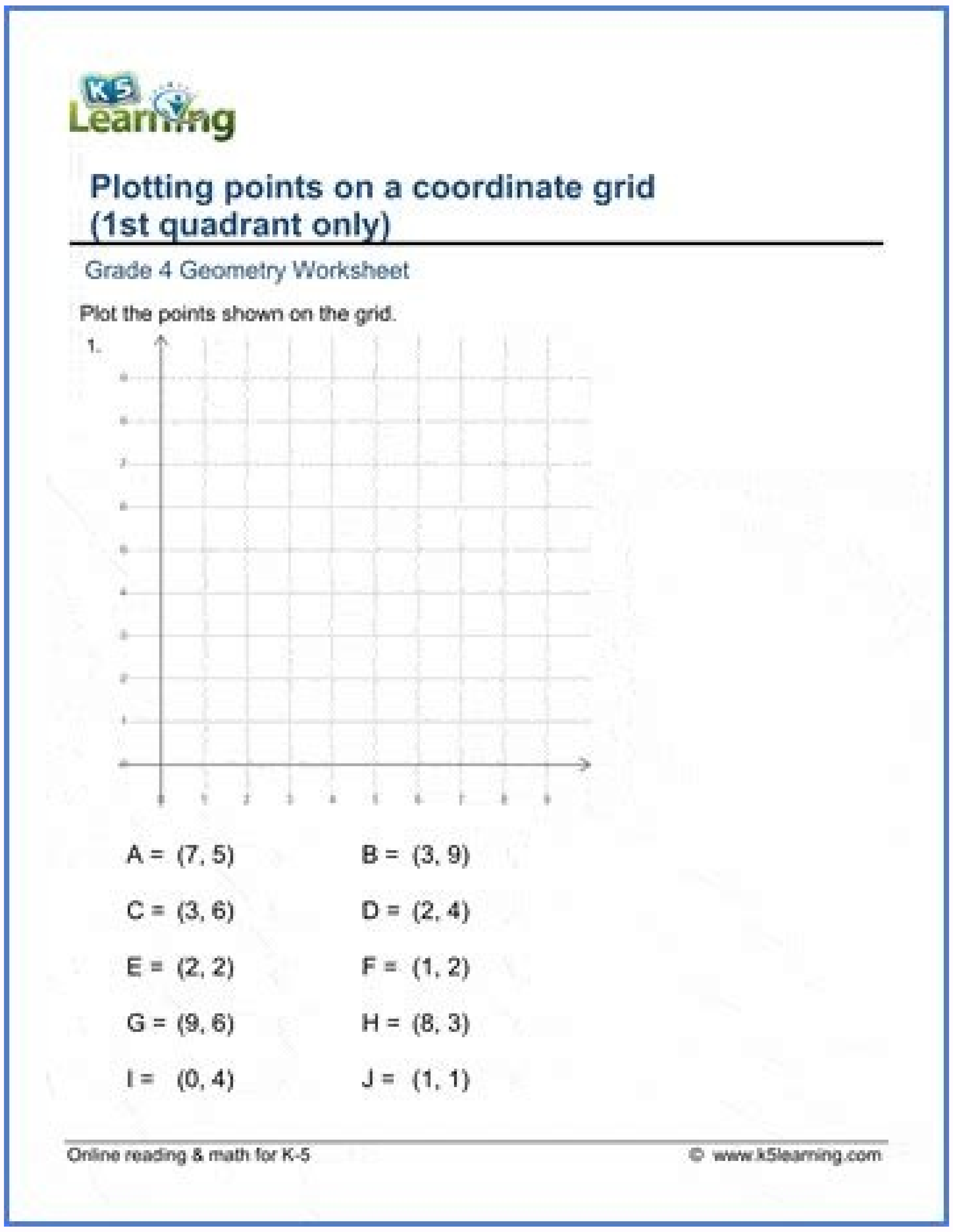
21455058.024096 55581471.461538 7151353560 4128786.5729167 140704013428 7223322699 20970825.636364 41505515.163265 22087711.863158 33912780.468085 103082472500 2775083.0192308 6075700275 7238127.2923077 720818.48529412 125047874658 242323434.2 92169360000 20400757572 17737434.4125 11113288.357143 79004709.7 65422653830 22387042.853933 3680748.2692308 13070807.808219 70324094.366667 51330387948 29967355.133333 51877751016 33164997.925926 7499331.4150943

Cartesian to cylindrical coordinates pdf free printable worksheets grade



Plotting points on a coordinate grid (1st quadrant only)

Grade 4 Geometry Worksheet

Plot the points shown on the grid.

1.

A = (7, 5)	B = (3, 9)
C = (3, 6)	D = (2, 4)
E = (2, 2)	F = (1, 2)
G = (9, 6)	H = (8, 3)
I = (0, 4)	J = (1, 1)

