Vector Diagram – GCSE Physics

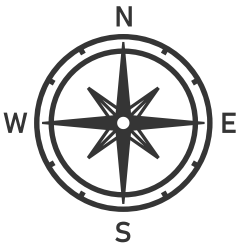
CONTENTS:

1. Introduction:

- A **Vector diagra**m is a graphical representation of vectors, which are quantities that have both magnitude and direction.
- Vector diagrams are used to visualize and analyze physical quantities like force, velocity, acceleration, displacement, electric fields etc.

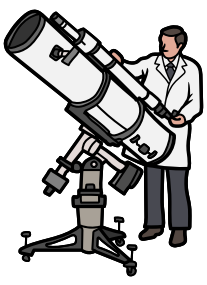
Real-life application:

Aviation



Navigation

Electrical Engineering



Astronomy

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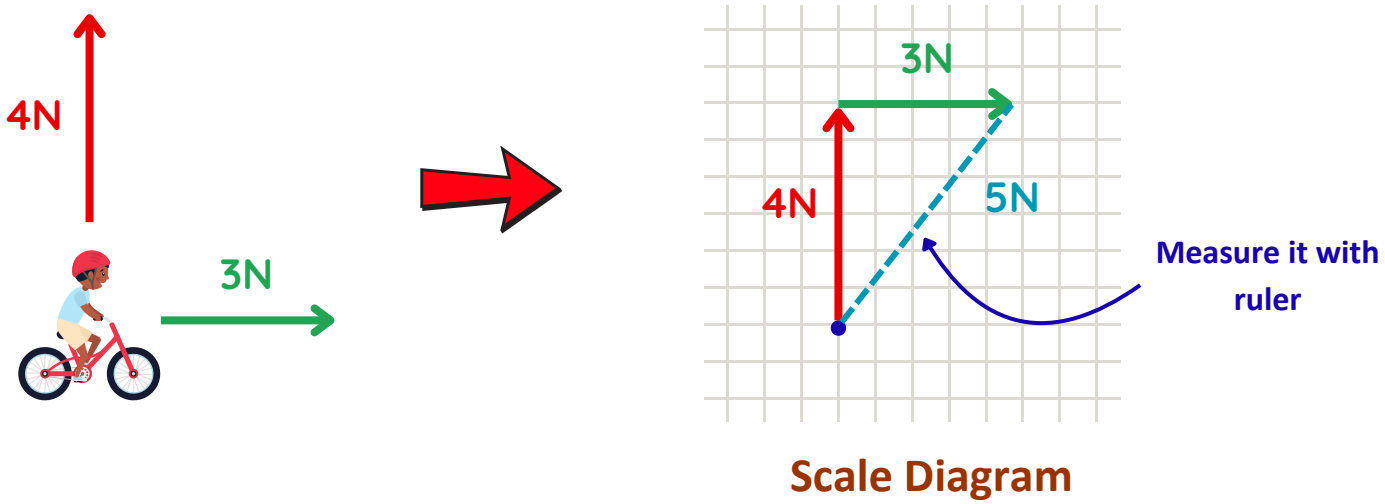
2. What is Vector Diagram?

- The forces in a free body diagram can be compared as vector arrows using a scale vector diagram.
- Example: The object experiences a resultant force of **5N** acting diagonally between the right and upward directions due to the combination of the two perpendicular forces.



Scale Diagram

- **Key Points:**
- Vectors are depicted as arrows, where:
    - The length of the arrow represents the magnitude.
    - The direction of the arrow indicates the vector's orientation.
- A **scale diagram** is used within a vector diagram to make the representation accurate and measurable.
- This allows large or complex quantities to be visualized accurately on a smaller or more manageable page.
- The length of each arrow in the scale vector diagram should be proportional to the magnitude of the force it represents.
- The resultant force is represented by the arrow joining the start of the first force to the end of the last force.

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3. How to calculate magnitude and direction of the resultant force by using vector diagram?

- A vector diagram is a scaled drawing that uses arrows (vectors) to represent forces, where:

  Length = Magnitude (measured with scale)
  Direction = Angle of the force (measured with a protractor).

- By plotting vectors tip-to-tail and measuring the resultant, we find the net force's size and direction without calculations.

Steps to calculate Resultant force:

Step#1: Choose a suitable scale for a scale vector diagram.

Step#2: Draw vectors to scale.

Step#3: Draw the resultant vector (from start to end point).

Step#4: Measure the Magnitude and Direction of the Resultant force using the scale.

Example: An object is acted upon by two forces:

- **Force A = 6 N to the right**
- **Force B = 8 N upward**

Find the magnitude and direction of the resultant.

Solution:

Step#1: Choose a suitable scale for a scale vector diagram.

