Physics
Chapter 05
Vectors

MCQs

_____ is a scalar quantity.

A: Distance
B: Momentum
C: Torque
D: Acceleration
Answer: B

_____ is a vector quantity.

A: Work
B: Density
C: Velocity
D: Temperature
Answer: C

A: Cannot be measured accurately from this data

B: 3.2 m
C: 4.6 m
D: 2.3 m
Answer: A

What will be the negative of a vector →A

A: Less than → A in magnitude
B: Equal in magnitude but opposite in direction to that of → A
C: Equal in magnitude but same in direction as → A
D: Greater than → A in magnitude
Answer: B

How will a force of 20 N acting on a body be represented on the page of a book?

A: 20 N force of some shape
B: A line of specific length according to scale
C: Cannot be represented
D: 20 N weight
Answer: B

A force of 100 N is acting vertically on a body. Find the horizontal component F x

A: Zero
B: 45 N
C: 45 N

D: 150 N
Answer: A

What is the angle between a vector and its negative vector?

A: Zero
B: 90 o
C: 180 o
D: 360 o
Answer: C

Which of the given trigonometric function is equal to the ratio cos θ / sin θ ?

A: cot θ
B: tan θ
C: sec θ
D: sin θ
Answer: A

230 dm ^3 milk flows towards the left in a glass tube 1 m long from one end and 610 of water flows towards the right in the same tube from the other end. They meet at the center of the tube. What will be the volume of the mixture?

A: 280 dm ^3
B: 560 dm ^3
C: 420 dm ^3
D: 840 dm ^3
Answer: D

wo forces 12 N and 5 N are added together by head to tail rule such that force of 12 N is taken as first force and 5 N is taken as second force. The resultant force has magnitude of 13 N. If we take 5 N as first force and 12 N as second force and add them by head to tail rule then what will be the magnitude of resultant force?

A: 10 N
B: 13 N
C: 15 N
D: 17 N
Answer: B

How will a force of 20 N acting on a body be represented on the page of a book?

A: 20 N force of some shape
B: A line of specific length according to scale

C: Cannot be represented
D: 20 N weight
Answer: B

Fill in the Blanks

1. A **Scalar** has only magnitude.
2. A **vector** has magnitude as well as direction.
3. A vector is represented by a straight line. In such a way that its length indicates magnitude and arrow – head indicates **direction** of the vector.
4. The angle between rectangular components of a vector is **right angle.**
5. Vector are added or subtracted graphically by **head-to-tail** ruel.
6. **Distance** is a scalar quantity.
7. **Velocity** is a vector quantity.
8. The Unit of force in international system of units is **newton**.
9. In a right angle triangle, the side opposite to the right angle is called **hypotenuse.**

Questions

i) Explain scalar and vector quantities.

Answer:

VECTOR QUANTITIES:

"The physical quantities which are completely specified by their magnitude and direction are called vector quantities."

EXAMPLE:

The displacement is a vector quantity which can be explained as

If a drill master asks a boy to move three steps, the boy does not know in which direction he has to move. If, however, he mentions the direction also, the confusion is removed. The distance moved by the boy and the direction of his motion give the magnitude and the direction of the displacement vector respectively. Some examples of vector quantities are force, momentum, velocity etc.

SCALAR QUANTITIES:

"The physical quantities which are specified by their magnitude and a unit are called scalar quantities."

Examples:

Time, distance, energy, volume, speed, etc. are all the scalar quantities. The normal rules of arithmetic are used to add, subtract, multiply and divide the scalar quantities.

ii) Mention which of the following quantities are scalars and which are vectors. Speed, velocity, force, mass, weight, displacement, work, temperature, wavelength, torque, acceleration, momentum.

Answer:

Scalar quantities: speed, mass, work, temperature, wavelength.

Vector quantities: velocity, force, weight, displacement, torque, acceleration, momentum.

iii) How can a vector be represented in magnitude and direction both?

Answer:

The vector is represented by an arrow. The length of the arrow gives the magnitude of the vector and the arrowhead shows the direction.

iv) What do you know about multiplication of a vector by a number?

