Virtual Learning

Physics

Newton's Second Law of Motion

April 14, 2020

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Newton's Second Law of Motion: April 14,2020

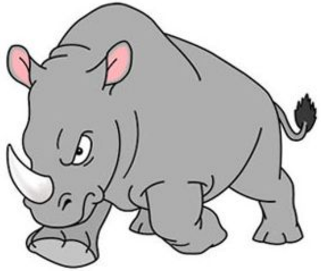
Objective/Learning Target:

Students will explore and explain Newton's Second Law of motion, and solve problems utilizing the law.

Quick Review

1. Suppose you place a ball in the middle of a wagon that is at rest and then abruptly pull the wagon forward.
   a. Describe the motion of the ball relative to the ground.
   b. Describe the motion of the ball relative to the wagon.

2. If a Rhino were chasing you, its enormous mass would be very threatening. But if you zigzagged, the Rhino’s mass would be to your advantage. Explain using using Newton’s First Law of Motion



Quick Review Answers

1a. Relative to the ground the ball would remain in the same place. It would roll due to friction as the wagon passed beneath but would remain over the same place on the ground.

1b. Relative to the wagon the ball rolls to the back of the wagon.

2. The large mass means a large inertia. This makes it difficult for the rhino to change directions, an object in motion stays in motion. Same for rabbits being chased by mountain lions, running backs and large linemen, small guards and large centers in basketball. Lions chasing Gazelles. Lots of other real world examples.

Newton’s Second Law of Motion

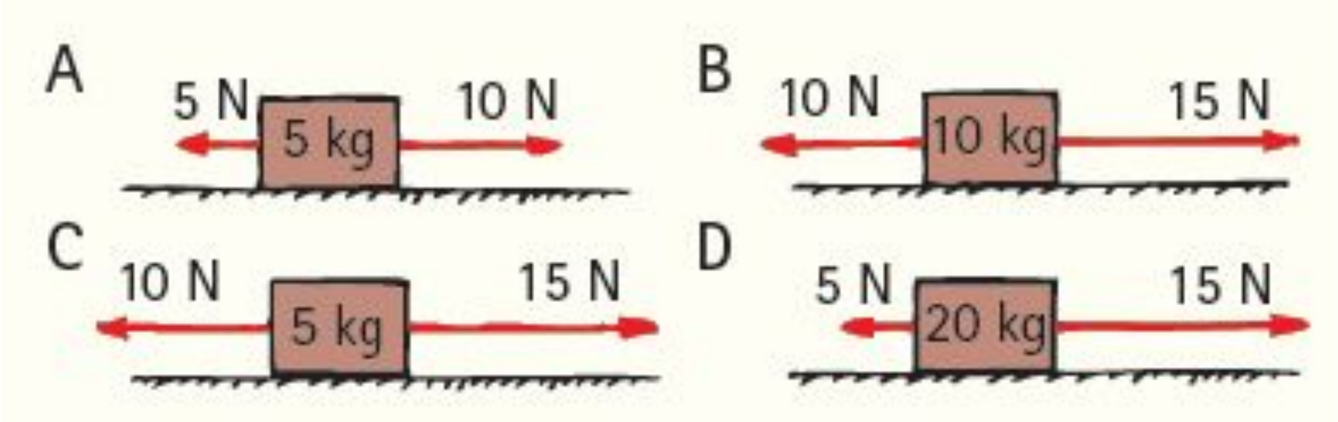
Link:[Newton's Second Law of Motion]

Directions:

- Read through Newton’s Second law of motion; and,
- Work through any examples on a separate piece of paper before you scroll down to the solution.
- On a separate piece of paper complete the practice problems on the following slides.
- Check your answers.
- For additional practice check out the conceptual questions and the problems and exercises in the table of contents for the online text linked above.

Practice Problem #1

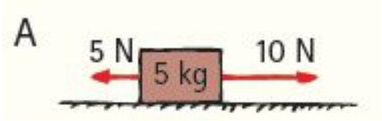
Boxes of various masses are on a frictionless level table.



Rank each of the following from greatest to least.

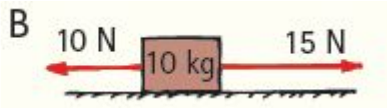
a. The net forces on the boxes.
b. The accelerations of the boxes.

Practice Problem #1 Answer



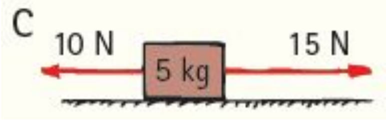
$F_{net} = 5N$

$a = 1\ m/s^2$



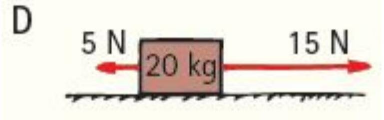
$F_{net} = 5N$

$a = 0.5\ m/s^2$



$F_{net} = 5N$

$a = 1\ m/s^2$



$F_{net} = 10N$

$a = 0.5\ m/s^2$

a. Net Forces from greatest to least: D, A=B=C

b. Accelerations from greatest to least: A=C, B=D

Practice Problem #2

Calculate the acceleration of a 2000 kg single-engine airplane as it begins its takeoff with an engine thrust of 500 N.

Practice Problem #2 Answer

Given:

Mass = 2000 kg

Force = 500 N

a =?

Formula

$$\text{Acceleration} = \frac{\text{Net Force}}{\text{Mass}}$$

so...

$$a = \frac{F_{net}}{M} = \frac{500\text{ N}}{2000\text{ kg}} = 0.25\text{ m/s}^2$$

Practice Problem #3

Sven’s van has a mass of 2300 kg. While traveling at 25 m/s, it brakes to a stop in 4 seconds.

What braking force was applied to stop the van?

Practice Problem #3 Answer

Given:
Mass = 2300 kg
Initial Velocity = 25 m/s
Final Velocity = 0 m/s
Time = 4 sec
a = ?
F_{net} = ?

Formulas:

$$a = \frac{F_{net}}{m} \qquad a = \frac{\Delta v}{\Delta t}$$

To Find Net Force you must know the acceleration and the mass. We are given only the mass, so we need to calculate the acceleration first. Then use that acceleration to solve for the net force using Newton's Second Law formula.

$$a = \frac{\Delta v}{\Delta t} \qquad \frac{(0\text{m/s} - 25\text{m/s})}{4\text{ sec}} = -6.25\text{m/s}^2$$

so… $F_{net} = ma = 2300\text{kg} * (-6.25\text{m/s}^2)$

$= -14{,}375\ \text{N}$

Additional Practice

For additional practice check out the conceptual questions and the problems and exercises in the table of contents from the online text linked above.