**Harold’s Vectors Cheat Sheet**

5 December 2022

**Definitions**

|  |  |  |
| --- | --- | --- |
| **Term** | **Formula** | **Example** |
| **Vector Notation** |  | Bold letter |
|  | Arrow on top |
| **Component Notation** |  |  |
|  |  |
|  | (2D) |
|  | What are velocity components? (article) | Khan Academy  **2D** | **3D** |
| **Vectors Used in Examples** | **2D**: set |  |
| **Magnitude** |  |  |
| Can also use .  Length of vector, but with no direction (scalar).  Similar to a hypotenuse.  Think multi-dimensional Pythagorean Theorem. | A vector |
| **Direction** | Divided into dimensional components. | A scalar with a direction is a vector.  Example: speed vs. velocity |
|  |  |
| **Unit Vector**  (Basis Vector) |  | Circumflex or “hat” on top.  Indicates direction only.  Always has a magnitude of one (1 or unit). |
|  |  |
| **Scalar** | *k, m* | A number with no direction or units. |
| **Orthogonal** | A change in one dimension does not change in any of the values in the other dimensions. | 2D: right angle  **Rectangular Coordinates:** The x-axis, y-axis, and z-axis are orthogonal to each other.  **Polar Coordinates:** The angle is orthogonal to the line segment length |
| if | Two vectors are orthogonal if their dot product is zero. |
|  | See the source image | See the source image |
| **Parallel** | If | Two vectors are parallel if they have the same direction. |
|  | Collinear of in opposite directions | See the source image |
| **Vector vs. Matrix** | vector = or matrix | A matrix with only one (1) row or column. |
|  | See the source image | |

**Vector Operations**

|  |  |  |
| --- | --- | --- |
| **Operation** | **Formula** | **Example** |
| **Addition** |  |  |
|  | Commutative |
|  | Associative |
|  | Distributive |
|  |
|  |  | The opposite vector |
| **Subtraction** |  | Change the direction of then add. |
|  | Parallel Two Vectors | |
| **Scalar Multiplication** |  |  |
| Changes the magnitude only. | |
|  |  | Scalar multiplication - Wikipedia |
| **Dot Product**  (Scalar Product) |  |  |
|  |  |
|  | Commutative |
|  | Distributive |
|  | Scalar Multiplication |
|  | Zero Vector Dot Product |
|  | Dot Product and Vector Magnitude Relationship |
| Is always a scalar. | |
|  |  | 8: Dot product as projection onto a unit vector | Download Scientific  Diagram |
| **Cross Product**  (Vector Product) |  | |
|  |  |
|  | Anti-Commutative |
|  | Not Commutative |
|  |
|  | Not Associative |
|  |
|  | Distributive |
|  |
|  | Scalar Multiplication |
|  |
| Is always a vector orthogonal to the other two vectors. | |
|  |  | Cross products (article) | Khan Academy |
| **Scalar Triple Product** |  | |
| **Vector Triple Product** |  | |

**Vector Applications**

|  |  |  |
| --- | --- | --- |
| **Application** | **Formula** | **Example** |
| **Projection** |  | The dot product - Math Insight |
| **Right Hand Rule** | The cross product produces a vector orthogonal to the other two vectors. | Use the right hand rule to determine direction of the cross product vector. |
|  | Right hand rule and the cross product | |
| **Area**  (Parallelagram) |  | Vector Product - Cross Product |
| **Volume**  (Parallelepiped) |  | 2.4 Products of Vectors | University Physics Volume 1 |
| **Torque** |  |  |
| **Coplanar** | Three vectors are coplanar if | All three vectors are in the same plane. |