1.1 Scalars and Vectors

Name: _____ Class: _____ Date: _____ **Total: 16 marks**

KEY WORDS vector • magnitude • components • scalar • direction

Objective

Build the skills to answer exam questions on **scalars and vectors** – resolving a vector into components, finding its magnitude and direction, and adding vectors.

You must be able to:

- distinguish a **scalar** (magnitude only) from a **vector** (magnitude **and** direction)
- resolve a vector into **components**: $A_x = A\cos\theta$, $A_y = A\sin\theta$
- find a vector's **magnitude** $A = \sqrt{A_x^2 + A_y^2}$ and its direction $\theta = \tan^{-1}(A_y/A_x)$
- add vectors by adding their components separately

1 Key knowledge and worked examples

Study these first. Each one shows the method for a question type used later – follow the steps and you can do the Practice and Exam-style questions yourself.

■ Scalar or vector?

A **scalar** has size only; a **vector** has size **and** direction.

scalar	vector
distance, speed, mass time, energy, temperature	displacement, velocity, force acceleration, momentum

■ Resolving into components

A vector of magnitude A at angle θ above the x-axis splits into

$$A_x = A\cos\theta, \qquad A_y = A\sin\theta.$$

For $A = 10$ at $\theta = 30°$: $A_x = 10\cos 30° = 8.7$, $A_y = 10\sin 30° = 5.0$.

■ **Magnitude and direction from components**

Reverse the process with Pythagoras and the tangent:

$$A = \sqrt{A_x^2 + A_y^2}, \qquad \theta = \tan^{-1}\frac{A_y}{A_x}.$$

For $A_x = 3$, $A_y = 4$: $A = \sqrt{3^2 + 4^2} = 5$, and $\theta = \tan^{-1}(4/3) = 53°$.

■ **Adding vectors by components**

Add the x-components and the y-components **separately**, then recombine. Two forces $\vec{F}_1 = (3, 0)$ N and $\vec{F}_2 = (0, 4)$ N:

$$\vec{F}_{\text{net}} = (3 + 0,\ 0 + 4) = (3, 4)\ \text{N}, \qquad |\vec{F}_{\text{net}}| = 5\ \text{N}.$$

2 Practice

Now apply the methods above.

2.1 State whether each is a scalar or a vector: (a) speed, (b) velocity, (c) mass, (d) acceleration. [2]

2.2 A displacement has magnitude 20 m at 60° above the x-axis. Find its x- and y-components. [2]

2.3 A vector has components $A_x = 6$ and $A_y = 8$. Find its magnitude. [2]

2.4 Add $\vec{A} = (5, 2)$ and $\vec{B} = (-1, 3)$ by components, and give the magnitude of the resultant. [2]

3 Exam-style questions

3.1 Which quantity is a vector? [1]

- **A** speed
- **B** distance
- **C** acceleration
- **D** mass

3.2 A vector of magnitude 12 makes an angle of 30° with the x-axis. Its x-component is closest to [1]

- **A** 6.0
- **B** 10.4
- **C** 12
- **D** 0

3.3 A vector has components $A_x = 9$ and $A_y = 12$.

(a) Find the magnitude of the vector. [2]

(b) Find the angle it makes with the x-axis. [1]

3.4 Two velocity vectors are $\vec{v}_1 = (4, 0)$ m s^{-1} and $\vec{v}_2 = (0, -3)$ m s^{-1}.

(a) Find the components of the resultant. [1]

(b) Find the magnitude and direction of the resultant. [2]