matrix multiplication to be done.

The number of columns in the first matrix, \(A\), must equal the number of rows in the second matrix, \(B\). The product of a \(3 \times 3\) matrix by a \(3 \times 1\) matrix is a \(1 \times 1\) matrix.

We illustrate matrix multiplication as follows:

\[
\begin{bmatrix}
3x_1 + 2x_2 + w_1 \\
3x_2 + 2x_3 + w_2 \\
3x_3 + 2x_4 + w_3
\end{bmatrix}
= 
\begin{bmatrix}
3x \\
x_2 \\
x_3
\end{bmatrix}
\begin{bmatrix}
w_1 \\
w_2 \\
w_3
\end{bmatrix}
= 
\begin{bmatrix}
w_{11} & w_{12} & w_{13} \\
w_{21} & w_{22} & w_{23} \\
w_{31} & w_{32} & w_{33}
\end{bmatrix}
\begin{bmatrix}
x \\
x_2 \\
x_3
\end{bmatrix}
\]

Important convention for indexing: in \(m_{ij}\) the first subscript \(i\) tells which row and the second tells which column the entry \(m_{ij}\) is in.
at a given time.

specifically the velocity of the point when the point is at a given position

4. (A) Write from a class common (differential equation)

\[
\begin{align*}
\text{For } 0^\circ \leq \theta \leq 180^\circ \\
\text{or } 180^\circ < \theta \leq 360^\circ \\
\text{using degrees.}
\end{align*}
\]

-\[
\begin{align*}
\text{For } 0 \leq \theta \leq \pi \\
\text{or } \pi \leq \theta \leq 2\pi \\
\text{using radians.}
\end{align*}
\]

Angle \( \theta \) ranges over the whole circle

\[
(\theta) \sin \phi = (\theta) \sin \phi
\]

3. Parametric: \( y = (\theta) \sin \phi \), \( x = (\theta) \cos \phi \)

2. Implicit: \( x^2 + \phi^2 = \phi^2 \)

1. Function to plot: \( x^2 - y^2 = \phi^2 \)

and ALSO \( x^2 - y^2 = \phi^2 \)

3. Mathematical expressions for curves:
Three separate numeric scalar additions define what vector

\((zq+\mathbf{r}q+xq+\mathbf{r}d,xq+\mathbf{r}d) = (zq+\mathbf{r}q,xq)\) (VECTOR ADDITION HERE) (+)(VECTOR ADDITION HERE)

Vector addition:

1. Locate a point.
2. Represent a displacement (or velocity): a combination of length and direction. Often drawn as an arrow.

More subtle—TWO ways to use vectors when a coordinate system (origin, axis directions, and unit length) is defined in a plane or 3d space, vectors locate points thereon. For graphics, for now, our vectors will have two or three numbers. For generic computer programmers, a vector is, very concretely, an array of

But first, we review/introduce vectors.
1. Apply a displacement to a point to locate another point.

2. Tail-to-head composition of displacements.

Basic geometric significance:
Problem: Calculate coordinates of point A.

Let's examine the house example: point A.
Get to A from a known point by adding displacements:

Base Point

E(2, 4, 1) = (2, 4, 0) + (0, 0, 1)

Displacement Vector

x axis

y axis

z axis
Base Point

\[(17, 4, 1) = (2, 4, 0) + (15, 0, 0)\]

Displacement Vector

\[E(2, 4, 1) = (2, 4, 0) + (0, 0, 1)\]
The displacement of \( A \) from base point equals \( (15, 5, 1) \).

By adding \( \overrightarrow{AB} \) displacement can be vector \( \overrightarrow{AB} \) added.
Shrinks length if \( |a| > 1 \).
Reverse direction if \( a > 0 \).
2. Stretches a displacement's length by a factor of \( a \).

(Uniform scaling transformation) that keeps the origin fixed.

I. Applied to points, it "blows up" (enlarges) the world by a factor of \( a \).

Basic geometric significance:

\[
(a, x, a^2y, axz) = (z, a^2x, ax^2, ax^2z) \cdot a
\]

Vector-scalar multiplication: \( a \) is a number.
PARAMETRIC REPRESENTATION OF LINES

A (straight) line \( L \) is determined by any two distinct points on \( L \).
\[
\begin{align*}
\mathbf{V} &= (x_2, y_2, z_2) - (x_1, y_1, z_1) \\
&= (x_2 - x_1, y_2 - y_1, z_2 - z_1) \\
&= \Delta x, \Delta y, \Delta z
\end{align*}
\]
\[
0 + \mathbf{p} = \Lambda \mathbf{v} + \mathbf{p}_1 = \mathbf{p}_1 \\
\Lambda \mathbf{v} + \mathbf{p}_1 = \mathbf{p}_2 = \mathbf{p}_2 \\
\mathbf{v} = \mathbf{p}_2 - \mathbf{p}_1
\]

Vector \( \mathbf{v} \) is the displacement from \( \mathbf{p}_1 \) to \( \mathbf{p}_2 \).
Remember \( \mathbf{V} = \mathbf{P}_2 - \mathbf{P}_1 \) minus \( \mathbf{V} \) is the midpoint between \( \mathbf{P}_1 \) and \( \mathbf{P}_2 \).
Remember \( \mathbf{v} = \mathbf{p}_2 - \mathbf{p}_1 \)

From \( \mathbf{p}_1 \) to \( \mathbf{p}_2 \)

\( \mathbf{p}_1 + \frac{3}{4} \mathbf{v} \) is \( \frac{3}{4} \) the way
Remember \( \mathbf{V} = \mathbf{P}_2 - \mathbf{P}_1 \) minus \( \mathbf{P}_1 \) to \( \mathbf{P}_2 \) direction.

