### 12.5 Lines and Planes in Space

1. Parametric Equation of a Line in $\mathbb{R}^{3}$ :
2. If $\ell$ is the line parametrized by $\mathbf{r}(t)=\langle 5-3 t,-2+t, 1+9 t\rangle$, find the equation of the line through $P(-6,4,-3)$ parallel to $\ell$.
3. Are the points $P(2,3,1), Q(4,2,2)$, and $R(8,0,4)$ on the same line?
4. Find a parametrization of the line through $P(3,1,-2)$ and $Q(-2,7,-4)$.
5. The line segment from $\mathbf{r}_{0}$ to $\mathbf{r}_{1}$ is given by the vector equation
6. Do the lines $\ell_{1}=\langle-2,5,1\rangle+t\langle 3,-4,2\rangle$ and $\ell_{2}=\langle 1,3,-4\rangle+t\langle-1,2,-3\rangle$ intersect?
7. Symmetric Equations:
8. Planes in $\mathbb{R}^{3}$ : The vector equation of a plane with direction vectors $\mathbf{a}$ and $\mathbf{b}$ through the point $R_{0}\left(x_{0}, y_{0}, z_{0}\right)$ is given by
where $\mathbf{r}=\langle x, y, z\rangle$ and $\mathbf{r}_{0}=\left\langle x_{0}, y_{0}, z_{0}\right\rangle$.
9. Definition of Normal: A vector $\mathbf{n}$ is normal to a plane $\mathscr{P}$ if $\mathbf{n}$ is orthogonal to every vector lying in the plane, that is to say, $\mathbf{n} \cdot \mathbf{a}=0$ for every vector a lying in plane $\mathscr{P}$.
10. Normal Form of a Plane: If $\mathbf{n}=\langle a, b, c\rangle$ is orthogonal to a plane with direction vectors a and $\mathbf{b}$ through the point $R_{0}\left(x_{0}, y_{0}, z_{0}\right)$, then
where $\mathbf{r}=\langle x, y, z\rangle$ and $\mathbf{r}_{0}=\left\langle x_{0}, y_{0}, z_{0}\right\rangle$.
11. Find an equation of the plane through the points $(-2,2,0),(-2,3,2)$, and $(1,2,2)$.
12. Find an equation of the plane through the point $(1,3,2)$ with normal vector $\langle 2,-1,5\rangle$.
13. Find an equation of the plane through the point $(4,-2,3)$ and parallel to the plane $3 x-7 z=12$.
14. Two planes are parallel if their normal vectors are parallel.
15. The distance from the point $\left(x_{0}, y_{0}, z_{0}\right)$ to the plane described by $a x+b y+c z+d=0$ is: distance $=\frac{\left|a x_{0}+b y_{0}+c z_{0}+d\right|}{\sqrt{a^{2}+b^{2}+c^{2}}}$