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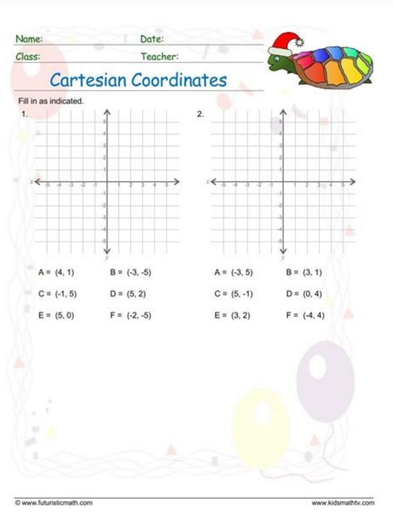
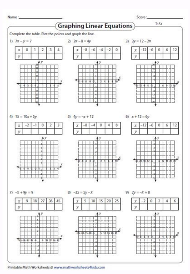
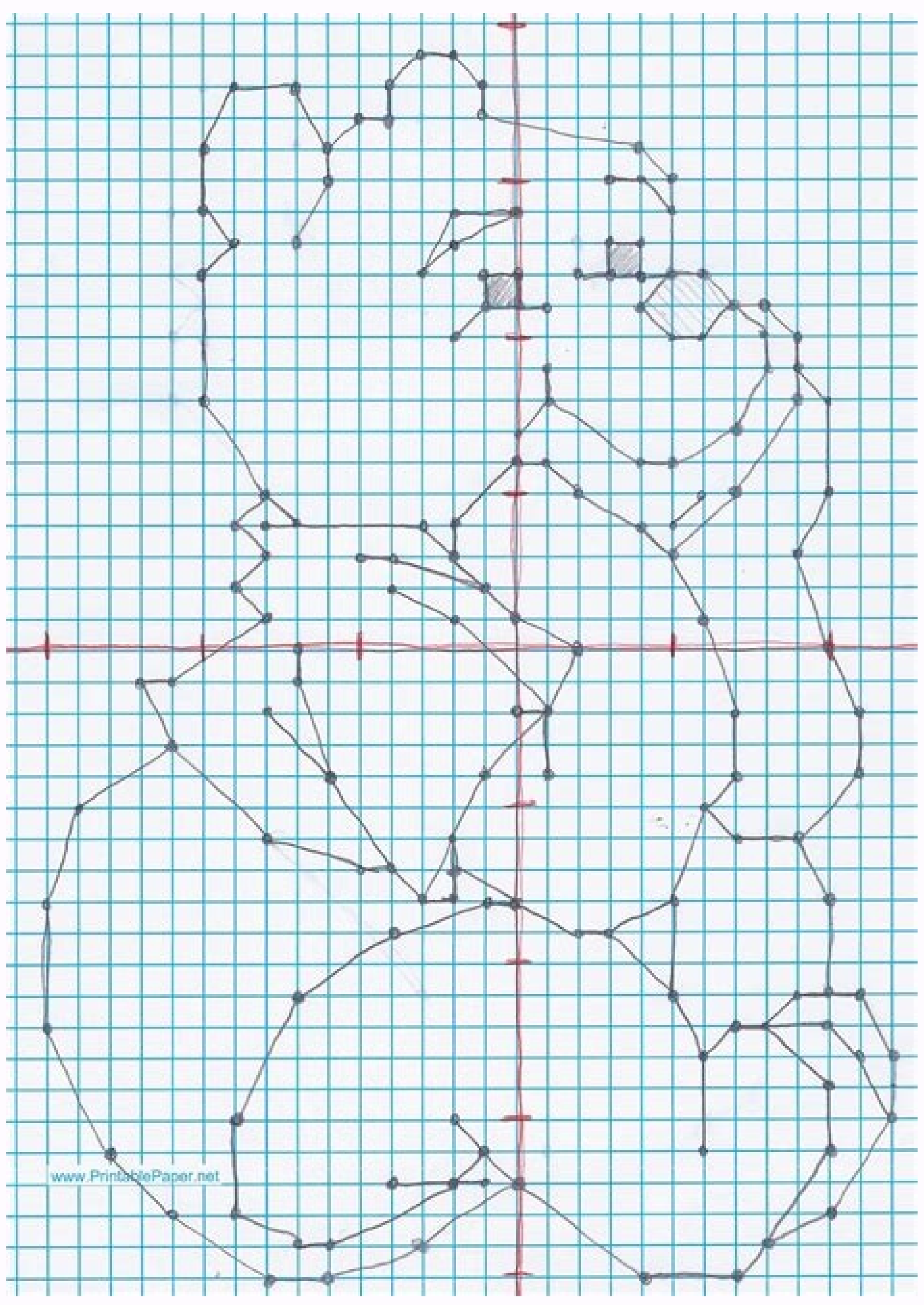
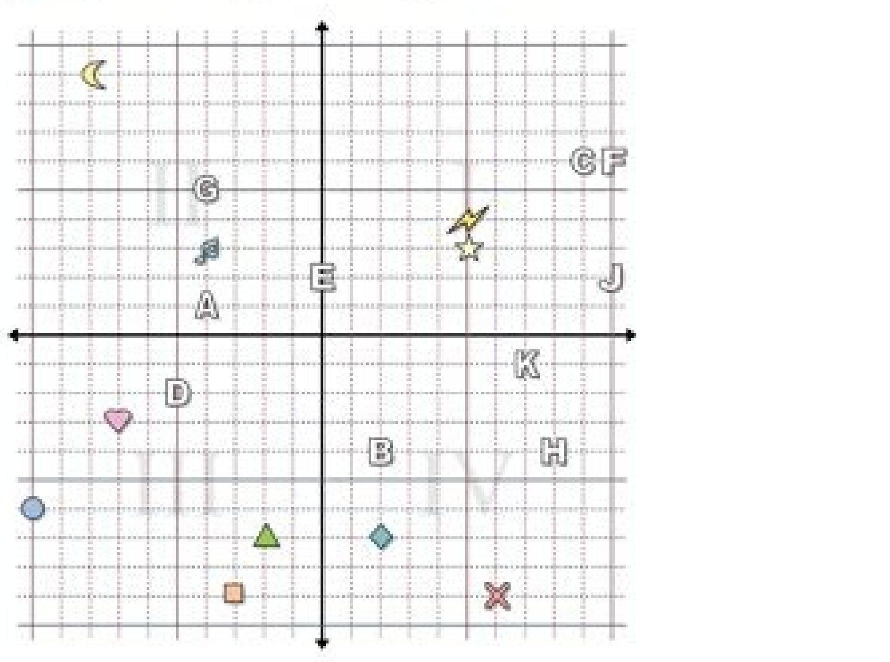






Reading Positive & Negative Coordinates Name:



Determine the coordinates of each figure.

1) Star	2) Lightning
3) Circle	4) Heart
5) Cross	6) Triangle
7) Moon	8) Square
9) Diamond	10) Music Note

Determine which letter is at each coordinate.

