LESSON MAKER PRO

Forces in Motion

Write a net-force equation for each situation. Solve with units and direction.

HIGH SCHOOL · PHY.2.5

PHY.2.5 "Use mathematical and computational analysis to derive simple equations of motion for various systems using Newton's second law (e.g., net force equations)."

NAME _____ DATE _____

THE BIG IDEA

Newton's second law is $F_{net} = ma$. Choose a positive direction, then subtract forces that act in the opposite direction. Use the net force to find acceleration, or rearrange the equation to find an unknown force.

WORKED EXAMPLE

A 9 kg cart has a 54 N force acting east and an 18 N force acting west. Find its acceleration.

1. Choose east as positive.
2. $F_{net} = 54\ N - 18\ N = 36\ N$ east.
3. $F_{net} = ma$, so $a = 36\ N / 9\ kg$.

Answer: 4 m/s² east

PRACTICE 6 problems

1 A 5 kg cart has a 25 N force acting to the right. Find its acceleration.

ANSWER _____

2 An 8 kg cart has a 40 N force acting right and a 16 N force acting left. Find its acceleration.

ANSWER _____

3 A 6 kg object accelerates at 2 m/s² north. Find the net force on it.

ANSWER _____

4 A 10 kg crate is pulled forward with 70 N while friction acts backward with 20 N. Find its acceleration.

ANSWER _____

5 A 12 kg cart accelerates at 2 m/s² right while drag acts with 6 N left. What applied force acts to the right?

ANSWER _____

6 A 15 kg cart has a 45 N force acting east and a 45 N force acting west. Find its acceleration.

ANSWER _____

APPLY IT Show your work

1 A skateboarder and board have a combined mass of 60 kg. A push applies 150 N forward while resistive forces total 30 N backward. What is their acceleration?

WORK SPACE

ANSWER _____

2 A cyclist and bike have a combined mass of 75 kg. The cyclist wants to accelerate at 2 m/s^2 forward while drag acts with 25 N backward. What forward drive force is needed?

WORK SPACE

ANSWER _____

CHALLENGE One step up

A 2 kg box pushes a 6 kg box as they move together to the right. A 32 N force pushes the 2 kg box right. Friction acts left with 2 N on the first box and 6 N on the second box. Write a net-force equation for both boxes as one system. Then find their acceleration and the contact force on the 6 kg box.

WORK SPACE AND ANSWER

Forces in Motion

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A 5 kg cart has a 25 N force acting to the right. Find its acceleration.	**5 m/s² right**
2	An 8 kg cart has a 40 N force acting right and a 16 N force acting left. Find its acceleration.	**3 m/s² right**
3	A 6 kg object accelerates at 2 m/s² north. Find the net force on it.	**12 N north**
4	A 10 kg crate is pulled forward with 70 N while friction acts backward with 20 N. Find its acceleration.	**5 m/s² forward**
5	A 12 kg cart accelerates at 2 m/s² right while drag acts with 6 N left. What applied force acts to the right?	**30 N right**
6	A 15 kg cart has a 45 N force acting east and a 45 N force acting west. Find its acceleration.	**0 m/s²**

PART 2 · APPLY IT

1. **2 m/s² forward** F_{net} = 150 N - 30 N = 120 N forward. Divide by 60 kg.
2. **175 N forward** The required net force is (75 kg)(2 m/s²) = 150 N forward. The drive force must also overcome 25 N of drag, so it is 175 N forward.

CHALLENGE

For the system, 32 N - 2 N - 6 N = (2 kg + 6 kg)a, so a = 3 m/s² right. For the 6 kg box, $F_{contact}$ - 6 N = (6 kg)(3 m/s²), so the contact force is 24 N right.

Accept equivalent net-force equations with either direction chosen as positive. For zero acceleration, no direction is needed.