

1 The puddle

The depth of a puddle in millimeters is given by

$$h = \frac{1}{10}(1 + \sin(\pi xy))$$

Your path through the puddle is given by

$$x = 3t \quad y = 4t$$

and your current position is $x = 3$, $y = 4$, with x and y also in millimeters, and t in seconds.

- (a) At your current position, how fast is the depth of water through which you are walking changing per unit time?
- (b) At your current position, how fast is the depth of water through which you are walking changing per unit distance?
- (c) **FOOD FOR THOUGHT** (optional)
There is a walkway over the puddle at $x = 10$. At your current position, how fast is the depth of water through which you are walking changing per unit distance *towards the walkway*.

2 The Path

You are climbing a hill along the steepest path, whose slope at your current location is $\frac{1}{5}$. There is another path branching off at an angle of 30° ($\frac{\pi}{6}$). How steep is it?

3 Electric Field of a Point Charge from the Potential

None

The electrostatic potential due to a point charge at the origin is given by:

$$V = \frac{1}{4\pi\epsilon_0} \frac{q}{r}$$

- (a) Find the electric field due to a point charge at the origin as a gradient in rectangular coordinates.
- (b) Find the electric field due to a point charge at the origin as a gradient in spherical coordinates.
- (c) Find the electric field due to a point charge at the origin as a gradient in cylindrical coordinates.