11) (9 , 6)	12) (7 , -1)
13) (2 , -4)	14) (-4 , 5)
15) (10 , 2)	16) (10 , 6)
17) (8 , -4)	18) (-4 , 1)
19) (0 , 2)	20) (-5 , -2)

Answers

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________
8. ____________
9. ____________
10. ____________
11. ____________
12. ____________
13. ____________
14. ____________
15. ____________
16. ____________
17. ____________
18. ____________
19. ____________
20. ____________

1-10	95	90	85	80	75	70	65	60	55	50
11-20	45	40	35	30	25	20	15	10	5	0

The points on a surface of the form \(θ=c\) are at a fixed angle from the \(x\)-axis, which gives us a half-plane that starts at the \(z\)-axis (Figures \(\PageIndex{3}\) and \(\PageIndex{4}\)). The point with spherical coordinates \((8,\dfrac{π}{3},\dfrac{π}{6})\) has rectangular coordinates \((2,2\sqrt{3},4\sqrt{3}).\) Finding the values in cylindrical coordinates is equally straightforward: \[\begin{align*} r&=ρ \sin φ \\[4pt] &= 8\sin \dfrac{π}{6} &=4 \\[4pt] θ&=θ \\[4pt] z&=ρ\cos φ\\[4pt] &= 8\cos\dfrac{π}{6} \\[4pt] &= 4\sqrt{3} .\end{align*}\] Thus, cylindrical coordinates for the point are \((4,\dfrac{π}{3},4\sqrt{3})\). Polar Coordinates Conversion from polar to cartesian (rectangular) x = r cos θ y = r sin θ r Conversion from cartesian to y θ polar: x r= x2 + y2 x y y cos θ = sin θ = tan θ = r r x 6. Hint Converting the coordinates first may help to find the location of the point in space more easily. As the value of \(z\) increases, the radius of the circle also increases. Answer This surface is a cylinder with radius \(6\). This is a familiar problem; recall that in two dimensions, polar coordinates often provide a useful alternative system for describing the location of a point in the plane, particularly in cases involving circles. Grid lines for spherical coordinates are based on angle measures, like those for polar coordinates. Answer b This set of points forms a half plane. There is no rotational or spherical symmetry that applies in this situation, so rectangular coordinates are a good choice. When the angle \(θ\) is held constant while \(r\) and \(z\) are allowed to vary, the result is a half-plane (Figure \(\PageIndex{6}\)). Worksheet #6–#8 14. There are actually two ways to identify \(φ\). Physicists studying electrical charges and the capacitors used to store these charges have discovered that these systems sometimes have a cylindrical symmetry. Hint \(r^2=x^2+y^2\) and \(\tan θ=\frac{y}{x}\) Answer \((8\sqrt{2},\frac{3π}{4},−7)\) The use of cylindrical coordinates is common in fields such as physics. Figure \(\PageIndex{6}\): In polar coordinates, the equation \(θ=π/4\) describes the ray extending diagonally through the first quadrant. Section 9.7 Polar, Cylindrical, and Spherical Coordinates Math 21a February 15, 2008 Announcements No class Monday 2/18. A football has rotational symmetry about a central axis, so cylindrical coordinates would work best. z cos ϕ = ρ 16. First-grade math students will be introduced to basic addition and subtraction, oftentimes in the form of word problems, over the course of the year, meaning they will be expected to add up to 20 and subtract numbers below fifteen, both of which won't require the students to re-group or "carry the one." These concepts are easiest understood through tactile demonstration such as number blocks or tiles or through illustration or example such as showing the class a pile of 15 bananas and taking away four of them, then asking the students to calculate then count the remaining bananas. Solution √ √ We have r = 3+1= 4 = 2, and √ 3 1 cos θ = sin θ = 2 2 This is satisfies by θ = π/6. These systems have complicated modeling equations in the Cartesian coordinate system, which make them difficult to describe and analyze. Figure \(\PageIndex{3}\): In rectangular coordinates, (a) surfaces of the form \(x=c\) are planes parallel to the \(yz\)-plane, (b) surfaces of the form \(y=c\) are planes parallel to the \(xz\)-plane, and (c) surfaces of the form \(z=c\) are planes parallel to the \(xy\)-plane. Worksheet #9–#10 When it comes to teaching first-grade students the common core standards of mathematics, there's no better way to practice than with worksheets geared toward repeatedly applying the same basic concepts such as counting, adding and subtracting without carrying, word problems, telling time, and calculating currency. In this way, cylindrical coordinates provide a natural extension of polar coordinates to three dimensions. \(x^2+y^2−y+z^2=0\) Subtract \(y\) from both sides of the equation. Then, looking at the triangle in the \(xy\)-plane with r as its hypotenuse, we have \(x=r\cos θ=ρ\sin φ \cos θ\). Example \(\PageIndex{3}\): Identifying Surfaces in the Cylindrical Coordinate System Describe the surfaces with the given cylindrical equations. The points on these surfaces are at a fixed distance from the \(z\)-axis. There could be more than one right answer for how the axes should be oriented, but we select an orientation that makes sense in the context of the problem. Hint The first two components match the polar coordinates of the point in the \(xy\)-plane. It may make sense to choose an unusual orientation for the axes if it makes sense for the problem. Click on the links in the rest of the article to discover worksheets for each of the topics addressed. Figure \(\PageIndex{14}\): The equation \(φ=\dfrac{5π}{6}\) describes a cone. Solution The radius of Earth is \(4000\)mi, so \(ρ=4000\). 1. The points on these surfaces are at a fixed angle from the \(z\)-axis and form a half-cone (Figure \(\PageIndex{11}\)). Because there is only one value for \(φ\) that is measured from the positive \(z\)-axis, we do not get the full cone (with two pieces). How should we orient the coordinate axes? One possible choice is to align the \(z\)-axis with the axis of symmetry of the weight block. onumber\] The point with rectangular coordinates \((1,−3,5)\) has cylindrical coordinates approximately equal to \((\sqrt{10},5.03,5).