

- Given the vectors $\vec{a} = \langle 2, 0, -1 \rangle$, $\vec{b} = \langle 3, -2, 4 \rangle$, and $\vec{c} = \langle 1, -4, 0 \rangle$, compute the following:
 - A unit vector in the direction of \vec{c} .
 - The angle between \vec{a} and \vec{b} (to the nearest tenth of a degree).
 - $\vec{a} \times \vec{b}$
 - The area of the triangle determined by \vec{a} and \vec{b} .
 - $\text{comp}_{\vec{b}}\vec{a}$.
 - A non-zero vector that is perpendicular to \vec{c} .
- Given the vectors $\vec{a} = \langle 1, 2, 0 \rangle$, $\vec{b} = \langle -1, 0, 2 \rangle$, and $\vec{c} = \langle 0, 1, 1 \rangle$, compute the following:
 - $2\vec{a} + 3\vec{b}$
 - $\vec{a} \cdot \vec{b}$.
 - A unit vector in the direction of \vec{a} .
 - The component of \vec{c} along \vec{a} .
 - The Volume of the parallelepiped determined by \vec{a}, \vec{b} and \vec{c} .
 - The angle between \vec{b} and \vec{c}
- Decide whether each of the following are true or false. If true, explain why. If false, give a counterexample.
 - If $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c}$, then $\vec{b} = \vec{c}$.
 - If $\vec{b} = \vec{c}$ then $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c}$.
 - $\vec{a} \cdot \vec{a} = \|\vec{a}\|$
 - If $\|\vec{a}\| > \|\vec{b}\|$, then $\vec{a} \cdot \vec{c} > \vec{b} \cdot \vec{c}$
 - If $\|\vec{a}\| = \|\vec{b}\|$, then $\vec{a} = \vec{b}$
- Let $P=(2,1,2)$ and $Q=(3,1,1)$ be points.
 - Find parametric equations for a line through these points.
 - Find the equation of a plane containing P, Q , and the origin.
- Given the lines $l_1 : x = 3; y = 6 - 2t; z = 3t + 1$ $l_2 : x = 1 + 2s; y = 3 + s; z = 2 + 2s$:
 - Show that the lines intersect by finding the coordinates of a point of intersection.
 - Find a vector orthogonal to both lines.
 - Find the equation of a plane containing both lines.
- Given the two planes $2x + y - z = 4$ and $3x - y + z = 6$
 - Find normal vectors to each plane.
 - Find parametric equations for the line of intersection of the two planes.
- Find both the parametric and symmetric equations for the line through the points $P(3, 5, 7)$ and $Q(-6, 2, 1)$.
- Find an equation of the plane through the point $(1, 4, -5)$ and parallel to the plane defined by $2x - 5y + 7z = 12$.

9. Sketch at least 3 traces, then sketch and identify the surface given by each of the following equations:

- (a) $y^2 + z^2 - x = 0$
- (b) $y^2 + z^2 = 1$
- (c) $4x^2 + 4y^2 - 2z^2 = 4$.
- (d) $4x^2 + y^2 - z^2 = 0$
- (e) $y^2 - 4 = 4x^2 + z^2$
- (f) $x^2 - z = y^2$

10. Let $\vec{r}(t) = \langle t^2, 4 + 3t, 4 - 3t \rangle$ be a vector valued function. Calculate the following:

- (a) $\vec{r}(t)$
- (b) $\vec{r}'(t)$
- (c) $\int_0^1 \vec{r}(t) dt$
- (d) the arc length of $\vec{r}(t)$ for $0 \leq t \leq 2$. (Just set up the integral, you do not need to evaluate it).
- (e) Find the values of t for which $\vec{r}(t)$ and $\vec{r}'(t)$ are perpendicular.

11. Let $\mathbf{r}(t) = \langle 3, 4\cos(t), 4\sin(t) \rangle$.

- (a) Sketch the curve traced out by the vector-valued function $\mathbf{r}(t)$. Indicate the orientation of the curve. What is geometric shape of this curve?
- (b) Find an equation in terms of t for $s(t)$, the arc length of the curve traced out by $\mathbf{r}(t)$ as a function of t for $t \geq 0$.
- (c) Find $\mathbf{r}'(t)$.
- (d) Find an expression for the angle between the vectors $\mathbf{r}(t)$ and $\mathbf{r}'(t)$.
- (e) Find the force acting on a 5 kilogram object moving along the path given by $\mathbf{r}(t)$, in units of meters and seconds (assume that no other forces are acting on this mass).
- (f) Find and draw the position and tangent vectors when $t = \pi$. Find 2 different vectors that are normal to $\mathbf{r}(\pi)$ and $\mathbf{r}'(\pi)$. Draw these vectors (carefully labeled) on the same axes (as the position and tangent vectors).

12. Let $\vec{v}(t) = \langle t^2 - 2t, 4t - 3, t^3 \rangle$.

- (a) Find $\vec{a}(t)$
- (b) If $\vec{r}(0) = \langle 4, -1, 0 \rangle$, find $\vec{r}(t)$.
- (c) Find the force acting on an object of mass 50kg with position function $\vec{r}(t)$ (in units of meters per second).
- (d) Find the speed of the object at time $t = 2$.

13. Suppose that a projectile is launched with initial velocity $v_0 = 100$ ft/s from a height of 0 feet and at an angle of $\theta = \frac{\pi}{6}$.

- (a) Assuming that the only force acting on the object is gravity, find the maximum altitude, horizontal range, and speed at impact of this projectile.
- (b) Find the landing point of this projectile if it weighs 1 pound, is launched due east, and there is a southerly wind force of 4 pounds.