LESSON MAKER PRO

Forces in Motion

Calculate friction, net force, acceleration, and tension.

HIGH SCHOOL · PHY.2.6

PHY.2.6 "Use mathematical and computational analysis to explore forces (e.g., friction, force applied, normal, and tension)."

NAME _____ **DATE** _____

TRACK EACH FORCE

For a sliding object, friction has magnitude $f = \mu N$ and points against its motion. Add forces by direction to find the net force, then use $F_{net} = ma$. On a level surface with no other vertical forces, $N = mg$; for a hanging object, compare tension with its weight, mg.

WORKED EXAMPLE

A 5 kg crate slides across a level floor. Its normal force is 50 N, the coefficient of friction is 0.3, and a 35 N force pulls it forward. Find its acceleration.

1. Find friction: $f = \mu N = 0.3 \times 50 = 15$ N.
2. Find net force: $F_{net} = 35 - 15 = 20$ N forward.
3. Find acceleration: $a = F_{net}/m = 20/5 = 4$ m/s^2 forward.

Answer: 4 m/s^2 forward

PRACTICE 6 problems

1 A box slides across a floor with a normal force of 60 N. The coefficient of friction is 0.2. What is the friction force?

ANSWER _____

2 A 28 N force pulls a sled to the right while friction acts with 9 N to the left. What is the net force?

ANSWER _____

3 A 6 kg cart has a net force of 18 N to the left. What is its acceleration?

ANSWER _____

4 A 7 kg crate rests on a level floor. No other vertical forces act on it. Use $g = 10$ m/s^2. What is the normal force?

ANSWER _____

5 A box slides forward with a normal force of 90 N. The coefficient of friction is 0.1, and a 31 N force pulls it forward. Find the friction force and the net force.

ANSWER _____

6 A motor holds an 11 kg lighting fixture motionless by a vertical cable. Use $g = 10$ m/s^2. What is the tension in the cable?

ANSWER _____

APPLY IT Show your work

1 You pull a 10 kg equipment case across a level gym floor with a horizontal force of 34 N. The coefficient of friction is 0.1. No other vertical forces act on the case. Use g = 10 m/s^2. What is the case's acceleration?

WORK SPACE

ANSWER _____

2 At a concert, a motor lifts a 12 kg speaker straight up. The speaker accelerates upward at 2 m/s^2. Use g = 10 m/s^2. What is the tension in the lifting cable?

WORK SPACE

ANSWER _____

CHALLENGE One step up

Two boxes are tied together and slide across a level floor. The rear box has a mass of 3 kg, and the front box has a mass of 7 kg. A 70 N horizontal force pulls the front box forward. Both boxes have a coefficient of friction of 0.1 with the floor. Use g = 10 m/s^2. Find the acceleration of the boxes and the tension in the rope between them.

WORK SPACE AND ANSWER

Forces in Motion

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A box slides across a floor with a normal force of 60 N. The coefficient of friction is 0.2. What is the friction force?	**12 N**
2	A 28 N force pulls a sled to the right while friction acts with 9 N to the left. What is the net force?	**19 N to the right**
3	A 6 kg cart has a net force of 18 N to the left. What is its acceleration?	**3 m/s^2 to the left**
4	A 7 kg crate rests on a level floor. No other vertical forces act on it. Use g = 10 m/s^2. What is the normal force?	**70 N upward**
5	A box slides forward with a normal force of 90 N. The coefficient of friction is 0.1, and a 31 N force pulls it forward. Find the friction force and the net force.	**Friction: 9 N backward; net force: 22 N forward**
6	A motor holds an 11 kg lighting fixture motionless by a vertical cable. Use g = 10 m/s^2. What is the tension in the cable?	**110 N**

PART 2 · APPLY IT

1. **2.4 m/s^2 forward** N = 10 × 10 = 100 N, so friction is 0.1 × 100 = 10 N. The net force is 34 - 10 = 24 N, and a = 24/10 = 2.4 m/s^2.
2. **144 N** The speaker's weight is 12 × 10 = 120 N. Since T - 120 = 12 × 2, the tension is 144 N.

CHALLENGE

Acceleration: 6 m/s^2 forward; tension: 21 N

For the challenge, total friction is 10 N, so the net force on both boxes is 60 N. On the rear box, tension must overcome 3 N of friction and provide 18 N of net force.