

4.12 Linear Transformations and Matrices

Name: _____ Class: _____ Date: _____

Total: 9 marks

KEY WORDS linear transformation

• matrix-vector multiplication

• matrix

• vector

Objective

Build the skills to answer exam questions on **linear transformations and matrices**.

You must be able to:

- apply a matrix to a vector by **matrix-vector multiplication**
- describe the geometric effect (scaling, identity)

1 Key knowledge and worked examples

Study these first. Each one shows the method for a question type used later.

■ Linear transformations

A 2×2 matrix acts on a vector:

$$\begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} ax + by \\ cx + dy \end{bmatrix}.$$

This transforms the plane – scaling, rotation, or reflection.

■ Example

$$\begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} \begin{bmatrix} 1 \\ 3 \end{bmatrix} = \begin{bmatrix} 2 \\ 6 \end{bmatrix} \text{ – a scaling by 2.}$$

2 Practice

2.1 State how a matrix acts on a vector.

[1]

2.2 Compute $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 5 \\ 2 \end{bmatrix}$. [1]

2.3 Compute $\begin{bmatrix} 2 & 0 \\ 0 & 3 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \end{bmatrix}$. [2]

3 Exam-style questions

3.1 The identity matrix $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ maps a vector to [1]

- ☐ **A** the zero vector
B itself
C its reverse
D twice itself

3.2 $\begin{bmatrix} 3 & 0 \\ 0 & 3 \end{bmatrix}$ applied to a vector gives a [1]

- ☐ **A** rotation
B scaling by 3
C reflection
D shift

3.3 $A = \begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix}$.

(a) Compute $A \begin{bmatrix} 1 \\ 4 \end{bmatrix}$. [1]

(b) Compute $A \begin{bmatrix} 3 \\ 0 \end{bmatrix}$. [1]

(c) Describe the effect. [1]

Solutions

Each answer shows the steps, then the **result**.

2.1

- by matrix-vector multiplication, giving $\begin{bmatrix} ax + by \\ cx + dy \end{bmatrix}$

2.2

- $\begin{bmatrix} 5 \\ 2 \end{bmatrix}$

2.3

- $\begin{bmatrix} 2 \\ 3 \end{bmatrix}$

3.1 B

- itself.

3.2 B

- scaling by 3.

3.3

(a)

- $\begin{bmatrix} 2 \\ 4 \end{bmatrix}$

(b)

- $\begin{bmatrix} 6 \\ 0 \end{bmatrix}$

(c)

- it stretches the x -component by 2 and leaves y unchanged