\) Exercise \(\PageIndex{2}\) Convert point \((−8,8,−7)\) from Cartesian coordinates to cylindrical coordinates. Figure \(\PageIndex{13}\): The surface described by equation \(θ=\dfrac{π}{3}\) is a half-plane. Rewrite the middle terms as a perfect square. For example, the cylinder described by equation \(x^2+y^2=25\) in the Cartesian system can be represented by cylindrical equation \(r=5\). Example \(\PageIndex{1}\): Converting from Cylindrical to Rectangular Coordinates Plot the point with cylindrical coordinates \((4,\dfrac{2π}{3},−2)\) and express its location in rectangular coordinates. Figure \(\PageIndex{7}\): The sphere centered at the origin with radius 3 can be described by the cylindrical equation \(r^2+z^2=9\). Exercise \(\PageIndex{3}\) Describe the surface with cylindrical equation \(r=6\). Choose the \(z\)-axis to align with the axis of the cone. Now, let’s think about surfaces of the form \(r=c\). A thoughtful choice of coordinate system can make a problem much easier to solve, whereas a poor choice can lead to unnecessarily complex calculations. Each trace is a circle. Students will also be expected to demonstrate a comprehension of addition, through completing word problems that feature addition sentences up to 10, and worksheets like " Adding to 10," " Adding to 15, " and "Adding to 20" will help teachers gauge students' comprehension of the basics of simple addition. Because \(ρ>0\), the surface described by equation \(θ=\dfrac{π}{3}\) is the half-plane shown in Figure \(\PageIndex{13}\). The measure of the angle formed by the rays is \(40°\). \end{align*}\] We choose the positive square root, so \(r=\sqrt{10}\).Now, we apply the formula to find \(θ\). The spherical coordinates of the point are \((2\sqrt{2},\dfrac{3π}{4},\dfrac{π}{6}).\) To find the cylindrical coordinates for the point, we need only find r: \(r=ρ\sin φ=2\sqrt{2}\sin(\dfrac{π}{6})=\sqrt{2}.\) The cylindrical coordinates for the point are \((\sqrt{2},\dfrac{3π}{4},\sqrt{6})\). Answer 1 1 3, 2π − arccos √ , arccos √ 3 3 18. \(x=ρ\sin φ\cos θ\) \(y=ρ\sin φ\sin θ\) \(z=ρ\cos φ\) Convert from rectangular coordinates to spherical coordinates These equations are used to convert from rectangular coordinates to spherical coordinates. The point lies \(2\) units below the \(xy\)-plane. Hint The \(θ\) and \(z\) components of points on the surface can take any value. \(ρ=13\) \(θ=\dfrac{2π}{3}\) \(φ=\dfrac{π}{4}\) Hint Think about what each component represents and what it means to hold that component constant. However, the equation for the surface is more complicated in rectangular coordinates than in the other two systems, so we might want to avoid that choice. Planes of these forms are parallel to the \(yz\)-plane, the \(xz\)-plane, and the \(xy\)-plane, respectively. How many are left? Last, in rectangular coordinates, elliptic cones are quadric surfaces and can be represented by equations of the form \(z^2=\dfrac{x^2}{a^2}+\dfrac{y^2}{b^2}.\) In this case, we could choose any of the three. Here's another way to ask the question: A man was holding some balloons and the wind blew 4 away. Polar Coordinates Cylindrical Coordinates Spherical Coordinates 15. Conversion between Cylindrical and Cartesian Coordinates The rectangular coordinates \((x,y,z)\) and the cylindrical coordinates \((r,θ,z)\) of a point are related as follows: These equations are used to convert from cylindrical coordinates to rectangular coordinates. Points on these surfaces are at a fixed distance from the origin and form a sphere. The point lies \(4\sqrt{3}\) units above the \(xy\)-plane. Exercise \(\PageIndex{5}\) Describe the surfaces defined by the following equations. Solution We have √ √ −1 x= 2 √ = −1 2 cos (5π/4) = 2 √ √ −1 y = 2 sin (5π/4) = 2 √ = −1 2 8. Solution Use the equations in Note to translate between spherical and cylindrical coordinates (Figure \(\PageIndex{12}\)): \[\begin{align*} x &=ρ\sin φ\cos θ \\[4pt] &=8 \sin(\dfrac{π}{6}) \cos(\dfrac{π}{3}) \\[4pt] &= 8(\dfrac{1}{2})\dfrac{1}{2} \\[4pt] &=2 \\[4pt] y &=ρ\sin φ\sin θ \\[4pt] &= 8\sin(\dfrac{π}{6})\sin(\dfrac{π}{3}) \\[4pt] &= 8(\dfrac{1}{2})\dfrac{\sqrt{3}}{2} \\[4pt] &= 2\sqrt{3} \\[4pt] z &=ρ\cos φ \\[4pt] &= 8\cos(\dfrac{π}{6}) \\[4pt] &= 8(\dfrac{\sqrt{3}}{2}) \\[4pt] &= 4\sqrt{3} \end{align*}\] Figure \(\PageIndex{12}\): The projection of the point in the \(xy\)-plane is \(4\) units from the origin. \(x^2+y^2+z^2=y\) Substitute rectangular variables using the equations above. The origin should be chosen based on the problem statement. In order to continue enjoying our site, we ask that you confirm your identity as a human. Its product suite reflects the philosophy that given great tools, people can do great things. Thank you very much for your cooperation. Some surfaces, however, can be difficult to model with equations based on the Cartesian system. Right-triangle relationships tell us that \(x=r\cos θ, y=r\sin θ,\) and \(\tan θ=y/x.\) Let’s consider the differences between rectangular and cylindrical coordinates by looking at the surfaces generated when each of the coordinates is held constant. Example \(\PageIndex{6}\): Identifying Surfaces in the Spherical Coordinate System Describe the surfaces with the given spherical equations. Worksheet #1–#5 11. 