A Force Of 42 N Is Needed To Start A Box Sliding Across The Floor. The Weight Of The Box Is 55 N. Draw

A Force Of 42 N Is Needed To Start A Box Sliding Across The Floor. The Weight Of The Box Is 55 N. Draw

---

Introduction

Understanding the forces involved in moving objects is fundamental in physics, especially in the study of friction and motion. In everyday life, we often encounter situations where a certain amount of force is required to initiate movement, overcome static friction, and maintain motion. Consider a scenario where a box weighing 55 N requires a force of 42 N to start sliding across the floor. This scenario encapsulates key concepts such as static friction, normal force, and the relationship between weight and frictional force.

In this article, we will delve into the physics behind this situation, explore the concepts of static and kinetic friction, analyze the forces at play, and provide a detailed drawing illustrating these forces. Whether you're a student preparing for exams or a curious learner interested in basic mechanics, this comprehensive guide will enhance your understanding of frictional forces and how they influence motion.

Understanding the Basic Concepts

What Is Force?

Force is any interaction that, when unopposed, will change the motion of an object. It can cause an object to accelerate, decelerate, or change direction. Force is a vector quantity, meaning it has both magnitude and direction.

Weight of the Object

The weight of an object is the force due to gravity acting on it. It is calculated as:

$$\text{Weight} (W) = m \times g$$

where:
- m is the mass of the object,
- g is the acceleration due to gravity (~9.81 m/s²).

In our scenario:
- The weight $W = 55\, \text{N}$.

Normal Force

The normal force (N) is the perpendicular force exerted by a surface supporting an object. On a flat horizontal surface without other vertical forces, the normal force equals the weight of the object:

$$N = W$$

Frictional Forces

Friction opposes the relative motion of surfaces in contact. There are two main types:

- Static Friction (f_s): Acts when the object is at rest. It resists the initiation of motion.

- Kinetic Friction (f_k): Acts when the object is sliding.

The maximum static friction force ($f_{s_{max}}$) is given by:

$$f_{s_{max}} = \mu_s \times N$$

where:

- μ_s is the coefficient of static friction.

Similarly, kinetic friction is:

$$f_k = \mu_k \times N$$

where:

- μ_k is the coefficient of kinetic friction.

In most cases, $\mu_s > \mu_k$.

Analyzing the Scenario

Given Data

- Weight of the box, $W = 55\, \text{N}$
- Force required to start the box sliding, $F_{applied} = 42\, \text{N}$

Objective

- Determine the coefficient of static friction (μ_s)
- Draw a free-body diagram illustrating the forces acting on the box

- Understand the relationship between the applied force and friction

---

Calculating the Coefficient of Static Friction

Since the applied force of 42 N is just enough to overcome static friction and initiate movement, it equals the maximum static friction force:

$$ F_{applied} = f_{s_{max}} = \mu_s \times N $$

Given that the normal force N on a horizontal surface is equal to the weight W:

$$ N = 55\, \text{N} $$

Thus,

$$ \mu_s = \frac{F_{applied}}{N} = \frac{42\, \text{N}}{55\, \text{N}} \approx 0.7636 $$

Result:

$$
\boxed{
\mu_s \approx 0.76
}
$$

This coefficient indicates the surface's static friction characteristics with the box.

Drawing the Free-Body Diagram

A clear free-body diagram (FBD) helps visualize all forces acting on the box. Below is a step-by-step description to draw the FBD:

Step 1: Draw the Box

- Sketch a simple rectangle representing the box.

Step 2: Draw the Force Vectors

- Weight (W): Draw a downward arrow from the center of the box, labeled $W = 55\, \text{N}$.
- Normal Force (N): Draw an upward arrow from the bottom of the box, labeled N. It should be equal in magnitude to W if the surface is flat.
- Applied Force ($F_{applied}$): Draw an arrow pointing horizontally to the right, labeled $42\, \text{N}$.

Step 3: Frictional Force (f_s)

- Draw an arrow opposing the direction of the applied force, pointing to the left, labeled f_s. This represents static friction resisting movement.

Complete Free-Body Diagram Illustration

```plaintext
▯ N = 55 N
|
| (Normal Force)
|
```

```
+---------+
| |
| Box |
| |
+---------+
|
□ W = 55 N (Weight)

Applied Force (to the right): □ 42 N (Force needed to start sliding)

Frictional Force (to the left): □ f_s (Static friction, up to 42 N)
```

Note: When the applied force reaches 42 N, it equals the maximum static friction, and the box begins to slide.

Understanding Static and Kinetic Friction in Real-Life Applications

The concepts discussed are applicable beyond theoretical physics. For example:

- In Engineering: Calculating the force needed to move machinery or objects.
- In Transportation: Understanding tire-road friction for safety.
- In Daily Life: Moving furniture or loading items.

Understanding the coefficients of static and kinetic friction helps in designing surfaces and choosing appropriate forces for movement.

