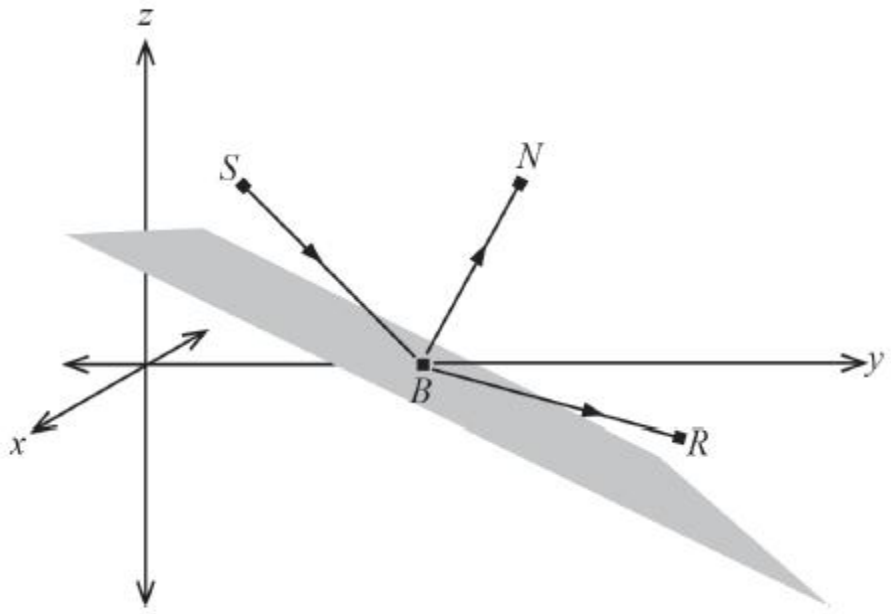
Question 20 **(7 marks)**

A laser pointer at point S directs a highly focused beam of light towards a mirror. The beam bounces off the mirror at point B and is then reflected away from the mirror toward point R.

The mirror's surface is given by the equation $\underset{\sim}{r} \cdot (\underset{\sim}{j}+2\underset{\sim}{k}) = 9$ and the laser pointer is positioned at point S with position vector $-2\underset{\sim}{i} + 3\underset{\sim}{j} + 6\underset{\sim}{k}$. The laser pointer is held so that the beam is pointed in the direction $\underset{\sim}{d}_1 = \underset{\sim}{i} + \underset{\sim}{j} - \underset{\sim}{k}$.



(a) Determine the position vector for point B. (4 marks)

The laser beam is reflected away from the mirror so that:

- the angle of the incoming beam $\overrightarrow{SB}$ to the normal of the mirror is equal to the angle of the reflected beam $\overrightarrow{BR}$ to the normal of the mirror i.e. $s\angle SBN = s\angle NBR$.
- the incoming beam $\overrightarrow{SB}$, the normal of the mirror and the reflected beam $\overrightarrow{BR}$ are all contained in one plane.

Let $\underset{\sim}{\hat{d}}_2$ = the unit vector in the direction of the reflected beam $\overrightarrow{BR}$ i.e. $\left|\underset{\sim}{\hat{d}}_2\right| = 1$.

(b) Determine the unit vector $\underset{\sim}{\hat{d}}_2$ giving components correct to 0.01. (3 marks)