7. Equation \(φ=\dfrac{5π}{6}\) describes all points in the spherical coordinate system that lie on a line from the origin forming an angle measuring \(\dfrac{5π}{6}\) rad with the positive \(z\)-axis. Solving this last equation for \(φ\) and then substituting \(ρ=\sqrt{r^2+z^2}\) (from the first equation) yields \(φ=\arccos(\dfrac{z}{\sqrt{r^2+z^2}})\). Answer Cartesian: \((−\frac{\sqrt{3}}{2},−\frac{1}{2},\sqrt{3}),\) cylindrical: \((1,−\frac{5π}{6},\sqrt{3})\) Example \(\PageIndex{5}\): Converting from Rectangular Coordinates Convert the rectangular coordinates \((−1,1,\sqrt{6})\) to both spherical and cylindrical coordinates. Check out "Understanding 1/2," this "Shape Book," and these additional 10 Geometry worksheets for late Kindergarten and Grade 1. \(θ=\dfrac{π}{3}\) \(φ=\dfrac{5π}{6}\) \(ρ=6\) \(ρ=\sin θ \sinφ\) Solution a. Starting with polar coordinates, we can follow this same process to create a new three-dimensional coordinate system, called the cylindrical coordinate system. In this case, \(y\) is negative and \(x\) is positive, which means we must select the value of \(θ\) between \(\dfrac{3π}{2}\) and \(2π\): \[\begin{align*} \tan θ &=\dfrac{y}{x} &=\dfrac{−3}{1} \\[4pt] θ &=\arctan(−3) &≈5.03\,\text{rad.} \end{align*}\] In this case, the z-coordinates are the same in both rectangular and cylindrical coordinates: \[z=5. Example \(\PageIndex{8}\): Choosing the Best Coordinate System In each of the following situations, we determine which coordinate system is most appropriate and describe how we would orient the coordinate axes. Note that if \(x=0\), then the value of \(θ\) is either \(\dfrac{π}{2},\dfrac{3π}{2},\) or \(0\), depending on the value of \(y\). One of the first things first graders have to master is the concept of counting to 20, which will help them quickly count beyond those basic numbers and begin to understand the 100s and 1000s by the time they reach the second grade. Outline Why different coordinate systems? A submarine generally moves in a straight line. in Japan, is the leading provider of high-performance software tools for engineering, science, and mathematics. 19. The coordinate \(θ\) in the spherical coordinate system is the same as in the cylindrical coordinate system, so surfaces of the form \(θ=c\) are half-planes, as before. Find the center of gravity of a bowling ball. A cone has several kinds of symmetry. Answer Spherical coordinates with the origin located at the center of the earth, the \(z\)-axis aligned with the North Pole, and the \(x\)-axis aligned with the prime meridian Based on this reasoning, cylindrical coordinates might be the best choice. However, if we restrict \(θ\) to values between \(0\) and \(2π\), then we can find a unique solution based on the quadrant of the \(xy\)-plane in which original point \((x,y,z)\) is located. In the \(xy\)-plane, the right triangle shown in Figure \(\PageIndex{1}\) provides the key to transformation between cylindrical and Cartesian, or rectangular, coordinates. When we convert to cylindrical coordinates, the \(z\)-coordinate does not change. Exercise \(\PageIndex{7}\) Which coordinate system is most appropriate for creating a star map, as viewed from Earth (see the following figure)? Let the center of Earth be the center of the sphere, with the ray from the center through the North Pole representing the positive \(z\)-axis. Cylindrical Coordinates Just add the vertical dimension Conversion from cylindrical to cartesian (rectangular): x = r cos θ y = r sin θ z =z Conversion from cartesian to cylindrical: r = x2 + y2 x y y cos θ = sin θ = tan θ = r r x z =z 13. Let \(c\) be a constant, and consider surfaces of the form \(ρ=c\). 10. First-grade teachers may also introduce their students to a base-level knowledge of fractions, geometric shapes, and mathematical patterns, though none of them are required course material until the second and third grades. Determine the amount of leather required to make a football. The equations can often be expressed in more simple terms using cylindrical coordinates. In the same way, measuring from the prime meridian, Columbus lies \(83°\) to the west. This is exactly the same process that we followed in Introduction to Parametric Equations and Polar Coordinates to convert from polar coordinates to two-dimensional rectangular coordinates. The equation describes a sphere centered at point \((0,\dfrac{1}{2},0)\) with radius \(\dfrac{1}{2}\). No office hours Tuesday 2/19. Find the volume of oil flowing through a pipeline. \(x^2+(y−\dfrac{1}{2})^2+z^2=\dfrac{1}{4}\). The angle between the half plane and the positive \(x\)-axis is \(θ=\dfrac{2π}{3}.\) Answer c Let \(P\) be a point on this surface. As young mathematicians progress through their early education, they will be expected to demonstrate comprehension of these basic skills, so it's important for teachers to be able to gauge their students' aptitudes in the subject by administering quizzes, working one on one with each student, and by sending them home with worksheets like the ones below to practice on their own or with their parent. As the name suggests, cylindrical coordinates are useful for dealing with problems involving cylinders, such as calculating the volume of a round water tank or the amount of oil flowing through a pipe. Solution Use the second set of equations from Note to translate from rectangular to cylindrical coordinates: \[\begin{align*} r^2 &= x^2+y^2 \\[4pt] r &=±\sqrt{1^2+(−3)^2} \\[4pt] &= ±\sqrt{10}. Note that this puts the \(z\)-axis in a horizontal orientation, which is a little different from what we usually do. Let’s assume Earth has the shape of a sphere with radius \(4000\) mi. Hint Because Sydney lies south of the equator, we need to add \(90°\) to find the angle measured from the positive \(z\)-axis. The Cartesian coordinate system provides a straightforward way to describe the location of points in space. Calculate the pressure in a conical water tank. Explore more concepts in these extra worksheets: Maplesoft™, a subsidiary of Cybernet Systems Co. Ltd. Polar Coordinates Cylindrical Coordinates Spherical Coordinates 12. Substitute \(r^2=x^2+y^2\) into equation \(r^2+z^2=9\) to express the rectangular form of the equation: \(x^2+y^2+z^2=9\). The variable \(θ\) represents the measure of the same angle in both the cylindrical and spherical coordinate systems. 