Answer:

MULTIPLICATION OF A VECTOR BY A NUMBER:

When a vector is multiplied by a number it remains a vector quantity. If the number, say n, is positive the new vector has magnitude n times the magnitude of the original vector and its direction remains the same.

EXAMPLE:

When a vector is multiplied by positive number: If a vector F is represented by a directed F line segment of length 2 cm, vectors 2F, and ½ F will be represented by

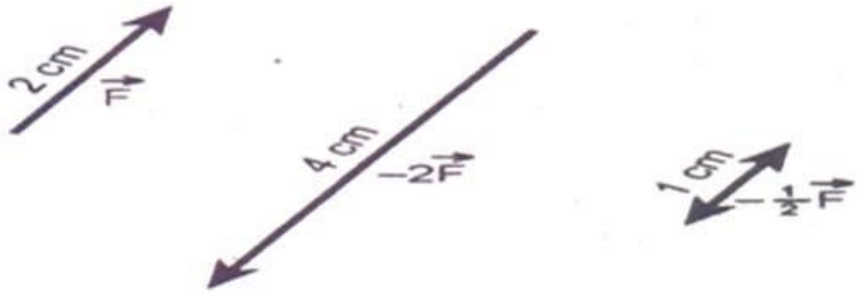
directed lines segments of length 4 cm and 1 cm respectively,

Note:

Note that the lines representing these vectors are parallel to one another, with their arrow-heads pointing in the same direction.

When a vector is multiplied by a negative number:

In case the vector F is multiplied by a negative number, say -n, the new vector has magnitude n times the magnitude of the original vector and direction, opposite to that of F. The vectors F, -2F and – ½ F have been shown in the figure.



NOTE:

Note that the negative sign causes a reversal of the direction of the arrow-head.

v) Define the terms negative vector and resultant vector.

Answer:

Negative Vector:

The negative vector (-A) of a vector A is such that it has the same magnitude as that of A but opposite direction.

Resultant Vector:

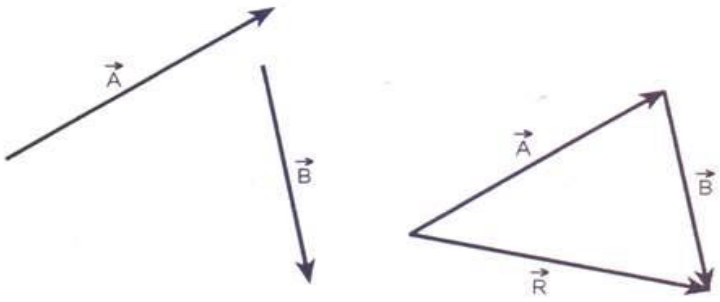
The addition of two or more vectors can be represented by a single vector, which is termed as a resultant vector.

vi) Explain head to tail rule of vector addition.

Answer:

Head-to-tail rule:

To add vectors graphically we use the head-to-tail rule. Draw the representative lines of vectors A and B on a suitable scale with respect to a system of convenient reference axes. Redraw their representative lines such that the head of A coincides with the tail of B. Draw the representative lines of another vector R, from the tail of A to the head of B, as shown in the figure.



The vector R represents the resultant of A and B.This method of adding vectors is known as head-to-tail rule of vector addition.

For addition of three or more vectors:

In order to add three or more vectors graphically, they are drawn on a suitable scale such that the head of one coincides with the tail of the other. The resultant vector is given, in magnitude and direction, by the straight line directed from the tail of the first vector to the head of the last one.

