

Section 1: Introduction to vectors

Solutions to Exercise level 2

$$1. \quad (i) \quad |\underline{a}| = \sqrt{2^2 + 1^2} = \sqrt{5}$$

$$\hat{\underline{a}} = \frac{1}{\sqrt{5}} \begin{pmatrix} 2 \\ 1 \end{pmatrix}$$

$$(ii) \quad |\underline{b}| = \sqrt{4^2 + (-3)^2} = 5$$

$$\hat{\underline{b}} = \frac{1}{5} \begin{pmatrix} 4 \\ -3 \end{pmatrix}$$

$$(iii) \quad |\underline{c}| = \sqrt{(-2)^2 + 5^2} = \sqrt{29}$$

$$\hat{\underline{c}} = \frac{1}{\sqrt{29}} \begin{pmatrix} -2 \\ 5 \end{pmatrix}$$

$$2. \quad (i) \quad \overline{AB} = -\underline{a} + \underline{b} = \underline{b} - \underline{a}$$

$$\overline{AC} = -\underline{a} + \underline{c} = \underline{c} - \underline{a}$$

$$(ii) \quad \overline{AM} = \frac{1}{2} \overline{AC} = \frac{1}{2}(\underline{c} - \underline{a})$$

$$(iii) \quad \overline{OM} = \overline{OA} + \overline{AM} = \underline{a} + \frac{1}{2}(\underline{c} - \underline{a}) = \frac{1}{2}\underline{a} + \frac{1}{2}\underline{c}$$

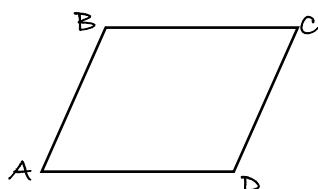
$$(iv) \quad \overline{NM} = \overline{OM} - \overline{ON} = \overline{OM} - \frac{1}{2}\overline{OB} = \frac{1}{2}\underline{a} + \frac{1}{2}\underline{c} - \frac{1}{2}\underline{b}$$

$$(v) \quad \text{If N and M coincide, } \overline{NM} = \underline{0}$$

$$\frac{1}{2}\underline{a} + \frac{1}{2}\underline{c} - \frac{1}{2}\underline{b} = \underline{0}$$

$$\underline{a} + \underline{c} = \underline{b}$$

3.



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$$\begin{aligned}\overline{OD} &= \overline{OA} + \overline{AD} \\ &= \overline{OA} + \overline{BC} \\ &= \overline{OA} + \overline{OC} - \overline{OB} \\ &= \underline{a} + \underline{c} - \underline{b}\end{aligned}$$

$$\begin{aligned}4. (i) \quad \overline{OL} &= \overline{OA} + \frac{1}{2}\overline{AB} & \overline{OM} &= \overline{OB} + \frac{1}{2}\overline{BC} \\ &= \begin{pmatrix} 2 \\ 3 \end{pmatrix} + \frac{1}{2}\left(\begin{pmatrix} 5 \\ 7 \end{pmatrix} - \begin{pmatrix} 2 \\ 3 \end{pmatrix}\right) & &= \begin{pmatrix} 5 \\ 7 \end{pmatrix} + \frac{1}{2}\left(\begin{pmatrix} 12 \\ 8 \end{pmatrix} - \begin{pmatrix} 5 \\ 7 \end{pmatrix}\right) \\ &= \begin{pmatrix} 2 \\ 3 \end{pmatrix} + \frac{1}{2}\begin{pmatrix} 3 \\ 4 \end{pmatrix} & &= \begin{pmatrix} 5 \\ 7 \end{pmatrix} + \frac{1}{2}\begin{pmatrix} 7 \\ 1 \end{pmatrix} \\ &= \begin{pmatrix} 3.5 \\ 5 \end{pmatrix} & &= \begin{pmatrix} 8.5 \\ 7.5 \end{pmatrix}\end{aligned}$$

$$\begin{aligned}(ii) \quad \overline{AC} &= \overline{OC} - \overline{OA} = \begin{pmatrix} 12 \\ 8 \end{pmatrix} - \begin{pmatrix} 2 \\ 3 \end{pmatrix} = \begin{pmatrix} 10 \\ 5 \end{pmatrix} \\ \overline{LM} &= \overline{OM} - \overline{OL} = \begin{pmatrix} 8.5 \\ 7.5 \end{pmatrix} - \begin{pmatrix} 3.5 \\ 5 \end{pmatrix} = \begin{pmatrix} 5 \\ 2.5 \end{pmatrix}\end{aligned}$$

$$\begin{aligned}(iii) \quad AC &= \sqrt{(12-2)^2 + (8-3)^2} = \sqrt{100+25} = 5\sqrt{5} \\ LM &= \sqrt{(8.5-3.5)^2 + (7.5-5)^2} = \sqrt{25+6.25} = 2.5\sqrt{5}\end{aligned}$$

(iv) AC and LM are parallel, and LM is half the length of AC.