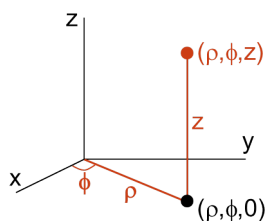


Discovery Exercise for Cylindrical and Spherical Coordinates

In cylindrical coordinates, the position of an object is specified by the following three numbers:

- ρ gives the distance from the z -axis
- ϕ gives the angle off the positive x -axis
- z gives the distance from the xy plane

Note that ρ and ϕ are the two-dimensional *polar* representation of the xy position of an object. The third variable, z , comes from Cartesian coordinates.



1. What are the Cartesian (x, y, z) coordinates of the point whose cylindrical coordinates are $\rho = 2$, $\phi = \pi/3$, $z = -2$?

2. What are the cylindrical (ρ, ϕ, z) coordinates of the point whose Cartesian coordinates are $(3, 4, 10)$? *See*

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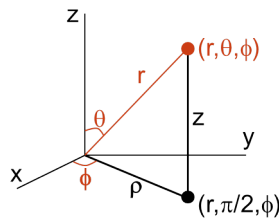
3. What shape is described by the equation $\rho = 2$? (It isn't a circle.)

4. What shape is described by the equation $\phi = \pi/3$? (It isn't a line.)

In spherical coordinates, the position of an object is specified by the following three numbers:

- r gives the distance from the origin
- θ gives the angle down from the z -axis
- ϕ gives the angle off the positive x -axis

Note that ϕ is the same variable in cylindrical and spherical coordinates. The drawing below shows both the cylindrical and the spherical coordinates for a point.



5. In the drawing above, the angle between the red line labeled r and the z -axis is labeled θ . The angle between the red line labeled r and the black line labeled z is not labeled. What is that angle in terms of spherical coordinates?
6. What are the Cartesian (x, y, z) coordinates of the point whose spherical coordinates are $r = 2$, $\theta = \pi/6$, $\phi = \pi/3$? *Hint:* begin by calculating the cylindrical ρ even though it is not your final goal.
7. What are the spherical (r, θ, ϕ) coordinates of the point whose Cartesian coordinates are $(3, 4, 10)$?

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8. What shape is described by the equation $r = 2$?
9. What shape is described by the equation $\theta = \pi/3$?