For parallel vectors:

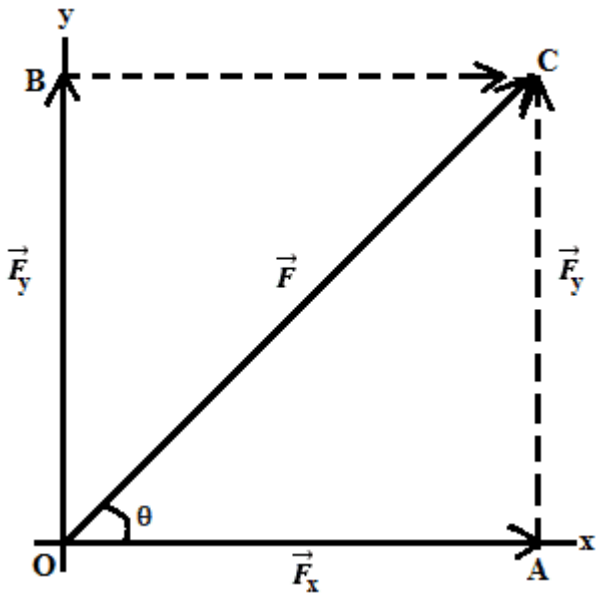
If a number of vectors act parallel to each other, the resultant of such vectors is a vector, whose magnitude is equal to the sum of the magnitudes of all the vectors to be added and its direction is the same as the direction of all the vectors.

vii) What are rectangular components of a vector? How are they determined?

Answer:

Rectangular components of a vector

The vectors, whose sum is equal to a given vector, are called the components vectors of that vector. A vector can be resolved into two components, at right angles to each other; such components are called rectangular components of the vector.



Explanation:

Consider a vector F as shown in figure. In order to resolve that vector into its effective rectangular components, we draw two perpendiculars CA and CB from the head of the vector F to x-axis and y-axis respectively as shown in figure. Now consider two vectors represented by directed line segments OA and OB or AC as shown. OA is along the x-axis, we shall denote this vector by F_x. Similarly the vector OB or AC, having its direction along or parallel to the y-axis, is denoted by the vector Fy. The sum of vectors Fx and Fy, by the head to tail rule is equal to F, and they are also at a right angle to each other. Therefore F_x and F_y are the rectangular components of vector F.

They can be determined in terms of magnitude of F and trigonometric ratios of angle θ. In the right angle triangle OAC, we have

$$\cos\theta = \frac{OA}{OC} \quad or\ OA = OC\cos\theta$$

In the form of vector F and its components, we can write it an

$$\mathbf{F_x = F\cos\theta \quad \ldots\ldots\ldots\ldots\ (1)}$$

Similarly,

$$\sin\theta = \frac{AC}{OC}\ or\ AC = OC\sin\theta$$

Therefore

$$\mathbf{F_y = F\sin\theta \quad \ldots\ldots\ldots\ldots\ (2)}$$

Thus rectangular components of a vector can be determined by using equations (1) and (2).

