**SCALARS & VECTORS**

**YEAR 2000**

1. , are two vectors which act at a point and make angle , respectively with . Find an expression only for the magnitude of their resultant using rectangular component method.

**DATA:**

Magnitude of

Magnitude of

Direction of

Direction of

**REQUIRED:**

Magnitude of resultant

**SOLUTION:**

**DETERMINATION OF X AND Y COMPONENT OF FORCES AND**

|  |  |
| --- | --- |
| **x-components** | **y-components** |
|  |  |
|  |  |
|  |  |

**DETERMINATION OF X AND Y COMPONENT OF THE RESULTANT**

|  |  |
| --- | --- |
| **x-component of resultant** | **y-component of resultant** |
|  |  |
|  |  |

**DETERMINATION OF MAGNTUDE OF THE RESULTANT**

Substituting the value of

**YEAR 1996**

If two vectors such that, , and

Evaluates (i) and (ii)

**DATA:**

, and

**REQUIRED:**

1. Dot product of
2. Magnitude of

**SOLUTION:**

**PART (i):**

Squaring on both sides

Ans.

**PART (ii):**

Ans.

**YEAR 1996**

Find the value of for which the following vectors are perpendicular to each other. ,

**DATA:**

**REQUIRED:**

The value of

**SOLUTION:**

Ans.

**YEAR 1992**

Find the angle between where

**DATA:**

**REQUIRED:**

The angle between

**FORMULA:**

**SOLUTION:**

First we find

Now,

|  |  |
| --- | --- |
|  |  |

Substituting all the values in eq. (i)

Eq. (i)

Ans.

**YEAR 1991**

Two vectors of magnitudes and make angle of and respectively with +x-axis in the x y-plane. Find the magnitude and direction of their cross product.

**DATA:**

Let,

1st Vector

2nd Vector

**REQUIRED:**

& direction of

**SOLUTION:**

**RESULT:**

The magnitude i.e. and its direction is along z-axis

**YEAR 1990**

It is possible that the magnitude of the result and of two vectors be equal to the magnitude of either vector?

**ANSWER:** Yes,

If and representing the sides an equilateral.

**YEAR 1990**

Can the magnitude of be same as

**ANSWER:**

YES, when are perpendicular to each other.

**YEAR 1989**

The water of a wide river is flowing from west to east with a velocity of . A boatman standing on one of the banks of the river wishes to take his boat to a point on the opposite bank exactly in front of his present position. He can row his boat with velocity of relative to the water in the direction of North West with what angle should he row the boat and what time will he take to cross the river.

**SOLUTION:**

Velocity of river =

Velocity of boat =

In

Ans.

Using Pythagoras’s Theorem

This the effective velocity of boat from South to North.

Now,

Ans.

**YEAR 2001**

An object moves along a straight line from to when a uniform force acts on it. Find the work done and the angle between the force and displacement.

**DATA:**

**REQUIRED:**

Work done =

Angle between

**SOLUTION:**

First we find

Ans.

The angle between force is given as,

Replace in eq. (i)

eq. (i)

Ans.

**YEAR 2002 (Pre-Medical)**

If and . Find a unit vector perpendicular to the plane containing both . If form the sides of parallelogram, find the area of the parallelogram.

**DATA:**

**REQUIRED:**

* Unit vector ┴ to the plane = ?
* Area of parallelogram = ?

**SOLUTION:**

* **FOR UNIT VECTOR:**

Ans.

**FOR AREA OF 11gm:**

Ans.

**YEAR 2003 (Per-Medical)**

Two forces of equal magnitudes are acting at a point; find the angle between the forces when the magnitude of resultant is also equal to the magnitude of either of these forces.

**SOLUTION:**

Let be the two forces and their resultant be . According to the condition

Using Cosine Law:

Ans.

**YEAR 2004**

Two forces of magnitude and are acting at a point. The magnitude of their resultant is ; find the angle between them.

**DATA:**

**REQUIRED:**

Angle between and

**FORMULA:**

**SOLUTION:**

Squaring on both sides

Ans.

**MOTION**

**YEAR 1989**

A car weighing is moving up on an inclined plane which rises per every with an acceleration of . If the frictional force is , how much force is exerted by the engine of the car?

**SOLUTION:**

The net force acting on the car can be given as,

According to Newton’s 2nd law of motion.

Ans.

**RESULT:**

of force is exerted by the engine of the car.

**YEAR 1990**

A ball of man and moving with a speed of , strikes a rigid wall in a direction perpendicular to the wall and is reflected back after a perfectly elastic collision. If during the collision the ball remains in contact with the wall for Calculate the average force exacted by the wall on the ball.

**DATA:**

Mass of ball =

Initial velocity =

Final velocity =

Time =

**REQUIRED:**

Force exacted by the wall on the ball =

**SOLUTION:**

Ans.

Here, negative sign represents the opposite direction of force on the ball by the wall w.r.t its initial direction of motion.

