General Physics

Question Bank

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- **H.W.:**
- **1- Show that the equation $d=vt^2$ dimensionally correct or not?**
- **2- Which of the following formulas for F could be correct?**

(a) $F = mvR$ (b) $F = m\left(\frac{v}{R}\right)^2$ (c) $F = \frac{mv^2}{R}$

Exercise Find the cross product of the following vectors:

(a) $\mathbf{j} \times \mathbf{k}$ (b) $\mathbf{i} \times 4\mathbf{i}$ (c) $(2\mathbf{i} + 3\mathbf{j} - \mathbf{k}) \times (3\mathbf{j} + 2\mathbf{k})$

(d) $3\mathbf{j} \times 5\mathbf{i}$ (e) $(\mathbf{i} - 3\mathbf{j} + \mathbf{k}) \times (2\mathbf{i} + \mathbf{j} - \mathbf{k})$

Exercise:

Find (a) the scalar projection of vector $\mathbf{a} = (2, 3, 1)$ in the direction of vector $\mathbf{b} = (5, -2, 2)$.

(b) the angle between **a** and **b**.

(c) the vector projection of **a** in the direction of **b**.

Question
If three vectors are given as

$$\vec{A} = i + j + k, \quad \vec{B} = 2i - j + 3k \quad and \quad \vec{C} = i + 2j - k,$$

then find the results of following equations given below:

a) $(\vec{A} + \vec{B}).\vec{C}$ *and* $\vec{C}.(\vec{A} + \vec{B})$

b) $\vec{A} \times (\vec{B} + \vec{C})$ *and* $(\vec{B} + \vec{C}) \times \vec{A}$

c) $(\vec{A} \times \vec{B}).\vec{C}$ *and* $\vec{A}.(\vec{B} \times \vec{C})$

d) $\vec{A} \times (\vec{B} \times \vec{C})$

Question

Assume that a car decelerates at $2.0 m/s^2$ and comes to a stop after traveling 25m.

a) Find the speed of the car at the start of the deceleration and

b) Find the time required to come to a stop.

Solution

We are given:

$a = -2.0 m/s^2$

$x = 25m$

$v = ?$

a) From

$$v^2 = v_0^2 + 2ax \quad \Rightarrow \quad v_0^2 = v^2 - 2ax \quad \Rightarrow \quad v_0^2 = 0 - 2(-2)(25) = 100$$

$$v_0 = 10 m/s$$

b) From $v = v_0 + at$ we have $t = \dfrac{v - v_0}{a} = \dfrac{-10}{-2} = 5s.$

Question

Assume that a car traveling at a constant speed of 30m/s passes a police car at rest. The policeman starts to move at the moment the speeder passes his car and accelerates at a constant rate of 3.0m/s^2 until he pulls even with the speeding car.

a) Find the time required for the policeman to catch the speeder and
b) Find the distance traveled during the chase.

Solution

We are given, for the speeder:

$v_0^s = 30m/s$, constant speed, then $a^s = 0$

and for the policeman:

$a_0^p = 3.0m/s^2$

a) The distance traveled by the speeder is given as $x^s = v^s t = 30t$. Distance traveled by policeman $x^p = x_0^p + v_0^p t + \frac{1}{2} a_p t^2$. When the policeman catches the speeder $x^s = x^p$ or,

$$x^s = x^s \quad \Rightarrow \quad 30t = 0 + 0 + \frac{3t^2}{2},$$

Solving for t we have $t = 0$ and $t = \frac{2}{3}(30) = 20s$. The first solution tells us that the speeder and the policeman started at the same point at $t = 0$, and the second one tells us that it takes 20 s for the policeman to catch up to the speeder.

b) Substituting back in above we find the distance that the speeder has taken

$x^s = 30(20) = 600m$

And also for the policeman

$$x^p = x_0^p + v_0^p t + \frac{1}{2} a_p t^2 = 0 + 0 + \frac{1}{2}(3)(20)^2 = 600m$$

Question

A rocket moves upward, starting from rest with an acceleration of 29.4m/s^2 for 4 s. At the end of this time, it runs out of fuel and continues to move upward. How high does it go totally?

Solution

For the first stage of the flight we are given:

$$a = 29.4 m/s^2 \quad for \quad t = 4s$$

This gives us the velocity and position at the end of the first stage of the flight:

$$v_1 = v_0 + at = 0 + 29.4(4) = 117.6 m/s$$

and

$$y_1 = y_0 + v_o t + \frac{1}{2}at^2 = 0 + 0 + \frac{1}{2}(29.4)(4)^2 = 235.2m$$

For the second stage of the flight, the rocket will go upward with its velocity till it stops (That is the Newton's Motion Law).So, we start with

$$v_1 = 117.6 m/s$$

$$a = g = -9.8 m/s^2$$

And we end up with $v_2 = 0$. We want to find the distance traveled in the second stage $(y_2 - y_1)$. We have,

$$v_2^2 = v_1^2 + 2a(\Delta y) \quad \Rightarrow \quad \Delta y = y_2 - y_1 = \frac{v_2^2 - v_1^2}{2g} = \frac{0^2 - (117.6)^2}{2(-9.8)} = 705.6m.$$

Therefore, the total distance taken by the rocket is $y_2 = y_1 + 705.6m = 235.2 + 705.6 = 940.8m$

Question

A train with a constant speed of 60km/h goes east for 40min. Then it goes 45° north-east for 20min. And finally it goes west for 50min. What is the average velocity of the train?

Question

The motion of a particle is given by $x = t^2 + 3t - 3$, where x is distance in meter and t is time in sec.

a) Find the velocity of the particle after 10 sec.

b) Find also acceleration of the particle. State whether acceleration is uniform of variable.

Example:

An object orbiting uniformly around a center, having radius of 1km, spreads 1^0 angle in 0.1s.

a. What is the linear velocity of this object?
b. What is the acceleration of the object?
c. Find the position vector in x and y components of that object for t=1s.

H.W.: Given an incline with angle 30 degrees which has a mass of 2kg placed upon it. It is attached by a rope over a pulley to a mass of 3kg which hangs vertically. Taking downward as the positive direction for the hanging mass find:

1- Acceleration of the system.

2- With this acceleration, find the tension in the rope and the weight for the hanging mass.