# Lines and Planes from Vectors

We are going to investigate the vector equations of a line **x** = **a** + λ**b** and a plane **y** = **a** + λ**b** + μ**c**.

 Open a new 3D Graph Page.

 Enter points with coordinates (0, 0, 0) and (1, 1, 2).

 Select (0, 0, 0) then (1, 1, 2), right-click and choose Create Vector. This is vector **a**.

 Use Drag Mode to look at the vector from different angles.

 Click x-y-z Orientation to return to the original view.

 Enter points with coordinates (–2, –3, 2) and (–1, –2, 3).

 Select (–2, –3, 2) then (–1, –2, 3), right-click and choose Create Vector. This is vector **b**.

 Select vector **b** the end point of vector **a**, right-click and choose Multiply Vector, changing the factor to λ. This is the vector λ**b**. 

Use Alt-L to type λ.

 Select the point (0, 0, 0) and the vectors **a** and λ**b**, right-click and choose Add Vectors. This is the vector **x** = **a** + λ**b**. 

 Select vector λ**b** the end point of vector **a**, right-click and choose Line from Vector. 

 Use the Constant Controller to change the value of λ. Concentrate on the end point of vector **x**. 

 Enter points with coordinates (0, –2, 2) and (0, –1, 3).

 Select (0, –2, 2) then (0, –1, 3), right-click and choose Create Vector. This is vector **c**.

 Select vector **c** the end point of vector λ**b**, right-click and choose Multiply Vector, changing the factor to μ. This is the vector μ**c**. 

Use Alt-m to type μ.

 Select the point (0, 0, 0) and the vectors **a,** λ**b** and μ**c**, right-click and choose Add
Vectors. This is the vector **y** = **a** + λ**b** +μ**c**. 

 Select vectors λ**b** and μ**c** and the end point of vector **a**, right-click and choose Plane. 

 Use the Constant Controller to change the values of λ and μ. Concentrate on the end point of vector **y**. 

To extend this activity further you could investigate the equation of a plane **a**.**x** = |**a**|².

 Open a new 3D Graph Page.

 Enter points with coordinates (0, 0, 0) and (a, b, c).

 Select (0, 0, 0) then (a, b, c), right-click and choose Create Vector. This is vector **a**.

 Enter the equation: ax + by + cz = a² + b² + c² 

 Attach a point to the plane.

 Select the end of vector **a** and the point in the plane, right-click and Create Vector. 

 Select the origin and the two vectors, right-click Add Vectors. This is vector **x**. 

What is the value of the scalar product of vectors **x** and **a**?