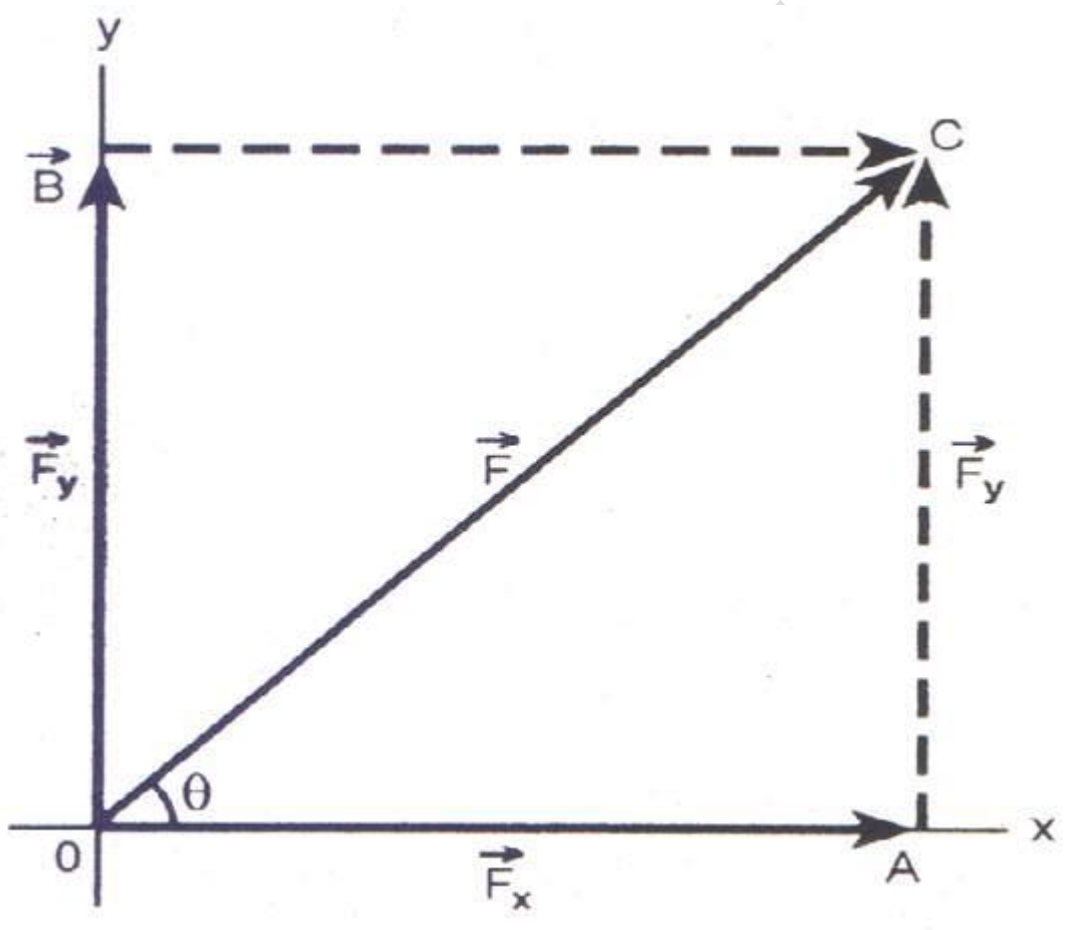
viii) How can a vector be determined if its rectangular components are known?

Answer:

If the rectangular components of a vector are given, then the magnitude and direction of that vector can be determined.

EXPLANATION:

Consider rectangular components of a vector F as F_x and F_y which are represented by directed line segments OA and OB respectively, both magnitude and direction. Adding these two components by head-to-tail rule, we can see from the following figure that the directed line segment OC represents the vector, in both magnitude and direction of the vector F.



To derive the expressions for the magnitude and direction of F in terms of the magnitudes of the rectangular components F_x and F_y, consider the right-angled

triangle OAC. By using Pythagoras theorem, we have

$OC^2 = OA^2 + AC^2$

Or $F^2 = F_x^2 + F_y^2$

or

Above equation gives the magnitude of the vector F.

And the direction of that vector is given by finding the angle of the vector as follows,

$$\tan\theta = \frac{AC}{OC}$$

$$tan\theta = \frac{F_y}{F_x}$$

Which gives?

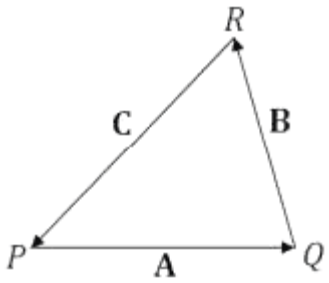
$$\tan^{-1}\theta = \frac{F_y}{F_x} \quad \ldots\ldots\ldots\ldots\ldots (b)$$

Thus the equations (a) and (b) completely determine the vector F in terms of its rectangular components.

ix) Is it possible to combine two vectors of different magnitudes to give a zero resultant? If not, can three vectors be combined?

Answer:

No, it is not possible to combine two vectors of different magnitude in order to get zero resultant. In order to get their resultant zero they should be equal in magnitude and opposite in direction. However, three vectors can be added to get zero resultant. If the three vectors are such that they can be represented by the sides of a triangle taken in cyclic order, then the vector sum of three vectors will be zero. Let three vectors A, B and C are the three vectors acting along the sides of triangle PQR as shown in figure.



As the head of A coincides with the tail of B, so by head to tail rule, the resultant of these three vectors will be zero.

x) Can a force directed north balance a force directed east? Explain.

Answer:

No, force in the north direction cannot balance the force in the east because for balancing a force a force should have equal magnitude and must be in the opposite direction. These conditions are not fulfilled in the present case, so the force in the north cannot balance the force in the east.

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