Chapter 11 Formulas

1. The magnitude of a vector: $||\mathbf{v}|| = \sqrt{v_1^2 + v_2^2 + v_3^2}$

2. The dot product: $\mathbf{u} \cdot \mathbf{v} = u_1 v_1 + u_2 v_2 + u_3 v_3$

3. The cross product: $\mathbf{u} \times \mathbf{v} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ u_1 & u_2 & u_3 \\ v_1 & v_2 & v_3 \end{vmatrix}$

4. Normalize a vector: $\mathbf{u} = \dfrac{\mathbf{v}}{||\mathbf{v}||}$

5. Angle between vectors: $\cos\theta = \dfrac{\mathbf{u} \cdot \mathbf{v}}{||\mathbf{u}||||\mathbf{v}||}$

6. Projection: $\text{proj}_{\mathbf{v}}\mathbf{u} = \left(\dfrac{\mathbf{u} \cdot \mathbf{v}}{||\mathbf{v}||^2}\right)\mathbf{v}$

7. Direction Cosines: $\cos\alpha = \dfrac{v_1}{||\mathbf{v}||} \qquad \cos\beta = \dfrac{v_2}{||\mathbf{v}||} \qquad \cos\gamma = \dfrac{v_3}{||\mathbf{v}||}$

8. Volume of a parallelepiped: $|\mathbf{u} \cdot (\mathbf{v} \times \mathbf{w})| = \begin{vmatrix} u_1 & u_2 & u_3 \\ v_1 & v_2 & v_3 \\ w_1 & w_2 & w_3 \end{vmatrix}$

9. Distance between two points: $D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$

10. Midpoint: $\left(\dfrac{x_2 + x_1}{2}, \dfrac{y_2 + y_1}{2}, \dfrac{z_2 + z_1}{2}\right)$

11. Equation of a Sphere: $(x - x_0)^2 + (y - y_0)^2 + (z - z_0)^2 = r^2$

12. Parametric Equation of a Line: $x = x_0 + at, \quad y = y_0 + bt, \quad z = z_0 + ct$

13. Symmetric Equation of a Line: $\dfrac{x - x_0}{a} = \dfrac{y - y_0}{b} = \dfrac{z - z_0}{c}$

14. Standard Form of a Plane: $a(x - x_0) + b(y - y_0) + c(z - z_0) = 0$

15. Distance between a Point and a Plane: $D = ||\text{proj}_{\mathbf{n}}\overrightarrow{PQ}|| = \dfrac{|\overrightarrow{PQ} \cdot \mathbf{n}|}{||\mathbf{n}||}$

16. Distance between a Point and a Line: $D = \dfrac{||\overrightarrow{PQ} \times \mathbf{u}||}{||\mathbf{u}||}$