Additional Considerations

Factors Affecting Friction

- Surface Texture: Rougher surfaces increase friction.
- Material Types: Different materials have different coefficients.
- Normal Force: Increasing weight increases normal force, thus increasing maximum static friction.
- Lubrication: Applying lubricants reduces friction.

Transition from Static to Kinetic Friction

Once the box begins sliding, static friction is replaced by kinetic friction, which is usually lower. This means less force is needed to keep the box moving than to start it moving.

Practical Example: Calculating Kinetic Friction

Suppose the coefficient of kinetic friction (μ_k) for the surface is 0.5. The force required to keep the box sliding at constant velocity would be:

$$F_{kinetic} = \mu_k \times N = 0.5 \times 55\, \text{N} = 27.5\, \text{N}$$

This is less than the static friction force, illustrating why more force is needed to start moving an object than to keep it moving.

Summary

- The static friction force resisting the start of motion is directly proportional to the normal force via the coefficient of static friction.

- The maximum static friction force in this scenario is approximately 42 N, corresponding to a coefficient of static friction of about 0.76.
- Drawing a free-body diagram helps visualize the balance of forces and understand the mechanics involved.
- Recognizing the difference between static and kinetic friction is crucial in applications involving movement and force calculations.

Conclusion

Understanding the forces involved when sliding an object across a surface is essential in physics and engineering. In the given scenario, a force of 42 N is required to overcome static friction and initiate movement of a 55 N weight box. The calculated coefficient of static friction (~0.76) provides insight into the surface's properties and the effort needed to move objects.

Drawing a detailed free-body diagram helps clarify how forces such as weight, normal force, applied force, and static friction interact. This foundational knowledge is applicable in various fields, including mechanical engineering, transportation, and everyday problem-solving.

By mastering these concepts, you enhance your ability to analyze and solve real-world problems involving motion and friction, making physics both practical and engaging.

Frequently Asked Questions

What does the 42 N force represent in the context of moving the box?

The 42 N force represents the force required to overcome static friction and initiate the movement of the box across the floor.

How is the coefficient of static friction between the box and the floor calculated from the given data?

The coefficient of static friction (μ) is calculated using the formula $\mu = F_s / W$, where F_s is the force needed to start motion (42 N) and W is the weight of the box (55 N). So, $\mu = 42\ N / 55\ N \approx 0.76$.

What is the significance of the weight of the box being 55 N in this problem?

The weight of the box (55 N) is used to determine the normal force exerted by the floor on the box, which is essential for calculating static friction.

If a force greater than 42 N is applied, what will happen to the box?

If a force greater than 42 N is applied, the static friction will be overcome, and the box will start sliding across the floor.

Why should a drawing or diagram be prepared for this problem?

A diagram helps visualize the forces acting on the box, such as applied force, static friction, and weight, making it easier to understand and solve the problem accurately.

Additional Resources

A Force Of 42 N Is Needed To Start A Box Sliding Across The Floor. The Weight Of The Box Is 55 N.

Draw.

Investigating the Frictional Dynamics of a Box on a Flat Surface

The seemingly simple act of sliding a box across the floor involves complex interactions of forces, particularly friction. The statement "A force of 42 N is needed to start a box sliding across the floor. The weight of the box is 55 N" provides a compelling starting point for an in-depth examination of static and kinetic friction, their coefficients, and the underlying physics principles. In this article, we delve into the mechanics, analyze the implications, and provide a comprehensive understanding suitable for educators, students, and physics enthusiasts.

Understanding the Fundamental Concepts

The Role of Friction in Motion Initiation

Friction is a resistive force that acts opposite to the relative motion or impending motion between two surfaces in contact. It is generally categorized into two types:

- Static Friction (Fs): Acts when the object is at rest relative to the surface.
- Kinetic Friction (Fk): Acts once the object is in motion.

The transition from static to kinetic friction marks the point where an applied force overcomes the maximum static friction, initiating movement.

The Relationship Between Force, Weight, and Friction

Given:

- The force needed to start sliding, $F_{start} = 42\, \mathrm{N}$
- The weight of the box, $W = 55\, \mathrm{N}$

This information suggests that static friction is at play initially, resisting motion until the applied force exceeds a certain threshold.

Analyzing the Given Data

Inferring the Coefficient of Static Friction

The maximum static friction force ($F_{s,\text{max}}$) can be expressed as:

$$
F_{s,\text{max}} = \mu_s \times N
$$

where:
- μ_s = coefficient of static friction
- N = normal force, which, for a horizontal surface, equals the weight W

Given that the applied force to initiate motion is $42\, \mathrm{N}$, and this force equals the maximum static friction:

$$
\mu_s = \frac{F_{s,\text{max}}}{N}
$$

Substituting known values:

$$
\mu_s = \frac{42\, \mathrm{N}}{55\, \mathrm{N}} \approx 0.7636
$$

Thus, the coefficient of static friction between the box and the floor is approximately 0.76.

