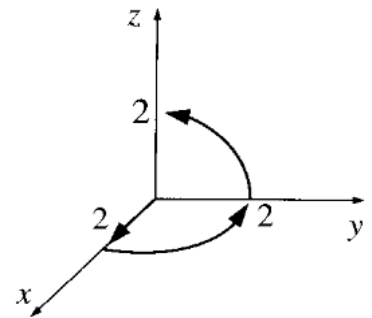


IIT Mandi
 School of Basic Sciences
 IC-121: Mechanics of Particles and Waves,
 Tutorial – 2

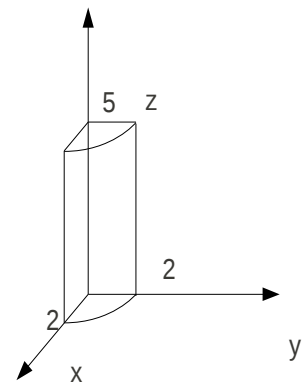
- 1) Find the expression for velocity and acceleration in cylindrical coordinates (Greiner 73)
- 2) Express the unit vectors in spherical polar coordinates $(\hat{r}, \hat{\theta}, \hat{\phi})$ in terms of Cartesian coordinates $(\hat{x}, \hat{y}, \hat{z})$. Work out the inverse formulas giving $(\hat{x}, \hat{y}, \hat{z})$ in terms of $(\hat{r}, \hat{\theta}, \hat{\phi})$.

- 3) Express $\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}$ in spherical polar coordinates.

- 4) Compute the gradient and Laplacian of the function $T = r(\cos \theta + \sin \theta \cos \phi)$. Check the Laplacian by converting T to Cartesian coordinates and using Laplacian in this coordinate system. Test the theorem of gradients $\int_{\vec{a}}^{\vec{b}} \vec{\nabla} T \cdot d\vec{l} = T(\vec{b}) - T(\vec{a})$ using the path shown (0, 0, 0) to (0, 0, 2)



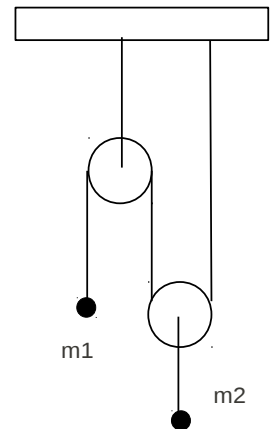
- 5) (a) Find the divergence of the function $\vec{v} = s(2 + \sin^2 \phi) \hat{\rho} + \rho \sin \phi \cos \phi \hat{\phi} + 3z \hat{z}$, (b) Test the divergence theorem for this function, using quarter-cylinder (radius 2 height 5). (c) Find the curl of \vec{v}



- 6) If a block slides with out friction down a fixed inclined plane with $\theta = 30^\circ$ what will be the block's acceleration. Find the expression for velocity of block after it moves from rest a distance x_0 down the plane.
- 7) Find the velocity of a particle undergoing vertical motion under gravity in a medium having a retarding force proportional to velocity. Write the equation of motion for the system. Find the solution of the equation of motion. Based on the solution comment on what happens to system

at very long time and at $t \rightarrow \infty$

- 8) Consider the pulley system with masses m_1 and m_2 . What are the accelerations of the masses? What is the tension in the string? Consider that the pulleys are massless



- 9) A mass m hangs from a massless string of length l . Conditions have set up such that the mass swing around a horizontal circle, with string making constant angle θ with the vertical, find the angular frequency of the motion.
- 10) For a given initial speed, at what inclination angle should a ball be thrown so that it travels the maximum horizontal distance by the time it returns to the ground? Assume that ground is horizontal, and ball released from the ground level. What is the optimal angle if the ground is sloped upward at an angle θ .