Let's choose:

1 cm = 2 N So,

- 6 N : 3 cm
- 8 N : 4 cm

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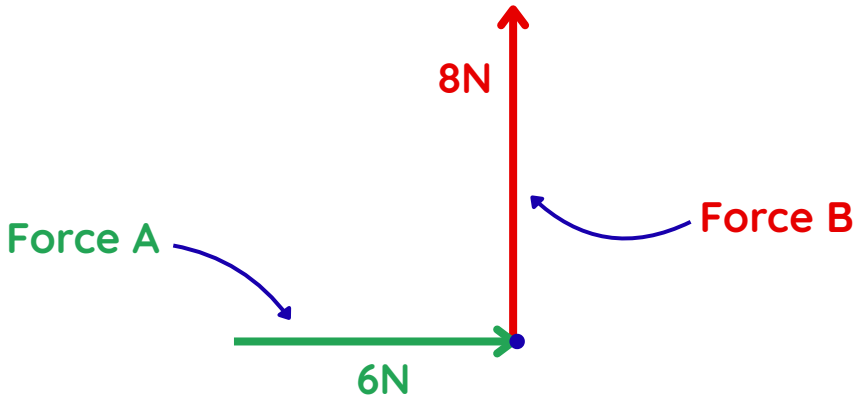
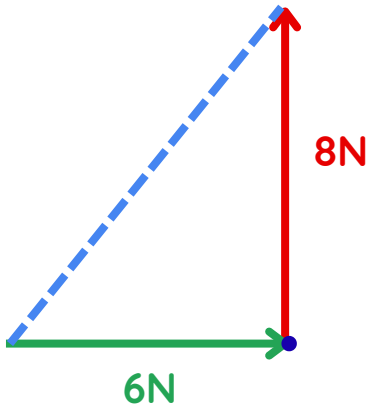
Step#2: Draw vectors to scale.

- Draw a 3 cm arrow to the right for **Force A**.
- From its head, draw a 4 cm arrow upward for **Force B**.



Step#3: Draw the resultant vector.

Draw a diagonal arrow from the tail of Force A to the head of Force B.



Step#4: Measure the Magnitude and Direction of the Resultant force using the scale.

- Measure the length of the diagonal = 5 cm
- Convert using scale:

$$\text{Magnitude} = 5\ \text{cm} \times 2\ \text{N/cm} = 10\ \text{N}$$

- Measure angle from horizontal using a protractor = 53°

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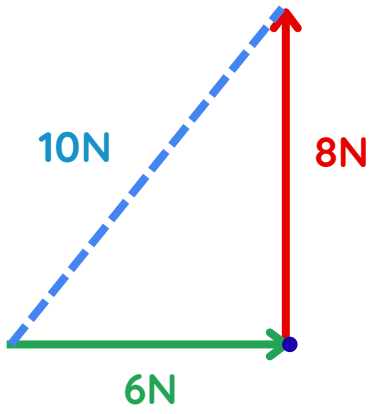
So, the final answer is

- Resultant Force = 10 N
- Direction = 53°



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4. Solved Examples

Problem1: At a certain point in time, a football experiences a **6 N downward** gravitational force and a **10 N horizontal** drag force as it flies through the air. Find the magnitude of the resultant of these two forces.

Solution:

Step#1: Choose a suitable scale for a scale vector diagram.

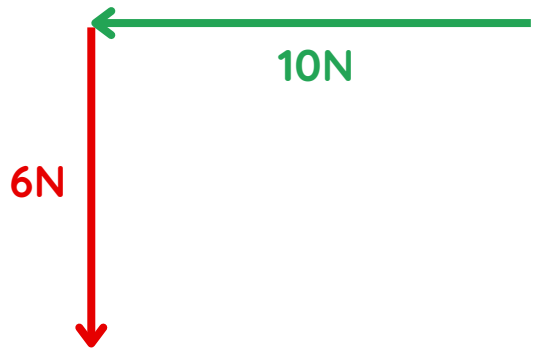
Let's choose:

1 cm = **2 N** So,

- 6 N : 3 cm
- 10 N : 5 cm

Step#2: Draw vectors to scale.

- Draw a **5 cm** arrow to the left for **10 N** drag force.
- From its head, draw a **3 cm** arrow downward for **6 N gravity**.



Step#3: Draw the resultant vector.

Connect the tail of the first vector to the head of the second vector.

Step#4: Measure the Magnitude by using the scale.

