1. Let \( F(x) \) and \( G(y) \) be antiderivatives of \( f(x) \) and \( g(y) \) resp. Then,
\[
\nabla (F(x) + G(y)) = \vec{F}(x,y)
\]

2. What is \( \nabla (\tan^{-1}(\frac{y}{x})) \)?

3. (a) \( F(x,y) = xy \)

(b) \( xy = c \Rightarrow y = \frac{c}{x} \) for \( x \neq 0 \).
Parameterize the curve via \( \langle t, \frac{c}{t} \rangle \).
The velocity field along this curve is \( \langle 1, -\frac{c}{t^2} \rangle \).
What is \( \langle y, x \rangle \cdot \langle 1, -\frac{c}{t^2} \rangle \)?

(d) If \( \gamma(t) = \langle x(t), y(t) \rangle \) is a flow line of \( \vec{F} \), then
\[
\frac{d\gamma}{dt} = \langle x'(t), y'(t) \rangle = \vec{F}(\gamma(t)) = \langle y(t), x(t) \rangle
\]
(3) (d) cont.

So \( x'(t) = y(t) \) and \( y'(t) = x(t) \).
Thus, \( x''(t) = y'(t) = x(t) \) and \( y''(t) = x'(t) = y(t) \).
Now, use part (c)

(4)(a) We find the flow line of \( \vec{F} \) passing through \((-2, 2)\) at time \( t=0 \):

\[
\langle x'(t), y'(t) \rangle = \langle 1, x(t) \rangle
\]

\[
\Rightarrow x(t) = t + C_1
\]
and so \( y(t) = \frac{1}{2} t^2 + C_1 t + C_2 \).

At time \( t=0 \), \( \langle x(0), y(0) \rangle = (C_1, C_2) = (-2, 2) \).

Hence, the flow line is

\[
\gamma(t) = \langle t - 2, \frac{1}{2} t^2 - 2t + 2 \rangle
\]

\[
= \langle t - 2, \frac{1}{2}(t-2)^2 \rangle
\]
and the particle follows a parabolic path.

(b) Use the distance formula (c) Compute arclength