2 f}{\partial x \partial y} = -\frac{1}{(y+1)^2}$ and $\frac{\partial^2 f}{\partial y \partial x} = -\frac{1}{(y+1)^2}$ so $\frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2 f}{\partial y \partial x}$.
- 3.5. $\frac{\partial^2 f}{\partial x \partial y} = -\frac{xy}{(x^2+y^2)^{3/2}}$ and $\frac{\partial^2 f}{\partial y \partial x} = -\frac{xy}{(x^2+y^2)^{3/2}}$ so $\frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2 f}{\partial y \partial x}$.
- 3.6. $\frac{\partial^2 f}{\partial x \partial y} = 2x \cos(y) - 2y \sin(x)$ and $\frac{\partial^2 f}{\partial y \partial x} = 2x \cos(y) - 2y \sin(x)$ so $\frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2 f}{\partial y \partial x}$.
- 3.7. $\frac{\partial^2 f}{\partial x \partial y} = \frac{1-(xy)^2}{(1+(xy)^2)^2}$ and $\frac{\partial^2 f}{\partial y \partial x} = \frac{1-(xy)^2}{(1+(xy)^2)^2}$ so $\frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2 f}{\partial y \partial x}$.

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