17. When we expanded the traditional Cartesian coordinate system from two dimensions to three, we simply added a new axis to model the third dimension. In three dimensions, this same equation describes a half-plane. HOWTO: Converting among Spherical, Cylindrical, and Rectangular Coordinates Rectangular coordinates \((x,y,z)\), cylindrical coordinates \((r,θ,z),\) and spherical coordinates \((ρ,θ,φ)\) of a point are related as follows: Convert from spherical coordinates to rectangular coordinates These equations are used to convert from spherical coordinates to rectangular coordinates. The line from the origin to the point’s projection forms an angle of \(π/3\) with the positive \(x\)-axis. There is no obvious choice for how the \(x\)-, \(y\)- and \(z\)-axes should be oriented. Figure \(\PageIndex{2}\): The Pythagorean theorem provides equation \(r^2=x^2+y^2\). The \(z\)-axis should align with the axis of the ball. We express angle measures in degrees rather than radians because latitude and longitude are measured in degrees. Notice that these equations are derived from properties of right triangles. The intersection of the prime meridian and the equator lies on the positive \(x\)-axis. In the Cartesian coordinate system, the location of a point in space is described using an ordered triple in which each coordinate represents a distance. Examples Example Find the spherical coordinates of the point with rectangular √ √ coordinates (2, −2, 3). However, in some cases, students may require additional attention or explanation beyond what worksheets alone can offer—for this reason, teachers should also prepare demonstrations in class to help guide students through the coursework. Also, note that, as before, we must be careful when using the formula \(\tan θ=\dfrac{y}{x}\) to choose the correct value of \(θ\). In spherical coordinates, Columbus lies at point \((4000,−83°,50°).\) Exercise \(\PageIndex{6}\) Sydney, Australia is at \(34°S\) and \(151°E.\) Express Sydney’s location in spherical coordinates. Last, what about \(θ=c\)? Answer The rectangular coordinates of the point are \((\frac{5\sqrt{3}}{2},\frac{5}{2},4).\) If this process seems familiar, it is with good reason. Polar Coordinates Cylindrical Coordinates Spherical Coordinates 3. The origin should be the bottom point of the cone. The equator is the trace of the sphere intersecting the \(xy\)-plane. c. Answer a This is the set of all points \(13\) units from the origin. Figure \(\PageIndex{16}\): In the latitude–longitude system, angles describe the location of a point on Earth relative to the equator and the prime meridian. For instance, think about this word problem: A man has 10 balloons and the wind blew 4 away. Figure \(\PageIndex{8}\): The traces in planes parallel to the \(xy\)-plane are circles. To identify this surface, convert the equation from spherical to rectangular coordinates, using equations \(y=ρsinφ\sin θ\) and \(ρ^2=x^2+y^2+z^2:\) \(ρ=\sin θ \sin φ\) \(ρ^2=ρ\sin θ\sin φ\) Multiply both sides of the equation by \(ρ\). Learn more about Maplesoft. Bowling balls normally have a weight block in the center. Solution Start by converting from rectangular to spherical coordinates: \[\begin{align*} ρ^2 &=x^2+y^2+z^2=(−1)^2+1^2+(\sqrt{6})^2=8 \\[4pt] \tan θ &=\dfrac{1}{−1} \\[4pt] ρ&=2\sqrt{2} \text{ and }θ=\arctan(−1)=\dfrac{3π}{4}. Example \(\PageIndex{2}\): Converting from Rectangular to Cylindrical Coordinates Convert the rectangular coordinates \((1,−3,5)\) to cylindrical coordinates. Note: There is not enough information to set up or solve these problems; we simply select the coordinate system (Figure \(\PageIndex{17}\)). Similarly, spherical coordinates are useful for dealing with problems involving spheres, such as finding the volume of domed structures. To describe the surface defined by equation \(z=r\), is it useful to examine traces parallel to the \(xy\)-plane. The derivation of the formula for \(y\) is similar. A sphere that has Cartesian equation \(x^2+y^2+z^2=c^2\) has the simple equation \(ρ=c\) in spherical coordinates. The origin should be some convenient physical location, such as the starting position of the submarine or the location of a particular port. In this section, we look at two different ways of describing the location of points in space, both of them based on extensions of polar coordinates. Equation \(ρ=6\) describes the set of all points \(6\) units away from the origin—a sphere with radius \(6\) (Figure \(\PageIndex{15}\)). Spherical coordinates are useful in analyzing systems that have some degree of symmetry about a point, such as the volume of the space inside a domed stadium or wind speeds in a planet’s atmosphere. In the spherical coordinate system, we again use an ordered triple to describe the location of a point in space. Figure \(\PageIndex{4}\): In cylindrical coordinates, (a) surfaces of the form \(r=c\) are vertical cylinders of radius \(r\), (b) surfaces of the form \(θ=c\) are half-planes at angle \(θ\) from the \(x\)-axis, and (c) surfaces of the form \(z=c\) are planes parallel to the \(xy\)-plane. Plot \(R\) and describe its location in space using rectangular, or Cartesian, coordinates. Assigning worksheets like "Order the Numbers to 50" will help teachers assess whether or not a student fully grasps the number line. The \(x\)- and \(y\)-axes could be aligned to point east and north, respectively. The origin could be the center of the ball or perhaps one of the ends. Example \(\PageIndex{7}\): Converting Latitude and Longitude to Spherical Coordinates The latitude of Columbus, Ohio, is \(40°\) N and the longitude is \(83°\) W, which means that Columbus is \(40°\) north of the equator. As we did with cylindrical coordinates, let’s consider the surfaces that are generated