**YEAR 1992:**

A gun mounted on wheels shoots a projectile with a muzzle velocity of at an angle of with the horizontal; find the horizontal recoil velocity of gun.

**DATA:**

Mass of projectile =

Mass of Gun =

Initial velocity of projectile

Initial velocity of gun

Final velocity of projectile =

**REQUIRED:**

Horizontal recoil velocity of gun =

**SOLUTION:**

the gun projectile system was initial at rest.

Final momentum of system is given as,

According to law of consecration of momentum

Here, negative sign represents the opposite direction of recoil of velocity of the gun.

**FOR HORIZONTAL RECOIL VELOCITY:**

Ans.

**YEAR 1994:**

A minibus starts moving from the position of rest at a bus stop with a uniform acceleration. During the 10th minute of its motion it covers a distance of . Calculate its acceleration and the total distance it covers in .

**DATA:**

Initial velocity of minibus =

Distance covered by minibus during 10th minute of its motion =

**REQUIRED:**

* Acceleration of minibus
* Total distance covered in 10minutes =

**SOLUTION:**

* The distance covered by bus during total 10 minutes is given by
* The distance covered by the minibus during 1st 9 minutes of its motion can be given as,

From figure it is clear that

Ans.

For distance, replace in eq. (i)

Ans.

**YEAR 1996, 2007**

A boy throws a ball vertically upward with a speed of . On the way down, it is caught at a point above the ground. How fast it was coming down at this point? How long did the tripe take

**SOLUTION:**

Consider the upward motion of the ball for upward motion.

* **FOR TIME TO REACH THE MAXIMUM HEIGHT:**
* **FOR MAXIMUM HEIGHT REACHED:**

Consider the downward motion of the ball.

**FOR :**

Ans.

**FOR :**

**FOR TOTAL TIME:**

Ans.

**RESULT:**

* The velocity of ball with which it hits the ground is
* Trip took in air.

**YEAR 1998:**

Two bodies and are attached to the ends of a string passing over a frictionless pulley such that the masses hang vertically. If the mass of one body is .

1. Find the mass of the second body which moves downward with an acceleration of .
2. Find the tension in the string.

**DATA:**

Mass of body

Mass of body

Tension in string

Acceleration

**FORMULA:**

**SOLUTION:**

* **FOR :**

Ans.

* **FOR TENSION:**

**YEAR 2000**

A motorcar is moving up a stop of with a velocity of , suddenly the engine fails, How much distance will car move before coming to rest. Assuming friction to be negligible.

**DATA:**

Velocity of car =

Final velocity of car =

Frictional force =

**REQUIRED:**

Distance covered by car before coming to rest =

**FORMULA:**



**SOLUTION:**

First we find the acceleration of car

Here, negative sign shows retardation

Now,

Ans.

**YEAR 2004, 2006**

A golf ball moving with a velocity of collides with a steel ball at rest. If the collision is elastic, compute the velocities of both balls after collision.

**DATA:**

Mass of golf ball

Mass of steel ball

In velocity of golf ball

Initial velocity of steel ball

**REQUIRED:**

Final velocity of golf ball

Final velocity of steel ball

**FORMULAE:**

**SOLUTION:**

**FOR VELOCITY OF GOLF BALL AFTER COLLSISION**

Ans.

Here, sign shown that the golf ball rebounces back after hitting the steel ball.

**FOR VELOCITY OF STEEL BALL AFTER COLLISION**

**YEAR 1991**

A stone is thrown vertically upward. If it takes to return to the ground, how high does the stone go?

**DATA:**

For upward motion

**REQUIRED:**

Height reached by stone

**FORMULAE:**

**SOLUTION:**

First we find the initial velocity of stone

Height reached by the stone is given as

Ans.

**MOTION IN TWO DIMENSION**

**YEAR 1995**

A

**YEAR 2002 (P.M)**

A telescope has the objective and the eye piece lenses of power and respectively. What are the magnifying power and the length of the telescope if it is focused for infinity.

**DATA:**

**YEAR 2003 (P.M)**

A compound microscope has an objective and an eye piece of focal length and respectively. The object is located at a distance of from the objective and forms an image close to the eye piece, find the separation of the lenses and the magnifying power of the microscope

**DATA:**

**YEAR 2004, 2006**

A magnifying glass of what power should be used to obtain an image of Magnification times,

**DATA:**

**YEAR 2005**

Two convex lenses of power Diopter and Diopters are used as an objective and eye piece of a telescope. Find the magnifying power and the length of the telescope when focused for infinity.

**DATA:**

**YEAR 2007**

If the magnifying power of telescope is and its length is , determine the focal length of its objective and eye piece when the telescope is focused for infinity.

**DATA:**

**YEAR 2008**

A compound microscope has an objective of a focal length and a tube long. The final image is produced at from the eye piece when the object is from the objective. What is the angular magnification?

**DATA:**

Applying than lens formula on objective:

Applying thin lens formula on eye piece: