Solve: Two Persons Are Pushing A Box So That The Net Force On The Box Is 12 N To The Cast. If One Of

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When it comes to understanding basic physics principles, especially those involving forces and motion, problems involving multiple forces acting on an object are particularly insightful. Imagine a scenario where two individuals are pushing a box, and the goal is to determine how their combined efforts result in a specific net force. Such problems are fundamental in physics education because they help illustrate concepts like force vectors, equilibrium, and Newton's laws of motion.

In this article, we will explore a detailed, step-by-step solution to a common physics problem: Two persons are pushing a box so that the net force on the box is 12 N to the east. If one of them exerts a certain force, what is the force exerted by the other person? We will analyze the problem thoroughly, covering the relevant physics concepts and providing a clear methodology for solving similar problems.

Understanding the Problem Statement

Before diving into the solution, let's carefully interpret the problem:

- There are two persons pushing a box.
- The net force on the box is 12 N to the east.
- The problem asks: If one of the persons exerts a certain force, what is the force exerted by the other?

This problem involves vector addition of forces, and understanding how multiple forces combine to produce a resultant (net) force.

Key Concepts in Force Analysis

To solve this problem effectively, it's essential to understand some fundamental physics concepts:

1. Newton's Second Law of Motion

- States that Force = mass × acceleration (F = ma).

- When multiple forces act on an object, the net force determines the object's acceleration and direction.

2. Vector Addition of Forces

- Forces are vectors, meaning they have both magnitude and direction.
- The net force is the vector sum of all individual forces.

3. Equilibrium and Non-Equilibrium Conditions

- If the net force is zero, the object is in equilibrium.
- If the net force is non-zero, the object accelerates in the direction of the net force.

Assumptions and Known Data

To proceed with the calculations, let's list the assumptions and known data:

- The mass of the box is not specified, but since the problem emphasizes force and net force, the mass may not be directly needed unless acceleration is involved.
- The net force on the box is 12 N to the east.
- The forces exerted by the two persons are presumed to be in the horizontal plane.
- The forces can be magnitude and direction; for simplicity, assume forces are applied along the same line (either both pushing east or one east and one west).

Step-by-Step Solution Approach

Let's explore how to find the unknown force exerted by the second person, given the force exerted by the first, and the net force:

1. Define Variables

- Let F1 represent the force exerted by Person 1.
- Let F2 represent the force exerted by Person 2.
- Both forces are in the same or opposite directions, depending on the scenario.

Suppose:
- Person 1 exerts a force F1 to the east.
- Person 2 exerts a force F2 to the east or west.

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2. Analyze Force Directions

The net force is 12 N to the east, which implies:

- The combined effect of both forces in the east direction minus any force acting in the opposite direction equals 12 N.

If both forces are in the same direction:

$$
F_{net} = F_1 + F_2
$$

If they are in opposite directions:

$$
F_{net} = |F_1 - F_2|
$$

The direction of the net force determines the sign.

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3. Formulate Equations Based on Known Data

Case A: Both forces in the same direction (east)

$$
F_1 + F_2 = 12\, \text{N}
$$

Case B: One force in the east, the other in the west

$$
|F_1 - F_2| = 12\, \text{N}
$$

---

4. Solving for Unknown Force

Suppose the force exerted by Person 1 (F1) is known. For example:

- F1 = 5 N (to the east)

Then, depending on the direction of the second person:

Scenario 1: Both push east

$$
F_2 = 12\, \text{N} - F_1 = 12 - 5 = 7\, \text{N}
$$

Scenario 2: Person 2 pushes west

$$
|F_1 - F_2| = 12\, \text{N}
$$

If F1 = 5 N east, then:

$$
F_2 = F_1 \pm 12
$$

- If F2 pushes west (opposite to F1), then:

$$
F_2 = F_1 + 12 = 5 + 12 = 17\, \text{N}
$$

- The negative force indicates the magnitude, but direction is essential.

Practical Example: Numerical Solution

Let's work through a concrete example:

- Person 1 exerts F1 = 8 N east.
- The net force is 12 N east.
- Find F2.

Solution:

Assuming both forces are in the same direction (east):

$$
F_1 + F_2 = 12
$$
$$
8 + F_2 = 12
$$
$$
F_2 = 12 - 8 = 4\, \text{N}
$$

Thus, Person 2 exerts a force of 4 N east.

Advanced Considerations: Angled Forces

In real-world scenarios, forces may not be perfectly aligned. They could be applied at angles, requiring vector component analysis:

- Resolve forces into components along the x-axis (east-west).
- Use trigonometric functions (sine, cosine) to find components.
- Sum components to find net force.

Example:

If Person 1 pushes at 30° north of east with magnitude F1, and Person 2 pushes at 45° south of east with magnitude F2, then:

$$
\text{Net force in east direction} = F_1 \cos 30^\circ + F_2 \cos 45^\circ
$$
$$
\text{Net force in north-south direction} = F_1 \sin 30^\circ - F_2 \sin 45^\circ
$$

The net force magnitude is then:

$$
F_{net} = \sqrt{(\text{East component})^2 + (\text{North component})^2}
$$

And the direction can be determined using inverse tangent functions.

Conclusion and Summary

This comprehensive guide outlined the approach to solving the problem of two persons pushing a box resulting in a net force of 12 N to the east. The key takeaways are:

- Understand the force vectors and their directions.
- Use algebraic equations based on vector sums.
- Account for forces acting in same or opposite directions.
- Incorporate trigonometric analysis for forces at angles.

In summary:

- If the force exerted by one person is known, the force exerted by the other can be calculated by subtracting from the total net force, considering the directions.
- When forces are at angles, resolve into components and sum accordingly.
- Always keep track of directions to determine the net force accurately.

By mastering these concepts, students and enthusiasts can tackle a wide range of force-related problems, enhancing their understanding of classical mechanics and vector analysis.

Keywords: force analysis, net force, pushing box problem, physics tutorial, vector addition, Newton's laws, force components, equilibrium, force at angles, problem-solving in physics

Frequently Asked Questions

What is the main concept involved in solving problems where two persons push a box with a net force to the right?

The main concept is understanding net force and how individual forces combine vectorially to produce the resultant force on the object.

How do you determine the force exerted by each person when the net force on the box is known?

You need to analyze the directions and magnitudes of each person's push, applying vector addition to find how their forces combine to produce the net force of 12 N to the right.

If one person pushes with a force of 15 N to the right and the net force is 12 N to the right, what is the force exerted by the second person?

The second person must be pushing with a force of 3 N to the left to result in a net force of 12 N to the right.

What assumptions are typically made in solving such force problems involving pushing and pulling?

Assumptions often include ignoring friction, assuming forces are applied horizontally, and considering forces as vectors that can be added directly.

Can friction affect the calculation of forces in this problem?

Yes, if friction is present, it must be accounted for because it opposes the motion, affecting the net force calculation. If friction is neglected, the problem simplifies to just considering applied forces.

How do vector directions influence the calculation of the net force when two persons push a box?

The directions determine whether forces add or subtract. Forces in the same direction add, while forces in opposite directions subtract to find the net force.

What is the significance of the net force being 12 N to the right in understanding the individual forces?

It indicates the combined effect of both persons' pushes, helping to determine the magnitude and direction of each force based on their contributions.

If the force exerted by one person increases, how does that affect the net force on the box?

An increase in one person's force, assuming constant the other's force, will increase the net force in the same direction, potentially making the box accelerate more to that side.

Additional Resources

Solve: Two Persons Are Pushing A Box So That The Net Force On The Box Is 12 N To The Cast. If One Of

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Investigative Analysis of Force Dynamics in Collaborative Pushing: A Case Study

In the realm of classical mechanics, understanding how multiple forces interact to produce a resultant or net force on an object is fundamental. The problem statement, “Solve: Two persons are pushing a box so that the net force on the box is 12 N to the cast. If one of,” presents a scenario that, at first glance, seems straightforward but offers deeper insights into force composition, vector addition, and equilibrium principles when multiple agents exert forces on a single object. This article aims to dissect this problem comprehensively, exploring the underlying physics principles, assumptions, and potential solutions, with a focus on real-world applications and pedagogical clarity.

Context and Significance of the Problem

The scenario of multiple individuals exerting force on a common object is ubiquitous in everyday life—from moving furniture to teamwork in industrial settings. Understanding the forces involved enables engineers and physicists to predict object behavior, optimize effort, and ensure safety. The problem’s structure, involving two persons pushing a box with a specified net force, serves as an ideal case for illustrating vector addition, force resolution, and the importance of directionality in force analysis.

Clarifying the Initial Problem Statement

The original prompt appears incomplete or contains typographical ambiguities, notably the phrase “net force on the box is 12 N to the cast,” which likely intends to say “to the East,” “to the east,” or similar. For clarity, we interpret the problem as:

> Two persons are pushing a box. The resultant (net) force on the box is 12 N towards the east. Given this, if one person exerts a force of a certain magnitude at a certain angle, what is the force exerted by the other person, and how do their vectors combine to produce the net force?

This interpretation aligns with standard physics problems involving multiple forces and vector addition.

Theoretical Foundations

Newton’s Second Law and Force Vectors

At its core, the problem hinges on Newton’s second law:

$$ \mathbf{F}_{net} = m \mathbf{a} $$

However, in a static or steady motion context where acceleration is negligible or constant, the net force determines the overall effect on the object’s motion.

Vector Addition and Force Resolution

When multiple forces act on an object, their vector sum determines the net force:

$$ \mathbf{F}_{net} = \mathbf{F}_1 + \mathbf{F}_2 $$

Each force can be broken down into components along perpendicular axes (e.g., x and y), and the resultant is obtained through vector addition:

$$
F_{net} = \sqrt{(F_{1x} + F_{2x})^2 + (F_{1y} + F_{2y})^2}
$$

Understanding the angles at which each person applies force is crucial to solving the problem.

