8.1 Obtain the components of the vectors below where \( L \) is the magnitude and \( \theta \) the angle made with the positive direction of the \( x \) axis \((-180^\circ < \theta \leq 180^\circ)\).
   (a) \( L = 3, \theta = 60^\circ \);
   (b) \( L = 3, \theta = -150^\circ \).

8.2 Two ships, \( S_1 \) and \( S_2 \) set off from the same point \( Q \). Each follows a route given by successive displacement vectors. In axes pointing east and north, \( S_1 \) follows the path to \( B \) via \( \overrightarrow{QA} = (2, 4) \), and \( \overrightarrow{AB} = (4, 1) \). \( S_2 \) goes to \( E \) via \( \overrightarrow{QC} = (3, 3) \), \( \overrightarrow{CD} = (1, 1) \) and \( \overrightarrow{DE} = (2, -3) \). Find the displacement vector \( \overrightarrow{BE} \) in component form.

8.3 Sketch a diagram to show that if \( A, B, C \) are any three points, then \( \overrightarrow{AB} + \overrightarrow{BC} + \overrightarrow{CA} = \overrightarrow{0} \). Formulate a similar result for any number of points.

8.4 Sketch a diagram to show that if \( A, B, C, D \) are any four points, then \( \overrightarrow{CD} = \overrightarrow{CB} + \overrightarrow{BA} + \overrightarrow{AD} \). Formulate a similar result for any number of points.

8.5 Two points \( A \) and \( B \) have position vectors \( a \) and \( b \) respectively. In terms of \( a \) and \( b \) find the position vectors of the following points on the straight line passing through \( A \) and \( B \).
   (a) The mid-point \( C \) of \( AB \);
   (b) a point \( U \) between \( A \) and \( B \) for which \( AU/UB = 1/3 \).

8.6 Suppose that \( C \) has position vector \( r \) and \( r = \lambda a + (1 - \lambda)b \) where \( \lambda \) is a parameter, and \( A, B \) are points with \( a, b \) as position vectors. Show that \( C \) describes a straight line. Indicate on a diagram the relative positions of \( A, B, C \), when \( \lambda < 0, 0 < \lambda < 1 \), and \( \lambda > 1 \).

8.7 Find the shortest distance from the origin of the line given in vector parametric form by \( \overrightarrow{r} = a + t b \), where
   \[
   a = (1, 2, 3) \quad \text{and} \quad b = (1, 1, 1),
   \]
   and \( t \) is the parameter (Hint: use a calculus method, with \( t \) as the independent variable.)

8.8 \( ABCD \) is any quadrilateral in three dimensions. Prove that if \( P, Q, R, S \) are the mid-points of \( AB, BC, CD, DA \) respectively, then \( PQRS \) is a parallelogram.

8.9 \( ABC \) is a triangle, and \( P, Q, R \) are the mid-points of the respective sides \( BC, CA, AB \). Prove that the medians \( AP, BQ, CR \) meet at a single point \( G \) (called the centroid of \( ABC \); it is the centre of mass of a uniform triangular plate.)

8.10 Show that the vectors \( \overrightarrow{OA} = (1, 1, 2), \overrightarrow{OB} = (1, 1, 1), \) and \( \overrightarrow{OC} = (5, 5, 7) \) all lie in one plane.