

Problem Set I

University Physics 1
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Problem 1:

A sports car starts from rest and accelerates uniformly at 5.0 m/s^2 . Calculate the distance the car travels in the first 4.0 seconds.

Solution

We are given the following values:

- Initial velocity $v_0 = 0 \text{ m/s}$
- Acceleration $a = 5.0 \text{ m/s}^2$
- Time $t = 4.0 \text{ s}$

We use the kinematic equation for displacement:

$$\begin{aligned}d &= v_0 t + \frac{1}{2} a t^2 \\d &= (0)(4.0) + \frac{1}{2}(5.0)(4.0)^2 \\d &= 0 + 0.5(5.0)(16) \\d &= 40 \text{ m}\end{aligned}$$

Answer:

$$d = 40 \text{ m}$$

Problem 2:

Vector \vec{A} has a magnitude of 10 units pointing East. Vector \vec{B} has a magnitude of 15 units at 60° North of East. Find the magnitude of the resultant vector $\vec{R} = \vec{A} + \vec{B}$. Include a vector diagram.

Solution

First, we resolve the vectors into components:

$$\begin{aligned}A_x &= 10, \quad A_y = 0 \\B_x &= 15 \cos(60^\circ) = 7.5 \\B_y &= 15 \sin(60^\circ) \approx 12.99\end{aligned}$$

Summing the components:

$$\begin{aligned}R_x &= 10 + 7.5 = 17.5 \\R_y &= 0 + 12.99 = 12.99\end{aligned}$$

Calculating the magnitude:

$$|\vec{R}| = \sqrt{(17.5)^2 + (12.99)^2} \approx 21.79$$

Vector Diagram: (Diagram not accurate. Example use only.)

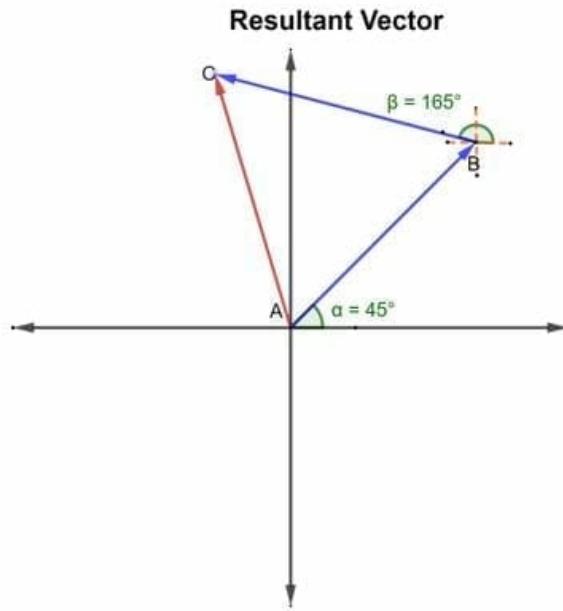


Figure 1: Example of captioned figure.

Answer:

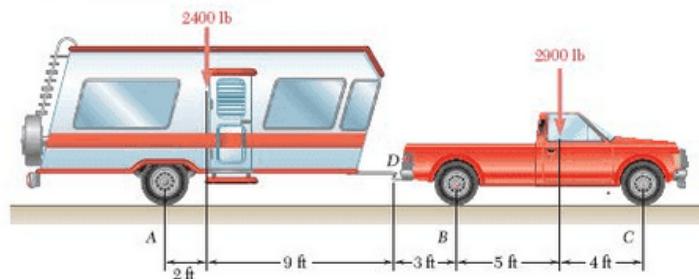
$$|\vec{R}| \approx 21.8 \text{ units}$$

Problem 3:

A crate of mass m sits on the back of a flatbed truck as shown in the figure below. If the truck accelerates to the right at $a = 3 \text{ m/s}^2$, what is the minimum coefficient of static friction μ_s required to keep the crate from sliding off?

Solution

Refer to the diagram of the truck below: (Diagram not accurate. Example use only.)



For the crate to move with the truck without sliding, the static friction force f_s must provide the acceleration. Using Newton's Second Law in the horizontal direction:

$$f_s = ma$$

The maximum static friction is $f_{s,max} = \mu_s N$. Since the vertical forces balance, $N = mg$. Therefore:

$$\begin{aligned}\mu_s mg &= ma \\ \mu_s g &= a \\ \mu_s &= \frac{a}{g} = \frac{3.0}{9.8} \approx 0.306\end{aligned}$$

Answer:

$\mu_s \approx 0.31$

Problem 4:

Problem statement/details.

Solution

– Solution Content –

You can do anything here.

$$e = mc^2$$

Answer:

Answer example