1 The puddle

The depth of a puddle in millimeters is given by

$$h = \frac{1}{10}\big(1 + \sin(\pi x y)\big)$$

Your path through the puddle is given by

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

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

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.