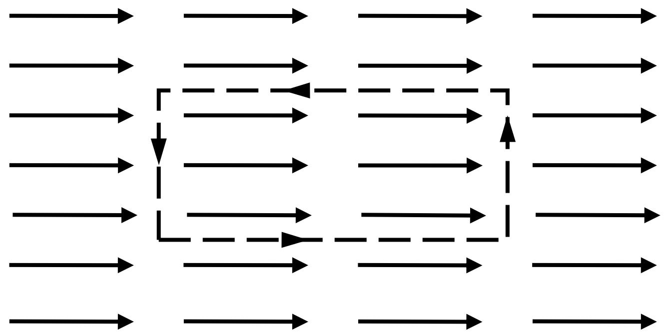
CT3-1. Consider the vector field $\vec{F} = F\,\hat{x}$, where F is a constant, and consider the closed square path *L* shown.



What can you say about the line integral $\oint_L \vec{F}\cdot d\vec{s}$?

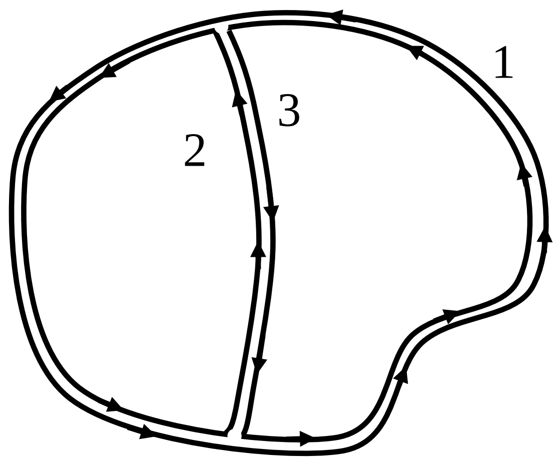
A) $\oint_L \vec{F}\cdot d\vec{s} = 0$

B) $\oint_L \vec{F}\cdot d\vec{s} > 0$

C) $\oint_L \vec{F}\cdot d\vec{s} < 0$

D) It cannot be determined from the information given.

CT3-2. Consider the three closed paths 1, 2, and 3 in some vector field $\vec{F}$, where paths 2 and 3 cover the larger path 1 as shown. What can you say about the 3 path integrals $\oint_1 \vec{F}\cdot d\vec{s}$, $\oint_2 \vec{F}\cdot d\vec{s}$, $\oint_3 \vec{F}\cdot d\vec{s}$?



A) $\oint_1 > \oint_2 + \oint_3$

B) $\oint_1 < \oint_2 + \oint_3$

C) $\oint_1 = \oint_2 + \oint_3$

D) Answer depends on the vector field **F.**

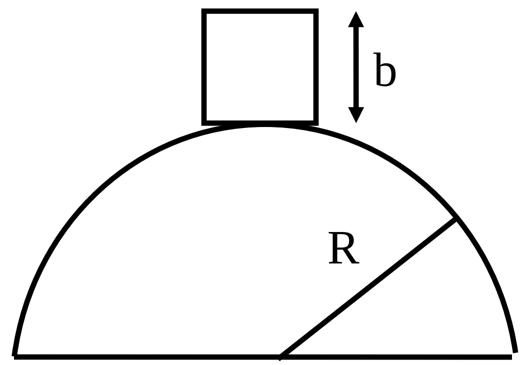
CT3-3. Consider the following two vector fields. Which vector field has zero curl everywhere?

A) Neither 1 nor 2.
B) 1 only.
C) 2 only.
D) Both 1 and 2.

CT3-4. Consider the following two vector fields. Which vector field has zero curl everywhere?

A) Neither 1 nor 2.
B) 1 only.
C) 2 only.
D) Both 1 and 2.

CT3-5. A square object of edge length b is perched on top of a stationary cylinder of radius R, as shown. The square can roll without slipping on the surface of the cylinder. Is the square in stable equilibrium?



A) Yes, the equilibrium is always stable
B) No, the equilibrium is always unstable
C) The equilibrium is always neutral
D) The nature of the equilibrium depends on the relative size of b and R.

CT3-6. A particle oscillates in a one-dimensional potential. Which of the following properties guarantees simple harmonic motion?

i) The period T is independent of the amplitude A
ii) The potential $U(x) = b\,x^2$ ($b > 0$)
iii) The force $F= – k\,x$ (Hooke's law, $k > 0$)
iv) The position is sinusoidal in time: $x = A \sin(\omega t + \alpha)$

A) only 1 property guarantees simple harmonic motion
B) exactly 2 properties guarantee simple harmonic motion
C) exactly 3 properties guarantee simple harmonic motion
D) all (any one of the properties guarantees simple harmonic motion)

CT3-7. A particle oscillates in a potential well which is <u>not</u> a simple $U(x) \sim x^2$ harmonic well. The well U(x) can be written as a Taylor series expansion about the equilibrium point x_0 (at which the first derivative dU/dx vanishes) :

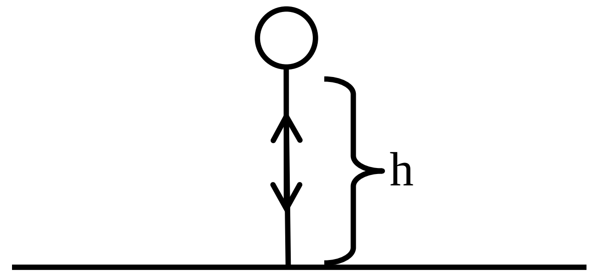
$$U(x) = U(x_0) + \frac{1}{2}U'' \cdot (x - x_0)^2 + \frac{1}{3!}U''' \cdot (x - x_0)^3 + \ldots$$

The higher derivatives U" and U'" are nonzero at $x = x_0$.

In the limit of very small oscillations, that is, in the limit of $(x - x_0) \rightarrow 0$, what can you say about this potential well?

A) The well definitely becomes harmonic..
B) The well definitely becomes anharmonic.
C) Whether the well becomes harmonic or anharmonic depends on the function U(x).

CT3-8. Consider a super ball which bounces up and down on super concrete. After the ball is dropped from an initial height h, it bounces with no dissipation and executes an infinite number of bounces back to height h Is the motion of the ball in z simple harmonic motion?



A) Yes, it is definitely simple harmonic motion.
B) No, it is definitely not simple harmonic motion.
C) It cannot be determined from the information given.

CT3-9. A particle is oscillating, back and forth with amplitude *A*, in a potential well $U(x) = k x^4, \quad k > 0$. Notice that, compared to the harmonic x^2 potential, the anharmonic x^4 potential has a flatter bottom and steeper sides. When the amplitude of oscillation is increased, what happens to the period T of the oscillation for the anharmonic x^4 potential?

A) period T increases, as A increases
B) period T decreases, as A increases
C) period T remains constant, as A increases.