From \( \mathbf{P}_1 \) to \( \mathbf{P}_2 \) in the way \( \mathbf{P}_1 \) plus \( (2) \mathbf{V} \) is 2 times the way.
Remember $V = P_2 - P_1$ minus $P_1$

From $P_1$ to $P_2$ in the OPPOSITE direction.

$P(\frac{-1}{2}) = P_1 + \frac{1}{2}V$ is $1/2$ times the way vector $P(t) = P_1 + tP_2$ with $t = \frac{-1}{2}$. 

$P(\frac{-1}{2}) = P_1 + (\frac{-1}{2})V$.
Parametric form for a line.

\[ \mathbf{P}(t) = \mathbf{P}_1 + t\mathbf{V} \]

With \( t > 0 \), \( \mathbf{P}(t) \) is BEYOND \( \mathbf{P}_1 \) away from \( \mathbf{P}_2 \)

With \( 0 \leq t \leq 1 \), \( \mathbf{P}(t) \) is BETWEEN \( \mathbf{P}_1 \) and \( \mathbf{P}_2 \)

With \( t < 0 \), \( \mathbf{P}(t) \) is BEYOND \( \mathbf{P}_2 \) away from \( \mathbf{P}_1 \)

Remember \( \mathbf{V} = \mathbf{P}_2 - \mathbf{P}_1 \)

Parametric form for a line.

\[ \mathbf{P}(t) = \mathbf{P}_1 + t\mathbf{V} \]
\[ \text{When } t = 0, \text{ then } \frac{1}{\alpha} \beta^{(1)} \eta = \frac{1}{\alpha} \beta^{(2)} \eta, \]

\[ \text{When } t = 1, \text{ then } \frac{1}{\alpha} \beta^{(1)} \eta = \frac{1}{\alpha} \beta^{(2)} \eta, \]

\[ \text{When } t = 1 - I, \text{ then } \frac{1}{\alpha} \beta^{(1)} \eta = \frac{1}{\alpha} \beta^{(2)} \eta. \]

When \( \frac{1}{\alpha} \) and \( \frac{1}{\beta} \) are points in \( \eta \) with weight \( \frac{1}{\alpha} \) and weight \( \frac{1}{\beta} \) on \( \eta \), we know \( \frac{1}{\alpha} \beta^{(1)} \eta \geq (t - 1) \geq 0 \), so we know \( \frac{1}{\alpha} \beta^{(1)} \eta \geq \frac{1}{\beta} \eta \geq 0 \).

\[ \frac{1}{\alpha} \beta^{(1)} \eta + \frac{1}{\alpha} \beta^{(2)} \eta = (t) \eta \]

\[ \frac{1}{\alpha} \beta^{(1)} \eta - \frac{1}{\beta} \beta^{(2)} \eta + \frac{1}{\alpha} \beta^{(1)} \eta = (1) \eta \]

\[ \text{Let's substitute displacement into the formula:} \]

\[ \frac{1}{\alpha} \beta^{(1)} \eta - \frac{1}{\beta} \beta^{(2)} \eta = \Lambda \eta, \]

\[ \text{where } \Lambda \eta + \frac{1}{\alpha} \beta^{(1)} \eta = (t) \eta \]

The parametric equation for expressing the straight line determined by distinct points \( \frac{1}{\alpha} \) and \( \frac{1}{\beta} \) is...
do it for $x(t)$, except to check your work. Why? 

... 

To solve the problem, find the $t$ for which $100, \quad \text{then}$ 

\[ t \frac{\pi}{2} - 98 = (t)z, \quad 12 + 11 = (t)h, \quad 50 + 100t = (t)x = 50 + 100t, \quad \text{and} \] 

In other words, $x$ (the $t$ for which $100, \quad \text{then}$ 

\[ t \frac{\pi}{2} - 32, \quad (t)41 + (98, 21, 100, 12) - (32, -98) = (100, 12, 98) - (32, -98), \quad \text{so the} \] 

\[ \Lambda t + \frac{1}{2} \mathbf{p} = (t) \mathbf{p}, \quad \text{and} \] 

\[ \mathbf{p} \text{ or not?} \] 

\[ (150, 33, 66) \text{ intersect the } x = 100 \text{ plane? Is the intersection between } \mathbf{p} \text{ and } \mathbf{p} \text{ that point does the line determined by } \mathbf{p} \text{ and } \mathbf{p} \text{ intersect the } x = 100 \text{ plane?} \]
But the method gives additional important information. Since \( t = 0.5 \)

\[
\begin{align*}
32 = 8 - 16 & = (0.5)x = x \\
27 & = 6 + 21 = (0.5)\hat{h} = \hat{h}
\end{align*}
\]

So \( t \) is solved by \( I/2 = t \).

Do it: \( 50 + 100 = 100 \).

Answer: \( x = 100 \).