Chapter 12 Review

1. Three-Dimensional Coordinate Systems
    a. Coordinate Planes
    b. Distance Formula
    c. Equation of Sphere $x^2 + y^2 + z^2 + Ax + By + Cz + D = 0$
2. Vectors
    a. Two and Three Dimensional Vector notation
    b. Vector Components
    c. Length or norm of a vector $|\mathbf{a}| = \sqrt{\mathbf{a} \cdot \mathbf{a}}$
    d. Addition of Vectors and multiplication by scalars
    e. Standard Basis Vectors
    f. Normalization of Vectors (creating unit vectors) $\mathbf{a} / |\mathbf{a}|$
    g. Force Problems
3. The Dot Product
    a. Definition
    b. Angle between vectors $\cos\theta = \dfrac{\mathbf{a} \cdot \mathbf{b}}{|\mathbf{a}||\mathbf{b}|}$
    c. Orthogonal (Perpendicular) Vectors $\mathbf{a} \cdot \mathbf{b} = 0$
    d. Direction Angles and Direction Cosines
    e. Scalar and Vector Projections $comp_{\mathbf{a}}\mathbf{b} = \dfrac{\mathbf{a} \cdot \mathbf{b}}{|\mathbf{a}|}$, $proj_{\mathbf{a}}\mathbf{b} = \dfrac{\mathbf{a} \cdot \mathbf{b}}{|\mathbf{a}|^2}\mathbf{a}$
    f. Work $W = \mathbf{F} \cdot \mathbf{D}$
4. The Cross Product
    a. Definition $\mathbf{a} \times \mathbf{b} = < a_2b_3 - a_3b_2, a_3b_1 - a_1b_3, a_1b_2 - a_2b_1 > = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$
    b. Determinants (2x2, 3x3)
    c. Magnitude and Direction of Cross Product $\mathbf{a} \times \mathbf{b} = ab\sin\theta$
    d. Cross Product of Parallel Vectors
    e. Area of Parallelogram = $|\mathbf{a} \times \mathbf{b}|$
    f. BAC-CAB Rule and other properties
    g. Scalar Triple Product and Volume of Parallelepiped $V = |\mathbf{a} \cdot \mathbf{b} \times \mathbf{c}|$
    h. Torque $\tau = \mathbf{r} \times \mathbf{F}$
5. Equations of Lines and Planes
    a. Parametric and Symmetric Equations for a Line $\mathbf{r} = \mathbf{r}_0 + t\mathbf{v}$
    b. Vector and Scalar Equations of Planes $\mathbf{N} \cdot (\mathbf{r} - \mathbf{r}_0) = 0 \Rightarrow ax + by + cz = d$
    c. Determination of Lines and Planes given a variety of information.
    d. Parallel/Perpendicular Lines or Planes or Angle between planes.
    e. Distance of a Point to a Plane
6. Cylinders and Quadric Surfaces
    a. Recognize Various Surfaces – Cylinders and Quadrics
    b. Slices: Intersection of Surfaces by planes parallel to the coordinate planes
    c. Parabolic-Circular-Elliptic Cylinders
    d. Ellipsoid-Elliptic Paraboloid-Hyperbolic Paraboloid-Cone-Hyperboloids of One and Two Sheets