1. Length of curve $(x(t), y(t), z(t)), a \leq t \leq b$ is $\int_a^b \sqrt{x'(t)^2 + y'(t)^2 + z'(t)^2}dt = \int_a^b ds$.

2. $\mathbf{u} \cdot \mathbf{v} = u_1v_1 + u_2v_2 + u_3v_3 = ||\mathbf{u}||||\mathbf{v}|| \cos\theta$.

3. $\mathbf{u} \times \mathbf{v} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ u_1 & u_2 & u_3 \\ v_1 & v_2 & v_3 \end{vmatrix} = (u_2v_3 - u_3v_2)\mathbf{i} + (u_3v_1 - u_1v_3)\mathbf{j} + (u_1v_2 - u_2v_1)\mathbf{k}$.

4. $||\mathbf{u} \times \mathbf{v}|| = ||\mathbf{u}||||\mathbf{v}|| \sin\theta =$ area of parallelogram, $(\mathbf{u} \times \mathbf{v}) \cdot \mathbf{w} =$ volume of parallelipiped.

5. Plane $A(x - x_0) + B(y - y_0) + C(z - z_0) = Ax + By + Cz - D = 0 \perp A\mathbf{i} + B\mathbf{j} + C\mathbf{k}$.

6. Line $x = x_0 + at, y = y_0 + bt, z = z_0 + ct$ through (x_0, y_0, z_0) in direction $a\mathbf{i} + b\mathbf{j} + c\mathbf{k}$.

7. Position $\mathbf{r}(t)$, velocity $\mathbf{v}(t) = \frac{d\mathbf{r}}{dt}$, speed $||\mathbf{v}(t)|| = \frac{ds}{dt}$, acceleration $\mathbf{a}(t) = \frac{d\mathbf{v}}{dt}$

8. $\nabla f = f_x\mathbf{i} + f_y\mathbf{j} + f_z\mathbf{k}$.

9. Directional derivative at $\mathbf{p}$ in direction $\mathbf{u}$: $D_{\mathbf{u}}f(\mathbf{p}) = \mathbf{u} \cdot \nabla f(\mathbf{p})$.

10. Chain rule: $\frac{d}{dt}(f(\mathbf{r}(t))) = \nabla f(\mathbf{r}(t)) \cdot \frac{d\mathbf{r}}{dt}$.

11. Tangent plane to $z = f(x, y)$ at (x_0, y_0, z_0): $z - z_0 = f_x(x_0, y_0)(x - x_0) + f_y(x_0, y_0)(y - y_0)$.

12. Second derivative test at (x_0, y_0) where $\nabla f((x_0, y_0)) = 0$: If $D = (f_{xx}f_{yy} - f_{xy}^2)((x_0, y_0))$, then: $(1) : D > 0, f_{xx} > 0)$ local min;$(2) D > 0, f_{xx} < 0$ local max; $(3) : D < 0$ saddle pt.

13. Area of graph $z = f(x, y)$ over region S in xy-plane: $\int\int_S \sqrt{f_x^2 + f_y^2 + 1}dA$.

14. Polar coordinates: $x = r\cos\theta, y = r\sin\theta, dA = rdrd\theta$.

15. Spherical coordinates: $x = \rho\sin\phi\cos\theta, y = \rho\sin\phi\sin\theta, z = \rho\cos\phi, dV = \rho^2\sin\phi d\rho d\theta d\phi$.

16. $div(\mathbf{F}) = \nabla \cdot \mathbf{F} = M_x + N_y + P_z$.

17. $curl(\mathbf{F}) = \nabla \times \mathbf{F} = (P_y - N_z)\mathbf{i} + (M_z - P_x)\mathbf{j} + (N_x - M_y)\mathbf{k}$.

18. $curl(\nabla f) = \mathbf{0}$.

19. If C is a curve $\mathbf{r}(t) = x(t)\mathbf{i} + y(t)\mathbf{j} + z(t)\mathbf{k}$, $a \leq t \leq b$, then $\int_C \mathbf{F} \cdot d\mathbf{r} = \int_C Mdx + Ndy + Pdz = \int_a^b (M\frac{dx}{dt} + N\frac{dy}{dt} + P\frac{dz}{dt})dt$ and $\int_C f\ ds = \int_a^b f(\mathbf{r}(t))||\frac{d\mathbf{r}}{dt}(t)||dt$.

20. If $\mathbf{F}$ is conservative means $\mathbf{F} = \nabla f$. If $\mathbf{F}$ conservative, then $curl(\mathbf{F}) = \mathbf{0}$.

21. If C is a curve from P to Q, $\int_C \nabla f \cdot d\mathbf{r} = f(Q) - f(P)$.

22. Green's Thm:$\oint_{\partial S} Mdx + Ndy = \int\int_S (N_x - M_y)dA$

23. Divergence Thm in plane: $\oint_{\partial S} \mathbf{F} \cdot \mathbf{n}ds = \int\int_S div(\mathbf{F})dA$, $\mathbf{n} =$ outward unit normal.

24. Divergence Thm in space: $\int\int_{\partial S} \mathbf{F} \cdot \mathbf{n}dS = \int\int\int_S div(\mathbf{F})dV$, $\mathbf{n} =$ outward unit normal..