Mechanics (1)[040101151] Fall 2025 Sheet(1)

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1. For a hexagon $ABCDEF$ with center at G. Prove that
$$\overline{AB} + \overline{AC} + \overline{AE} + \overline{AF} = 4\overline{AG}$$
Also, for any point O, prove that
$$\overline{OA} + \overline{OB} + \overline{OC} + \overline{OD} + \overline{OE} + \overline{OF} = 6\overline{OG}$$
2. In a triangle ABC, the mid points of sides AB and AC are respectively, E and F. The point of intersection between CE and BF is O.
Prove that $\overline{BF} + \overline{CE} = \overline{EA} + \overline{FA}$
Also, find $\overline{AO}$ in terms of $\overline{AB}$ and $\overline{AC}$.
3. Given $\bar{r}_1 = 3\hat{\imath} - 2\hat{\jmath} + \hat{k}$, $\bar{r}_2 = 2\hat{\imath} - 4\hat{\jmath} - 3\hat{k}$ and $\bar{r}_3 = -\hat{\imath} + 2\hat{\jmath}$, find the magnitudes of
a) $\bar{r}_3$ b) $\bar{r}_1 + \bar{r}_2 + \bar{r}_3$ c) $2\bar{r}_1 - 3\bar{r}_2 - 5\bar{r}_3$
4. If $\bar{r}_1 = 2\hat{\imath} - \hat{\jmath} + \hat{k}$, $\bar{r}_2 = \hat{\imath} + 3\hat{\jmath} - 2\hat{k}$, $\bar{r}_3 = -2\hat{\imath} + \hat{\jmath} - 3\hat{k}$ and $\bar{r}_4 = 3\hat{\imath} + 2\hat{\jmath} + 5\hat{k}$, find scalers a, b, c such that $\bar{r}_4 = a\bar{r}_1 + b\bar{r}_2 + c\bar{r}_3$
5. Find the angles which the line joining the points $(1, -3, 2)$ and $(3, -5, 1)$ makes with the coordinate axes.
6. let $\bar{a} = \langle 1, -3, 2\rangle$, $\bar{b} = \langle -1, 1, 1\rangle$, $\bar{c} = \langle 2, 6, 9\rangle$

find the indicated vector or scalar in the following problems

i. $\boldsymbol{2\bar{a} - (\bar{b} - \bar{c})}$

ii. $\boldsymbol{\bar{b} + 2(\bar{a} - 3\bar{c})}$

iii. $\boldsymbol{-6\bar{b} + 4(\bar{a} + 2\bar{c})}$

iv. $\boldsymbol{|2\bar{b}||\bar{c}|}$

v. $\boldsymbol{\left|\frac{\bar{a}}{|\bar{a}|}\right| + 5\left|\frac{\bar{b}}{|\bar{b}|}\right|}$

vi. $\boldsymbol{|\bar{b}|\bar{a} + |\bar{a}|\bar{b}}$

7. For the points $P(1,-1,1), Q(2,-2,2), R(2,0,1)$ and $S(3,-1,2)$; does $\overline{PQ} = \overline{RS}$??
8. Let $\bar{v} = -\hat{\imath} + 5\hat{\jmath} - 2\hat{k}$, $\bar{\omega} = 3\hat{\imath} + \hat{\jmath} + \hat{k}$

   Find:

   (i) $\bar{v} - \bar{\omega}$

   (ii) $\bar{v} + \bar{\omega}$

   (iii) $\frac{\bar{v}}{|\bar{v}|}$

   (iv) The vector $\bar{u}$ such that $\bar{u} + \bar{v} + \bar{\omega} = 2\hat{\jmath} + \hat{k}$

   (v) Is there a scalar vector m such that $m(\bar{v} + 2\bar{\omega}) = \hat{k}$, If so, find it?

   (vi) Is $|\bar{v} - \bar{\omega}| = |\bar{v}| - |\bar{\omega}|$? . If not, which quantity is larger?

(vii) Is $|\bar{v} + \bar{\omega}| = |\bar{v}| + |\bar{\omega}|$? . If not, which quantity is larger?

9. Find a unit vector in the same direction as

$$\bar{a} = 10\hat{\imath} - 5\hat{\jmath} + 10\hat{k}$$

10. Find a unit vector in the opposite direction of

$$\bar{a} = \hat{\imath} + 3\hat{\jmath} + 2\hat{k}$$

11. Find a vector $\bar{b}$ that is four times as long as $\bar{a} = \hat{\imath} - \hat{\jmath} + \hat{k}$ in the same direction as $\bar{a}$

12. Find a vector $\bar{b}$ for which $|\bar{b}| = \frac{1}{2}$ that is parallel to $\bar{a} = -6\hat{\imath} + 3\hat{\jmath} - 2\hat{k}$ but has the opposite direction.