when each of the coordinates is held constant. Exercise \(\PageIndex{4}\) Plot the point with spherical coordinates \((2,−\frac{5π}{6},\frac{π}{6})\) and describe its location in both rectangular and cylindrical coordinates. The \(x\)-axis could be chosen to point straight downward or to some other logical direction. Figure \(\PageIndex{11}\): In spherical coordinates, surfaces of the form \(ρ=c\) are spheres of radius \(ρ\) (a), surfaces of the form \(θ=c\) are half-planes at an angle \(θ\) from the \(x\)-axis (b), and surfaces of the form \(ϕ=c\) are half-cones at an angle \(ϕ\) from the \(z\)-axis (c). \(θ=\dfrac{π}{4}\) \(r^2+z^2=9\) \(z=r\) Solution a. Figure \(\PageIndex{17}\): (credit: (a) modification of work by scl hua, Wikimedia, (b) modification of work by DVIDSHUB, Flickr, (c) modification of work by Michael Malak, Wikimedia, (d) modification of work by Sean Mack, Wikimedia, (e) modification of work by Elvert Barnes, Flickr) Solution Clearly, a bowling ball is a sphere, so spherical coordinates would probably work best here. This set forms a sphere with radius \(13\). The orientation of the other two axes is arbitrary. Movement to the west is then described with negative angle measures, which shows that \(θ=−83°\), Because Columbus lies \(40°\) north of the equator, it lies \(50°\) south of the North Pole, so \(φ=50°\). Example: Rectangular to Polar Example Find the polar coordinates of the point with rectangular √ coordinates (3, 1). By convention, the origin is represented as \((0,0,0)\) in spherical coordinates. \end{align*}\] This is the equation of a cone centered on the \(z\)-axis. \(x^2+y^2−y+\dfrac{1}{4}+z^2=\dfrac{1}{4}\) Complete the square. In addition, we are talking about a water tank, and the depth of the water might come into play at some point in our calculations, so it might be nice to have a component that represents height and depth directly. \(ρ=\sqrt{r^2+z^2}\) \(θ=θ\) \(φ=\arccos(\dfrac{z}{\sqrt{r^2+z^2}})\) The formulas to convert from spherical coordinates to rectangular coordinates may seem complex, but they are straightforward applications of trigonometry. This simple display of subtraction will help guide students through the process of early arithmetic, which can be additionally aided by these subtraction facts to 10. Definition: The Cylindrical Coordinate System In the cylindrical coordinate system, a point in space (Figure \(\PageIndex{1}\)) is represented by the ordered triple \((r,θ,z)\), where \((r,θ)\) are the polar coordinates of the point’s projection in the \(xy\)-plane \(z\) is the usual \(z\)-coordinate in the Cartesian coordinate system Figure \(\PageIndex{1}\): The right triangle lies in the \(xy\)-plane. Express the location of Columbus in spherical coordinates. This equation describes a sphere centered at the origin with radius 3 (Figure \(\PageIndex{7}\)). Although the shape of Earth is not a perfect sphere, we use spherical coordinates to communicate the locations of points on Earth. Last, consider surfaces of the form \(φ=0\). The origin should be located at the physical center of the ball. The radius of the circles increases as \(z\) increases. If \(c\) is a constant, then in rectangular coordinates, surfaces of the form \(x=c, y=c,\) or \(z=c\) are all planes. Yes office hours Wednesday 2/20 2–4pm SC 323. Polar Coordinates Cylindrical Coordinates Spherical Coordinates 5. Solution Conversion from cylindrical to rectangular coordinates requires a simple application of the equations listed in Note: \[\begin{align*} x &=r\cos θ=4\cos\dfrac{2π}{3}=−2 \\[4pt] y &=r\sin θ=4\sin \dfrac{2π}{3}=2\sqrt{3} \\[4pt] z &=−2 \end{align*}.\] The point with cylindrical coordinates \((4,\dfrac{2π}{3},−2)\) has rectangular coordinates \((−2,2\sqrt{3},−2)\) (Figure \(\PageIndex{5}\)). For example, the trace in plane \(z=1\) is circle \(r=1\), the trace in plane \(z=3\) is circle \(r=3\), and so on. These points form a half-cone (Figure). To make this easy to see, consider point \(P\) in the \(xy\)-plane with rectangular coordinates \((x,y,0)\) and with cylindrical coordinates \((r,θ,0)\), as shown in Figure \(\PageIndex{2}\). In spherical coordinates, we have seen that surfaces of the form \(φ=c\) are half-cones. Too often we ask questions where the unknown is at the end of the question, but the unknown can also be put at the beginning of the question. Spherical coordinates make it simple to describe a sphere, just as cylindrical coordinates make it easy to describe a cylinder. The position vector of this point forms an angle of \(φ=\dfrac{π}{4}\) with the positive \(z\)-axis, which means that points closer to the origin are closer to the axis. d. The \(z\)-axis should probably point upward. In other words, these surfaces are vertical circular cylinders. In this case, the triple describes one distance and two angles. Example: Polar to Rectangular Example Find the rectangular coordinates of the point with polar √ coordinates (2, 5π/4). We can use the equation \(φ=\arccos(\dfrac{z}{\sqrt{x^2+y^2+z^2}})\). Why different coordinate systems? When working with first-grade students, it's important to start from where they are. \(ρ^2=x^2+y^2+z^2\) \(\tan θ=\dfrac{y}{x}\) \(φ=\arccos(\dfrac{z}{\sqrt{x^2+y^2+z^2}}).