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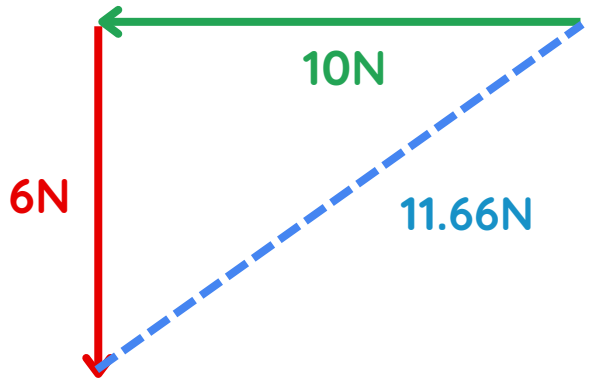
- Resultant = 5.83 cm
- Convert:

$$\text{Magnitude} = 5.83\ \text{cm} \times 2\ \text{N/cm} = 11.66\ \text{N}$$

So, the final answer is - resultant Force = 11.66 N



- **The forces are balanced if their scale vector diagram forms a closed loop.**

Problem2: Three forces act on an object at a point:

- **Force A = 4 N**
- **Force B = 3 N**

If the object is in equilibrium, find Force C and show that the vector diagram forms a closed triangle.

Solution:

Step #1: Choose a Scale

Let's use:

1 cm = 1 N

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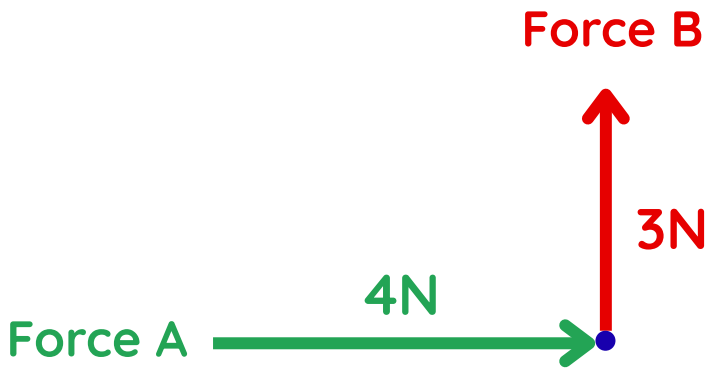
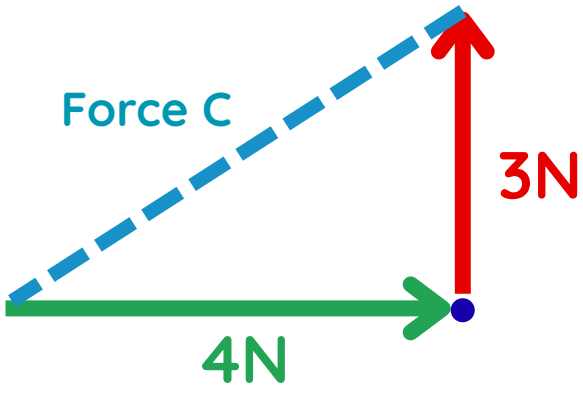
Step#2: Draw vectors to scale.

- Draw a 4 cm arrow to the right and mark as force A.
- From the head of Force A, draw a 3 cm arrow upward and mark as Force B.



Step#3: Draw the resultant vector.

To balance the other two, draw a vector from the head of **Force B** back to the tail of **Force A**. This completes the triangle the diagram is a closed loop



Step #4: Measure Force C

- Use a ruler to measure the closing side:
- It should be 5 cm
- So, Force C = 5 N (using 1 cm = 1 N)

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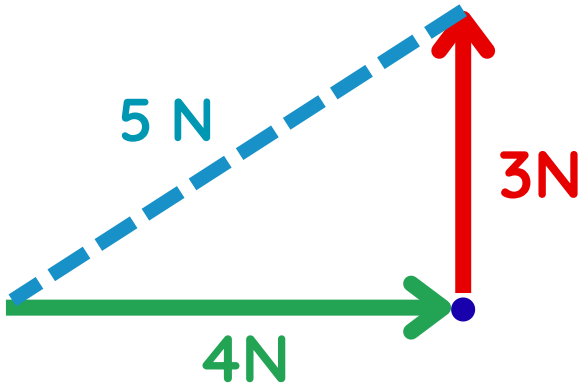
So, it forms a closed triangle and Resultant = 0 N, because forces are balanced,



5. FAQs

1. What is a vector diagram?

A drawing that uses arrows (vectors) to represent forces or movements, where:

- Length = Size of force (e.g., 1 cm = 10 N)
- Direction = Where the force acts (measured with a protractor).

2. How do you find the resultant force?

To find resultant force, follow these steps:

1. Draw vectors tip-to-tail to scale.
2. Connect the start to the end — this is your resultant force.
3. Measure its length (convert to force using your scale) and angle.

3. How do I know if forces are balanced?

If the vector diagram forms a **closed loop** (the last arrow ends where the first started), forces are balanced. If not, they're unbalanced.

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4. Can I add more than two vectors in a diagram?

Yes! Just keep adding them tip-to-tail in any order - the resultant will be the same.

5. How do I represent equilibrium in a vector diagram?

In equilibrium, vectors form a closed shape with no gap - the resultant is zero.