Implication of the Coefficient

A coefficient of static friction of 0.76 indicates a relatively high resistance to initial movement, typical for rough or textured surfaces. This value is consistent with common materials like rubber on concrete or similar combinations.

Drawing the Frictional Forces

Constructing a Force Diagram

A typical free-body diagram of the box includes:

- Weight (W) acting downward.
- Normal force (N) acting upward, balanced to the weight.
- Applied force (F) acting horizontally.
- Frictional force (F_f) opposing the motion, with static or kinetic friction depending on the state.

Step-by-step Drawing Instructions

1. Draw a rectangle representing the box.
2. Draw an arrow downward labeled $W = 55\, \mathrm{N}$.
3. Draw an upward arrow labeled N. Since surface is horizontal, $N = W = 55\, \mathrm{N}$.
4. Draw a rightward arrow representing the applied force $F = 42\, \mathrm{N}$.

5. Draw an arrow opposite to the applied force labeled F_{f}, representing static friction. When at threshold, $F_{f} = F_{s,\text{max}} = 42\, \mathrm{N}$.

Interpreting the Force Thresholds

Static vs. Kinetic Friction in Practice

- Before motion: Static friction opposes the applied force, reaching a maximum of 42 N.
- At the threshold: The applied force equals maximum static friction, initiating movement.
- After motion starts: Kinetic friction takes over, which is usually less than static friction, allowing the box to slide with less force.

Estimating Kinetic Friction Coefficient

If the problem provides data on the force needed to keep the box sliding at constant velocity, similar calculations can determine kinetic friction coefficient μ_k. Absent that data, typical ratios suggest:

$$
\mu_k \approx 0.6 \times \mu_s \approx 0.46
$$

but this is speculative without explicit data.

Practical Implications and Applications

Real-World Context

Understanding the force required to initiate movement has broad applications:

- Material Selection: Choosing surfaces with desired frictional properties.
- Design of Mechanical Systems: Ensuring motors or actuators produce sufficient force.
- Ergonomic Considerations: Evaluating human effort needed to move objects.

Engineering and Safety Considerations

- Accurate measurements of static friction are critical in designing slip-resistant floors.
- In logistics, knowing how much force is necessary to move packages informs handling protocols.

Visual Representation: Drawing the Force Diagram

(Here, describe how to create a clear, scaled drawing)

1. Draw the box: a rectangle labeled "Box."
2. Add forces:
- Downward arrow labeled $W = 55\, \mathrm{N}$.
- Upward arrow labeled N, equal in length to W.
- Rightward arrow labeled $F = 42\, \mathrm{N}$.
- Leftward arrow labeled $F_f = 42\, \mathrm{N}$ (at threshold).
3. Indicate the point of impending motion: The applied force just surpasses static friction, initiating movement.

Further Considerations and Experimental Validation

Testing the Model

To validate the inferred coefficients:

- Conduct experiments measuring the actual force to start sliding and to maintain motion.
- Use different surface materials to observe variations.

Limitations and Assumptions

- Assumes a perfectly horizontal surface.
- Neglects effects like surface irregularities, air resistance, or internal deformation.
- Considers static friction at maximum threshold; real systems may have variations.

Conclusion

The scenario where a force of 42 N is needed to start a box sliding across the floor with a weight of 55 N encapsulates fundamental principles of friction. By analyzing the data, we deduce a static friction coefficient of approximately 0.76, reflective of a relatively rough surface interaction. Drawing the force diagram helps visualize the forces involved and aids in understanding the transition from static to kinetic friction.

This investigation underscores the importance of precise force measurements in physics and engineering, highlights the practical relevance of frictional concepts, and demonstrates the value of detailed analysis in interpreting seemingly simple physical phenomena.

Key Takeaways:

- Static friction can be characterized by a coefficient derived from the maximum force required to initiate movement.
- The normal force equals the weight in horizontal scenarios.
- Force diagrams are essential tools for visualizing and solving real-world physics problems.

- Understanding frictional forces informs safer, more efficient design and handling practices.

This comprehensive review aims to deepen understanding of the mechanics behind the initial movement of objects and provide a solid foundation for further exploration into frictional phenomena.

A Force Of 42 N Is Needed To Start A Box Sliding Across The Floor The Weight Of The Box Is 55 N Draw

A Force Of 42 N Is Needed To Start A Box Sliding Across The Floor The Weight Of The Box Is 55 N Draw

Related Articles

- A Hiker Leaves Camp And Walks 5 Km On Abearing Of 058. He Stops For A Break, Thencontinues Walking For
- A Spinner Has 8 Sections: 2 Purple, 2 Yellow, 3 Blue,and 1 Red.What Is The Probability Of Spinning And
- A Wheatstone Bridge With R1=200,R2=400,R3=500 And R4=600. E1=5V Find A) E0 B) E0 For R1=250. State The

Back to Home