Assumptions and Constraints for a Complete Solution

To develop a thorough solution, certain assumptions are necessary:

- The surface is frictionless or frictional effects are negligible unless specified.
- The persons exert forces with known magnitudes or directions, or both.
- The forces are constant during the interaction.
- The forces are coplanar and can be represented in a 2D coordinate system.

- The net force's magnitude is 12 N, directed east (or specified direction).

Without explicit angles or force magnitudes, the problem becomes an exploration of possible force configurations that satisfy the net force condition.

Analytical Approach to the Force Composition

Case 1: Both persons push along the same line (collinear forces)

Suppose:

- Person A exerts a force F_A directed east.
- Person B exerts a force F_B, also directed east.

Then, the net force:

$$
F_{net} = F_A + F_B = 12\, \text{N}
$$

If the force exerted by Person A is known, the force by Person B is simply:

$$
F_B = 12\, \text{N} - F_A
$$

This straightforward case illustrates the simplest scenario where forces are aligned.

Case 2: Forces at angles to each other

Realistically, persons may push at angles to each other, leading to vector addition involving components:

$$
\mathbf{F}_A = F_A (\cos \theta_A, \sin \theta_A)
$$
$$
\mathbf{F}_B = F_B (\cos \theta_B, \sin \theta_B)
$$

The resultant:

$$
\mathbf{F}_{net} = (F_A \cos \theta_A + F_B \cos \theta_B, F_A \sin \theta_A + F_B \sin \theta_B)
$$

Given the magnitude and direction of $\mathbf{F}_{net}$:

$$
\

$$
|\mathbf{F}_{net}| = 12\, \text{N}
$$
$$
\text{Direction} = \text{East}
$$

which implies:

$$
F_{net,x} = 12\, \text{N}
$$
$$
F_{net,y} = 0
$$

Using these, we derive the necessary relationships:

$$
F_A \cos \theta_A + F_B \cos \theta_B = 12
$$
$$
F_A \sin \theta_A + F_B \sin \theta_B = 0
$$

By choosing specific angles or force magnitudes, one can solve for the other variables.

Practical Examples and Numerical Solutions

Example 1: Both push at 45° angles to the east

Suppose:

- Person A pushes at 45° north of east.
- Person B pushes at 45° south of east.
- Both exert equal forces F.

The components:

$$
F_A = F_B = F
$$

$$
F_{A,x} = F \cos 45^\circ = \frac{F}{\sqrt{2}}
$$
$$
F_{A,y} = F \sin 45^\circ = \frac{F}{\sqrt{2}}
$$
$$

$$
F_{B,x} = \frac{F}{\sqrt{2}}
$$
$$
F_{B,y} = -\frac{F}{\sqrt{2}}
$$

Sum of x-components:

$$
F_{net,x} = \frac{F}{\sqrt{2}} + \frac{F}{\sqrt{2}} = \sqrt{2} F
$$

Sum of y-components:

$$
F_{net,y} = \frac{F}{\sqrt{2}} - \frac{F}{\sqrt{2}} = 0
$$

Thus, the net force magnitude:

$$
F_{net} = \sqrt{(F_{net,x})^2 + (F_{net,y})^2} = \sqrt{(\sqrt{2} F)^2 + 0} = 2 F
$$

To achieve $F_{net} = 12\, \text{N}$:

$$
2 F = 12 \Rightarrow F = 6\, \text{N}
$$

Therefore, each person exerts 6 N at 45° angles to produce a net force of 12 N eastward.

Example 2: One person pushes straight east, the other at an angle

Suppose:

- Person A pushes directly east with force F_A.
- Person B pushes at an angle θ_B north of east with force F_B.

Given the net force is 12 N eastward, and assuming F_A is known or varies, the equations become:

$$
F_A + F_B \cos \theta_B = 12
$$
$$
F_B \sin \theta_B = 0
$$

Since the net y-component must be zero, $F_B \sin \theta_B = 0$ implies:

- Either $F_B = 0$ (not interesting), or
- $\sin \theta_B = 0 \Rightarrow \theta_B = 0^\circ$ or 180°

But $\theta_B = 0^\circ$ (push directly east), then:

$$
F_A + F_B = 12
$$

If $F_A = 8\, \text{N}$, then $F_B = 4\, \text{N}$.

Alternatively, if $\theta_B = 180^\circ$ (push west), then:

$$
F_A - F_B = 12
$$

which would imply the second person pushes westward, opposing the net force eastward.

Real-World Implications and Pedagogical Insights

The above analysis demonstrates that in collaborative force scenarios:

- The direction of exerted forces critically affects the net force.
- Equal magnitudes do not necessarily produce equal effects unless directions are aligned.
- The vector addition principle enables precise calculations of force combinations needed to achieve desired movement or net force.

In practical terms, such analysis informs ergonomic strategies in manual labor, robot design for collaborative tasks, and safety protocols.

Advanced Considerations

Friction and External Forces

In real-world applications, frictional forces often oppose pushing efforts. To incorporate this:

$$
\mathbf{F}_{net} = \mathbf{F}_A + \mathbf{F}_B -
$$

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