\) Convert from spherical coordinates to cylindrical coordinates These equations are used to convert from spherical coordinates to cylindrical coordinates. Example \(\PageIndex{4}\): Converting from Spherical Coordinates Plot the point with spherical coordinates \((8,\dfrac{π}{3},\dfrac{π}{6})\) and express its location in both rectangular and cylindrical coordinates. In the following example, we examine several different problems and discuss how to select the best coordinate system for each one. \(r=ρ\sin φ\) \(θ=θ\) \(z=ρ\cos φ\) Convert from cylindrical coordinates to spherical coordinates These equations are used to convert from cylindrical coordinates to spherical coordinates. Spherical Coordinates like the earth, but not exactly Conversion from spherical to cartesian (rectangular): x = ρ sin ϕ cos θ y = ρ sin ϕ sin θ z = ρ cos ϕ Conversion from cartesian to spherical: r= x2 + y2 ρ = x2 + y2 + z2 x y y cos θ = sin θ = tan θ = Note: In this picture, r should r r x be ρ. In this case, however, we would likely choose to orient our \(z\)-axis with the center axis of the pipeline. The line from the origin to the point’s projection forms an angle of \(\dfrac{2π}{3}\) with the positive \(x\)-axis. Definition: spherical coordinate system In the spherical coordinate system, a point \(P\) in space (Figure \(\PageIndex{9}\)) is represented by the ordered triple \((ρ,θ,φ)\) where \(ρ\) (the Greek letter rho) is the distance between \(P\) and the origin \((ρ≠0);\) \(θ\) is the same angle used to describe the location in cylindrical coordinates; \(φ\) (the Greek letter phi) is the angle formed by the positive \(z\)-axis and line segment \(\bar{OP}\), where \(O\) is the origin and \(0≤φ≤π.\) Figure \(\PageIndex{9}\): The relationship among spherical, rectangular, and cylindrical coordinates. The prime meridian represents the trace of the surface as it intersects the \(xz\)-plane. Answer \((4000,151°,124°)\) Cylindrical and spherical coordinates give us the flexibility to select a coordinate system appropriate to the problem at hand. Determine the velocity of a submarine subjected to an ocean current. The resulting surface is a cone (Figure \(\PageIndex{8}\)). \(x=r\cos θ\) \(y=r\sin θ\) \(z=z\) These equations are used to convert from rectangular coordinates to cylindrical coordinates \(r^2=x^2+y^2\) \(\tan θ=\dfrac{y}{x}\) \(z=z\) As when we discussed conversion from rectangular coordinates to polar coordinates in two dimensions, it should be noted that the equation \(\tan θ=\dfrac{y}{x}\) has an infinite number of solutions. The \(z\)-coordinate describes the location of the point above or below the \(xy\)-plane. In the cylindrical coordinate system, location of a point in space is described using two distances \((r\) and \(z)\) and an angle measure \((θ)\). Figure also shows that \(ρ^2=r^2+z^2=x^2+y^2+z^2\) and \(z=ρ\cos φ\). The dimension of space comes from nature The measurement of space comes from us Different coordinate systems are different ways to measure space 4. Exercise \(\PageIndex{1}\) Point \(R\) has cylindrical coordinates \((5,\frac{π}{6},4)\). Additionally, students will be expected to recognize number patterns and should practice their skills in counting by 2s, counting by 5s, and counting by 10s and identifying whether a number is greater than or less than to 20, and be able to parse out mathematical equations from word problems like these, which may include ordinal numbers up to 10 In terms of practical math skills, the first grade is also an important time to ensure students understand how to tell time on a clock face and how to count U.S. coins up to 50 cents. c. The length of the hypotenuse is \(r\) and \(θ\) is the measure of the angle formed by the positive \(x\)-axis and the hypotenuse. Hint What kinds of symmetry are present in this situation? Figure \(\PageIndex{5}\): The projection of the point in the \(xy\)-plane is 4 units from the origin. Answer √ √ √ √ 3 3 3 1 −1 3 3 2· · ,2 · · ,2 · = , , −1 2 2 2 2 2 2 2 20. Imagine a ray from the center of Earth through Columbus and a ray from the center of Earth through the equator directly south of Columbus. \end{align*}\] Because \((x,y)=(−1,1)\), then the correct choice for \(θ\) is \(\frac{3π}{4}\). Figure \(\PageIndex{15}\): Equation \(ρ=6\) describes a sphere with radius \(6\). Answer 1 1 3, 2π − arccos √ , arccos √ 3 3 Example Find the rectangular coordinates of the point with spherical coordinates (2, π/6, 2π/3). In cylindrical coordinates, a cone can be represented by equation \(z=kr,\) where \(k\) is a constant. He only has 6 balloons left, how many did he start with? In geography, latitude and longitude are used to describe locations on Earth’s surface, as shown in Figure. Therefore, in cylindrical coordinates, surfaces of the form \(z=c\) are planes parallel to the \(xy\)-plane. b. A more simple approach, however, is to use equation \(z=ρ\cos φ.\) We know that \(z=\sqrt{6}\) and \(ρ=2\sqrt{2}\), so \(\sqrt{6}=2\sqrt{2}\cos φ,\) so \(\cos φ=\dfrac{\sqrt{6}}{2\sqrt{2}}=\dfrac{\sqrt{3}}{2}\) and therefore \(φ=\dfrac{π}{6}\). When working with first-grade students, it's important to start from where they understand and work your way up, ensuring that each students masters each concept individually before moving on to the next topic. To find the equation in rectangular coordinates, use equation \(φ=\arccos(\dfrac{z}{\sqrt{x^2+y^2+z^2}}).\) \[\begin{align*} \dfrac{5π}{6} &=\arccos(\dfrac{z}{\sqrt{x^2+y^2+z^2}}) \\[4pt] \cos\dfrac{5π}{6}&=\dfrac{z}{\sqrt{x^2+y^2+z^2}} \\[4pt] −\dfrac{\sqrt{3}}{2}&=\dfrac{z}{\sqrt{x^2+y^2+z^2}} \\[4pt] \dfrac{3}{4} &=\dfrac{z^2}{x^2+y^2+z^2} \\[4pt] \dfrac{3x^2}{4}+\dfrac{3y^2}{4}+\dfrac{3z^2}{4} &=z^2 \\[4pt] \dfrac{3x^2}{4}+\dfrac{3y^2}{4}−\dfrac{z^2}{4} &=0. 2. Points with coordinates \((ρ,\dfrac{π}{3},φ)\) lie on the plane that forms angle \(θ=\dfrac{π}{3}\) with the positive \(x\)-axis. Figure \(\PageIndex{10}\): The equations that convert from one system to another are derived from right-triangle relationships. The position of the \(x\)-axis is arbitrary. 9. These skills will be essential as students begin to apply two-digit addition and subtraction in the second grade. Looking at Figure, it is easy to see that \(r=ρ \sin φ\). These points form a half-cone. It is also important to focus on thinking concepts. A pipeline is a cylinder, so cylindrical coordinates would be best the best choice.

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