3D Vectors with Mathematica

Vectors are defined as rows:

```
A = {a1, a2, a3};
B = {b1, b2, b3};
```

Scalar multiplication:

```
c * A
```

```
{a1 c, a2 c, a3 c}
```

Dot products can be done with two different commands:

```
Dot[A, B]
A.B
```

```
a1 b1 + a2 b2 + a3 b3
```

```
a1 b1 + a2 b2 + a3 b3
```

Vector lengths are computed with the **`Norm`** command.

```
Norm[A]
```

$$\sqrt{\text{Abs}[a1]^2 + \text{Abs}[a2]^2 + \text{Abs}[a3]^2}$$

Vector cross products are computed with two different commands:

```
Cross[A, B]
A × B
```

```
{-a3 b2 + a2 b3, a3 b1 - a1 b3, -a2 b1 + a1 b2}
```

```
{-a3 b2 + a2 b3, a3 b1 - a1 b3, -a2 b1 + a1 b2}
```

The **`MatrixForm`** command displays vectors in column format:

```
MatrixForm[%]
```

$$\begin{pmatrix} -a3\ b2 + a2\ b3 \\ a3\ b1 - a1\ b3 \\ -a2\ b1 + a1\ b2 \end{pmatrix}$$

Example: Compute the Dot and Cross Products of A = (1, 3, 2) and B = (2, 3, 5). Evaluate the following commands to see the result.

```
A = {1, 3, 2};
B = {2, 3, 5};
Dot[A, B]
Cross[A, B]
```

Verify that the cross product of A and B is always orthogonal to A and B, by showing that (AxB).A=0 and (AxB).B=0.

```
A = {a1, a2, a3};
B = {b1, b2, b3};
```

```
Dot[Cross[A, B], A]
```

```
a3 (-a2 b1 + a1 b2) + a2 (a3 b1 - a1 b3) + a1 (-a3 b2 + a2 b3)
```

```
Simplify[%]
```

```
0
```

```
Dot[Cross[A, B], B]
```

```
(-a2 b1 + a1 b2) b3 + b2 (a3 b1 - a1 b3) + b1 (-a3 b2 + a2 b3)
```

```
Simplify[%]
```

```
0
```